Oregon Manufacturing Innovation Center R&D
33701 Charles T Parker Way,
Scappoose OR 97056

Additive Manufacturing Innovation Center

PROJECT MANUAL
Volume 3 of 3

Sept. 27 2021

Project #1503

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Architect's Project Number: **1503**

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OMIC ADDITIVE MANUFACTURING CENTER

Scappoose, OR

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BASIC FIRE SUPPRESSION REQUIREMENTS

PART 1 GENERAL

1.1. DESCRIPTION OF WORK

A. This Section specifies the basic requirements for all Contractor installed equipment. It applies to all sections included in Division 21. The requirements herein are an expansion upon the requirements of Division 1.

B. Provide all materials, labor and equipment required to install complete and fully operational fire protection systems as indicated by the contract drawings, this specification, and requirements of authority (ies) having jurisdiction (AHJ).

C. Contractor shall provide complete engineering calculations and design of the fire protection system satisfying the direction and criteria of this specification and all other supporting documents and drawings.

D. Provide the design and all materials, labor and equipment required to install a complete and fully operational fire protection system as indicated by the contract drawings and this specification.

E. Contractor shall not compromise or diminish any existing building system, service or function in his execution of the work. Any such potential impacts shall be immediately brought to the attention of the Architect.

F. Obtain and pay for all permits, licenses, fees and taxes applicable to this project as required by law.

G. Cooperate with other trades in furnishing material and information required for installation and operation of mechanical items.

H. Requirements for the following are included:

1. Related work (other Contract Documents and specification sections) that must be combined with the requirements of this Section.
    a. Design performance.
    b. Delivery, storage, and handling.
    c. Quality assurance and standards.
    d. Submittals.
    e. Product quality, basic type, and finishes.
    f. Equipment identification.
    g. Excavation and backfill.
    h. Installation.
    i. Mounting and shimming.
    j. Inspection.
    k. Safety considerations.
    l. Cleaning, startup, and adjustments.

1.2. RELATED WORK

A. This general section shall be used in conjunction with the following other specifications and related Contract Documents to establish the total requirements for the project equipment and systems:

1. Division 1 sections included in this Project specifications.

2. The Contract.
3. General and specific specifications and drawings included in the project.

1.3. DEFINITIONS

A. Indicated": Refers to graphic representations, notes or schedules in the Drawings; or to other paragraphs or schedules in Specifications and similar requirements in the Contract Documents.
   1. Terms such as "shown", "noted", "scheduled", and "specified", are used to notify or help the user to locate reference. Location is not limited.

B. "Directed": Terms such as "directed", Requested", "authorized", "selected", "approved", "required", and "permitted" mean directed by Architect/Engineer, approved by Architect/Engineer and similar phrases.

C. "Approved": When used in conjunction with Architect/Engineer's action on contract submittals, applications, requests, is limited to Architect/Engineer's duties and responsibilities as stated in the Conditions of the Contract.

D. "Regulations": Includes laws, ordinances, statutes and lawful orders issued by authorities having jurisdiction, as well as rules, conventions and agreements within the construction industry that control performance of Work.

E. "Furnish": Means to supply and deliver to the Project site, ready for unloading, unpacking, assembly, installation and similar operations.

F. "Install": Describes operations at Project site including actual unloading, temporary storage, unpacking, assembling, erecting, placing, anchoring, supporting, isolating, applying, working to dimension, finishing, curing, protecting, cleaning and similar operations.

G. "Provide": Means to furnish and install.

H. "Installer": A contractor, or another entity engaged by the contractor, either as an employee, subcontractor, or contractor of a lower tier, to perform a particular construction activity including installation, erection, application or similar operations.
   1. Installers are required to be experienced in operations they are engaged to perform.
   2. The term "experience" means having successfully completed a minimum of three previous projects similar in scope and size to this Project and within the time frame indicated in the "Quality Assurance" section of the Specifications. In addition, in means being familiar with special requirements indicated and having complied with requirements of authorities having jurisdiction.

I. "Project Site": Is defined as the space available to the Contractor for performing construction activities, either exclusively or in conjunction with others performing other work as part of Project.

1.4. DESIGN PERFORMANCE

A. Compliance by the Contractor and/or Vendor with the provisions of this Specification does not relieve him of the responsibilities of furnishing equipment and materials of proper design, suited to meet operating guarantees at the specified service conditions.

1.5. SUBMITTALS

A. Product Data: Submit complete sets of manufacturer's product data in .PDF format for approval. All Submittals to be received in no more than (3) three packages. See Division 1 for further information regarding submittal requirements. Literature submitted shall clearly indicate the model number, capacity, rated operating conditions, size, weight, support requirements, electrical power requirements, utility (fuel, air, cooling water, etc.) requirements, and options furnished. Submittals shall include, but are not necessarily limited to the following;

1. Fire Protection: Piping materials, valves, fittings, supports, switches, alarms, sprinkler heads, compressors, and fire pumps and the like. Provide minimum 36 x 24 size system layout shop drawings. Provide hydraulic calculations.
2. Calculations: Provide for sizing of all utility services, including fire sprinkler main and all building piping; pumps head and flow sizing for all systems; thermal expansion and seismic restraints; and all other calculations and all other calculations consistent with good engineering practice. Include design criteria used and assumptions made.

B. Operation and Maintenance Data: Submit three complete sets of manufacturer's literature bound in a three ring binder for approval. Data shall include installation, start-up, and maintenance instructions, parts lists, and wiring diagrams. Include all material on a CD-ROM or USB device.

C. Substitutions: System design was based upon the equipment and materials listed on the drawings and specifications herein. At contractor's option, another manufacturer's equipment of similar quality, capacity and features may be submitted for prior approval per Section 01 30 00. Prior permission to substitute does not relieve the contractor of the responsibility of including this information in the bound submittal packages.

1.6. QUALITY ASSURANCE

A. Codes and Standards: Comply with the provisions of the following codes, standards and specifications, except where more stringent requirements are shown or specified:

1. State of Oregon "IBC".
2. State of Oregon "IMC".
3. State of Oregon "UPC".
4. State of Oregon "IFC".
5. NPC Codes and Standards including, but not limited to, NFPA 13 and NFPA 25.

B. Drawings: All drawings are diagrammatic and show general design, arrangement, and extent of the systems. Do not scale drawings for rough-in dimensions, nor use as shop drawings.

C. Installer Qualifications: Company specializing in performing the work required with a minimum of five years documented experience.

1.7. DELIVERY, STORAGE AND PROTECTION

A. Delivery: Deliver to site with manufacturer's labels intact and legible.

B. Preparation for shipment:
   1. Each unit shall be suitably prepared for the shipment specified and for storage in accordance with manufacturer's instructions in a manner requiring no disassembly prior to operation.
   2. The Contractor shall be solely responsible for the adequacy of the Preparation for Shipment provisions employed with respect to materials and application.
   3. One complete set of Installations, Operating and Maintenance Instructions shall be packed and shipped with the equipment. This set is in addition to the sets that are to be sent directly to the Owner.

C. Handling: Avoid damage. Comply with manufacturer's installation instruction requirements for rigging, unloading and transporting units.

D. Storage: Inside protected from weather, dirt and construction dust. Where necessary to store outside, elevate well above grade and enclose with durable, waterproof wrapping. Cap all pipe ends. Taping pipe ends is not adequate or allowable.

1.8. PROJECT CONDITIONS

A. General: Provide products which are compatible with other portions of the work and provide products with the proper power characteristics and similar adaptations for the project.

B. Arrangement: Arrange piping parallel with primary lines of the building construction and with a minimum 7 feet overhead clearance in unfinished equipment rooms where possible. Conceal all piping where possible unless indicated otherwise. Locate operating and control equipment properly to provide easy access for operation and maintenance. Give right-of-way to piping which must be sloped for drainage. Set all equipment level or as recommended by manufacturer.

C. Coordination: Where several elements of the work must be sequenced and positioned in order to fit the available space, prepare shop drawings showing the actual physical dimensions (at accurate scale) required for installation and submit prior to purchase/fabrication/installation of any of the elements involved in the coordination.

1.9. STANDARDS

A. General: Provide all new materials and equipment, identical to apparatus or equipment in successful operation for a minimum of five years. Provide materials of comparable quality omitted here but necessary to complete the work. Maximum allowable variation from stated capacities, minus 5% to plus 10% as approved in each case.

B. Governing Standards: The following are typical standards generally referenced in these specifications and identified by their acronym. Factory Mutual (FM), Federal Specifications (FS), American Society for Testing Materials (ASTM), American National Standards Institute (ANSI), Manufacturer's Standardization Society of the Valve and Fitting Industry, Standard Practice (MSS SP-69), Underwriters Laboratory (UL) numbers are given.

1.10. WARRANTIES

A. Contractor shall provide a 1 year warranty on all equipment, materials and workmanship for a period of one year from the date of owner's acceptance.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.1. LAYOUT AND COORDINATION

A. Site Examination: Before starting work, carefully examine site and all Contract Drawings. Become thoroughly familiar with conditions governing work on this project. Verify all indicated elevations, building measurements, rough-in dimensions and equipment locations before proceeding with any work.

B. Utility Locations: The location of all utilities, wires, conduits, pipes, ducts, or other service facilities are shown in a general way only on the drawings. Ascertain whether any additional facilities other than those shown on the plans may be present and determine the exact location and elevations of all utilities prior to commencing installation.

C. Discrepancies: Any error, conflict or discrepancy in Drawings, Specifications and/or existing conditions shall be reported immediately. Do not proceed with any questionable items of work until clarification of same has been made. Should rearrangement or re-routing of piping or ductwork be necessary, provide for approval the simplest layout possible for that particular portion of the work. Under no circumstances shall beams, girders, footings or columns be cut for mechanical items. Casting of pipes into concrete is prohibited unless so shown on Drawings.

D. The Contractor shall cooperate with others to avoid interferences and delays in the construction work.

E. Interference as a result of poor coordination or lack of cooperation with other trades shall be corrected at the Contractor's expense.

3.2. CUTTING AND PATCHING

A. General: Perform cutting and patching in accordance with Division 1.

B. Protection: During cutting and patching, protect adjacent installations. Provide temporary barriers to prevent the spread of dust and dirt outside of the immediate work area.

C. Repair: Patch finished surfaces and building components using new materials to match the existing.

D. Inspection: Upon written direction from the Architect, uncover and restore work to provide for observation of concealed work.

3.3. EXCAVATION AND BACKFILL

A. General: Perform all necessary excavation and backfill required for the installation of mechanical work. Any piping or other work damaged by the Contractor's operations shall be repaired at the Contractor's expense.

B. Water: Keep all excavations free of standing water. Excavations damaged or softened by water or frost shall be re-excavated and filled back to original level with approved material at the Contractor's expense.

C. Test: During the progress of the work for compacted fill, the Owner reserves the right to request compaction tests made under the direction of a testing laboratory.

D. Trench Excavation: Excavate trenches to the necessary depth and width, removing rocks, unstable soil (silt, peat, etc.) roots and stumps. Width of trench shall be adequate for proper installation of piping or conduit.

E. Foundation and Bedding:
   1. Proper preparation of foundation, placement of foundation material where required, and placement of bedding material shall precede the installation of the pipe. This shall include leveling of the trench bottom as well as placement and compaction of required bedding material to a uniform grade so that piping rests upon a continuous and uniform bedding.
   2. Where excavation has been made below the required grade, the Contractor shall provide, place and compact suitable bedding material to restore the proper grade elevation.

F. Provide tracer wire over top of piping.
   1. Construction:
      a. Conductor: Solid or stranded copper per spec ASTM B-3.
      b. Insulation: High Molecular Weight Polyethylene (HMWPE) ASTM D-1248. Various insulation colors dependant on usage.
      c. Temperature: 70 degrees C dry and wet.
      d. Voltage: 20 and 30 Mil = 30 to 300 volts. 45 Mil = 600 volts.

G. Backfilling: Upon acceptance of installed piping systems, trenches shall be backfilled in lifts. Backfill material shall be placed and compacted in lifts not to exceed 6 inches in depth to a height of 1 inch above the top of trench. Backfill shall be placed to obtain contact with the entire periphery of the pipe without disturbing pipe placement.

H. Compaction: One of the following methods or combination thereof shall be required; 1) Mechanical Tamper or Vibratory Compactor. Compaction shall be sufficient to attain 95% of maximum density at optimum moisture content. Water "puddling" or "washing" is prohibited.

I. Bedding/Backfill Material: Where native material has been removed, necessary foundation material consisting of 3/4 inch minus crushed rock or fill sand shall be placed and compacted to form a firm base of the required thickness. Backfill material shall be the same. Follow the pipe manufacturer's installation instructions when specified materials are specifically prohibited.

3.4. MECHANICAL EQUIPMENT WIRING

A. Provide all motor starters, control devices, and wiring complete from power source indicated on Drawings.

B. Equipment and systems shown on the Drawings and/or specifications, are based upon requirements of specific manufacturers which are intended as somewhat typical of several makes which may be approved. Provide all field wiring and/or devices necessary for a complete and operable system controls for the actual selected equipment/system.

3.5. INSTALLATION

A. Locating and Positioning Equipment: Observe all Codes and Regulations and good common practice in locating and installing equipment and material so that completed installation presents the least possible hazard. Maintain recommended clearances for repair and service to all equipment.

B. Anchorage: Anchor and/or brace all mechanical equipment, piping and ductwork to resist displacement due to seismic action, include snubbers on equipment mounted on spring isolators.

C. Where mounting heights or locations are not identified, install systems, equipment and materials to provide maximum headroom.

D. Provide clearance for installation of insulation and access to valves, fittings, etc., on pipe systems.

E. Install systems, materials and equipment giving right of way to systems required to be installed at a specific slope or operation by gravity.

F. Installation shall be in accordance with the requirements of the equipment manufacturer, including special requirements for seismic restraints.

3.6. MOUNTING AND SHIMMING

A. Mount and install equipment per manufacturer's recommendations.

B. Level the equipment by means of 304 stainless steel wedges (stainless steel plates and stainless steel shims). Wedge taper shall not be greater than 1/4 inch per foot. Use double wedges to provide a level bearing surface for the equipment. Secure each pair of wedges in their final positions with one tack weld on each side after leveling is complete. Wedging shall be executed in a manner that will prevent a change in level or springing of the Baseplate when the anchor bolts are tightened.

3.7. INSPECTION

A. The Contractor shall inspect his work to ensure the installation and workmanship is in accordance with these specifications and acceptable industry standards.

B. All materials, equipment, and workmanship shall be subject to inspection at any time by the Owner. Contractor shall correct any work, materials, or equipment not in accordance with the Contract Documents.

3.8. SAFETY CONSIDERATIONS

A. All equipment shall be installed with suitable access clearances that satisfy OSHA and code requirements for maintenance or removal of replaceable parts and components, and with necessary unions or flanges to perform the maintenance or removal without removing the connecting appurtenances.

3.9. CLEANING, START-UP, AND ADJUSTING

A. The Contractors shall be responsible for proper operation of all systems, minor subsystems, and services provided under this section. He shall coordinate start-up procedures, calibration, and system checkout with all project managers. Any system operational problems shall be diagnosed; all correctional procedures shall be initiated as required to bring out the system into compliance with the design, and the problem then shall be rechecked to verify that the system operates normally.

B. Thoroughly clean all parts of the installation at the completion of the work. The Contractor shall clean up and remove from the premises all refuse material, crates, and rubbish arising from his work.

END OF SECTION

FIRE PROTECTION BASIC MATERIALS AND METHODS

PART 1 GENERAL

1.1. SECTION INCLUDES

A. Pipe, fittings, valves, and connections for sprinkler, standpipe and fire hose, and combination sprinkler and standpipe systems.

1.2. RELATED REQUIREMENTS

A. Section 21 13 00 - Fire Suppression Sprinklers: Sprinkler systems design.

1.3. REFERENCE STANDARDS

A. ASME B16.1 - Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250; The American Society of Mechanical Engineers; 2010.
B. ASME B16.5 - Pipe Flanges and Flanged Fittings; The American Society of Mechanical Engineers; 2009.
C. ASTM A47/A47M - Standard Specification for Ferritic Malleable Iron Castings; 2009.
D. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless; 2012.
E. ASTM A135/A135M - Standard Specification for Electric-Resistance Welded Steel Pipe; 2009.
F. ASTM A795/A795M - Standard Specification for Black and Hot-Dipped Zinc-Coated (Galvanized) Welded and Seamless Steel Pipe for Fire Protection Use; 2008.
G. AWWA C110/A21.10 - American National Standard for Ductile-Iron and Gray-Iron Fittings, 3 In. Through 48 In. (75 mm Through 1200 mm), for Water and Other Liquids; American Water Works Association; 2008.
H. AWWA C111/A21.11 - Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings; American Water Works Association; 2007 (ANSI/AWWA C111/A21.11).
I. AWWA C151/A21.51 - Ductile-Iron Pipe, Centrifugally Cast, for Water; American Water Works Association; 2009 (ANSI/AWWA C151/A21.51).
J. NFPA 13 - Standard for the Installation of Sprinkler Systems; National Fire Protection Association; 2010.
K. UL (FPED) - Fire Protection Equipment Directory; Underwriters Laboratories Inc.; Current Edition, Including All Revisions.
L. UL 262 - Gate Valves for Fire-Protection Service; Underwriters Laboratories Inc.; Current Edition, Including All Revisions.
M. UL 312 - Check Valves for Fire-Protection Service; Underwriters Laboratories Inc.; Current Edition, Including All Revisions.

1.4. SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Product Data: Provide manufacturers catalogue information. Indicate valve data and ratings.

C. Shop Drawings: Indicate pipe materials used, jointing methods, supports, floor and wall penetration seals. Indicate installation, layout, weights, mounting and support details, and piping connections. Shop drawings shall be minimum 36 x 24 size.
D. Project Record Documents: Record actual locations of components and tag numbering.
E. Operation and Maintenance Data: Include installation instructions and spare parts lists.

1.5. QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum five years documented experience.
B. Installer Qualifications: Company specializing in performing the work of this section with minimum five years documented experience.
C. Conform to UL, FM, and Warnock Hersey requirements.
D. Valves: Bear UL, FM, and Warnock Hersey label or marking. Provide manufacturer's name and pressure rating marked on valve body.
E. Products Requiring Electrical Connection: Listed and classified as suitable for the purpose specified and indicated.

1.6. DELIVERY, STORAGE, AND HANDLING

A. Deliver and store valves in shipping containers, with labeling in place.
B. Provide temporary protective coating on cast iron and steel valves.
C. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.

PART 2 PRODUCTS

2.1. FIRE PROTECTION SYSTEMS

A. Sprinkler Systems: Conform work to NFPA 13.
B. Welding Materials and Procedures: Conform to ASME Code.

2.2. BURIED PIPING

A. Cast Iron Pipe: AWWA C151/A21.51.
   1. Fittings: AWWA C110, standard thickness.
   2. Joints: AWWA C111, rubber gasket.
   3. Mechanical Couplings: Shaped composition sealing gasket, steel bolts, nuts, and washers.

2.3. ABOVE GROUND PIPING

A. Steel Pipe: ASTM A795 Schedule 10, ASTM A53 Schedule 40, ASTM A135/A135M Schedule 10, ASTM A135/A135M UL listed light wall type, or ASTM A795 Schedule 40, black or galvanized.
   1. Steel Fittings: ASME B16.9, wrought steel, buttwelded, ASME B16.5, buttweld ends, ASTM A 234/A 234M, wrought carbon steel or alloy steel, ASME B16.5,

steel flanges and fittings, or ASME B16.11, forged steel socket welded and threaded.

2. Cast Iron Fittings: ASME B16.1, flanges and flanged fittings.
3. Malleable Iron Fittings: ASME B16.3, threaded fittings and ASTM A 47/A 47M.
4. Mechanical Grooved Couplings: Malleable iron housing clamps to engage and lock, "C" shaped elastomeric sealing gasket, steel bolts, nuts, and washers; galvanized for galvanized pipe.
5. Mechanical Formed Fittings: Carbon steel housing with integral pipe stop and O-ring pocked and O-ring, uniformly compressed into permanent mechanical engagement onto pipe.

2.4. FLEXIBLE SPRINKLER HOSE FITTINGS

A. FlexHead Industries flexible sprinkler connections.

2.5. PIPE HANGERS AND SUPPORTS

A. Hangers for Pipe Sizes 1/2 to 1-1/2 inch: Malleable iron or carbon steel, adjustable swivel, split ring.
B. Hangers for Pipe Sizes 2 inches and Over: Carbon steel, adjustable, clevis.
C. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
D. Vertical Support: Steel riser clamp or angle ring.
E. Floor Support: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.

2.6. GATE VALVES

A. Up to and including 2 inches:
   1. Bronze body, bronze trim, rising stem, handwheel, solid wedge or disc, threaded ends.
B. Over 2 inches:
   1. Iron body, bronze trim, rising stem pre-grooved for mounting tamper switch, handwheel, OS&Y, solid rubber covered bronze or cast iron wedge, flanged ends.
C. Over 4 inches:
   1. Iron body, bronze trim, non-rising stem with bolted bonnet, solid bronze wedge, flanged ends, iron body indicator post assembly.

2.7. ANGLE VALVES

A. Up to and including 2 inches:
   1. Bronze body, bronze trim, rising stem and handwheel, inside screw, renewable rubber disc, threaded ends, with backseating capacity repackable under pressure.
B. Over 2 inches:
   1. Iron body, bronze trim, rising stem, handwheel, OS&Y, plug-type disc, flanged ends, renewable seat and disc.

2.8. BALL VALVES

A. Up to and including 2 inches:
   1. Bronze two piece body, brass, chrome plated bronze, or stainless steel ball, teflon seats and stuffing box ring, lever handle and balancing stops, threaded ends with union.

2.9. CHECK VALVES

A. Up to and including 2 inches:
   1. Bronze body and swing disc, rubber seat, threaded ends.
B. Over 2 inches:
   1. Iron body, bronze trim, swing check with rubber disc, renewable disc and seat, flanged ends with automatic ball check.
C. 4 inches and Over:
   1. Iron body, bronze disc, stainless steel spring, resilient seal, threaded, wafer, or flanged ends.

2.10. DRAIN VALVES

A. Ball Valve:
   1. Brass with cap and chain, 3/4 inch hose thread.

PART 3 EXECUTION

3.1. PREPARATION

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

3.2. INSTALLATION

A. Install sprinkler system and service main piping, hangers, and supports in accordance with NFPA 13.
B. Route piping in orderly manner, plumb and parallel to building structure. Maintain gradient.
C. Install piping to conserve building space, to not interfere with use of space and other work.
D. Group piping whenever practical at common elevations.
E. Sleeve pipes passing through partitions, walls, and floors.
F. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.
G. Pipe Hangers and Supports:
   1. Install hangers to provide minimum 1/2 inch space between finished covering and adjacent work.

2. Place hangers within 12 inches of each horizontal elbow.
3. Use hangers with 1-1/2 inch minimum vertical adjustment. Design hangers for pipe movement without disengagement of supported pipe.
4. Support vertical piping at every other floor. Support riser piping independently of connected horizontal piping.
5. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.
6. Prime coat exposed steel hangers and supports. Refer to Section 09 90 00. Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.

H. Slope piping and arrange systems to drain at low points. Use eccentric reducers to maintain top of pipe level.

I. Prepare pipe, fittings, supports, and accessories for finish painting. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welding. Refer to Section 09 90 00.

J. Do not penetrate building structural members unless indicated.

K. Provide sleeves when penetrating footings, floors, and walls. Seal pipe and sleeve penetrations to achieve fire resistance equivalent to fire separation required.

L. When installing more than one piping system material, ensure system components are compatible and joined to ensure the integrity of the system. Provide necessary joining fittings. Ensure flanges, union, and couplings for servicing are consistently provided.

M. Die cut threaded joints with full cut standard taper pipe threads with red lead and linseed oil or other non-toxic joint compound applied to male threads only.

N. Install valves with stems upright or horizontal, not inverted. Remove protective coatings prior to installation.

O. Provide gate or ball valves for shut-off or isolating service.

P. Provide drain valves at main shut-off valves, low points of piping and apparatus.

Q. The fire sprinkler contractor shall coordinate and provide for the location of all fire sprinkler drain piping and drain receptor piping, whether or not indicated on the contract documents. The routing of low point drains to any location where there is no drain receptor is NOT acceptable.

END OF SECTION

FIRE SUPPRESSION SPRINKLERS

PART 1 GENERAL

1.1. SECTION INCLUDES
A. Wet-pipe sprinkler system.
B. Dry-pipe sprinkler system.
C. System design, installation, and certification.
D. Fire department connections.

1.2. RELATED REQUIREMENTS
A. Section 07 84 00 - Firestopping.
B. Section 21 05 00- Fire Protection Basic Materials and Methods: Pipe, fittings, and valves.
C. Division 26: Electrical characteristics and wiring connections.

1.3. REFERENCE STANDARDS
A. NFPA 13 - Standard for the Installation of Sprinkler Systems; National Fire Protection Association; 2010.
B. UL (FPED) - Fire Protection Equipment Directory; Underwriters Laboratories Inc.; current edition.

1.4. ADMINISTRATIVE REQUIREMENTS
A. Preinstallation Meeting: Convene one week before starting work of this section.

1.5. SUBMITTALS
A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Product Data: Provide data on sprinklers, valves, and specialties, including manufacturers catalog information. Submit performance ratings, rough-in details, weights, support requirements, and piping connections.
C. Shop Drawings:
   1. Submit preliminary layout of finished ceiling areas indicating only sprinkler locations coordinated with ceiling installation.
   2. Indicate hydraulic calculations, detailed pipe layout, hangers and supports, sprinklers, components and accessories. Indicate system controls.
   3. Submit shop drawings, product data, and hydraulic calculations to authority having jurisdiction and Fire Marshall for approval. Submit proof of approval to Architect/Engineer.
   4. Shop drawings shall be minimum 36 x 24 size.
D. Project Record Documents: Record actual locations of sprinklers and deviations of piping from drawings. Indicate drain and test locations.
E. Manufacturer's Certificate: Certify that system has been tested and meets or exceeds code requirements.

F. Operation and Maintenance Data: Include components of system, servicing requirements, record drawings, inspection data, replacement part numbers and availability, and location and numbers of service depot.
G. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
   1. See Section 01 60 00 - Materials and Equipment, for additional provisions.
   2. Extra Sprinklers: Type and size matching those installed, in quantity required by referenced NFPA design and installation standard.
   3. Sprinkler Wrenches: For each sprinkler type.

1.6. QUALITY ASSURANCE
A. Maintain one copy of referenced design and installation standard on site.
B. Conform to UL requirements.
C. Designer Qualifications: Design system under direct supervision of a recognized fire sprinkler contractor experienced in design of this type of work and licensed in Oregon.
D. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum five years documented experience.
E. Installer Qualifications: Company specializing in performing the work of this section with minimum five years documented experience approved by manufacturer.
F. Equipment and Components: Provide products that bear UL label or marking.
G. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc., as suitable for the purpose specified and indicated.

1.7. DELIVERY, STORAGE, AND HANDLING
A. Store products in shipping containers and maintain in place until installation. Provide temporary inlet and outlet caps. Maintain caps in place until installation.

PART 2 PRODUCTS

2.1. SPRINKLER SYSTEM
A. Sprinkler System: Provide coverage for entire building.
B. Occupancy: Comply with NFPA 13.
C. Water Supply: Determine volume and pressure from water flow test data.
   1. If test data is not available assume 2000 gpm at 20 psig.
   2. Revise design when test data available prior to submittals.
D. Interface system with building fire and smoke alarm system.
E. Provide fire department connections where indicated, or as required by Authority Having Jurisdiction.
F. Storage Cabinet for Spare Sprinklers and Tools: Steel, located adjacent to alarm valve.

2.2. SPRINKLERS
A. Suspended Ceiling Type: Recessed pendant type with matching push on escutcheon plate.

1. Manufacturers:
   a. Tyco.
   b. Reliable: www.reliablesprinkler.com.
   c. Viking.
2. Response Type: Quick or Standard.
3. Coverage Type: Standard or Extended.
4. Finish: Chrome plated.
5. Escutcheon Plate Finish: Chrome plated.
6. Fusible Link: Fusible solder link type or Glass bulb type, temperature rated for specific area hazard.

B. Exposed Area Type: Standard type .
1. Manufacturers:
   a. Tyco.
   b. Viking.
   c. Reliable: www.reliablesprinkler.com.
2. Response Type: Quick or Standard.
3. Coverage Type: Standard or Extended.
4. Finish: Brass.
5. Fusible Link: Fusible solder link type or Glass bulb type, temperature rated for specific area hazard.

C. Sidewall Type: Recessed horizontal sidewall type with matching push on escutcheon plate.
1. Manufacturers:
   a. Tyco.
   b. Viking.
   c. Reliable: www.reliablesprinkler.com.
2. Response Type: Quick or Standard.
3. Coverage Type: Standard or Extended.
4. Finish: Chrome plated.
5. Escutcheon Plate Finish: Chrome plated.
6. Fusible Link: Fusible solder link type or Glass bulb type, temperature rated for specific area hazard.

D. Dry Sprinklers: Recessed pendant type with matching push on estucheon plate.
1. Manufacturers:
   a. Viking.
   b. Tyco.
   c. Reliable: www.reliablesprinkler.com.
2. Response Type: Quick or Standard.
3. Coverage Type: Standard or Extended.
4. Finish: Brass.
5. Escutcheon Plate Finish: Brass.
6. Fusible Link: Fusible solder link type or Glass bulb type, temperature rated for specific area hazard.

2.3. PIPING SPECIALTIES

A. Wet Pipe Sprinkler Alarm Valve: Check type valve with divided seat ring, rubber faced clapper to automatically actuate water motor alarm and electric alarm, with pressure retard chamber and variable pressure trim; with test and drain valve.

B. Dry Pipe Sprinkler Alarm Valve: Check type valve with divided seat ring, rubber faced clapper to automatically actuate water motor alarm and electric alarm, with accelerator; with test and drain valve.

C. Electric Alarm: Electrically operated red enameled gong with pressure alarm switch.

D. Water Flow Switch: Vane type switch for mounting horizontal or vertical, with two contacts; rated 10 amp at 125 volt AC and 2.5 amp at 24 volt DC. Grinnell Model VSR-1.

E. Fire Department Connections:
   1. Type: Remote, located on site (provided by others).

F. Air Compressor: UL listed single unit capable of being hard wired where required by AHJ, electric motor driven, motor, motor starter, safety valves, check valves, air maintenance device incorporating electric pressure switch and unloader valve. Compressor shall have capacity to charge to system pressure within 15 minutes. Refer to Division 26 for electrical characteristics.

G. Supervisory Switches: As manufactured by Grinnell OSYSU-1 or OSYSU-2, Potter-Roemer Figure 6220, or approved equal.

PART 3 EXECUTION

3.1. INSTALLATION

A. Install in accordance with referenced NFPA design and installation standard.

B. Install equipment in accordance with manufacturer's instructions.

C. Install buried shut-off valves in valve box. Provide post indicator.

D. Locate outside alarm gong on building wall.

E. Place pipe runs to minimize obstruction to other work.

F. Place piping in concealed spaces above finished ceilings.

G. Center sprinklers in one direction only in ceiling tile with location in other direction variable, dependent upon spacing and coordination with ceiling elements.

H. Provide oversize escutcheons on all sprinklers to allow for seismic movement.

I. Apply masking tape or paper cover to ensure concealed sprinklers, cover plates, and sprinkler escutcheons do not receive field paint finish. Remove after painting. Replace painted sprinklers.

J. Flush entire piping system of foreign matter.

K. Hydrostatically test entire system.

L. Require test be witnessed by Fire Marshal and Architect/Engineer.

M. Seal all sprinkler penetrations in hardlid ceiling.

3.2. INTERFACE WITH OTHER PRODUCTS

A. Ensure required devices are installed and connected as required to fire alarm system.

3.3. START-UP AND TESTING

A. Starting Procedures: Follow manufacturer's written procedures. If no procedures are prescribed by manufacturer, proceed as follows:

1. Verify that specialty valves, trim, fittings, controls, and accessories have been installed correctly and operate correctly.
2. Verify that specified tests of piping are complete.
3. Check that damaged sprinkler and sprinklers with paint or coating not specified have been replaced with new, correct type of sprinklers.
4. Check that sprinklers are correct type, have correct finish and temperature ratings, and have guards where required for applications.
5. Check that potable water supplies have correct type of backflow preventer.
6. Check that hose valves and fire department connections have threads compatible with local fire department equipment and have correct pressure rating.
7. Fill wet-pipe sprinkler systems with water.
8. Energize circuits to electrical equipment and devices.
9. Adjust operating controls and pressure settings.

END OF SECTION

BASIC PLUMBING REQUIREMENTS

PART 1 GENERAL

1.1. DESCRIPTION OF WORK

A. This Section specifies the basic requirements for all Contractor installed equipment. It applies to all sections included in Division 22. The requirements herein are an expansion upon the requirements of Division 1.

B. Provide all materials, labor and equipment required to install complete and fully operational plumbing systems as indicated by the contract drawings and this specification.

C. Obtain and pay for all permits, licenses, fees and taxes applicable to this project as required by law.

D. Cooperate with other trades in furnishing material and information required for installation and operation of mechanical items.

E. Requirements for the following are included:
   1. Related work (other Contract Documents and specification sections) that must be combined with the requirements of this Section.
   2. Design performance.
   3. Delivery, storage, and handling.
   4. Quality assurance and standards.
   5. Submittals.
   6. Product quality, basic type, and finishes.
   7. Equipment identification.
   8. Excavation and backfill.
   9. Installation.
   10. Mounting and shimming.
   11. Inspection.
   12. Safety considerations.
   13. Cleaning, startup, and adjustments.

1.2. RELATED WORK

A. This general section shall be used in conjunction with the following other specifications and related Contract Documents to establish the total requirements for the project equipment and systems:
   1. Division 1 sections included in this Project specifications.
   2. The Contract.
   3. General and specific mechanical specifications and drawings included in the project.

1.3. DEFINITIONS

A. “Indicated”: Refers to graphic representations, notes or schedules in the Drawings; or to other paragraphs or schedules in Specifications and similar requirements in the Contract Documents.
   1. Terms such as “shown”, “noted”, “scheduled”, and “specified”, are used to notify or help the user to locate reference. Location is not limited.

B. "Directed": Terms such as "directed", Requested", "authorized", "selected", "approved", "required", and "permitted" mean directed by Architect/Engineer, approved by Architect/Engineer and similar phrases.
C. "Approved": When used in conjunction with Architect/Engineer's action on contract submittals, applications, requests, is limited to Architect/Engineer's duties and responsibilities as stated in the Conditions of the Contract.
D. "Regulations": Includes laws, ordinances, statutes and lawful orders issued by authorities having jurisdiction, as well as rules, conventions and agreements within the construction industry that control performance of Work.
E. "Furnish": Means to supply and deliver to the Project site, ready for unloading, unpacking, assembly, installation and similar operations.
F. "Install": Describes operations at Project site including actual unloading, temporary storage, unpacking, assembling, erecting, placing, anchoring, supporting, isolating, applying, working to dimension, finishing, curing, protecting, cleaning and similar operations.
G. "Provide": Means to furnish and install.
H. "Installer": A contractor, or another entity engaged by the contractor, either as an employee, subcontractor, or contractor of a lower tier, to perform a particular construction activity including installation, erection, application or similar operations.
    1. Installers are required to be experienced in operations they are engaged to perform.
    2. The term "experience" means having successfully completed a minimum of three previous projects similar in scope and size to this Project and within the time frame indicated in the "Quality Assurance" section of the Specifications. In addition, in means being familiar with special requirements indicated and having complied with requirements of authorities having jurisdiction.
I. "Project Site": Is defined as the space available to the Contractor for performing construction activities, either exclusively or in conjunction with others performing other work as part of Project.

1.4. DESIGN PERFORMANCE

A. Compliance by the Contractor and/or Vendor with the provisions of this Specification does not relieve him of the responsibilities of furnishing equipment and materials of proper design, mechanically suited to meet operating guarantees at the specified service conditions.

1.5. SUBMITTALS

A. Product Data: Submit complete sets of manufacturer's product data in .PDF format for approval. All submittals are to be received in no more than (3) three packages. See Division 1 for further information regarding submittal requirements. Literature submitted shall clearly indicate the model number, capacity, rated operating conditions, noise levels, size, weight, support requirements, rough-in data and dimensions, electrical power requirements, wiring diagrams, utility (fuel, air, cooling water, etc.) requirements, and options furnished. Submittals shall include, but are not necessarily limited to the following;

1. Plumbing: Piping and insulation; Plumbing fixtures, including trim; insulation; valves; hangers and supports; equipment bases; isolators; water heaters; booster pumps and the like.

B. Operation and Maintenance Data: Submit three complete sets of manufacturer's literature in .PDF format for approval. Data shall include installation, start-up, and maintenance instructions, parts lists, and wiring diagrams. Include all material on a CD-ROM or USB device.

C. Substitutions: System design was based upon the equipment and materials listed on the drawings and specifications herein. At contractor's option, another manufacturer's equipment of similar quality, capacity and features may be submitted for prior approval per Section 01 60 00. Prior permission to substitute does not relieve the contractor of the responsibility of including this information in the bound submittal packages.

1.6. QUALITY ASSURANCE

A. Codes and Standards: Comply with the provisions of the following codes, standards and specifications, except where more stringent requirements are shown or specified:
1. State of Oregon "IBC".
2. State of Oregon "IMC".
3. State of Oregon "UPC".
4. State of Oregon "IFC".
5. ANSI/ASHRAE 90 - “Energy Efficient Design of New Buildings….”
6. ANSI B31.9 "Building Service Piping".
7. NFPA - 54 and 90B.

B. Drawings: All drawings are diagrammatic and show general design, arrangement, and extent of the systems. Do not scale drawings for rough-in dimensions, nor use as shop drawings.

C. Installer Qualifications: Company specializing in performing the work required with a minimum of five years documented experience.

D. Contractor shall furnish and install all work in accordance with manufacturers' recommendations and instructions.

1.7. DELIVERY, STORAGE AND PROTECTION

A. Delivery: Deliver to site with manufacturer's labels intact and legible.

B. Preparation for shipment:
1. Each unit shall be suitably prepared for the shipment specified and for storage in accordance with manufacturer's instructions in a manner requiring no disassembly prior to operation.
2. The Contractor shall be solely responsible for the adequacy of the Preparation for Shipment provisions employed with respect to materials and application.
3. One complete set of Installations, Operating and Maintenance Instructions shall be packed and shipped with the equipment. This set is in addition to the sets that are to be sent directly to the Owner.

C. Handling: Avoid damage. Comply with manufacturer's installation instruction requirements for rigging, unloading and transporting units.

D. Storage: Inside protected from weather, dirt and construction dust. Where necessary to store outside, elevate well above grade and enclose with durable, waterproof wrapping. Cap all pipe ends. Taping pipe ends is not adequate or allowable.

1.8. PROJECT CONDITIONS

A. General: Provide products which are compatible with other portions of the work and provide products with the proper power characteristics and similar adaptations for the project.

B. Arrangement: Arrange piping parallel with primary lines of the building construction and with a minimum 7 feet overhead clearance in unfinished equipment rooms where possible. Conceal all piping where possible unless indicated otherwise. Locate operating and control equipment properly to provide easy access for operation and maintenance. Give right-of-way to piping which must be sloped for drainage. Set all equipment level or as recommended by manufacturer.

C. Coordination: Where several elements of the work must be sequenced and positioned in order to fit the available space, prepare shop drawings showing the actual physical dimensions (at accurate scale) required for installation and submit prior to purchase/fabrication/installation of any of the elements involved in the coordination.

1.9. STANDARDS

A. General: Provide all new materials and equipment, identical to apparatus or equipment in successful operation for a minimum of five years. Provide materials of comparable quality omitted here but necessary to complete the work. Maximum allowable variation from stated capacities, minus 5% to plus 10% as approved in each case.

B. Governing Standards: The following are typical standards generally referenced in these specifications and identified by their acronym. Federal Specifications (FS), American Society for Testing Materials (ASTM), American National Standards Institute (ANSI), Manufacturer's Standardization Society of the Valve and Fitting Industry, Standard Practice (MSS SP-69), Cast Iron Soil Pipe Institute (CISPI), Underwriters Laboratory (UL) numbers are given.

1.10. WARRANTIES

A. Contractor shall provide a 1 year warranty on all equipment, materials and workmanship for a period of one year from the date of owner's acceptance.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.1. LAYOUT AND COORDINATION

A. Site Examination: Before starting work, carefully examine site and all Contract Drawings. Become thoroughly familiar with conditions governing work on this project. Verify all

indicated elevations, building measurements, rough-in dimensions and equipment locations before proceeding with any work.

B. Utility Locations: The location of all utilities, wires, conduits, pipes, ducts, or other service facilities are shown in a general way only on the drawings and in some instances are taken from existing drawings. Ascertain whether any additional facilities other than those shown on the plans may be present and determine the exact location and elevations of all utilities prior to commencing installation.

C. Discrepancies: Any error, conflict or discrepancy in Drawings, Specifications and/or existing conditions shall be reported immediately. Do not proceed with any questionable items of work until clarification of same has been made. Should rearrangement or re-routing of piping or ductwork be necessary, provide for approval the simplest layout possible for that particular portion of the work. Under no circumstances shall beams, girders, footings or columns be cut for mechanical items. Casting of pipes into concrete is prohibited unless so shown on Drawings.

D. The Contractor shall cooperate with others to avoid interferences and delays in the construction work.

E. Interference as a result of poor coordination or lack of cooperation with other trades shall be corrected at the Contractor's expense.

3.2. CUTTING AND PATCHING

A. General: Perform cutting and patching in accordance with Division 1.

B. Protection: During cutting and patching, protect adjacent installations. Provide temporary barriers to prevent the spread of dust and dirt outside of the immediate work area.

C. Repair: Patch finished surfaces and building components using new materials to match the existing.

D. Inspection: Upon written direction from the Architect, uncover and restore work to provide for observation of concealed work.

3.3. EXCAVATION AND BACKFILL

A. General: Perform all necessary excavation and backfill required for the installation of mechanical work. Any piping or other work damaged by the Contractor's operations shall be repaired at the Contractor's expense.

B. Water: Keep all excavations free of standing water. Excavations damaged or softened by water or frost shall be re-excavated and filled back to original level with approved material at the Contractor's expense.

C. Test: During the progress of the work for compacted fill, the Owner reserves the right to request compaction tests made under the direction of a testing laboratory.

D. Trench Excavation: Excavate trenches to the necessary depth and width, removing rocks, unstable soil (silt, peat, etc.) roots and stumps. Width of trench shall be adequate for proper installation of piping or conduit.

E. Foundation and Bedding:

1. Proper preparation of foundation, placement of foundation material where required, and placement of bedding material shall precede the installation of the pipe. This shall include leveling of the trench bottom as well as placement and

compaction of required bedding material to a uniform grade so that piping rests upon a continuous and uniform bedding.

2. Where excavation has been made below the required grade, the Contractor shall provide, place and compact suitable bedding material to restore the proper grade elevation.

F. Provide tracer wire over top of piping.
   1. Construction:
      a. Conductor: Solid or stranded copper per spec ASTM B-3.
      b. Insulation: High Molecular Weight Polyethylene (HMWPE) ASTM D-1248. Various insulation colors dependant on usage.
      c. Temperature: 70 degrees C dry and wet.
      d. Voltage: 20 and 30 Mil = 30 to 300 volts. 45 Mil = 600 volts.

G. Backfilling: Upon acceptance of installed piping systems, trenches shall be backfilled in lifts. Backfill material shall be placed and compacted in lifts not to exceed 6 inches in depth to a height of 1 inch above the top of trench. Backfill shall be placed to obtain contact with the entire periphery of the pipe without disturbing pipe placement.

H. Compaction: One of the following methods or combination thereof shall be required; 1) Mechanical Tamper or Vibratory Compactor. Compaction shall be sufficient to attain 95% of maximum density at optimum moisture content. Water "puddling" or "washing" is prohibited.

I. Bedding/Backfill Material: Where native material has been removed, necessary foundation material consisting of 3/4 inch minus crushed rock or fill sand shall be placed and compacted to form a firm base of the required thickness. Backfill material shall be the same. Follow the pipe manufacturer's installation instructions when specified materials are specifically prohibited.

3.4. MECHANICAL EQUIPMENT WIRING

A. Provide all motor starters, control devices, and wiring complete from power source indicated on Drawings.

B. Equipment and systems shown on the Drawings and/or specifications, are based upon requirements of specific manufacturers which are intended as somewhat typical of several makes which may be approved. Provide all field wiring and/or devices necessary for a complete and operable system controls for the actual selected equipment/system.

3.5. INSTALLATION

A. Locating and Positioning Equipment: Observe all Codes and Regulations and good common practice in locating and installing mechanical equipment and material so that completed installation presents the least possible hazard. Maintain recommended clearances for repair and service to all equipment.

B. Anchorage: Anchor and/or brace all mechanical equipment, piping to resist displacement due to seismic action, include snubbers on equipment mounted on spring isolators.

C. Where mounting heights or locations are not identified, install systems, equipment and materials to provide maximum headroom.

D. Provide clearance for installation of insulation and access to valves, fittings, damper actuators, etc. on pipe and duct systems.
E. Install systems, materials and equipment giving right of way to systems required to be installed at a specific slope or operation by gravity.
F. Flush clean and disinfect domestic water system.
G. Provide chrome plated rigid or flexible supplies to fixtures with stops, reducers, and escutcheons.
H. Provide trap primers and piping for floor drains and floor sinks.
I. Installation shall be in accordance with the requirements of the equipment manufacturer, including special requirements for seismic restraints.
J. Equipment Manufacturer's Responsibility and Services:
    1. A manufacturer's representative for major equipment and operating systems shall be provided as necessary to assist the Contractor during installation, and to provide written certification that the equipment has been installed as specified and in accordance with the manufacturer's representative.
    2. The manufacturer's representative shall provide the initial startup of equipment in the presence of the Owner.
        a. Provide a pre-start check of all piping, valves, control devices, control panels, and equipment.
        b. Calibrate and adjust equipment and controls for operation at the specified design and conditions.
        c. Provide a record of all startup events noting problems and their resolution.
        d. Provide a record of all set points for operational controls and devices.
    3. Upon the completion of the equipment startup, provide instructional time with the Owner's personnel to review the operations and maintenance manuals and perform each step necessary for startup, shutdown, troubleshooting, and routine maintenance. The instructional time shall be scheduled through the Owner.
    4. Upon completion of the inspections, startup, testing, and checkout procedures, the equipment manufacturer shall submit written notice to the Owner that the units are ready for use by the Owner. Provide a certificate of calibration for all equipment.

3.6. MOUNTING AND SHIMMING

A. Mount equipment as shown on the Drawings, or per manufacturer requirements.
B. Level the equipment by means of 304 stainless steel wedges (stainless steel plates and stainless steel shims). Wedge taper shall not be greater than 1/4 inch per foot. Use double wedges to provide a level bearing surface for the equipment. Secure each pair of wedges in their final positions with one tack weld on each side after leveling is complete. Wedging shall be executed in a manner that will prevent a change in level or springing of the Baseplate when the anchor bolts are tightened.

3.7. INSPECTION

A. The Contractor shall inspect his work to ensure the installation and workmanship is in accordance with these specifications and acceptable industry standards for the work being done.

B. All materials, equipment, and workmanship shall be subject to inspection at any time by the Owner. Contractor shall correct any work, materials, or equipment not in accordance with the Contract Documents.

3.8. SAFETY CONSIDERATIONS

A. All equipment shall be installed with suitable access clearances that satisfy OSHA and code requirements for maintenance or removal of replaceable parts and components, and with necessary inions or flanges to perform the maintenance or removal without removing the connecting appurtenances.

B. Where equipment requiring periodic maintenance cannot be reached by normal walkways because of interference with ductwork, piping, or other obstructions the Contractor shall notify the Owner and propose an alternate safe means of access. These may include construction of an overhead platform with stairway or ladder ends and safety railings or handholds, or walk-through duct plenums with hinged access doors, or as required to meet OSHA standards for safe maintenance procedures.

3.9. CLEANING, START-UP, AND ADJUSTING

A. The Contractors shall be responsible for proper operation of all systems, minor subsystems, and services provided under this section. He shall coordinate start-up procedures, calibration, and system checkout with all project managers. Any system operational problems shall be diagnosed; all correctional procedures shall be initiated as required to bring out the system into compliance with the design, and the problem then shall be rechecked to verify that the system operates normally.

B. Thoroughly clean all parts of the installation at the completion of the work. The Contractor shall clean up and remove from the premises all refuse material, crates, and rubbish arising from his work. Remove, clean, and reinstall all filters. Belt-drive tensions and alignments shall be checked. All motors and bearings shall be lubricated in accordance with the manufacturer's service manuals prior to equipment start-up. Provide a lubrication schedule for every item of equipment furnished under this section. The schedule shall include the type of lubricant and the application frequency.

END OF SECTION

METERS AND GAUGES FOR PLUMBING PIPING

PART 1 GENERAL

1.1. SECTION INCLUDES
A. Pressure gauges and pressure gauge taps.
B. Thermometers and thermometer wells.

1.2. RELATED REQUIREMENTS
A. Section 22 10 05 - Plumbing Piping.

1.3. REFERENCE STANDARDS
A. ASME B40.100 - Pressure Gauges and Gauge Attachments; 2013.
B. ASTM E1 - Standard Specification for ASTM Liquid-in-Glass Thermometers; 2014.
C. ASTM E77 - Standard Test Method for Inspection and Verification of Thermometers; 2014, with Editorial Revision (2017).

1.4. SUBMITTALS
A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Product Data: Provide list that indicates use, operating range, total range and location for manufactured components.
C. Project Record Documents: Record actual locations of components and instrumentation.
D. Operation and Maintenance Data: Section 01 70 00.
E. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
   1. See Section 01 60 00 - Materials and Equipment, for additional provisions.

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

PART 2 PRODUCTS

2.1. PRESSURE GAUGES
A. Manufacturers:
   1. Weksler; Model 401: www.weksler-gauges.com.
   2. Trerice; Model 700 Series: www.trerice.com.
   3. Ametek (U.S. Gauge); Model Series 540: www.ametekusg.com.
   4. Other approved manufacturers: Ashcroft, Marshalltown, Weiss.
   5. Substitutions: See Section 01 60 00 - Materials and Equipment.
B. Pressure Gages: ASME B40.100, drawn steel case, phosphor bronze bourdon tube, rotary brass movement, brass socket, with front recalibration adjustment, black scale on white background.
   1. Case: Steel with brass bourdon tube.

2. Size: 4-1/2 inch diameter.
3. Mid-Scale Accuracy: One percent.
4. Scale: Psi and kPa.

2.2. PRESSURE GAUGE TAPPINGS

A. Manufacturers:
1. Weksler: www.weksler-gauges.com.
2. Trerice : www.trerice.com.
3. Ametek (U.S. Gauge): www.ametekusg.com.
4. Other approved manufacturers: Ashcroft, Marshalltown, Weiss.
5. Substitutions: See Section 01 60 00 - Materials and Equipment.

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

C. Ball Valve: Brass 1/4 inch NPT cock, for 200 psi. Lever handle.
1. Product: A12 manufactured by Weksler, or approved equal.

D. Needle Valve: Brass, 1/4 inch NPT for minimum 150 psi.
1. Product: BBV4 manufactured by Weksler.

E. Pulsation Damper: Pressure snubber, brass with 1/4 inch connections.
1. Product: WG41/WG42 manufactured by Weksler.

F. Syphon: Steel, Schedule 40, 1/4 inch angle or straight pattern.
1. Product: AO31 manufactured by Weksler.

2.3. STEM TYPE THERMOMETERS

A. Manufacturers:
1. Weksler Glass Thermometer Corp: www.wekslerglass.com.
2. Trerice; Model A00: www.trerice.com.
3. Ametek (U.S. Gauge); Model Fig. MN: www.ametekusg.com.
4. Other approved manufacturers: Ashcroft, Marshalltown, Weiss.
5. Substitutions: See Section 01 60 00 - Materials and Equipment.

B. Thermometers - Fixed Mounting: Red- or blue-appearing non-toxic liquid in glass; ASTM E1; lens front tube, cast aluminum case with enamel finish.
1. Size: 9 inch scale.
2. Window: Clear glass.
3. Stem: 3/4 inch brass.
4. Accuracy: 2 percent, per 1.
5. Calibration: Degrees F.

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

2.4. THERMOMETER SUPPORTS

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

PART 3 EXECUTION

3.1. INSTALLATION

A. Install in accordance with manufacturer's instructions.
B. Provide one pressure gauge per pump, installing taps before strainers and on suction and discharge of pump. Pipe to gauge.
C. Install pressure gages with pulsation dampers. Provide needle valve to isolate each gage. Extend nipples to allow clearance from insulation.
D. Install thermometers in piping systems in sockets in short couplings. Enlarge pipes smaller than 2-1/2 inch for installation of thermometer sockets. Ensure sockets allow clearance from insulation.
E. Coil and conceal excess capillary on remote element instruments.
F. Provide instruments with scale ranges selected according to service with largest appropriate scale.
G. Install gauges and thermometers in locations where they are easily read from normal operating level. Install vertical to 45 degrees off vertical.
H. Adjust gauges and thermometers to final angle, clean windows and lenses, and calibrate to zero.
I. Locate test plugs adjacent to pressure gages and pressure gage taps.

3.2. SCHEDULES

A. Pressure Gauges, Location and Scale Range:
   1. Pumps, 0 to 150 psi.
   2. Sprinkler system, 0 to 250 psi.
   3. Backflow preventers, 0 to 150 psi.
B. Stem Type Thermometers, Location and Scale Range:
   1. Water zone supply and return, 0 to 200 degrees F.
   2. Domestic hot water supply and recirculation, 0 to 200 degrees F.

END OF SECTION

HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT

PART 1 GENERAL

1.1. SECTION INCLUDES

A. Pipe hangers and supports.
B. Hanger rods.
C. Flashing.
D. Sleeves.
E. Mechanical sleeve seals.
F. Formed steel channel.
G. Firestopping relating to mechanical work.
H. Firestopping accessories.

1.2. RELATED SECTIONS

A. Section 07 92 00 - Joint Sealants: Product requirements for sealant materials for placement by this section.
B. Section 09 90 00 - Painting and Coating: Product and execution requirements for painting specified by this section.
C. Section 22 10 05 - Plumbing Piping.
D. Section 22 07 16 - Plumbing Equipment Insulation: Execution requirements for placement of hangers and supports specified by this section.

1.3. REFERENCES

A. ASME B31.9 - Building Services Piping; The American Society of Mechanical Engineers.
B. ASTM E84 - Test Method for Surface Burning Characteristics of Building Materials; American Society for Testing and Materials.
C. ASTM E119 - Method for Fire Tests of Building Construction and Materials; American Society for Testing and Materials.
D. ASTM E814 - Test Method of Fire Tests of Through Penetration Firestops; American Society for Testing and Materials.
E. UL 723 - Tests for Surface Burning Characteristics of Building Materials; Underwriters Laboratories Inc.
F. UL 1479 - Fire Tests of Through-Penetration Firestops; Underwriters Laboratories Inc.

1.4. DEFINITIONS

A. Firestopping (Through-Penetration Protection System): Sealing or stuffing material or assembly placed in spaces between and penetrations through building materials to arrest movement of fire, smoke, heat, and hot gases through fire rated construction.

1.5. SYSTEM DESCRIPTION

A. Firestopping Materials: ASTM E119 and ASTM E814 (UL 1479) to achieve fire ratings of adjacent construction noted in Division 1 documents and in accordance with UL Design Numbers.

B. Surface Burning: ASTM E84/UL 723 with maximum flame spread/smoke developed rating of 25/450.

C. Firestop interruptions to fire rated assemblies, materials, and components.

1.6. SUBMITTALS

A. Section 01 30 00 - Administrative Requirements: Submittal procedures.

B. Shop Drawings: Indicate system layout with location including critical dimensions, sizes, and pipe hanger and support locations and detail of trapeze hangers.

C. Product Data:
   1. Hangers and Supports: Submit manufacturers catalog data including load capacity.
   2. Firestopping: Submit data on product characteristics, performance and limitation criteria.

D. Manufacturer's Installation Instructions:
   1. Hangers and Supports: Submit special procedures and assembly of components.
   2. Firestopping: Submit preparation and installation instructions.

E. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

F. Engineering Judgements: For conditions not covered by UL or WH listed designs, submit judgements by licensed professional engineer suitable for presentation to authority having jurisdiction for acceptance as meeting code fire protection requirements.

1.7. QUALITY ASSURANCE

A. Perform Work in accordance with State of Oregon standards.

B. Perform Work in accordance with AWS D1.1 for welding hanger and support attachments to building structure.

C. Maintain one copy of the document on site.

1.8. QUALIFICATIONS

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

B. Installer: Company specializing in performing Work of this section with minimum three years documented experience.

1.9. PRE-INSTALLATION MEETINGS

A. Section 01 30 00 - Administrative Requirements: Pre-installation meeting.

B. Convene minimum one week prior to commencing work of this section.

1.10. DELIVERY, STORAGE, AND HANDLING

A. Section 01 60 00 - Materials and Equipment: Requirements for transporting, handling, storing, and protecting products.
B. Accept materials on site in original factory packaging, labeled with manufacturer's identification.
C. Protect from weather and construction traffic, dirt, water, chemical, and mechanical damage, by storing in original packaging.

1.11. ENVIRONMENTAL REQUIREMENTS

A. Section 01 60 00 - Materials and Equipment: Environmental conditions affecting products on site.
B. Do not apply firestopping materials when temperature of substrate material and ambient air is below 60 degrees F.
C. Maintain this minimum temperature before, during, and for minimum 3 days after installation of firestopping materials.
D. Provide ventilation in areas to receive solvent cured materials.

1.12. FIELD MEASUREMENTS

A. Verify field measurements prior to fabrication.

1.13. WARRANTY

A. Section 01 77 00 - Contract Closeout: Product warranties and product bonds.

PART 2 PRODUCTS

2.1. PIPE HANGERS AND SUPPORTS

A. Manufacturers:
   1. Tolco Inc.
   2. Anvil.
   3. Michigan Hanger Company, Inc.
   4. PHD Manufacturing Co.
   5. Superstrut.
   6. Unistrut.
   7. Substitutions: Section 01 60 00 - Materials and Equipment.
B. Plumbing Piping - DWV:
   1. Conform to ASME B31.9.
   2. Hangers for Pipe Sizes 1/2 to 2-1/2 inches: Carbon steel, adjustable swivel, split ring.
   3. Hangers for Pipe Sizes 3 inches and Larger: Carbon steel, adjustable, clevis.
   4. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.

5. Wall Support for Pipe Sizes 3 inches and Smaller: Cast iron hook.
6. Wall Support for Pipe Sizes 4 inches and Larger: Welded steel bracket and wrought steel clamp.
7. Floor Support: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
8. Copper Pipe Support: Copper-plated, carbon-steel adjustable, ring.

C. Plumbing Piping - Water:
1. Conform to ASME B31.9.
2. Hangers for Pipe Sizes 1/2 to 2-1/2 inches (unless other noted): Carbon steel, adjustable swivel, split ring.
3. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
4. Wall Support for Pipe Sizes 2-1/2 inches and Smaller: Cast iron hook.
5. Floor Support for Cold Pipe: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
6. Copper Pipe Support: Copper-plated, Carbon-steel ring.

2.2. ACCESSORIES

A. Hanger Rods: Mild steel threaded both ends, threaded on one end, or continuous threaded.

2.3. FLASHING

A. Metal Flashing: 26 gage thick galvanized steel.
B. Metal Counterflashing: 22 gage thick galvanized steel.
C. Lead Flashing:
1. Waterproofing: 5 lb./sq. ft. sheet lead
2. Soundproofing: 1 lb./sq. ft. sheet lead.
D. Flexible Flashing: 1.85 inches thick sheet butyl; compatible with roofing.
E. Caps: Steel, 22 gage minimum; 16 gage at fire resistant elements.

2.4. SLEEVES

A. Sleeves for Pipes Through Non-fire Rated Beams Walls, Footings, and Potentially Wet Floors: Steel pipe or 18 gage thick galvanized steel.
B. Sealant: Acrylic; refer to Section 07 90 05 - Joint Sealers.
C. Sleeves Through Rated Conrete Decks: ASTM E 814 (UL 1479), UL Classified for W, L, F, T, and FM approved. Hilti Model Series CP/CPS; HoldRite "Hydroflam" Pro Series, or 3M Fire Barrier Cast-In Devices.

2.5. MECHANICAL SLEEVE SEALS

A. Manufacturers:
1. Thunderline Link-Seal, Inc. Model Series LS.
2. NMP Corporation.
3. Substitutions: Section 01 60 00 - Materials and Equipment.

B. Product Description: Modular mechanical type, consisting of interlocking synthetic rubber links shaped to continuously fill annular space between object and sleeve, connected with bolts and pressure plates causing rubber sealing elements to expand when tightened, providing watertight seal and electrical insulation.

2.6. FORMED STEEL CHANNEL

A. Manufacturers:
   1. Unistrut Model Series P1000.
   2. Superstrut Model Series 1200.
   3. Michigan Hanger “O-Strut” Model A-12.
   4. Substitutions: Section 01 60 00 - Materials and Equipment.

B. Product Description: Galvanized 12 gage thick steel. With holes 1-1/2 inches on center.

2.7. FIRESTOPPING

A. Manufacturers:
   1. Specified Technology Inc. (STI) Model SpecSeal Series 100.
   2. Dow Corning Corp.
   3. Hilti Corp.
   4. International Protective Coating Corp.
   5. 3M fire Protection Products.
   6. Substitutions: Section 01 60 00 - Materials and Equipment.

B. Product Description: Different types of products by multiple manufacturers are acceptable as required to meet specified system description and performance requirements; provide only one type for each similar application.
   1. Silicone Firestopping Elastomeric Firestopping: Single or multiple component silicone elastomeric compound and compatible silicone sealant.
   2. Foam Firestopping Compounds: Single or Multiple component foam compound.
   3. Formulated Firestopping Compound of Incombustible Fibers: Formulated compound mixed with incombustible non-asbestos fibers.
   4. Fiber Stuffing and Sealant Firestopping: Composite of mineral or ceramic fiber stuffing insulation with silicone elastomer for smoke stopping.
   5. Mechanical Firestopping Device with Fillers: Mechanical device with incombustible fillers and silicone elastomer, covered with sheet stainless steel jacket, joined with collars, penetration sealed with flanged stops.
   6. Intumescent Firestopping: Intumescent putty compound which expands on exposure to surface heat gain.
   7. Firestop Pillows: Formed mineral fiber pillows.

C. Color: As selected from manufacturer's full range of colors.

2.8. FIRESTOPPING ACCESSORIES

A. Primer: Type recommended by firestopping manufacturer for specific substrate surfaces and suitable for required fire ratings.

B. Dam Material: Permanent:
   1. Mineral fiberboard.
   2. Mineral fiber matting.
   3. Sheet metal.
   4. Plywood or particle board.
   5. Alumina silicate fire board.

C. Installation Accessories: Provide clips, collars, fasteners, temporary stops or dams, and other devices required to position and retain materials in place.

D. General:
   1. Furnish UL listed products.
   2. Select products with rating not less than rating of wall or floor being penetrated.

E. Non-Rated Surfaces:
   1. Stamped steel, chrome plated, hinged, split ring escutcheons or floor plates or ceiling plates for covering openings in occupied areas where piping is exposed.
   2. For exterior wall openings below grade, furnish mechanical sealing device to continuously fill annular space between piping and cored opening or water-stop type wall sleeve.

PART 3 EXECUTION

3.1. EXAMINATION

A. Section 01 30 00 - Administrative Requirements: Verification of existing conditions before starting work.

B. Verify openings are ready to receive sleeves.

C. Verify openings are ready to receive firestopping.

3.2. PREPARATION

A. Clean substrate surfaces of dirt, dust, grease, oil, loose material, or other matter affecting bond of firestopping material.

B. Remove incompatible materials affecting bond.

C. Install backing or damming materials to arrest liquid material leakage.

D. Obtain permission from Architect/Engineer before using powder-actuated anchors.

E. Do not drill or cut structural members.

3.3. INSTALLATION - PIPE HANGERS AND SUPPORTS

A. Install in accordance with ASME 31.9.

B. Support horizontal piping as scheduled.

C. Install hangers with minimum 1/2 inch space between finished covering and adjacent work.

D. Place hangers within 12 inches of each horizontal elbow.

E. Use hangers with 1-1/2 inches minimum vertical adjustment.

F. Support horizontal cast iron pipe adjacent to each hub, with 5 feet maximum spacing between hangers.
G. Support vertical piping at every floor. Support vertical cast iron pipe at each floor at hub.
H. Where piping is installed in parallel and at same elevation, provide multiple pipe or trapeze hangers.
I. Support riser piping independently of connected horizontal piping.
J. Provide copper plated hangers and supports for copper piping.
K. Design hangers for pipe movement without disengagement of supported pipe.
L. Prime coat exposed steel hangers and supports. Refer to Section 09 9000 - Painting and Coating. Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.
M. Provide clearance in hangers and from structure and other equipment for installation of insulation. Refer to Section 22 07 16 - Plumbing Equipment Insulation.

3.4. INSTALLATION - EQUIPMENT

A. Provide housekeeping pads of concrete, minimum 4 inches thick and extending 6 inches beyond all anchor bolts for supported equipment.

3.5. INSTALLATION - FLASHING

A. Provide flexible flashing and metal counterflashing where piping penetrate weather or waterproofed walls, floors, and roofs.
B. Flash vent and soil pipes projecting 3 inches minimum above finished roof surface with lead worked 1 inch minimum into hub, 8 inches minimum clear on sides with 24 x 24 inches sheet size. For pipes through outside walls, turn flanges back into wall and caulk, metal counter-flash, and seal.
C. Flash floor drains in floors with topping over finished areas with lead, 10 inches clear on sides with minimum 36 x 36 inches sheet size. Fasten flashing to drain clamp device.
D. Seal floor, and mop sink drains watertight to adjacent materials.
E. Adjust storm collars tight to pipe with bolts; caulk around top edge. Use storm collars above roof jacks. Screw vertical flange section to face of curb.

3.6. INSTALLATION - SLEEVES

A. Exterior watertight entries: Seal with mechanical sleeve seals.
B. Set sleeves in position in forms. Provide reinforcing around sleeves.
C. Size sleeves large enough to allow for movement due to expansion and contraction. Provide for continuous insulation wrapping.
D. Extend sleeves through floors 1 inch above finished floor level. Caulk sleeves.
E. Where piping penetrates floor, ceiling, or wall, close off space between pipe or duct and adjacent work with stuffing or fire-stopping insulation and caulk airtight. Provide close fitting metal collar or escutcheon covers at both sides of penetration.
F. Install chrome plated steel escutcheons at finished surfaces.

3.7. INSTALLATION - FIRESTOPPING

A. Install material at fire rated construction perimeters and openings containing penetrating sleeves, piping, ductwork, and other items, requiring firestopping.

B. Apply primer where recommended by manufacturer for type of firestopping material and substrate involved, and as required for compliance with required fire ratings.

C. Apply fire-stopping material in sufficient thickness to achieve required fire and smoke rating to uniform density and texture.

D. Compress fibered material to maximum 40 percent of its uncompressed size.

E. Place foamed material in layers to ensure homogenous density, filling cavities and spaces.

F. Place sealant to completely seal junctions with adjacent dissimilar materials.

G. Place intumescent coating in sufficient coats to achieve rating required.

H. Remove dam material after firestopping material has cured.

I. Fire Rated Surface:

1. Seal opening at floor, wall, partition, ceiling, and roof as follows:
    a. Install sleeve through opening and extending beyond minimum of 1 inch on both sides of building element.
    b. Size sleeve allowing minimum of 1 inch void between sleeve and building element.
    c. Pack void with backing material.
    d. Seal ends of sleeve with UL listed fire resistive silicone compound to meet fire rating of structure penetrated.
    e. Where cable tray, bus, cable bus, conduit, wire-way, trough, penetrates fire rated surface, install firestopping product in accordance with manufacturer's instructions.

J. Non-Rated Surfaces:

1. Seal opening through non-fire rated wall, partition, floor, ceiling and roof opening as follows:
    a. Install sleeve through opening and extending beyond minimum of 1 inch on both sides of building element.
    b. Size sleeve allowing minimum of 1 inch void between sleeve and building element.
    c. Install type of firestopping material recommended by manufacturer.
    d. Install escutcheons, floor plates or ceiling plates where conduit, penetrates non-fire rated surfaces in occupied spaces. Occupied spaces include rooms with finished ceilings and where penetration occurs below finished ceiling.
    e. Exterior wall openings below grade: Assemble rubber links of mechanical sealing device to size of piping and tighten in place, in accordance with manufacturer's instructions.
    f. Interior partitions: Seal pipe penetrations at clean rooms, laboratories, hospital spaces, computer rooms, telecommunication rooms, data rooms. Apply sealant to both sides of penetration to completely fill annular space between sleeve and conduit.

3.8. FIELD QUALITY CONTROL

A. Section 01 45 00 - Contractor's Quality Control Program, and []: Field inspecting, testing, adjusting, and balancing.

B. Inspect installed firestopping for compliance with specifications and submitted schedule.

3.9. CLEANING

A. Section 01 77 00 - Contract Closeout: Requirements for cleaning.

B. Clean adjacent surfaces of firestopping materials.

3.10. PROTECTION OF FINISHED WORK

A. Section 01 77 00 - Contract Closeout: Requirements for protecting finished Work.

B. Protect adjacent surfaces from damage by material installation.

END OF SECTION

PLUMBING SEISMIC RESTRAINT

PART 1 GENERAL

1.1. SECTION INCLUDES

A. Seismic restraint of equipment and piping.

1.2. RELATED SECTIONS

A. Section 22 00 00 - Basic Plumbing Requirements.
B. Section 22 05 29 - Hangers and Supports for Plumbing Piping and Equipment.
C. Section 22 07 19 - Plumbing Piping Insulation.
D. Section 22 10 05 - Plumbing Piping.
E. Section 22 30 00 - Plumbing Equipment.
F. Section 22 40 00 - Plumbing Fixtures.

1.3. QUALITY ASSURANCE

A. Seismic Restraints:
   1. The Anchorage and/or seismic restraint of permanent equipment and associated systems listed below shall be designed to resist the total design seismic forces prescribed in the latest edition of the International Building Code.
      a. All floor or roof-mounted equipment weighing 400 lbs or greater.
      b. All suspended or wall-mounted equipment weighing 20 lbs or greater.
      c. All vibration-isolated equipment weighing 20 lbs or greater.
      d. All gas piping systems throughout the building.
      e. All piping 1 1/4 inches nominal diameter and larger located in boiler, mechanical equipment and refrigeration mechanical rooms.
      f. All piping 2 1/2 inches nominal diameter and larger.
      g. Pipes, electrical conduit and ducts supported by a trapeze where none of those elements would individually require bracing, require bracing when the combined operating weight of all elements supported by the trapeze is 10 lbs/ft or greater.
B. All calculations shall be in accordance with Chapter 16 of the latest edition of the International Building Code.

1.4. SUBMITTALS

A. Submit the following in accordance with Section 01 30 00:
   1. All anchorage and seismic restraints shall be designed and stamped by a professional engineer licensed in the state of the project location. Design shall include:
      a. Number, size and location of anchors for floor or roof-mounted equipment. For curb-mounted equipment, provide design of attachment of both the unit to the curb and the curb to the structure. In addition, provide calculations or test data verifying the curb can accept the seismic loads.

b. Number, size and location of seismic restraint devices and anchors for vibration-isolated and suspended equipment. Provide calculations or test data verifying the horizontal and vertical ratings of the seismic restraint devices.

c. Number, size and location of braces and anchors for suspended piping and ductwork on shop drawings. In addition:

1. The contractor must select a single seismic restraint system pre-designed to meet the requirements of the latest edition of the International Building Code such as the 2011 Mason Industries Seismic Restraint Guidelines for Suspended Piping, Ductwork, Electrical Systems and floor and roof mounted equipment.
2. Details or designs from separate seismic restraint guidelines are not acceptable. Installations not addressed by the selected system must be designed, detailed and submitted along with the shop drawings.
3. Maximum seismic loads shall be indicated on drawings at each brace location. Drawings shall bear the stamp and signature of the registered professional engineer licensed in the state of the project location who designed the layout of the braces.

PART 2 PRODUCTS

2.1. MANUFACTURERS

A. Amber Booth.
B. Mason Industries, Inc.
C. Kinetics Corporation.
D. Vibrex.
E. Substitutions: Under provisions of Section 01 60 00.

2.2. SEISMIC RESTRAINTS

A. General Requirements:
1. Seismic restraints shall be provided for all equipment, both supported and suspended, piping and ductwork as listed above.
2. Bracing of piping and ductwork shall be in accordance with provisions set forth in SMACNA seismic restraint manual.
3. Structural requirements for restraints, including their attachment to building structure, shall be reviewed and approved by the structural engineer.
4. Attachments to supported or suspended equipment must be coordinated with the equipment manufacturer.

B. Supported Equipment Products:
1. Seismic restraints shall consist of interlocking steel members restrained by shock absorbent neoprene materials compounded to bridge bearing specifications as previously noted in paragraph 1.03. Elastomeric materials shall be replaceable and be a minimum 3/4-inch thick. Snubbers shall be manufactured with an air gap

between hard and resilient material of not less than 1/8-inch, nor more than 1/4-inch. Type 1 - Seismic Snubbers: All-directional seismic snubbers shall consist of interlocking steel members restrained by a one-piece molded neoprene bushing of bridge bearing neoprene. Bushing shall be replaceable and a minimum of 1/4 inch thick. A minimum air gap of 1/8 inch shall be incorporated in the snubber design in all directions before contact is made between the rigid and resilient surfaces. Snubber end caps shall be removable to allow inspection of internal clearances. The snubber shall be designed to accept horizontal and vertical seismic loads as defined in Section 1.03.B. Mason Type Z-1225 or Z-1011.

2. Each snubber shall be capable of restraint in all three mutually orthogonal directions. Type 2 - Seismic Sway Braces - Seismic sway braces shall consist of galvanized steel aircraft cables or steel angles/channels. Cables braces shall be designed to resist seismic tension loads and steel braces shall be designed to resist both tension and compression loads with a minimum safety factor of 2. Brace end connections shall be steel assemblies that swivel to the final installation angle. Do not mix cable and steel braces to brace the same system or equipment. Steel angles, when required, shall be clamped to the threaded hanger rods at the seismic sway brace locations utilizing a minimum of two ductile iron clamps. Sway braces shall be designed to accept horizontal and vertical seismic loads as defined in Section 1.03.B. Mason Type SCB, SSB, SRC and UC.
3. Submittals shall include load versus deflection curves up to 1/2-inch on the x, y and z planes.
4. Mason Model Z-1011

C. Bracing of Pipes:
1. Provide seismic bracing of all piping as detailed below. (Exception: Piping suspended by individual hangers 12 inches or less in length, as measured from the top of the pipe to the bottom of the support where the hanger is attached, need not be braced).
   a. Brace all gas piping.
   b. Brace all piping located in boiler rooms, mechanical equipment rooms, and refrigeration mechanical rooms that is 1-1/4-inch nominal diameter and larger.
   c. Brace all pipes 2-1/2-inch nominal diameter and larger.
2. For all gas piping, as specified in 1(a) the bracing details, schedules, and notes may be used, except that transverse bracing shall be at 20 feet maximum, and longitudinal bracing shall be at 40 feet maximum.
3. Seismic braces for pipes on trapeze hangers may be used.
4. Provide flexibility in joints where pipes pass through building seismic joints or expansion joints or where rigidly supported pipes connect to equipment with vibration isolators. For threaded piping, the flexibility may be provided by the installation of swing joints.
5. Cast iron pipe of all types, glass pipe, and any other pipe jointed with a shield and clamp assembly, where the top of the pipe is 12 inches or more from the

supporting structure, shall be braced on each side of a change in direction of 90 degrees or more. Riser joints shall be braced or stabilized between floors.

6. Vertical risers shall be laterally supported with a riser clamp at each floor. For buildings greater than six stories high, all risers shall be engineered individually.

D. Suspended Equipment and Piping:

1. Cable Method: The seismic restraint shall consist of a combination of stranded steel aircraft cable and the specified vibration isolation hanger with an added nut and neoprene and steel washer. The cable resists lateral and downward motion. The modified vibration hanger resists upward motion.
2. Cable attachment details, cable size, and the neoprene and steel washers shall be sized by the manufacturer and are to be indicated in the Shop Drawings.
3. Provide detailed Shop Drawings for approval in sufficient time to allow structural attachment work to be incorporated into the normal work sequence.

PART 3 EXECUTION

3.1. SEISMIC RESTRAINTS

A. General:

1. Install and adjust seismic restraints so that the equipment, piping, and ductwork supports are not degraded by the restraints.
2. Restraints must not short circuit vibration isolation systems or transmit objectionable vibration or noise.

B. Supported Equipment:

1. Each vibration isolation frame for supported equipment shall have a minimum of four seismic snubbers mounted as close as possible to the vibration isolators and/or the frame extremities.
2. Care must be taken so that a minimum 1/8-inch air gap in the seismic restraint snubber is preserved on all sides in order that the vibration isolation potential of the isolator is not compromised. This requires that the final snubber adjustment be completed after the vibration isolators are properly installed and the installation approved.

C. Bracing of Pipes:

1. Branch lines may not be used to brace main lines.
2. Transverse bracing shall be at 40 feet maximum except where a lesser spacing is indicated in the SMACNA tables for bracing of pipes.
3. Longitudinal bracing shall be at 80 feet maximum except where a lesser spacing is indicated in the tables. In pipes where thermal expansion is a consideration, an anchor point may be used as the specified longitudinal brace provided that it has a capacity equal to or greater than a longitudinal brace. The longitudinal braces and connections must be capable of resisting the additional force induced by expansion and contraction.
4. A rigid piping system shall not be braced to dissimilar parts of the building or to two dissimilar building systems that may respond differently during an earthquake.

5. Transverse bracing for one pipe section may also act as longitudinal bracing for a pipe section of the same size connected perpendicular to it if the bracing is installed within 24 inches of the elbow or tee.

D. Suspended Equipment and Piping Cable Method:
   1. Cables shall be adjusted to a degree of slackness approved by the Structural Engineer.
   2. Uplift and downward restraint nuts and washers for the Type HST hangers shall be adjusted so that there is a minimum 1/4-inch clearance.

END OF SECTION

IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

PART 1 GENERAL

1.1. SECTION INCLUDES
A. Nameplates.
B. Tags.
C. Pipe markers.
D. Labels.
E. Lockout devices.

1.2. REFERENCE STANDARDS
A. ASME A13.1 - Scheme for the Identification of Piping Systems; 2015.
B. ASME A13.1 - Scheme for the Identification of Piping Systems; 2015.
C. ASTM D709 - Standard Specification for Laminated Thermosetting Materials; 2017.

1.3. SUBMITTALS
A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. List: Submit list of wording, symbols, letter size, and color coding for mechanical identification.
C. Chart and Schedule: Submit valve chart and schedule, including valve tag number, location, function, and valve manufacturer's name and model number.
D. Product Data: Provide manufacturers catalog literature for each product required.
E. Manufacturer's Installation Instructions: Indicate special procedures, and installation.
F. Project Record Documents: Record actual locations of tagged valves.

PART 2 PRODUCTS

2.1. PLUMBING COMPONENT IDENTIFICATION GUIDELINE
A. Pipe Markers: 3/4 inch diameter and higher.

2.2. MANUFACTURERS
A. Brady Corporation: www.bradycorp.com.
B. Safety Sign Company: www.safetysignco.com.
C. Seton Identification Products: www.seton.com/aec.
D. Substitutions: See Section 01 60 00 - Materials and Equipment.

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

2.4. TAGS

A. Plastic Tags: Laminated three-layer plastic with engraved black letters on light contrasting background color. Tag size minimum 1-1/2 inch diameter.
B. Metal Tags: Brass with stamped letters; tag size minimum 1-1/2 inch diameter with smooth edges.
C. Valve Tag Chart: Typewritten letter size list in anodized aluminum frame.

2.5. PIPE MARKERS

A. Comply with ASME A13.1.
B. Plastic Pipe Markers: Factory fabricated, flexible, semi- rigid plastic, preformed to fit around pipe or pipe covering; minimum information indicating flow direction arrow and identification of fluid being conveyed.
C. Plastic Tape Pipe Markers: Flexible, vinyl film tape with pressure sensitive adhesive backing and printed markings.
D. Underground Plastic Pipe Markers: Bright colored continuously printed plastic ribbon tape, minimum 6 inches wide by 4 mil thick, manufactured for direct burial service.
E. Identification Scheme, ASME A13.1:
    1. Primary: External Pipe Diameter, Uninsulated or Insulated.
    2. Secondary: Color scheme per fluid service.
        a. Water; Potable, Cooling, Boiler Feed, and Other: White text on green background.

2.6. LABELS

A. Description: Aluminum, size 1.9 x 0.75 inches, adhesive backed with printed identification.

2.7. LOCKOUT DEVICES

A. Lockout Hasps:
    1. Manufacturers:
        a. Anodized aluminum or reinforced nylon hasp with erasable label surface; size minimum 7-1/4 x 3 inches.
B. Valve Lockout Devices:
    1. Steel device preventing access to valve operator, accepting lock shackle.

PART 3 EXECUTION

3.1. PREPARATION

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

3.2. INSTALLATION

A. Install plastic nameplates with corrosive-resistant mechanical fasteners, or adhesive. Apply with sufficient adhesive to ensure permanent adhesion and seal with clear lacquer.
B. Install tags with corrosion resistant chain.
C. Install plastic pipe markers in accordance with manufacturer's instructions.
D. Install plastic tape pipe markers complete around pipe in accordance with manufacturer's instructions.
E. Install underground plastic pipe markers 6 to 8 inches below finished grade, directly above buried pipe.
F. Identify tanks, and water treatment devices with 8 x 4 inch plastic nameplates. Small devices, such as in-line pumps, may be identified with tags.
G. Identify valves in main and branch piping with tags.
H. Identify piping, concealed or exposed, with plastic pipe markers. Use tags on piping 3/4 inch diameter and smaller. Identify service, flow direction. Install in clear view and align with axis of piping. Locate identification not to exceed 20 feet on straight runs including risers and drops, adjacent to each valve and Tee, at each side of penetration of structure or enclosure, and at each obstruction.

END OF SECTION

PLUMBING PIPING INSULATION

PART 1 GENERAL

1.1. SECTION INCLUDES
A. Piping insulation.

1.2. RELATED REQUIREMENTS
A. Section 07 84 00 - Firestopping.
B. Section 22 10 05 - Plumbing Piping: Placement of hangers and hanger inserts.
C. Section 22 05 29 - Hangers and Supports for Plumbing Piping and Equipment.

1.3. REFERENCE STANDARDS
A. ASTM C177 - Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus; 2019.
B. ASTM C195 - Standard Specification for Mineral Fiber Thermal Insulating Cement; 2007 (Reapproved 2013).
C. ASTM C449 - Standard Specification for Mineral Fiber Hydraulic-Setting Thermal Insulating and Finishing Cement; 2007 (Reapproved 2013).
D. ASTM C547 - Standard Specification for Mineral Fiber Pipe Insulation; 2017.
E. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2018.
F. ASTM E96/E96M - Standard Test Methods for Water Vapor Transmission of Materials; 2016.

1.4. SUBMITTALS
A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Product Data: Provide product description, thermal characteristics, list of materials and thickness for each service, and locations.
C. Manufacturer's Instructions: Indicate installation procedures that ensure acceptable workmanship and installation standards will be achieved.

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

1.6. DELIVERY, STORAGE, AND HANDLING
A. Accept materials on site, labeled with manufacturer's identification, product density, and thickness.

1.7. FIELD CONDITIONS

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

PART 2 PRODUCTS

2.1. REGULATORY REQUIREMENTS

A. Surface Burning Characteristics: Flame spread/Smoke developed index of 25/50, maximum, when tested in accordance with ASTM E84.
B. Materials shall not contain pentabrominated diphenyl ethers (PBDEs) in amounts greater than allowed by Oregon law.

2.2. GLASS FIBER

A. Manufacturers:
   1. Knauf Insulation; Pipe Insulation ASJ-SSL: www.knaufusa.com.
   2. Johns Manville; SSL II: www.jm.com.
   3. Owens Corning Corp: www.owenscorning.com.
   4. CertainTeed Corporation: www.certainteed.com.
   5. Knauf Insulation: www.knaufusa.com.
   6. Substitutions: See Section 01 60 00 - Materials and Equipment.
B. Insulation: ASTM C547 ; rigid molded, noncombustible.
   1. 'K' value: ASTM C177, 0.24 at 75 degrees F.
   2. Maximum service temperature: 850 degrees F.
   3. Maximum moisture absorption: 0.2 percent by volume.
C. Vapor Barrier Jacket: White Kraft paper with glass fiber yarn, bonded to aluminized film; moisture vapor transmission when tested in accordance with ASTM E96/E96M of 0.02 perm-inches.
D. Tie Wire: 0.048 inch stainless steel with twisted ends on maximum 12 inch centers.
E. Vapor Barrier Lap Adhesive: Compatible with insulation.
   1. Compatible with insulation.
F. Insulating Cement/Mastic: ASTM C195; hydraulic setting on mineral wool.
   1. ASTM C195; hydraulic setting on mineral wool.
G. Indoor Vapor Barrier Finish:
   1. Cloth: Untreated; 9 oz/sq yd weight.
   2. Vinyl emulsion type acrylic, compatible with insulation, black color.
H. Outdoor Vapor Barrier Mastic: Vinyl emulsion type acrylic or mastic, compatible with insulation, black color.
   1. Vinyl emulsion type acrylic or mastic, compatible with insulation, black color.
I. Outdoor Breather Mastic: Vinyl emulsion type acrylic or mastic, compatible with insulation, black color.
   1. Vinyl emulsion type acrylic or mastic, compatible with insulation, black color.
J. Insulating Cement: ASTM C449.

1. ASTM C449/C449M.

PART 3 EXECUTION

3.1. EXAMINATION

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

3.2. INSTALLATION

A. Install in accordance with manufacturer's instructions.
B. Install in accordance with North American Insulation Manufacturers Association (NAIMA) National Insulation Standards.
C. Exposed Piping: Locate insulation and cover seams in least visible locations.
D. Insulated pipes conveying fluids below ambient temperature: Insulate entire system including fittings, valves, unions, flanges, strainers, flexible connections, pump bodies, and expansion joints.
E. Glass fiber insulated pipes conveying fluids below ambient temperature:
   1. Provide vapor barrier jackets, factory-applied or field-applied. Secure with self-sealing longitudinal laps and butt strips with pressure sensitive adhesive. Secure with outward clinch expanding staples and vapor barrier mastic.
   2. Insulate fittings, joints, and valves with molded insulation of like material and thickness as adjacent pipe. Finish with glass cloth and vapor barrier adhesive or PVC fitting covers.
F. For hot piping conveying fluids 140 degrees F or less, do not insulate flanges and unions at equipment, but bevel and seal ends of insulation.
G. Glass fiber insulated pipes conveying fluids above ambient temperature:
   1. Provide standard jackets, with or without vapor barrier, factory-applied or field-applied. Secure with self-sealing longitudinal laps and butt strips with pressure sensitive adhesive. Secure with outward clinch expanding staples.
   2. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe. Finish with glass cloth and adhesive or PVC fitting covers.
H. Inserts and Shields:
   1. Application: Piping 1-1/2 inches diameter or larger.
   2. Shields: Galvanized steel between pipe hangers or pipe hanger rolls and inserts.
   3. Insert location: Between support shield and piping and under the finish jacket.
   4. Insert configuration: Minimum 6 inches long, of same thickness and contour as adjoining insulation; may be factory fabricated.
   5. Insert material: Hydrous calcium silicate insulation or other heavy density insulating material suitable for the planned temperature range.
I. Continue insulation through walls, sleeves, pipe hangers, and other pipe penetrations. Finish at supports, protrusions, and interruptions. At fire separations, refer to Section 07 84 00.

J. Pipe Exposed in Mechanical Equipment Rooms or Finished Spaces (less than 10 feet above finished floor): Finish with PVC jacket and fitting covers.

3.3. SCHEDULES

A. Plumbing Systems:
   1. Domestic Hot Water Supply:
      a. Glass Fiber, Rigid, Insulation:
         1. Pipe Size Range: Under 2 inch.
         2. Thickness: 1 inch.
         3. Pipe Size Range: Over 2 inch.
         4. Thickness: 1-1/2 inch.
   2. Domestic Hot Water Recirculation:
      a. Glass Fiber Insulation:
         1. Pipe Size Range: All sizes.
         2. Thickness: 1 inch.
   3. Domestic Cold Water:
      a. Glass Fiber, Rigid, Insulation:
         1. Pipe Size Range: 1 inch and under.
         2. Thickness: 1/2 inch.
         3. Pipe Size Range: Over 1 inch.
         4. Thickness: 1 inch.
   4. Roof Drain Bodies: Flexible Duct Wrap with multi-purpose, foil-scrim-kraft jacket. Use tie-wire to secure in place. Minimum thickness: 1 inch.
   5. Roof Drainage Within 10 Feet of the Exterior:
      a. Glass Fiber, Rigid, Insulation:
         1. Pipe Size Range: All sizes.
         2. Thickness: 1 inch.
   6. Roof Drainage Run Horizontal at Roof Level:
      a. Glass Fiber, Rigid, Insulation:
         1. Pipe Size Range: All sizes.
         2. Thickness: 1 inch.

END OF SECTION

PLUMBING PIPING

PART 1 GENERAL

1.1. SECTION INCLUDES

A. Pipe, pipe fittings, specialties, and connections for piping systems.
   1. Sanitary sewer.
   2. Domestic water.
   3. Storm water.
   4. Flanges, unions, and couplings.
   5. Ball valves.
   6. Valves.
   7. Flow controls.
   8. Check valves.
   9. Relief valves.
   10. Strainers.

1.2. RELATED REQUIREMENTS

A. Section 07 84 00 - Firestopping.
B. Section 22 05 29 - Plumbing Hangers and Supports.
C. Section 22 05 49 - Plumbing Seismic Restraint.
D. Section 22 05 53 - Identification for Plumbing Piping and Equipment.
E. Section 31 05 13 - Earthwork.
F. Division 26 - Equipment Wiring: Electrical characteristics and wiring connections.

1.3. REFERENCE STANDARDS

A. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings; 2012.
B. ASME B16.22 - Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings; 2018.
C. ASME B31.9 - Building Services Piping; 2014.
D. ASTM B3 - Standard Specification for Soft or Annealed Copper Wire; 2007.
E. ASTM B32 - Standard Specification for Solder Metal; 2008 (Reapproved 2014).
F. ASTM B42 - Standard Specification for Seamless Copper Pipe, Standard Sizes; 2015a.
G. ASTM B88 - Standard Specification for Seamless Copper Water Tube; 2016.
H. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2018.
I. AWS A5.8M/A5.8 - Specification for Filler Metals for Brazing and Braze Welding; 2011 (Amended 2012).
J. AWWA C651 - Disinfecting Water Mains; 2014.
K. CISPI 301 - Standard Specification for Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste and Vent Piping Applications; 2009 (Revised 2012).
L. CISPI 310 - Specification for Coupling for Use in Connection with Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications; 2011 (Revised 2012).
M. MSS SP-80 - Bronze Gate, Globe, Angle and Check Valves; 2013.
N. NSF 61 - Drinking Water System Components - Health Effects; 2020.

O. NSF 372 - Drinking Water System Components - Lead Content; 2020.
P. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials; Current Edition, Including All Revisions.

1.4. SUBMITTALS
A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Product Data: Provide data on pipe materials, pipe fittings, valves, and accessories. Provide manufacturers catalog information. Indicate valve data and ratings.
C. Project Record Documents: Record actual locations of valves.

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

1.6. REGULATORY REQUIREMENTS
A. Perform work in accordance with applicable plumbing code.
B. Conform to applicable code for installation of backflow prevention devices.
C. Provide certificate of compliance from authority having jurisdiction indicating approval of installation of backflow prevention devices.

1.7. DELIVERY, STORAGE, AND HANDLING
A. Accept valves on site in shipping containers with labeling in place. Inspect for damage.
B. Provide temporary protective coating on cast iron and steel valves.
C. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.
D. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system. Store pipe on sleepers, a minimum of 4 inches above surrounding grade, at all times.

PART 2 PRODUCTS

2.1. GENERAL REQUIREMENTS
A. Potable Water Supply Systems: Provide piping, pipe fittings, and solder and flux (if used), that comply with NSF 61 and NSF 372 for maximum lead content; label pipe and fittings.
B. Plenum-Installed Acid Waste Piping: Flame-spread index equal or below 25 and smoke-spread index equal or below 50 according to ASTM E84 or UL 723 tests.

2.2. SANITARY SEWER PIPING, BURIED WITHIN 5 FEET OF BUILDING

A. Cast Iron Pipe: CISPI 301, hubless.
   1. Fittings: Cast iron.
   2. Joints: Neoprene gaskets and stainless steel clamp-and-shield assemblies. Mission Heavyweight, Husky 4000, Clamp-All 120 system, Ideal Triden, or approved.

2.3. SANITARY SEWER PIPING, ABOVE GRADE

A. Cast Iron Pipe: CISPI 301, hubless, service weight.
   1. Fittings: Cast iron.
   2. Joints: CISPI 310, ASTM 1277, neoprene gaskets and stainless steel clamp-and-shield assemblies.

2.4. SANITARY SEWER VENT PIPING

A. ABS Pipe: ASTM D2661 or ASTM D2751 (Solid Wall).
   1. Fittings: ABS.
   2. Joints: Solvent welded with ASTM D2235 cement.

B. PVC Pipe: ASTM D2665 (Solid Wall).
   1. Fittings: PVC.
   2. Joints: Solvent Welded, with ASTM D2564 solvent cement.

2.5. DOMESTIC WATER PIPING, INDIVIDUAL SUPPLY TO PLUMBING FIXTURES

A. PEX Tube: ASTM F876, SDR9.
   1. Fittings: ASTM F877, brass insert type with metal bands or brass or plastic compression type matching tube dimensions.
   2. Manifold: ASTM F877, multi-outlet, corrosion resistant metal assembly with corrosion resistant metal valve for each outlet.

2.6. DOMESTIC WATER PIPING, BURIED WITHIN 5 FEET OF BUILDING

A. Copper Pipe: ASTM B42, annealed.
   1. Fittings: ASME B16.18, cast copper alloy or ASME B16.22 wrought copper and bronze.
   2. Joints: AWS A5.8, BCuP silver braze.

2.7. DOMESTIC WATER PIPING, ABOVE GRADE

A. Copper Tube: ASTM B88 (ASTM B88M), Type L (B), Drawn (H).
   1. Fittings: ASME B16.18, cast copper alloy or ASME B16.22, wrought copper and bronze.
   2. Joints: ASTM B32, alloy Sn95 solder.

2.8. STORM WATER PIPING, BURIED WITHIN 5 FEET OF BUILDING

A. Cast Iron Pipe: CISPI 301, hubless, service weight.
   1. Fittings: Cast iron.
   2. Joints: Neoprene gaskets and stainless steel clamp-and-shield assemblies. Mission Heavyweight, Husky 4000, Clamp-All 120 system, Ideal Triden, or approved.

2.9. STORM WATER PIPING, ABOVE GRADE

A. Cast Iron Pipe: CISPI 301, hubless, service weight.
   1. Fittings: Cast iron.
   2. Joints: CISPO 310, ASTM 1277, Neoprene gaskets and stainless steel clamp-and-shield assemblies.

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. GATE VALVES

A. Manufacturers:
   1. Hammond Valve Co.; Model IB640/IB641: www.hammondvalve.com.
   2. NIBCO, Inc.; T/S-111-LF: www.nibco.com.
   3. Milwaukee Valve Company; Model 148/1150: www.milwaukeevalve.com.
   4. Stockham; Model B-100/B-122: www.stockham.com.
   5. Apollo Valve: Model 101SLF/101TLF: www.apollovalves.com.
   6. Substitutions: See Section 01 60 00 - Materials and Equipment.
B. Up To and Including 3 Inches:
   1. MSS-SP-13, 300PSI CWP, lead free, bronze body and trim, rising stem, handwheel, inside screw, solid wedge disc, solder or threaded ends.

2.12. BALL VALVES

A. Manufacturers:
   1. Hammond Valve Co.; Model 8501/8901: www.hammondvalve.com.
   2. NIBCO, Inc.; T/S-FP-600A / T/S-585-80-LF: www.nibco.com.
   3. Watts; Model FBV-1/B-6000: www.watts.com.

4. Stockham; Model S216-BR-R-T: www.stockham.com.
5. Apollo; Model 77CLF: www.apollovalves.com.
6. Milwaukee Valve Company; Model BA-125/BA-100: www.milwaukeevalve.com.
7. Substitutions: See Section 01 60 00 - Materials and Equipment.

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

C. Up to and including 3 inches:
1. MSS SP 110, 600 PSI-CWP, bronze, two piece body, lead free brass ball, full port, teflon seats and stuffing box ring, blow-out proof stem, lever handle solder or threaded ends.

2.13. FLOW CONTROLS

A. Manufacturers:
1. NIBCO, Inc.; Model T/S-1805-LF: www.nibco.com.
2. ITT Bell & Gossett: www.bellgossett.com.
3. Griswold Controls: www.griswoldcontrols.com.
4. Taco, Inc.: www.taco-hvac.com.
5. Substitutions: See Section 01 60 00 - Product Requirements.

B. Construction: Class 125, Brass or bronze body with union on inlet and outlet, temperature and pressure test plug on inlet and outlet, blowdown/backflush drain.

C. Calibration: Control flow within 5 percent of selected rating, over operating pressure range of 10 times minimum pressure required for control, maximum minimum pressure 3.5 psi.

2.14. SPRING LOADED CHECK VALVES

A. Manufacturers:
1. Hammond Valve; IR9354: www.hammondvalve.com.
2. NIBCO, Inc.; Model F-910-LF: www.nibco.com.
3. Milwaukee Valve Company; Model Series 1800: www.milwaukeevalve.com.
4. Apollo Valve; Model 910WB: www.apollovalves.com.
5. Substitutions: See Section 01 60 00 - Materials and Equipment.

B. Class 125, globe style, iron body, bronze trim, stainless steel springs, bronze disc, seals, flanged ends.

2.15. RELIEF VALVES

A. Pressure Relief:
1. Manufacturers:
a. Watts Regulator Company: www.wattsregulator.com.
b. Cash-Acme: www.cashacme.com.
c. Zurn/Wilkins: www.zurn.com.

d. Apollo Valve: www.apollovalves.com.
e. Substitutions: See Section 01 60 00 - Materials and Equipment.

2. AGA Z21.22 certified, bronze body, teflon seat, steel stem and springs, automatic, direct pressure actuated.

B. Temperature and Pressure Relief:

1. Manufacturers:
   a. Watts Regulator Company: www.wattsregulator.com.
   b. Cash-Acme: www.cashacme.com.
   c. Zurn/Wilkins: www.zurn.com.
   d. Apollo Valve: www.apollovalves.com.
   e. Substitutions: See Section 01 60 00 - Materials and Equipment.
2. AGA Z21.22 certified, bronze body, teflon seat, stainless steel stem and springs, automatic, direct pressure actuated, temperature relief maximum 210 degrees F, capacity ASME (BPV IV) certified and labelled.

2.16. STRAINERS

A. Manufacturers:

1. Watts Regulator Company: www.wattsregulator.com.
2. Hammond Valve: www.hammondvalve.com.
3. Milwaukee Valve Company: www.milwaukeevalve.com.
4. Apollo: www.apollovalves.com.
5. Stockham: www.stockham.com.
6. Substitutions: See Section 01 60 00 - Materials and Equipment.

B. Size 2 inch and Under:

1. Threaded brass body for 175 psi CWP, Y pattern with 1/32 inch stainless steel perforated screen.
2. Class 150, threaded bronze body 300 psi CWP, Y pattern with 1/32 inch stainless steel perforated screen.

C. Size 1-1/2 inch to 4 inch:

1. Class 125, flanged iron body, Y pattern with 1/16 inch stainless steel perforated screen.

PART 3 EXECUTION

3.1. EXAMINATION

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

3.2. PREPARATION

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

3.3. INSTALLATION

A. Install in accordance with manufacturer's instructions.
B. Provide non-conducting dielectric connections wherever jointing dissimilar metals.
C. Route piping in orderly manner and maintain gradient. Route parallel and perpendicular to walls.
D. Install piping to maintain headroom, conserve space, and not interfere with use of space.
E. Group piping whenever practical at common elevations.
F. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.
G. Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings.
H. Provide access where valves and fittings are not exposed.
I. Establish elevations of buried piping outside the building to ensure not less than 2 ft of cover.
J. Provide tracer wire over top of piping.
    1. Construction:
        a. Conductor: Solid or stranded copper per spec ASTM B-3.
        b. Insulation: High Molecular Weight Polyethylene (HMWPE) ASTM D-1248. Various insulation colors dependant on usage.
        c. Temperature: 70 degrees C dry and wet.
        d. Voltage: 20 and 30 Mil = 30 to 300 volts. 45 Mil = 600 volts.
K. Install vent piping penetrating roofed areas to maintain integrity of roof assembly.
L. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc-rich primer to welding.
M. Prepare exposed, unfinished pipe, fittings, supports, and accessories for finish painting.
N. Excavate in accordance with specifications.
O. Backfill in accordance with specifications.
P. Install valves with stems upright or horizontal, not inverted.
Q. Install water piping to ASME B31.9.
R. Sleeve pipes passing through partitions, walls, and floors.

3.4. APPLICATION

A. Install unions downstream of valves and at equipment or apparatus connections.
B. Install brass male adapters each side of valves in copper piped system. Solder adapters to pipe.
C. Install gate valves for shut-off and to isolate equipment, or part of systems.
D. Install globe valves for throttling, bypass, or manual flow control services.
E. Provide spring-loaded check valves on discharge of water pumps.
F. Provide flow controls in water recirculating systems where indicated.

3.5. TOLERANCES

A. Drainage Piping: Establish invert elevations within 1/2 inch vertically of location indicated and slope to drain at minimum of 1/4 inch per foot slope.

B. Water Piping: Slope at minimum of 1/32 inch per foot and arrange to drain at low points.

3.6. DISINFECTION OF DOMESTIC WATER PIPING SYSTEM

A. Prior to starting work, verify system is complete, flushed, and clean.

B. Ensure acidity (pH) of water to be treated is between 7.4 and 7.6 by adding alkali (caustic soda or soda ash) or acid (hydrochloric).

C. Inject disinfectant, free chlorine in liquid, powder, tablet, or gas form throughout system to obtain 50 to 80 mg/L residual.

D. Bleed water from outlets to ensure distribution and test for disinfectant residual at minimum 15 percent of outlets.

E. Maintain disinfectant in system for 24 hours.

F. If final disinfectant residual tests less than 25 mg/L, repeat treatment.

G. Flush disinfectant from system until residual equal to that of incoming water or 1.0 mg/L.

H. Take samples no sooner than 24 hours after flushing, from 10 percent of outlets and from water entry, and analyze in accordance with AWWA C651.

3.7. SERVICE CONNECTIONS

A. Provide new sanitary sewer services. Before commencing work, check invert elevations required for sewer connections, confirm inverts and ensure that these can be properly connected with slope for drainage and cover to avoid freezing.

B. Provide new water service complete with approved reduced pressure backflow preventer and water meter, pressure reducing valve, and sand strainer.

1. Provide 18 gage, 0.0478-inch galvanized sheet metal sleeve around service main to 6 inch above floor and 6 feet minimum below grade. Size for minimum of 2 inches of loose batt insulation stuffing.

END OF SECTION

PLUMBING PIPING SPECIALTIES

PART 1 GENERAL

1.1. SECTION INCLUDES
A. Floor drains and floor sinks.
B. Trap primers.

1.2. RELATED REQUIREMENTS
A. Section 22 10 05 - Plumbing Piping.
B. Section 22 40 00 - Plumbing Fixtures.
C. Section 22 30 00 - Plumbing Equipment.
D. Division 26 - Equipment Wiring: Electrical characteristics and wiring connections.

1.3. REFERENCE STANDARDS
A. 36 CFR 1191 - Americans with Disabilities Act (ADA) Accessibility Guidelines for Buildings and Facilities; Architectural Barriers Act (ABA) Accessibility Guidelines; current edition.

1.4. SUBMITTALS
A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Product Data: Provide component sizes, rough-in requirements, service sizes, and finishes.
C. Manufacturer's Instructions: Indicate Manufacturer's Installation Instructions: Indicate assembly and support requirements.
D. Project Record Documents: Record actual locations of equipment, cleanouts, backflow preventers, water hammer arrestors.
E. Operation Data: Indicate frequency of treatment required for interceptors.
F. Maintenance Data: Include installation instructions, spare parts lists, exploded assembly views.
G. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
   1. Extra Loose Keys for Outside Hose Bibbs: Two.

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

1.6. DELIVERY, STORAGE, AND HANDLING
A. Accept specialties on site in original factory packaging. Inspect for damage.

PART 2 PRODUCTS (ON THE DRAWINGS)

PART 3 EXECUTION

3.1. INSTALLATION

A. Install in accordance with manufacturer's instructions.
B. Extend cleanouts to finished floor or wall surface. Lubricate threaded cleanout plugs with mixture of graphite and linseed oil. Ensure clearance at cleanout for rodding of drainage system.
C. Encase exterior cleanouts in concrete flush with grade.
D. Install floor cleanouts at elevation to accommodate finished floor.
E. Install approved portable water protection devices on plumbing lines where contamination of domestic water may occur; on janitor rooms, fire sprinkler systems, premise isolation, irrigation systems, flush valves, and interior and exterior hose bibbs.
F. Pipe relief from backflow preventer to nearest drain.
G. Install water hammer arrestors complete with accessible isolation valve on hot and cold water supply piping to lavatories sinks washing machine outlets.
H. Install air chambers on hot and cold water supply piping to each fixture or group of fixtures (each washroom). Fabricate same size as supply pipe or 3/4 inch minimum, and minimum 18 inches long.
I. Install service shut-off valve for trap primers.

END OF SECTION

GENERAL-SERVICE COMPRESSED-AIR SYSTEMS

PART 1 GENERAL

1.1. SECTION INCLUDES

A. Pipe and pipe fittings.
B. Unions and couplings.
C. Air compressor.
D. Air receiver and accessories.
E. Refrigerated air dryer.

1.2. RELATED REQUIREMENTS

A. Section 07 84 00 - Firestopping.
B. Section 22 05 49 - Plumbing Seismic Restraint.
C. Section 22 05 53 - Identification for Plumbing Piping and Equipment: Identification of piping system.
D. Division 26: Electrical characteristics and wiring connections.

1.3. REFERENCE STANDARDS

A. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings; 2012.
B. ASME B16.22 - Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings; 2018.
C. ASME B31.9 - Building Services Piping; 2014.
D. ASTM B32 - Standard Specification for Solder Metal; 2008 (Reapproved 2014).
E. ASTM B88 - Standard Specification for Seamless Copper Water Tube; 2016.
F. MSS SP-80 - Bronze Gate, Globe, Angle and Check Valves; 2013.

1.4. SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Product Data: Provide manufacturers catalog literature with capacity, weight, and electrical characteristics and connection requirements.
C. Test Reports: Submit inspector's certificate for air receiver for inclusion in Operating and Maintenance Manuals.
D. Project Record Documents: Record actual locations of equipment and components. Modify shop drawings to indicate final locations.

1.5. QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience.
B. Pressure Vessels: Comply with applicable code for installation of pressure vessels.
C. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

1.6. DELIVERY, STORAGE, AND HANDLING

A. Accept air compressors, refrigerated air dryer on site in factory-fabricated containers with shipping skids and plastic pipe end protectors in place. Inspect for damage.

B. Protect piping and equipment from weather and construction traffic.

1.7. WARRANTY

A. See Section 01 77 00 - Contract Closeout, for additional warranty requirements.

PART 2 PRODUCTS

2.1. PIPE AND PIPE FITTINGS

A. Copper Tube: ASTM B88 Type K (A), drawn.
   1. Fittings: ASME B16.18, cast copper alloy or ASME B16.22, wrought copper and bronze.
   2. Joints: ASTM B32, solder, Grade Sn95.

B. Aluminum Pipe: AirNet, ASTM B 241, Extruded Aluminum Alloy:
   1. Fittings: Wrought aluminum alloy, ASTM B221.

2.2. VALVES

A. Ball Valves:
   1. Manufacturers:
      a. AirNet; PF Series: www.airnet-system.com.
      b. Substitutions: See Section 01 60 00 - Materials and Equipment.

B. Swing Check Valves:
   1. Manufacturers:
      a. Hammond Valve; Model IB940/IR1124: www.hammondvalve.com.
      b. Nibco, Inc.; Model T-413/F-918B: www.nibco.com.
      c. Stockham; Model B-320/G-931: www.stockham.com.
      d. Milwaukee Valve Company; Model F-2974: www.milwaukeevalve.com.
      e. Substitutions: See Section 01 60 00 - Materials and Equipment.
   2. Up to 3 Inches:
      a. MSS SP-80, Class 125, bronze body and cap, bronze swing disc with rubber seat, solder or threaded ends.

C. Air Outlets:
   1. Quick Connector: 3/8 inch brass, snap on connector with self closing valve, Style A, L, T, or M.

D. Butterfly Valves:
   1. Manufacturer:
      a. AirNet; Black Series: www.sirenet-system.com.

2.3. UNIONS AND COUPLINGS

A. Unions:
   1. AirNet: www.airnet-systems.com.
B. Dielectric Connections: Union with galvanized or plated steel threaded end, copper solder end, water impervious isolation barrier.
C. Flexible Connector: Neoprene with brass threaded connectors.

2.4. COMPRESSOR

A. Owner furnished, Contractor installed.

2.5. AIR DRYER

A. Owner furnished, Contractor installed.

2.6. AIR RECEIVER (S)

A. Owner furnished, Contractor installed.

PART 3 EXECUTION

3.1. INSTALLATION

A. Install equipment in accordance with manufacturer's instructions.
B. Install compressor unit on concrete housekeeping pad.
C. Install compressor unit on vibration isolators. Level and bolt in place.
D. Make air cock and drain connection on horizontal casing.
E. Install line size gate valve and check valve on compressor discharge.
F. Install replaceable cartridge type filter silencer of adequate capacity for each compressor.
G. Connect condensate drains to nearest floor drain.
H. Install valved bypass around air dryer. Factory insulate inlet and outlet connections. Refer to Section 22 05 23.
I. Install valved drip connections at low points of piping system.
J. Install takeoffs to outlets from top of main, with shut off valve after takeoff. Slope takeoff piping to outlets.
K. Install compressed air couplings, female quick connectors, and pressure gauges where outlets are indicated.
L. Install tees instead of elbows at changes in direction of piping. Fit open end of each tee with plug.
M. Identify piping system and components.

3.2. FIELD QUALITY CONTROL

A. See Section 01 45 00 - Contractor's Quality Control Program, for additional requirements.

B. Compressed Air Piping Leak Test: Prior to initial operation, clean and test compressed air piping in accordance with ASME B31.1.
C. Repair or replace compressed air piping as required to eliminate leaks, and retest to demonstrate compliance.
D. Cap and seal ends of piping when not connected to mechanical equipment.

END OF SECTION

PLUMBING EQUIPMENT

PART 1 GENERAL

1.1. SECTION INCLUDES
A. In-line circulator pumps.
B. Water heaters.
C. Expansion Tanks.

1.2. RELATED REQUIREMENTS
A. Section 22 10 05 - Plumbing Piping.
B. Section 22 10 06 - Plumbing Piping Specialties.
C. Division 26: Electrical characteristics and wiring connections.

1.3. REFERENCE STANDARDS
A. UL 174 - Standard for Household Electric Storage Tank Water Heaters; Current Edition, Including All Revisions.

1.4. SUBMITTALS
A. See Section 01 30 00 - Administrative Requirements, for submittals procedures.
B. Product Data:
   1. Provide dimension drawings of water heaters indicating components and connections to other equipment and piping.
   2. Indicate pump type, capacity, power requirements.
   3. Provide certified pump curves showing pump performance characteristics with pump and system operating point plotted. Include NPSH curve when applicable.
   4. Provide electrical characteristics and connection requirements.
C. Project Record Documents: Record actual locations of components.
D. Operation and Maintenance Data: Include operation, maintenance, and inspection data, replacement part numbers and availability, and service depot location and telephone number.
E. Warranty Documentation: Submit manufacturer warranty and ensure that forms have been completed in Owner's name and registered with manufacturer.
F. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
   1. See Section 01 60 00 - Materials and Equipment, for additional provisions.

1.5. QUALITY ASSURANCE
A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience.
B. Identification: Provide pumps with manufacturer's name, model number, and rating/capacity identified by permanently attached label.
C. Performance: Ensure pumps operate at specified system fluid temperatures without vapor binding and cavitation, are non-overloading in parallel or individual operation, operate within 25 percent of midpoint of published maximum efficiency curve.

1.6. CERTIFICATIONS
A. Water Heaters: NSF approved.
B. Electric Water Heaters: UL listed and labeled to UL 174.
C. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc., as suitable for the purpose specified and indicated.

1.7. DELIVERY, STORAGE, AND HANDLING
A. Provide temporary inlet and outlet caps. Maintain caps in place until installation.

1.8. WARRANTY
A. See Section 01 77 00 - Contract Closeout - , for additional warranty requirements.
B. Provide 10 year manufacturer warranty for domestic water heaters.

PART 2 PRODUCTS

2.1. WATER HEATER MANUFACTURERS
A. A.O. Smith Water Products Co: www.hotwater.com.
B. Bradford-White: www.bradfordwhite.com.
C. Rheem Manufacturing Company: www.rheem.com.
D. Substitutions: See Section 01 60 00 - Materials and Equipment.

2.2. COMMERCIAL ELECTRIC WATER HEATERS
A. Type: Factory-assembled and wired, electric, vertical storage.
B. Performance:
   1. As indicated on Drawings.
C. Electrical Characteristics:
   1. Refer to Division 26.
D. Tank: Glass lined welded steel; 4 inch diameter inspection port, thermally insulated with minimum 2 inches glass fiber or polyurethane encased in corrosion-resistant steel jacket; baked-on enamel finish.
E. Controls: Automatic immersion water thermostat; externally adjustable temperature range from 60 to 180 degrees F, flanged or screw-in nichrome elements, high temperature limit thermostat.
F. Accessories: Provide:
   1. Water connections: Brass.
   2. Dip tube.
   3. Drain Valve.
   4. Anode: Magnesium.
   5. Temperature and Pressure Relief Valve: ASME labelled.
G. Heating Elements: Flange-mounted immersion elements; individual elements sheathed with Incoloy corrosion-resistant metal alloy, rated less than 75 Watts per square inch.

2.3. DIAPHRAGM-TYPE COMPRESSION TANKS

A. Manufacturers:
   1. Amtrol Inc.; Model ST-C: www.amtrol.com.
   2. ITT Bell & Gossett; PTA: www.bellgossett.com.
   3. Taco, Inc.: www.taco-hvac.com.
   4. Substitutions: See Section 01 60 00 - Materials and Equipment.

B. Construction: Welded steel, tested and stamped in accordance with ASME BPVC-VIII-1; supplied with National Board Form U-1, rated for working pressure of 125 psig, with flexible EPDM diaphragm sealed into tank, and steel legs or saddles.

C. Accessories: Pressure gage and air-charging fitting, tank drain; precharge as indicated on drawings.

2.4. IN-LINE CIRCULATOR PUMPS

A. Manufacturers:
   1. Armstrong Pumps Inc.: www.armstrongpumps.com.
   2. ITT Bell & Gossett: www.bellgossett.com.
   3. Taco, Inc.: www.taco-hvac.com.
   4. Substitutions: See Section 01 60 00 - Materials and Equipment.

B. Casing: Bronze, rated for 125 psig working pressure, with stainless steel rotor assembly.

C. Impeller: Bronze.

D. Shaft: Alloy steel with integral thrust collar and two oil lubricated bronze sleeve bearings.

E. Seal: Carbon rotating against a stationary ceramic seat.

F. Drive: Flexible coupling.

G. Performance: See Drawings.

PART 3 EXECUTION

3.1. INSTALLATION

A. Install plumbing equipment in accordance with manufacturer's instructions, as required by code, and complying with conditions of certification, if any.

B. Coordinate with plumbing piping work to achieve operating system.

C. Domestic Water Storage Tanks:
   1. Provide steel pipe support, independent of building structural framing members.
   2. Clean and flush prior to delivery to site. Seal until pipe connections are made.

D. Pumps:
   1. Provide line sized isolating valve and strainer on suction and line sized soft seated check valve and balancing valve on discharge.
   2. Ensure pumps operate at specified system fluid temperatures without vapor binding and cavitation, are non-overloading.

END OF SECTION

PLUMBING FIXTURES

PART 1 GENERAL

1.1. SECTION INCLUDES

A. Water closets.
B. Urinals.
C. Lavatories.
D. Sinks.
E. Service sinks.
F. Drinking fountains.
G. Wash fountains.
H. Emergency eye and face wash.

1.2. RELATED REQUIREMENTS

A. Section 06 41 00 - Custom-built Casework and Shelving: Preparation of counters for sinks; lavatory tops.
B. Section 07 92 00 - Joint Sealants: Seal fixtures to walls and floors.
C. Section 22 10 05 - Plumbing Piping.
D. Section 22 10 06 - Plumbing Piping Specialties.
E. Section 22 30 00 - Plumbing Equipment.
F. Division 26 - Equipment Wiring: Electrical characteristics and wiring connections.

1.3. REFERENCE STANDARDS

A. ANSI A117.1 - Accessible and Usable Buildings and Facilities.
B. ANSI Z358.1 - American National Standard for Emergency Eyewash and Shower Equipment; 2014.
C. ASHRAE Std 18 - Methods of Testing for Rating Drinking-Water Coolers with Self-Contained Mechanical Refrigeration; 2013.
D. ASME A112.6.1M - Supports for Off-the-Floor Plumbing Fixtures for Public Use; 1997 (Reaffirmed 2017).
E. ASME A112.18.1 - Plumbing Supply Fittings; 2018.
F. ASME A112.19.1M - Enameled Cast Iron Plumbing Fixtures; The American Society of Mechanical Engineers; 2008 (R2011).
G. ASME A112.19.2 - Ceramic Plumbing Fixtures; 2013.
H. ASME A112.19.3 - Stainless Steel Plumbing Fixtures; 2017.
I. ASME A112.19.4M - Porcelain Enameled Formed Steel Plumbing Fixtures; 1994 (R2009).

1.4. SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Product Data: Provide catalog illustrations of fixtures, sizes, rough-in dimensions, utility sizes, trim, and finishes.
C. Manufacturer's Instructions: Indicate installation methods and procedures.
D. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

E. Maintenance Data: Include fixture trim exploded view and replacement parts lists.
F. Warranty: Submit manufacturer warranty and ensure forms have been completed in Owner's name and registered with manufacturer.
G. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
   1. See Section 01 60 00 - Materials and Equipment, for additional provisions.

1.5. CLOSEOUT SUBMITTALS
A. Section 01 77 00 - Contract Closeout: Closeout procedures.
B. Operation and Maintenance Data: Submit fixture, trim, exploded view and replacement parts lists.

1.6. QUALITY ASSURANCE
A. Perform work in accordance with applicable codes.
B. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience.
C. Installer Qualifications: Company specializing in performing work of this section with minimum three years experience.

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

1.8. PRE-INSTALLATION MEETINGS
A. Section 01 30 00 - Administrative Requirements: Pre-installation meeting.
B. Convene minimum one week prior to commencing work of this section.

1.9. DELIVERY, STORAGE, AND HANDLING
A. Section 01 60 00 - Materials and Equipment: Product storage and handling requirements.
B. Accept fixtures on site in factory packaging. Inspect for damage.
C. Protect installed fixtures from damage by securing areas and by leaving factory packaging in place to protect fixtures and prevent use.

1.10. WARRANTY
A. Section 01 77 00 - Contract Closeout: Product warranties and product bonds.

PART 2 PRODUCTS (ON THE DRAWINGS)

PART 3 EXECUTION

3.1. EXAMINATION
A. Section 01 30 00 - Administrative Requirements: Coordination and project conditions.

B. Verify that walls and floor finishes are prepared and ready for installation of fixtures.
C. Verify that electric power is available and of the correct characteristics.
D. Confirm that millwork is constructed with adequate provision for the installation of counter top lavatories and sinks.

3.2. PREPARATION

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

3.3. INSTALLATION

A. Install work in accordance with all applicable codes.
B. Install each fixture with trap, easily removable for servicing and cleaning.
C. Provide chrome plated rigid or flexible supplies to fixtures with screwdriver stops, reducers, and escutcheons.
D. Install components level and plumb.
E. Install and secure fixtures in place with wall supports and bolts.
F. Seal fixtures to wall and floor surfaces with sealant as specified in Section 07 90 05, color to match fixture.
G. Solidly attach water closets to floor with lag screws. Lead flashing is not intended hold fixture in place.
H. For ADA accessible water closets, install flush valve with handle to wide side of stall.

3.4. INTERFACE WITH WORK OF OTHER SECTIONS

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

3.5. ADJUSTING

A. Section 01 77 00 - Contract Closeout: Testing, adjusting, and balancing.
B. Adjust stops or valves for intended water flow rate to fixtures without splashing, noise, or overflow.

3.6. PROTECTION

A. Protect installed products from damage due to subsequent construction operations.
B. Do not permit use of fixtures by construction personnel.
C. Repair or replace damaged products before Date of Substantial Completion.

END OF SECTION

BASIC HVAC REQUIREMENTS

PART 1 GENERAL

1.1. DESCRIPTION OF WORK

A. This Section specifies the basic requirements for all Contractor installed equipment. It applies to all sections included in Division 23. The requirements herein are an expansion upon the requirements of Division 1.

B. Provide all materials, labor and equipment required to install complete and fully operational HVAC systems as indicated by the contract drawings and this specification.

C. Obtain and pay for all permits, licenses, fees and taxes applicable to this project as required by law.

D. Cooperate with other trades in furnishing material and information required for installation and operation of mechanical items.

E. Requirements for the following are included:
   1. Related work (other Contract Documents and specification sections) that must be combined with the requirements of this Section.
   2. Design performance.
   3. Delivery, storage, and handling.
   4. Quality assurance and standards.
   5. Submittals.
   6. Product quality, basic type, and finishes.
   7. Equipment identification.
   8. Design criteria.
   9. Installation.
   10. Mounting and shimming.
   11. Inspection.
   12. Safety considerations.
   13. Cleaning, startup, and adjustments.

1.2. RELATED WORK

A. This general section shall be used in conjunction with the following other specifications and related Contract Documents to establish the total requirements for the project equipment and systems:
   1. Division 1 sections included in this Project specifications.
   2. The Contract.
   3. General and specific mechanical specifications and drawings included in the project.

1.3. DEFINITIONS

A. “Indicated”: Refers to graphic representations, notes or schedules in the Drawings; or to other paragraphs or schedules in Specifications and similar requirements in the Contract Documents.
   1. Terms such as “shown”, “noted”, “scheduled”, and “specified”, are used to notify or help the user to locate reference. Location is not limited.

B. "Directed": Terms such as "directed", Requested", "authorized", "selected", "approved", "required", and "permitted" mean directed by Architect/Engineer, approved by Architect/Engineer and similar phrases.
C. "Approved": When used in conjunction with Architect/Engineer's action on contract submittals, applications, requests, is limited to Architect/Engineer's duties and responsibilities as stated in the Conditions of the Contract.
D. "Regulations": Includes laws, ordinances, statutes and lawful orders issued by authorities having jurisdiction, as well as rules, conventions and agreements within the construction industry that control performance of Work.
E. "Furnish": Means to supply and deliver to the Project site, ready for unloading, unpacking, assembly, installation and similar operations.
F. "Install": Describes operations at Project site including actual unloading, temporary storage, unpacking, assembling, erecting, placing, anchoring, supporting, isolating, applying, working to dimension, finishing, curing, protecting, cleaning and similar operations.
G. "Provide": Means to furnish and install.
H. "Installer": A contractor, or another entity engaged by the contractor, either as an employee, subcontractor, or contractor of a lower tier, to perform a particular construction activity including installation, erection, application or similar operations.
    1. Installers are required to be experienced in operations they are engaged to perform.
    2. The term "experience" means having successfully completed a minimum of three previous projects similar in scope and size to this Project and within the time frame indicated in the "Quality Assurance" section of the Specifications. In addition, in means being familiar with special requirements indicated and having complied with requirements of authorities having jurisdiction.
I. "Project Site": Is defined as the space available to the Contractor for performing construction activities, either exclusively or in conjunction with others performing other work as part of Project.

1.4. DESIGN PERFORMANCE

A. Compliance by the Contractor and/or Vendor with the provisions of this Specification does not relieve him of the responsibilities of furnishing equipment and materials of proper design, mechanically suited to meet operating guarantees at the specified service conditions.

1.5. SUBMITTALS

A. Product Data: Submit complete sets of manufacturer's product data in .PDF format for approval. All submittals are to be received in no more than (3) three packages. See Division 1 for further information regarding submittal requirements. Literature submitted shall clearly indicate the model number, capacity, rated operating conditions, noise levels, size, weight, support requirements, rough-in data and dimensions, electrical power requirements, wiring diagrams, utility (fuel, air, cooling water, etc.) requirements, and options furnished. Submittals shall include, but are not necessarily limited to the following;

1. HVAC: Boilers; chillers; pumps; air handling units; colling towers; fans; piping; valves; supports and anchors; louvers; grilles; diffusers; controls and the like.
2. Calculations: Provide for factory selection and sizing of all noise attenuation; vibration; isolation; thermal expansion and seismic restraints; with good engineering practice. Include design criteria used and assumptions made.

B. Operation and Maintenance Data: Submit three complete sets of manufacturer's literature bound in a three ring binder for approval. Data shall include installation, start-up, and maintenance instructions, parts lists, and wiring diagrams. Include all material on a CD-ROM or USB device.

C. Substitutions: System design was based upon the equipment and materials listed on the drawings and specifications herein. At contractor's option, another manufacturer's equipment of similar quality, capacity and features may be submitted for prior approval per Section 01 60 00. Prior permission to substitute does not relieve the contractor of the responsibility of including this information in the bound submittal packages.

D. When specified, prepare and submit shop drawings and prints of plans, sections, details and diagrams to minimum scale (1/4" = 1'-0"). Mechanical and pump rooms shall be 1/2" = 1'-0" minimum scale. Drawings shall be coordinated, dimensioned and indicate equipment, recommended clearances, pipe, duct, fire protection and electrical in relation to architectural and structural features. Include minor piping, drains, valves and the like. Indicate exact locations and elevations of valves, piping specialties, access doors, dampers and the like.

E. Shop drawings shall be created and submitted on AutoCAD release 2017 or later.

F. Air Balancing Report: Provide .PDF reports stating the design air and hydronic flow requirements per, air inlet and air outlet and the final adjusted airflow volume for the same.

1.6. QUALITY ASSURANCE

A. Codes and Standards: Comply with the provisions of the following codes, standards and specifications, except where more stringent requirements are shown or specified:

1. State of Oregon "IBC".
2. State of Oregon "IMC".
3. State of Oregon "UPC".
4. State of Oregon "IFC".
5. ANSI/ASHRAE 90 - “Energy Efficient Design of New Buildings….”
6. ANSI/ASHRAE 62 - “Ventilation for Acceptable Indoor Air Quality.”
7. NEBB - “Procedural Standard for Testing, Adjusting and Balancing of Environmental Systems.”
8. SMACNA - "HVAC Duct Construction Standards".
9. NFPA - Section 90B.

B. Wherever the specification call for or describe materials or construction of better quality or larger sizes than are required by the above rules and regulations, these specifications shall govern. Should there be any direct conflict between the above rules and regulations and the specifications the rules shall govern.

C. Drawings: All drawings are diagrammatic and show general design, arrangement, and extent of the systems. Do not scale drawings for rough-in dimensions, nor use as shop drawings.
D. Installer Qualifications: Company specializing in performing the work required with a minimum of five years documented experience.
E. Contractor shall furnish and install all work in accordance with manufacturers' recommendations and instructions.
F. Equipment shall have U.L. label listing.

1.7. MATERIALS AND SUBSTITUTIONS

A. Shop drawings of proposed material and equipment that differ from the specified basis of design materials and equipment shall be accompanied by shop drawings that define changes physical layout and performance. These drawings shall show modifications of architectural, plumbing, electrical and mechanical work required by the proposed materials and equipment such as relocation of flues, drains, piping, ducts, revised electrical circuits, relocation of roof or wall penetrations, revised foundations and the like.

1.8. DELIVERY, STORAGE AND PROTECTION

A. Delivery: Deliver to site with manufacturer's labels intact and legible.
B. Preparation for shipment:
   1. Each unit shall be suitably prepared for the shipment specified and for storage in accordance with manufacturer's instructions in a manner requiring no disassembly prior to operation.
   2. The Contractor shall be solely responsible for the adequacy of the Preparation for Shipment provisions employed with respect to materials and application.
   3. One complete set of Installations, Operating and Maintenance Instructions shall be packed and shipped with the equipment. This set is in addition to the sets that are to be sent directly to the Owner.
C. Handling: Avoid damage. Comply with manufacturer's installation instruction requirements for rigging, unloading and transporting units.
D. Storage: Inside protected from weather, dirt and construction dust. Where necessary to store outside, elevate well above grade and enclose with durable, waterproof wrapping. Cap all pipe ends. Taping pipe ends is not adequate or allowable.

1.9. PROJECT CONDITIONS

A. General: Provide products which are compatible with other portions of the work and provide products with the proper power characteristics and similar adaptations for the project.
B. Arrangement: Arrange ductwork and piping parallel with primary lines of the building construction and with a minimum 7 feet overhead clearance in unfinished equipment rooms where possible. Conceal all piping and ductwork where possible unless indicated otherwise. Locate operating and control equipment properly to provide easy access for

operation and maintenance. Give right-of-way to piping which must be sloped for drainage. Set all equipment level or as recommended by manufacturer.

C. Coordination: Where several elements of the work must be sequenced and positioned in order to fit the available space, prepare shop drawings showing the actual physical dimensions (at accurate scale) required for installation and submit prior to purchase/fabrication/installation of any of the elements involved in the coordination.

1.10. STANDARDS

A. General: Provide all new materials and equipment, identical to apparatus or equipment in successful operation for a minimum of five years. Provide materials of comparable quality omitted here but necessary to complete the work. Maximum allowable variation from stated capacities, minus 5% to plus 10% as approved in each case.

B. Governing Standards: The following are typical standards generally referenced in these specifications and identified by their acronym. Federal Specifications (FS), American Society for Testing Materials (ASTM), American National Standards Institute (ANSI), Manufacturer's Standardization Society of the Valve and Fitting Industry, Standard Practice (MSS SP-69), Cast Iron Soil Pipe Institute (CISPI), Underwriters Laboratory (UL) numbers are given.

C. Wherever the specifications call for or describe materials or construction of better quality or larger sizes than are required by the above standards or code, these specifications shall govern. For any direct conflict between the specifications and the above standards or codes, the standards and codes shall govern.

1.11. WARRANTIES

A. Comply with Division 01 section - Project Closeout.

B. Equipment under this section of the specifications shall be guaranteed for a period of one year from date of acceptance against defective materials, design, and workmanship.

C. Contractor shall leave entire installation in complete working order and free from defects in material, workmanship, or finish.

D. The HVAC contractor, by accepting these specifications and by signing the sub-contract, shall guarantee the following:

1. All equipment, material, and workmanship against defects in material and workmanship for a period of one (1) year from date of final acceptance by the Owner. The HVAC contractor shall furnish written guarantee to replace defective work and materials furnished under this section, at no cost to the Owner, for this one (1) year period.
2. That equipment and material will produce the results specified.

E. The Owner reserves the right to make temporary repairs as necessary to keep equipment in operating condition without voiding the guarantees or relieving responsibility during the guarantee period.

F. Provide, at no cost to the Owner, one qualified service technician for an 8-hour period after a period of 90 calendar days from date of acceptance of systems by Owner to repair, replace any latent deficiency.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.1. LAYOUT AND COORDINATION

A. Site Examination: Before starting work, carefully examine site and all Contract Drawings. Become thoroughly familiar with conditions governing work on this project. Verify all indicated elevations, building measurements, rough-in dimensions and equipment locations before proceeding with any work.

B. Utility Locations: The location of all utilities, wires, conduits, pipes, ducts, or other service facilities are shown in a general way only on the drawings and in some instances are taken from existing drawings. Ascertain whether any additional facilities other than those shown on the plans may be present and determine the exact location and elevations of all utilities prior to commencing installation.

C. The inclusion and proper location of supports, pads, sleepers, openings, anchoring and the like provided by others is the responsibility of the contractor under this section. Cutting and/or boring shall be permitted under this section only with the written approval or the Architect.

D. It shall be the contractor's responsibility to coordinate and have provided by other trades where not covered by the Contractor's work scope of work all electrical wiring and power to equipment, controls and devices, all plumbing and any other work from other trades as required to provide fully functional HVAC systems per contract documents.

E. Discrepancies: Any error, conflict or discrepancy in Drawings, Specifications and/or existing conditions shall be reported immediately. Do not proceed with any questionable items of work until clarification of same has been made. Should rearrangement or re-routing of piping or ductwork be necessary, provide for approval the simplest layout possible for that particular portion of the work. Under no circumstances shall beams, girders, footings or columns be cut for mechanical items. Casting of pipes into concrete is prohibited unless so shown on Drawings.

F. The Contractor shall cooperate with others to avoid interferences and delays in the construction work.

G. Interference as a result of poor coordination or lack of cooperation with other trades shall be corrected at the Contractor's expense.

3.2. CUTTING AND PATCHING

A. General: Perform cutting and patching in accordance with Division 1.

B. Protection: During cutting and patching, protect adjacent installations. Provide temporary barriers to prevent the spread of dust and dirt outside of the immediate work area.

C. Repair: Patch finished surfaces and building components using new materials to match the existing.

D. Inspection: Upon written direction from the Architect, uncover and restore work to provide for observation of concealed work.

3.3. MECHANICAL EQUIPMENT WIRING

A. Provide all motor starters, control devices, and wiring complete from power source indicated on Drawings.

B. Equipment and systems shown on the Drawings and/or specifications, are based upon requirements of specific manufacturers which are intended as somewhat typical of several makes which may be approved. Provide all field wiring and/or devices necessary for a complete and operable system controls for the actual selected equipment/system.

3.4. INSTALLATION

A. Manufacturer's directions shall be followed in cases where the manufacturers of materials and equipment used in this contract furnish directions covering points not shown in the drawings and specifications.

B. Locating and Positioning Equipment: Observe all Codes and Regulations and good common practice in locating and installing mechanical equipment and material so that completed installation presents the least possible hazard. Maintain recommended clearances for repair and service to all equipment.

C. Anchorage: Anchor and/or brace all mechanical equipment, piping and ductwork to resist displacement due to seismic action, include snubbers on equipment mounted on spring isolators.

D. Where mounting heights or locations are not identified, install systems, equipment and materials to provide maximum headroom.

E. Provide clearance for installation of insulation and access to valves, fittings, damper actuators, etc. on pipe and duct systems.

F. Install systems, materials and equipment giving right of way to systems required to be installed at a specific slope or operation by gravity.

G. Provide condensate drain piping to over nearest floor drain for all coils, furnaces, boilers, domestic water heaters and the likes.

H. Provide all sheaves required for final air balance. Contractor shall not make assumptions or exceptions concerning the number of sheave replacements or adjustments necessary to meet the design requirements. Balance all HVAC systems to provide the amount of air indicated at each diffuser, grille or register.

I. Do not operate fans for any purpose until ductwork is clean, filters in place, bearings lubricated, and the fan has been test run under observation. Fans shall not be used during construction unless specifically authorized by the Owner and reviewed by the Engineer.

J. Provide balancing dampers on duct take-off to diffusers, grilles, and registers, regardless of whether dampers are specified as part of the diffuser, grille, or register assembly.

K. Installation shall be in accordance with the requirements of the equipment manufacturer, including special requirements for seismic restraints.

L. Equipment Manufacturer's Responsibility and Services:

1. A manufacturer's representative for major equipment and operating systems shall be provided as necessary to assist the Contractor during installation, and to provide written certification that the equipment has been installed as specified and in accordance with the manufacturer's representative.

2. The manufacturer's representative shall provide the initial startup of equipment in the presence of the Owner.
   a. Provide a pre-start check of all piping, valves, control devices, control panels, and equipment.
   b. Calibrate and adjust equipment and controls for operation at the specified design and conditions.
   c. Provide a record of all startup events noting problems and their resolution.
   d. Provide a record of all set points for operational controls and devices.
3. Upon the completion of the equipment startup, provide instructional time with the Owner's personnel to review the operations and maintenance manuals and perform each step necessary for startup, shutdown, troubleshooting, and routine maintenance. The instructional time shall be scheduled through the Owner.
4. Upon completion of the inspections, startup, testing, and checkout procedures, the equipment manufacturer shall submit written notice to the Owner that the units are ready for use by the Owner. Provide a certificate of calibration for all equipment.

3.5. MOUNTING AND SHIMMING

A. Mount equipment as shown on the Drawings. Provisions for mounting special equipment on spring isolators, snubbers, and inertia bases are specified in Section 23 05 48, Vibration Isolation and Sound and Seismic Controls for HVAC Piping and Equipment.

B. Level the equipment by means of 304 stainless steel wedges (stainless steel plates and stainless steel shims). Wedge taper shall not be greater than 1/4 inch per foot. Use double wedges to provide a level bearing surface for the equipment. Secure each pair of wedges in their final positions with one tack weld on each side after leveling is complete. Wedging shall be executed in a manner that will prevent a change in level or springing of the Baseplate when the anchor bolts are tightened.
   1. Adjust rotating equipment assemblies such that the driving units are properly aligned, plumb and level with the driven units and all interconnecting shafts and couplings.
   2. All rotating equipment shall be checked for proper alignment with dial indicators or laser after completion of grouting. The alignment must be within the tolerances required by the equipment manufacturer. The final alignment check shall be witnessed by the Owner.

3.6. INSPECTION

A. The Contractor shall inspect his work to ensure the installation and workmanship is in accordance with these specifications and acceptable industry standards for the work being done.

B. All materials, equipment, and workmanship shall be subject to inspection at any time by the Owner. Contractor shall correct any work, materials, or equipment not in accordance with the Contract Documents.

C. Any work enclosed or covered up prior to inspection and testing shall be uncovered. After the work has been tested, inspected and accepted, repair as necessary to return disturbed work to its original and proper condition at no cost to the Owner.

3.7. SAFETY CONSIDERATIONS

A. All equipment shall be installed with suitable access clearances that satisfy OSHA and code requirements for maintenance or removal of replaceable parts and components, and with necessary unions or flanges to perform the maintenance or removal without removing the connecting appurtenances.

B. Where equipment requiring periodic maintenance cannot be reached by normal walkways because of interference with ductwork, piping, or other obstructions the Contractor shall notify the Owner and propose an alternate safe means of access. These may include construction of an overhead platform with stairway or ladder ends and safety railings or handholds, or walk-through duct plenums with hinged access doors, or as required to meet OSHA standards for safe maintenance procedures.

3.8. CLEANING, START-UP, AND ADJUSTING

A. The Contractors shall be responsible for proper operation of all systems, minor subsystems, and services provided under this section. He shall coordinate start-up procedures, calibration, and system checkout with all project managers. Any system operational problems shall be diagnosed; all correctional procedures shall be initiated as required to bring out the system into compliance with the design, and the problem then shall be rechecked to verify that the system operates normally.

B. Thoroughly clean all parts of the installation at the completion of the work. The Contractor shall clean up and remove from the premises all refuse material, crates, and rubbish arising from his work. Remove, clean, and reinstall all filters. Belt-drive tensions and alignments shall be checked. All motors and bearings shall be lubricated in accordance with the manufacturer's service manuals prior to equipment start-up. Provide a lubrication schedule for every item of equipment furnished under this section. The schedule shall include the type of lubricant and the application frequency.

END OF SECTION

VIBRATION ISOLATION AND SOUND AND SEISMIC CONTROLS FOR HVAC PIPING AND EQUIPMENT

PART 1 GENERAL

1.1. SECTION INCLUDES

A. Vibration-isolated equipment support bases.
B. Vibration isolators.
C. External seismic snubber assemblies.
D. Seismic restraint systems.
E. Vibration-isolated and/or seismically engineered roof curbs.
F. Duct Silencers.
G. Cross-Talk Silencers.

1.2. RELATED REQUIREMENTS

A. Section 22 15 00 - General Service Compressed Air System.
B. Section 23 05 49 - HVAC Seismic Restraint.

1.3. REFERENCE STANDARDS

A. ASCE 19 - Structural Applications of Steel Cables for Buildings; 2016.
B. ASHRAE (HVACA) - ASHRAE Handbook - HVAC Applications; Most Recent Edition Cited by Referring Code or Reference Standard.
C. FEMA 412 - Installing Seismic Restraints for Mechanical Equipment; 2002.
D. FEMA 414 - Installing Seismic Restraints for Duct and Pipe; 2004.
E. FEMA E-74 - Reducing the Risks of Nonstructural Earthquake Damage; 2012.
F. MFMA-4 - Metal Framing Standards Publication; 2004.
G. SMACNA (SRM) - Seismic Restraint Manual Guidelines for Mechanical Systems; 2008.

1.4. SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Product Data:
   1. Provide manufacturer's product literature documenting compliance with PART 2 PRODUCTS.
   2. Include seismic rating documentation for each isolator and restraint component accounting for horizontal, vertical, and combined loads.
C. Shop Drawings:
   1. Provide schedule of vibration isolator type with location and load on each.
   2. Include selections from prescriptive design tables that indicate compliance with the applicable building code and the vibration isolator manufacturer's requirements.
   3. Clearly indicate the load and capacity assumptions selected. Include copies of any calculations.
   4. Include the calculations that indicate compliance with the applicable building code for seismic controls and the vibration isolator manufacturer's requirements.

5. Include the seal of the Professional Structural Engineer registered in the State of Oregon in which the Project is located, on drawings and calculations which at a minimum include the following:
    a. Seismic Restraint Details: Detailed drawings of seismic restraints and snubbers including anchorage details that indicate quantity, diameter, and depth of penetration, edge distance, and spacing of anchors.
    b. Equipment Seismic Qualification Certification: Certification by the manufacturer or responsible party that each piece of equipment provided will withstand seismic force levels as specified in the applicable building code for seismic controls.
        1. Basis for Certification: Indicate whether the withstand certification is based on actual testing of assembled components, on calculations, or on historic data.
        2. Indicate equipment to be sufficiently durable to resist design forces and or remain functional after the seismic event.
    c. Dimensioned outline drawings of equipment identifying center of gravity, locations, and provisions for mounting and anchorage.
    d. Detailed description of the equipment anchorage devices on which the certifications are based.

D. Manufacturer's Instructions: Indicate installation instructions with special procedures and setting dimensions.

1.5. QUALITY ASSURANCE

A. Comply with applicable building code.
B. Perform design and installation in accordance with applicable codes.
C. Designer Qualifications: Perform design under direct supervision of a Professional Structural Engineer experienced in design of this type of work and registered and licensed in Oregon.
D. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section, with not less than three years of documented experience.
    1. Member of Vibration Isolation and Seismic Control Manufacturers Association (VISCMA).
E. Installer Qualifications: Company specializing in performing the work of this section with minimum three years of documented experience.
F. Testing Agency Qualifications: Independent firm specializing in performing testing and inspections of the type specified in this section.

PART 2 PRODUCTS

2.1. MANUFACTURERS

A. Kinetics Noise Control, Inc.: www.kineticsnoise.com.
B. Mason Industries: www.mason-ind.com.

C. M.W. Saussé & Co., Inc.; www.vibrex.net.
D. Amber/Booth Company: www.amberbooth.com.
E. Substitutions: See Section 01 60 00 - Materials and Equipment.

2.2. PERFORMANCE REQUIREMENTS

A. General:
1. All vibration isolators, base frames and inertia bases to conform to all uniform deflection and stability requirements under all operating loads.
2. Steel springs to function without undue stress or overloading.
3. Steel springs to operate in the linear portion of the load versus deflection curve over deflection range of not less than 50 percent above specified deflection.
4. Lateral to vertical stiffness ratio to not exceed 0.08 with spring deflection at minimum 75 percent of specified deflection.

B. Provide vibration isolation on motor driven equipment over 2.0 hp, plus connected piping and ductwork.
C. Provide minimum static deflection of isolators for equipment as follows:
1. Upper Floors, Normal
a. 400 - 600 rpm: 3.5 inch
b. 600 - 800 rpm: 2 inch
c. 800 - 900 rpm: 1 inch
d. 1100 - 1500 rpm: 0.5 inch
e. Over 1500 rpm: 0.2 inch

2.3. VIBRATION ISOLATORS

A. General Requirements:
1. Resilient Materials for Vibration Isolators: Oil, ozone, and oxidant resistant.
B. Non-Seismic Type:
1. All Elastomeric-Fiber Glass Pads:
a. Configuration: Flat or molded.
b. Thickness: 0.25 inch minimum.
c. Assembly: Single or multiple layers using bonded, galvanized sheet metal separation plate between each layer with load plate providing evenly distributed load over pad surface.
2. Elastomeric Mounts:
a. Material: Oil, ozone, and oxidant resistant compounds.
b. Assembly: Encapsulated load transfer plate bolted to equipment and base plate with anchor hole bolted to supporting structure.
3. Steel Springs:
a. Assembly: Freestanding, laterally stable without housing.
b. Leveling Device: Rigidly connected to equipment or frame.
4. Restrained Steel Springs:

a. Housing: Rigid blocking during rigging prevents equipment installed and operating height from changing during temporary weight reduction.
b. Equipment Wind Loading: Adequate means for fastening isolator top to equipment and isolator base plate to supporting structure.

5. Elastomeric Hangers:
   a. Housing: Steel construction containing elastomeric isolation element to prevent rod contact with housing and short-circuiting of isolating function.
   b. Furnish steel load distribution plate sandwiching elastomeric element to housing.
6. Spring Hanger:
   a. Housing: Steel construction containing stable steel spring and integral elastomeric element preventing metal to metal contact.
   b. Bottom Opening: Sized to allow plus/minus 15 degrees rod misalignment.
7. Combination Elastomeric-Spring Hanger:
   a. Housing: Steel construction containing stable steel spring with elastomeric element in series isolating upper connection of hanger box to building structure.
   b. Bottom Opening: Sized to allow plus/minus 15 degrees rod misalignment.
8. Thrust Restraints:
   a. Housing: Steel construction containing stable steel spring and integral elastomeric element installed in pairs to resist air pressure thrusts.
   b. Bottom Openings: Sized to allow plus/minus 15 degrees rod misalignment.

C. Seismic Type:
1. Coil Springs Consisting of Multiple Elements:
   a. Housing: Manufactured from cast iron, cast aluminum, or steel material.
   b. Ductile Material: Designed and rated for seismic applications.
   c. Spring: Restrained by housing without significant degradation of vibration isolation capabilities during normal equipment operating conditions.
   d. Resilient Snubbing Grommet System: Incorporated and designed with clearances of no more than 0.25 inch in any direction preventing direct metal-to-metal contact between supported member and fixed restraint housing.
   e. Resilient Pad: Located in series with spring.
   f. Coil Springs: Color coded elements to have a lateral stiffness greater than 0.8 times the rated vertical stiffness with 50 percent overload capacity.
   g. Finish: Suitable for the application.
2. All Directional Elastomeric:
   a. Material: Molded from oil, ozone, and oxidant resistant compounds.
   b. Operating Parameters: Designed to operate within the isolator strain limits providing maximum performance and service life.
   c. Attachment Method: Encapsulated load transfer plate bolted to equipment and base plate with anchor hole bolted to supporting structure.

d. Rating: Cast iron and aluminum housings rated for seismic restraint applications.
e. Minimum Operating Static Deflections: Deflections indicated in project documents are not to exceed published load capacities.

2.4. EXTERNAL SEISMIC SNUBBER ASSEMBLIES

A. Description: Steel snubbing assemblies designed for external attachment to both equipment and supporting structure that, as part of a complete system, restrain equipment motion in all directions during a seismic event while maintaining vibration isolation during normal operation.
B. Seismic Snubbing Elements:
   1. Air Gap: Between 0.125 inches and 0.25 inches unless otherwise indicated.
   2. Points of Contact: Cushioned with resilient material, minimum 0.25 inch thick; capable of being visually inspected for damage and replaced.
C. Comply with:
   1. ASHRAE Handbook - HVAC Applications
   2. FEMA 412
   3. FEMA 413
   4. FEMA 414
   5. FEMA E-74
   6. SMACNA - Seismic Duct Restraint Manual
D. All Directional External:
   1. Application: Minimum three (3) snubbers are required for each equipment installation, oriented properly to restrain isolated equipment in all directions.
   2. Construction: Interlocking steel construction attached to the building structure and equipment in a manner consistent with anticipated design loads.
   3. Performance: Equipment movement at each snubber location limited to a maximum of 0.25 inches in any direction without significantly degrading the vibration isolation capability of the isolator during normal operating conditions.
   4. Resilient Pad: Minimum 0.25 inch thick cushions any impact and prevents metal-to-metal contact.
E. Lateral External:
   1. Application: Minimum three (3) snubbers are required for each stable equipment installation, oriented properly to restrain isolated equipment in all lateral directions where uplift forces are zero or addressed by other restraints.
   2. Construction: Steel construction attached to the building structure and equipment in a manner consistent with anticipated design loads.
   3. Performance: Equipment movement at each snubber location limited to a maximum of 0.25 inches in any direction without significantly degrading the vibration isolation capability of the isolator during normal operating conditions.
   4. Resilient Pad: Minimum 0.25 inch thick cushions any impact and prevents metal-to-metal contact.
F. Omni Directional External:

1. Application: Minimum four (4) snubbers are required for each stable equipment installation, oriented properly to restrain isolated equipment in all lateral directions.
2. Construction: Steel construction attached to the building structure and equipment in a manner consistent with anticipated design loads.
3. Performance: Equipment movement at each snubber location limited to a maximum of 0.25 inches in any direction without significantly degrading the vibration isolation capability of the isolator during normal operating conditions.
4. Resilient Pad: Minimum 0.25 inch thick cushions any impact and prevents metal-to-metal contact.

G. Horizontal Single Axis External:
1. Application: Minimum four (4) snubbers are required for each stable equipment installation, oriented properly to restrain isolated equipment in all lateral directions where uplift forces are zero or addressed by other restraints.
2. Construction: Steel construction attached to the building structure and equipment in a manner consistent with anticipated design loads.
3. Performance: Equipment movement at each snubber location limited to a maximum of 0.25 inches in any direction without significantly degrading the vibration isolation capability of the isolator during normal operating conditions.
4. Resilient Pad: Minimum 0.25 inch thick cushions any impact and prevents metal-to-metal contact.

2.5. SEISMIC RESTRAINT SYSTEMS

A. Description: System components and accessories specifically designed for field assembly and attachment of seismic restraints.

B. Cable Restraints:
1. Comply with ASCE 19.
2. Cables: Pre-stretched, galvanized steel wire rope with certified break strength.
3. Cable Connections: Use only swaged end fittings. Cable clips and wedge type end fittings are not permitted in accordance with ASCE 19.
4. Use protective thimbles for cable loops where potential for cable damage exists.

C. Rigid Restraints: Use MFMA-4 steel channel (strut), steel angle, or steel pipe for structural element; suitable for both compressive and tensile design loads.

D. Comply with:
1. ASHRAE Handbook - HVAC Applications
2. FEMA 412
3. FEMA 413
4. FEMA 414
5. FEMA E-74
6. SMACNA - Seismic Duct Restraint Manual

E. Cable Restraints:
1. Wire Rope: Steel wire strand cables sized to resist seismic loads in all lateral directions.

2. Protective Thimbles: Eliminates potential for dynamic cable wear and strand breakage.
3. Size: Based on the lesser of cable capacity or anchor load taking into account bracket geometry.
4. Connections:
   a. Use overlapping wire rope U clips, cable clamping bolts, swaged sleeves or seismically rated tool-less wedge insert lock connectors.
   b. Internally brace clevis hanger bracket cross bolt to prevent deformation.
5. Vertical Suspension Rods: Attach required bracing of sufficient strength to prevent rod buckling from vertical compression forces utilizing series of attachment clips.

F. Rigid Restraints:
1. Structural Element: Sized to resist seismic loads in all lateral directions and carry both compressive and tensile loading.
2. Size: Based on the lesser of cable capacity or anchor load taking into account bracket geometry.
3. Connections: Internally brace clevis hanger bracket cross bolt to prevent deformation.
4. Static Support System: Anchorage capable of carrying additional tension loads generated by the vertical component of the rigid brace compression which is additive to any static load requirements on the system.
5. Vertical Suspension Rods: Attached required bracing of sufficient strength to prevent rod buckling from vertical compression forces utilizing series of attachment clips.

2.6. VIBRATION-ISOLATED AND/OR SEISMICALLY ENGINEERED ROOF CURBS

A. Vibration Isolation Curbs:
1. Nonseismic Curb Rail:
   a. Location: Between existing roof curb and rooftop equipment.
   b. Construction: Aluminum or steel.
   c. Integral vibration isolation to comply with requirements of this section.
   d. Weather exposed components consist of corrosion resistant materials.
2. Nonseismic Curb:
   a. Location: Between structure and rooftop equipment.
   b. Construction: Aluminum or steel.
   c. Integral vibration isolation to comply with requirements of this section.
   d. Weather exposed components consist of corrosion resistant materials.

B. Seismic Type:
1. Non-isolated Curb and Fabricated Equipment Piers:
   a. Location: Between structure and rooftop equipment.
   b. Construction: Steel.
   c. Weather exposed components consist of corrosion resistant materials.

2. Vibration Isolation Curb:
   a. Location: Between structure and rooftop equipment.
   b. Construction: Steel.
   c. Integral vibration isolation to conform to requirements of this section.
   d. Snubbers consist of minimum 0.25 inch thick resilient pads to avoid metal-to-metal contact without compromising vibration isolating capabilities.
   e. Weather exposed components consist of corrosion resistant materials.

2.7. DUCT SILENCERS

A. Manufacturers:
   1. VAW Systems.
   2. Industrial Acoustics Co.; www.industrialacoustics.com.
   3. Rink Sound Control: www.ruskin.com.
   4. Commercial Acoustics: www.commercialacoustics.com.
   5. Substitutions: See Section 01 60 00 - Product Requirements.

B. Description: Duct section with sheet metal outer casing, sound absorbing fill material, and inner casing of perforated sheet metal; incorporating interior baffles of similar construction. Fabricate in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible, capable of withstanding -10in. wg. static pressure.

C. Configuration: Tubular with inner casing and liner, with absorptive aerodynamically shaped center body with nose cone and truncated tail cone, diameter as indicated on Drawings.

D. Configuration: Rectangular with lined splitters with radius nose and contoured tails, minimum 5 feet long.

E. Length: See Drawings.

F. Size: See Drawings.

G. Materials:
   1. Outer Casing: Minimum 22 gage thick galvanized steel stiffened with mastic filled lock formed seams, 4 inch long, 11 gage slip joints on both ends.
   2. Inner Casing and Splitters: Minimum 22 gage thick perforated galvanized steel.
   3. Fill: Glass fiber or mineral wool of minimum 4 lb/cu ft density.
   4. Fill Liner: Bonded glass fiber matting. 1 mil Mylar film.

H. Rating: See Drawings.

2.8. CROSS-TALK SILENCERS

A. Manufacturers:
   1. VAW Systems.
   2. Industrial Acoustics Co.; Model Quietvent Silencers: www.industrialacoustics.com.
   3. Rink Sound Control; Model Soun Chek Air Vent Silencers: www.ruskin.com.
   4. Commercial Acoustics; Model TS/DS/CS Transfer Silencers: www.commercialacoustics.com.

5. Substitutions: See Section 01 60 00 - Product Requirements.

B. Description: Duct section with sheet metal outer casing, sound absorbing fill material, and inner casing of perforated sheet metal; incorporating interior baffles of similar construction. Fabricate in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible.

C. Configuration: Rectangular, lined with inner casings with splitters with radius nosed and contoured tails, dimensions and configuration as required.

D. Materials:
1. Outer Casing: Minimum 22 gage thick galvanized steel stiffened with mastic filled lock formed seams, 3 inch long, 11 gage slip joints on both ends.
2. Inner Casing and Splitters: Minimum 24 gage thick perforated galvanized steel.
3. Fill: Glass fiber or mineral wool of minimum 4 lb/cu ft density.
4. Fill Liner: Bonded glass fiber matting. 1 mil Mylar film.

E. Rating:
1. Speech Interference Level (SIL): Minimum 40dB.
2. Static Pressure Drop at 200 fpm Face Velocity: less than 0.05 inches wg.

PART 3 EXECUTION

3.1. INSTALLATION

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

B. Install anchors and fasteners in accordance with ICC Evaluation Services, LLC (ICC-ES) evaluation report conditions of use where applicable.

C. Secure fasteners according to manufacturer's recommended torque settings.

D. Install flexible piping connections to provide sufficient slack for vibration isolation and/or seismic relative displacements as indicated or as required.

3.2. INSTALLATION - GENERAL

A. Install in accordance with manufacturer's instructions.

B. On closed spring isolators, adjust so side stabilizers are clear under normal operating conditions.

C. Prior to making piping connections to equipment with operating weights substantially different from installed weights, block up equipment with temporary shims to final height. When full load is applied, adjust isolators to load to allow shim removal.

D. Support piping connections to equipment mounted on isolators using isolators or resilient hangers as follows:
1. Up to 4 Inches Pipe Size: First three points of support.

3.3. INSTALLATION - SEISMIC

A. Refer to Section 23 0549.

3.4. FIELD QUALITY CONTROL

A. See Section 01 45 00 - Contractor's Quality Control Program, for additional requirements.
B. Inspect vibration isolation and/or seismic control components for damage and defects.
C. Correct deficiencies and replace damaged or defective vibration isolation and/or seismic control components.
D. Inspect isolated equipment after installation and submit report. Include static deflections.

END OF SECTION

HVAC SEISMIC RESTRAINT

PART 1 GENERAL

1.1. SECTION INCLUDES

A. Seismic restraint of equipment, piping and ductwork.

1.2. RELATED SECTIONS

A. Section 23 00 00 - Basic HVAC Requirements.
B. Section 23 05 48 - Vibration Isolation and Sound and Seismic Controls for HVAC Piping and Equipment.
C. Section 23 31 00 - HVAC Ducts and Casings.
D. Section 23 36 00 - Air Terminal Units.
E. Section 23 73 13 - Modular Indoor Central-Station Air-Handling Units.
F. Section 23 74 13 - Packaged Outdoor Central-Station Air-Handling Units.
G. Section 23 81 27 - Split-System Heating and Cooling.

1.3. QUALITY ASSURANCE

A. Seismic Restraints:
    1. The Anchorage and/or seismic restraint of permanent equipment and associated systems listed below shall be designed to resist the total design seismic forces prescribed in the latest edition of the International Building Code.
        a. All floor or roof-mounted equipment weighing 400 lbs. or greater.
        b. All suspended or wall-mounted equipment weighing 20 lbs. or greater.
        c. All vibration-isolated equipment weighing 20 lbs. or greater.
        d. All piping 1 1/4 inches nominal diameter and larger located in boiler, mechanical equipment and refrigeration mechanical rooms.
        e. All piping 2 1/2" inches nominal diameter and larger.
        f. All ductwork 6 square feet and larger in cross sectional area.
        g. All round ductwork 28 inches in diameter and larger.
        h. Pipes, electrical conduit and ducts supported by a trapeze where none of those elements would individually require bracing, require bracing when the combined operating weight of all elements supported by the trapeze is 10 lbs/ft or greater.
B. All calculations shall be in accordance with Chapter 16 of the latest edition of the International Building Code.

1.4. SUBMITTALS

A. Submit the following in accordance with Section 01 30 00:
    1. All anchorage and seismic restraints shall be designed and stamped by a professional engineer licensed in the state of the project location. Design shall include:
        a. Number, size and location of anchors for floor or roof-mounted equipment. For curb-mounted equipment, provide design of attachment of both the

unit to the curb and the curb to the structure. In addition, provide calculations or test data verifying the curb can accept the seismic loads.

b. Number, size and location of seismic restraint devices and anchors for vibration-isolated and suspended equipment. Provide calculations or test data verifying the horizontal and vertical ratings of the seismic restraint devices.

c. Number, size and location of braces and anchors for suspended piping and ductwork on shop drawings. In addition:

1. The contractor must select a single seismic restraint system pre-designed to meet the requirements of the latest edition of the International Building Code such as the 2011 Mason Industries Seismic Restraint Guidelines for Suspended Piping, Ductwork, Electrical Systems and floor and roof mounted equipment.
2. Details or designs from separate seismic restraint guidelines are not acceptable. Installations not addressed by the selected system must be designed, detailed and submitted along with the shop drawings.
3. Maximum seismic loads shall be indicated on drawings at each brace location. Drawings shall bear the stamp and signature of the registered professional engineer licensed in the state of the project location who designed the layout of the braces.

PART 2 PRODUCTS

2.1. MANUFACTURERS

A. Amber Booth.
B. Mason Industries, Inc.
C. Kinetics Corporation.
D. Vibrex.
E. Substitutions: Under provisions of Section 01 60 00.

2.2. SEISMIC RESTRAINTS

A. General Requirements:

1. Seismic restraints shall be provided for all equipment, both supported and suspended, piping and ductwork as listed above.
2. Bracing of piping and ductwork shall be in accordance with provisions set forth in SMACNA seismic restraint manual.
3. Structural requirements for restraints, including their attachment to building structure, shall be reviewed and approved by the structural engineer.
4. Attachments to supported or suspended equipment must be coordinated with the equipment manufacturer.

B. Supported Equipment Products:

1. Seismic restraints shall consist of interlocking steel members restrained by shock absorbent neoprene materials compounded to bridge bearing specifications as

previously noted in paragraph 1.3. Elastomeric materials shall be replaceable and be a minimum 3/4-inch thick. Snubbers shall be manufactured with an air gap between hard and resilient material of not less than 1/8-inch, nor more than 1/4-inch. Type 1 - Seismic Snubbers: All-directional seismic snubbers shall consist of interlocking steel members restrained by a one-piece molded neoprene bushing of bridge bearing neoprene. Bushing shall be replaceable and a minimum of 1/4 inch thick. A minimum air gap of 1/8 inch shall be incorporated in the snubber design in all directions before contact is made between the rigid and resilient surfaces. Snubber end caps shall be removable to allow inspection of internal clearances. The snubber shall be designed to accept horizontal and vertical seismic loads as defined in Section 1.03.B. Mason Type Z-1225 or Z-1011.

2. Each snubber shall be capable of restraint in all three mutually orthogonal directions. Type 2 - Seismic Sway Braces - Seismic sway braces shall consist of galvanized steel aircraft cables or steel angles/channels. Cables braces shall be designed to resist seismic tension loads and steel braces shall be designed to resist both tension and compression loads with a minimum safety factor of 2. Brace end connections shall be steel assemblies that swivel to the final installation angle. Do not mix cable and steel braces to brace the same system or equipment. Steel angles, when required, shall be clamped to the threaded hanger rods at the seismic sway brace locations utilizing a minimum of two ductile iron clamps. Sway braces shall be designed to accept horizontal and vertical seismic loads as defined in Section 1.03.B. Mason Type SCB, SSB, SRC and UC.
3. Submittals shall include load versus deflection curves up to 1/2-inch on the x, y and z planes.
4. Mason Model Z-1011

C. Bracing of Pipes:

1. Provide seismic bracing of all piping as detailed below. (Exception: Piping suspended by individual hangers 12 inches or less in length, as measured from the top of the pipe to the bottom of the support where the hanger is attached, need not be braced).
   a. Brace all gas piping.
   b. Brace all piping located in boiler rooms, mechanical equipment rooms, and refrigeration mechanical rooms that is 1-1/4-inch nominal diameter and larger.
   c. Brace all pipes 2-1/2-inch nominal diameter and larger.
2. For all gas piping, as specified in 1(a) the bracing details, schedules, and notes may be used, except that transverse bracing shall be at 20 feet maximum, and longitudinal bracing shall be at 40 feet maximum.
3. Seismic braces for pipes on trapeze hangers may be used.
4. Provide flexibility in joints where pipes pass through building seismic joints or expansion joints or where rigidly supported pipes connect to equipment with vibration isolators. For threaded piping, the flexibility may be provided by the installation of swing joints.

5. Cast iron pipe of all types, glass pipe, and any other pipe jointed with a shield and clamp assembly, where the top of the pipe is 12 inches or more from the supporting structure, shall be braced on each side of a change in direction of 90 degrees or more. Riser joints shall be braced or stabilized between floors.
6. Vertical risers shall be laterally supported with a riser clamp at each floor. For buildings greater than six stories high, all risers shall be engineered individually.

D. Bracing of Ductwork:
1. Brace rectangular ducts with cross sectional areas of 6 square feet and larger. Brace flat oval ducts in the same manner as rectangular ducts. Brace round ducts with diameters of 28 inches and larger. Brace flat oval ducts the same as rectangular ducts of the same nominal size (Exception: No bracing is required if the duct is suspended by hangers 12 inches or less in length, as measured from the top of the duct to the bottom of the support where the hanger is attached).
2. Transverse bracing shall occur at the interval specified in the SMACNA tables or at both ends if the duct run is less than the specified interval. Transverse bracing shall be installed at each duct turn and at each end of a duct run, with a minimum of one brace at each end.
3. Longitudinal bracing shall occur at the interval specified in the SMACNA tables with at least one brace per duct run. Transverse bracing for one duct section may also act as longitudinal bracing for a duct section connected perpendicular to it if the bracing is installed within four feet of the intersection of the ducts and if the bracing is sized for the larger duct. Duct joints shall conform to SMACNA duct construction standards.

E. Suspended Equipment and Piping and Ductwork:
1. Cable Method: The seismic restraint shall consist of a combination of stranded steel aircraft cable and the specified vibration isolation hanger with an added nut and neoprene and steel washer. The cable resists lateral and downward motion. The modified vibration hanger resists upward motion.
2. Cable attachment details, cable size, and the neoprene and steel washers shall be sized by the manufacturer and are to be indicated in the Shop Drawings.
3. Provide detailed Shop Drawings for approval in sufficient time to allow structural attachment work to be incorporated into the normal work sequence.

PART 3 EXECUTION

3.1. SEISMIC RESTRAINTS

A. General:
1. Install and adjust seismic restraints so that the equipment, piping, and ductwork supports are not degraded by the restraints.
2. Restraints must not short circuit vibration isolation systems or transmit objectionable vibration or noise.

B. Supported Equipment:

1. Each vibration isolation frame for supported equipment shall have a minimum of four seismic snubbers mounted as close as possible to the vibration isolators and/or the frame extremities.
2. Care must be taken so that a minimum 1/8-inch air gap in the seismic restraint snubber is preserved on all sides in order that the vibration isolation potential of the isolator is not compromised. This requires that the final snubber adjustment be completed after the vibration isolators are properly installed and the installation approved.

C. Bracing of Pipes:
1. Branch lines may not be used to brace main lines.
2. Transverse bracing shall be at 40 feet maximum except where a lesser spacing is indicated in the SMACNA tables for bracing of pipes.
3. Longitudinal bracing shall be at 80 feet maximum except where a lesser spacing is indicated in the tables. In pipes where thermal expansion is a consideration, an anchor point may be used as the specified longitudinal brace provided that it has a capacity equal to or greater than a longitudinal brace. The longitudinal braces and connections must be capable of resisting the additional force induced by expansion and contraction.
4. A rigid piping system shall not be braced to dissimilar parts of the building or to two dissimilar building systems that may respond differently during an earthquake.
5. Transverse bracing for one pipe section may also act as longitudinal bracing for a pipe section of the same size connected perpendicular to it if the bracing is installed within 24 inches of the elbow or tee.

D. Bracing of Ductwork:
1. Hangers must be positively attached to the duct within 2 inches of the top of the duct with a minimum of two #10 sheet metal screws.
2. Group of ducts may be combined in larger frame so that the combined weights and dimensions of the ducts are less than or equal to the maximum weight and dimensions of the duct for which bracing details are selected.
3. Walls, including gypsum board nonbearing partitions, which have ducts running through them, may replace a typical transverse brace. Provide solid blocking around duct penetrations at stud wall construction.
4. Unbraced ducts shall be installed with a 6-inch minimum clearance to vertical ceiling hanger wires.

E. Suspended Equipment, Piping, and Ductwork Cable Method:
1. Cables shall be adjusted to a degree of slackness approved by the Structural Engineer.
2. Uplift and downward restraint nuts and washers for the Type HST hangers shall be adjusted so that there is a minimum 1/4-inch clearance.

END OF SECTION

IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 GENERAL

1.1. SECTION INCLUDES
A. Nameplates.
B. Tags.
C. Labels.
D. Lockout devices.

1.2. RELATED REQUIREMENTS
A. Section 09 90 00 - Painting and Coating: Identification painting.

1.3. REFERENCE STANDARDS
A. ASTM D709 - Standard Specification for Laminated Thermosetting Materials; 2017.

1.4. SUBMITTALS
A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. List: Submit list of wording, symbols, letter size, and color coding for mechanical identification.
C. Product Data: Provide manufacturers catalog literature for each product required.
D. Manufacturer's Installation Instructions: Indicate special procedures, and installation.
E. Project Record Documents: Record actual locations of tagged valves.

PART 2 PRODUCTS

2.1. MANUFACTURERS
A. Brady Corporation: www.bradycorp.com.
B. Safety Sign Company: www.safetysignco.com.
C. Seton Identification Products: www.seton.com/aec.
D. Substitutions: See Section 01 60 00 - Materials and Equipment.

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

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

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

2.4. LABELS
A. Description: Aluminum, size 1.9 x 0.75 inches, adhesive backed with printed identification.

2.5. LOCKOUT DEVICES
A. Lockout Hasps:
   1. Manufacturers:
      a. Anodized aluminum or Reinforced nylon hasp with erasable label surface; size minimum 7-1/4 x 3 inches.
B. Valve Lockout Devices:
   1. Steel device preventing access to valve operator, accepting lock shackle.

PART 3 EXECUTION

3.1. PREPARATION
A. Degrease and clean surfaces to receive adhesive for identification materials.
B. Prepare surfaces in accordance with Section 09 90 00 for stencil painting.

3.2. INSTALLATION
A. Install nameplates with corrosive-resistant mechanical fasteners, or adhesive. Apply with sufficient adhesive to ensure permanent adhesion and seal with clear lacquer.
B. Install tags with corrosion resistant chain.
C. Install plastic pipe markers in accordance with manufacturer's instructions.
D. Install plastic tape pipe markers complete around pipe in accordance with manufacturer's instructions.
E. Identify air handling units, pumps with 8 x 4 inch plastic nameplates. Small devices may be identified with tags.
F. Identify control panels and major control components outside panels with plastic nameplates.
G. Install ductwork with plastic nameplates. Identify with air handling unit identification number and area served. Locate identification at air handling unit, at each side of penetration of structure or enclosure, and at each obstruction.

END OF SECTION

HVAC ENCLOSED MOTOR CONTROLLERS

PART 1 GENERAL

1.1. SECTION INCLUDES
A. Manual motor controllers.
B. Magnetic motor controllers.
C. Combination magnetic motor controllers and disconnects.

1.2. RELATED REQUIREMENTS
A. Section 26 05 29 - Hangers and Supports for Electrical Systems.
B. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.
C. Section 26 28 13 - Fuses.

1.3. REFERENCE STANDARDS
A. NECA 1 - Standard for Good Workmanship in Electrical Construction; National Electrical Contractors Association; 2010.
B. NEMA ICS 2 - Industrial Control and Systems: Controllers, Contactors, and Overload Relays, Rated Not More Than 2000 Volts AC or 750 Volts DC; National Electrical Manufacturers Association; 2000 (R2005).
C. NEMA ICS 5 - Industrial Control and Systems: Control Circuit and Pilot Devices; National Electrical Manufacturers Association; 2000 (R2010).
D. NEMA ICS 6 - Industrial Control and Systems: Enclosures; National Electrical Manufacturers Association; 1993 (R2006).
E. NEMA KS 1 - Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum); National Electrical Manufacturers Association; 2001 (R2006).
F. NETA STD ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems; International Electrical Testing Association; 2009.
G. NFPA 70 - National Electrical Code; National Fire Protection Association; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

1.4. SUBMITTALS
A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Product Data: Provide catalog sheets showing voltage, controller size, ratings and size of switching and overcurrent protective devices, short circuit ratings, dimensions, and enclosure details.
C. Test Reports: Indicate field test and inspection procedures and test results.
D. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.
E. Maintenance Data: Replacement parts list for controllers.

1.5. QUALITY ASSURANCE

A. Conform to requirements of NFPA 70.
B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience and with service facilities within 100 miles of Project.
C. Products: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

PART 2 PRODUCTS

2.1. MANUFACTURERS

A. Eaton Corporation; Cutler-Hammer Product: www.eaton.com.
B. General Electric Company: www.geindustrial.com.
C. Schneider Electric; Square D Products: www.schneider-electric.us.
D. Allen Bradley: www.ab.com.
E. Substitutions: See Section 01 60 00 - Materials and Equipment.

2.2. MANUAL CONTROLLERS

A. Manual Motor Controllers: NEMA ICS 2, AC general-purpose, Class A, manually operated, full-voltage controller with overload element, red pilot light, field reversible auxiliary contact, and push button operator.
B. Fractional Horsepower Manual Controllers: NEMA ICS 2, AC general-purpose, Class A, manually operated, full-voltage controller for fractional horsepower induction motors, with thermal overload unit, red pilot light, and push button operator.
C. Motor Starting Switches: NEMA ICS 2, AC general-purpose Class A manually operated, full-voltage controller for fractional horsepower induction motors, without thermal overload unit, with red pilot light and key operator.
D. Enclosures: NEMA ICS 6, Type as required to meet conditions of installation.

2.3. AUTOMATIC CONTROLLERS

A. Magnetic Motor Controllers: NEMA ICS 2, AC general-purpose Class A magnetic controller for induction motors rated in horsepower.
B. Coil Operating Voltage: 120 volts, 60 Hertz.
C. Overload Relays: NEMA ICS 2; bimetal.
D. Enclosures: NEMA ICS 6, Type as required to meet conditions of installation.
E. For starters above 10 HP at 230 volts or 20 HP at 460 volts, provide soft-start with horsepower rated speed bypass contactor, keypad, and LCD to display starter set-up/status/diagnostics and constant current and current ramp modes.

2.4. ACCESSORIES

A. Auxiliary Contacts: NEMA ICS 2, 2 field convertible contacts in addition to seal-in contact.
B. Cover Mounted Pilot Devices: NEMA ICS 5, heavy duty oiltight type.
C. Pilot Device Contacts: NEMA ICS 5, Form Z, rated A150.
D. Pushbuttons: Recessed and lockable type.
E. Indicating Lights: Transformer, LED type.
F. Selector Switches: Rotary type, HOA. Provided on all automatic controllers.
G. Relays: NEMA ICS 2.
H. Control Power Transformers: 120 volt secondary. Provide fused primary, secondary, and bond unfused leg of secondary to enclosure.
I. Solid-state leg loss protection for 3 phase motors.

2.5. DISCONNECTS (AS APPLICABLE)

A. Combination Controllers: Combine motor controllers with disconnects in common enclosure. Obtain IEC Class 2 coordinated component protection.
B. Thermal Magnetic Circuit Breakers: Integral thermal and instantaneous magnetic trip in each pole; UL listed.
C. Motor Circuit Protector: Circuit breakers with integral instantaneous magnetic trip in each pole; UL listed.
D. Nonfusible Switch Assemblies: NEMA KS 1, enclosed knife switch with externally operable handle.
E. Fusible Switch Assemblies: NEMA KS 1, enclosed knife switch with externally operable handle. Fuse clips: Designed to accommodate Class R fuses.

PART 3 EXECUTION

3.1. INSTALLATION

A. Install enclosed controllers where indicated, in accordance with manufacturer's instructions.
B. Install securely, in a neat and workmanlike manner, as specified in NECA 1.
C. Provide supports in accordance with Section 26 05 29.
D. Height: 5 ft to operating handle.
E. Provide fuses for fusible switches; refer to Section 26 28 13 for product requirements.
F. Select and install overload heater elements in motor controllers to match installed motor characteristics.
G. Identify enclosed controllers in accordance with Section 26 05 53.
H. All single-phase motors shall have manual or automatic controllers as required by control sequence.
I. All three phase motors shall have automatic controllers.
J. All controllers shall be provided with enclosure.

3.2. FIELD QUALITY CONTROL

A. Perform field inspection and testing in accordance with Section 01 45 00.
B. Inspect and test in accordance with NETA STD ATS, except Section 4.
C. Perform inspections and tests listed in NETA STD ATS, Section 7.16.1.

END OF SECTION

HVAC VARIABLE FREQUENCY CONTROLLERS

PART 1 GENERAL

1.1. SECTION INCLUDES

A. Variable frequency controllers.

1.2. REFERENCE STANDARDS

A. NEMA ICS 7.1 - Safety Standards for Construction and Guide for Selection, Installation, and Operation of Adjustable Speed Drive Systems; National Electrical Manufacturers Association; 2013.

B. NEMA ICS 7 - Industrial Control and Systems: Adjustable-Speed Drives; National Electrical Manufacturers Association 2006.

C. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); National Electrical Manufacturers Association 2003.

D. NETA STD ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems; International Electrical Testing Association; 2007.

E. NFPA 70 - National Electrical Code; National Fire Protection Association; 2008.

1.3. SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide catalog sheets showing voltage, controller size, ratings and size of switching and overcurrent protective devices, short circuit ratings, dimensions, and enclosure details.

C. Shop Drawings: Indicate front and side views of enclosures with overall dimensions and weights shown; conduit entrance locations and requirements; and nameplate legends.

D. Test Reports: Indicate field test and inspection procedures and test results.

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

F. Manufacturer's Field Reports: Indicate start-up inspection findings.

G. Operation Data: NEMA ICS 7.1. Include instructions for starting and operating controllers, and describe operating limits that may result in hazardous or unsafe conditions.

H. Maintenance Data: NEMA ICS 7.1. Include routine preventive maintenance schedule.

I. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.

1. See Section 01 60 00 - Materials and Equipment, for additional provisions.
2. Extra Air Filters: Two of each type.

1.4. QUALITY ASSURANCE

A. Conform to requirements of NFPA 70.

B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience and with service facilities within 100 miles of Project.

C. Products: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

1.5. DELIVERY, STORAGE, AND HANDLING

A. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.

B. Handle in accordance with manufacturer's written instructions. Lift only with lugs provided for the purpose. Handle carefully to avoid damage to components, enclosure, and finish.

PART 2 PRODUCTS

2.1. MANUFACTURERS

A. ABB: www.abb.us.

B. Danfoss: www.danfoss.com.

C. Yaskawa: www.yaskawa.com

D. Substitutions: See Section 01 60 00 - Materials and Equipment.

2.2. DESCRIPTION

A. Variable Frequency Controllers: Enclosed controllers suitable for operating the indicated loads, in conformance with requirements of NEMA ICS 7. Select unspecified features and options in accordance with NEMA ICS 3.1.

1. Employ microprocessor-based inverter logic isolated from power circuits.
2. Employ pulse-width-modulated inverter system.
3. Design for ability to operate controller with motor disconnected from output.
4. Design to attempt five automatic restarts following fault condition before locking out and requiring manual restart.

B. Enclosures: NEMA 250, Type 1, suitable for equipment application in places restricted to persons employed on the premises.

C. The variable frequency drive shall be RoHS compliant. Circuit boards shall be lead free. No electrolytic capacitors allowed.

D. Finish: Manufacturer's standard enamel.

2.3. OPERATING REQUIREMENTS

A. Rated Input Voltage: Refer to Electrical drawings.

B. Motor Nameplate Voltage: Refer to Electrical drawings.

C. Displacement Power Factor: Between 1.0 and 0.95, lagging, over entire range of operating speed and load.

D. Operating Ambient: 0 degrees F to 150 degrees F.

E. Minimum Efficiency at Full Load: 97 percent.

F. Volts Per Hertz Adjustment: Plus or minus 10 percent.

G. Current Limit Adjustment: 60 to 110 percent of rated.
H. Acceleration Rate Adjustment: 0.5 to 30 seconds.
I. Deceleration Rate Adjustment: 1 to 30 seconds.
J. Input Signal: 4 to 20 mA DC and 0 to 10 mV DC.

2.4. COMPONENTS

A. Display: Provide integral digital display to indicate output voltage, output frequency, output current, motor speed, total kWh consumed, kWh trip and run counters and total hours run.
   1. Filters: the VFD shall be provided with built-in RFI filters and all models 3 HP or more shall include a DC Choke.
   2. Communication: the VFD shall have the capability of communicating with over the following protocols:
      a. BACnet/MSTP and BACnet/IP
      b. LONBus
      c. Modbus RTU and Modbus/TCP
      d. N2
   3. Memory: the control panel shall have EEPROM to retain all parameters when the VFD is powered down.
B. Status Indicators: Separate indicators for overcurrent, overvoltage, ground fault, overtemperature, and input power ON.
C. Furnish HAND-OFF-AUTOMATIC selector switch and manual speed control. HOA features built into the keypad are acceptable.
D. Include undervoltage release.
E. Control Power Source: Separate circuit.
F. Door Interlocks: Furnish mechanical means to prevent opening of equipment with power connected, or to disconnect power if door is opened; include means for defeating interlock by qualified persons.
G. Safety Interlocks: Furnish terminals for remote contact to inhibit starting under both manual and automatic mode.
H. Control Interlocks: Furnish terminals for remote contact to allow starting in automatic mode.
I. Manual Bypass: Not required unless noted otherwise on the drawings.
J. Emergency Stop: Use dynamic brakes for emergency stop function.
K. Disconnecting Means: Include integral circuit breaker with interrupt rating of 65k AIC or higher, or fused disconnect switch on the line side of each controller.
L. Wiring Terminations: Match conductor materials and sizes indicated.

2.5. SOURCE QUALITY CONTROL

A. Shop inspect and perform standard productions tests for each controller.
B. Make completed controller available for inspection at manufacturer's factory prior to packaging for shipment. Notify Owner at least 7 days before inspection is allowed.
C. Allow witnessing of factory inspections and tests at manufacturer's test facility. Notify Owner at least 7 days before inspections and tests are scheduled.

PART 3 EXECUTION

3.1. EXAMINATION

A. Verify that surface is suitable for controller installation.
B. Do not install controller until building environment can be maintained within the service conditions required by the manufacturer.
C. Verify that field measurements are as indicated on shop drawings or instructed by manufacturer.

3.2. INSTALLATION

A. Install in accordance with NEMA ICS 7.1 and manufacturer's instructions.
B. Tighten accessible connections and mechanical fasteners after placing controller.
C. Provide fuses in fusible switches; refer to Division 26 for product requirements.
D. Select and install overload heater elements in motor controllers to match installed motor characteristics.
E. Provide engraved plastic nameplates; refer to Division 23 for product requirements and location.
F. Neatly type label inside each motor controller door identifying motor served, nameplate horsepower, full load amperes, code letter, service factor, and voltage/phase rating. Place in clear plastic holder.

3.3. FIELD QUALITY CONTROL

A. Provide the service of the manufacturer's field representative to prepare and start controllers.
B. Perform field inspection and testing in accordance with Section 01 45 00.
C. Inspect and test in accordance with NETA STD ATS, except Section 4.
D. Perform inspections and tests listed in NETA STD ATS, Section 7.17.

3.4. ADJUSTING

A. Make final adjustments to installed controller to assure proper operation of load system. Obtain performance requirements from installer of driven loads.

3.5. CLOSEOUT ACTIVITIES

A. Demonstrate operation of controllers in automatic and manual modes.

END OF SECTION

TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 GENERAL

1.1. SECTION INCLUDES

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

1.2. RELATED REQUIREMENTS

A. Section 01 21 00 - Allowances: Inspection and testing allowances.
B. Section Section 01 45 00 - Contractor's Quality Control Program: Employment of testing agency and payment for services.
C. Section 01 91 13 - General Commissioning Requirements: Commissioning requirements that apply to all types of work.

1.3. REFERENCE STANDARDS

A. AABC (NSTSB) - AABC National Standards for Total System Balance, 7th Edition; 2016.
B. ASHRAE Std 111 - Measurement, Testing, Adjusting, and Balancing of Building HVAC Systems; 2008.

1.4. SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Qualifications: Submit name of adjusting and balancing agency and TAB supervisor for approval within 30 days after award of Contract.
C. TAB Plan: Submit a written plan indicating the testing, adjusting, and balancing standard to be followed and the specific approach for each system and component.
    1. Submit to Architect.
    2. Submit to the Commissioning Authority, Construction Manager, and HVAC controls contractor.
    3. Submit six weeks prior to starting the testing, adjusting, and balancing work.
    4. Include certification that the plan developer has reviewed Contract Documents, the equipment and systems, and the control system with the Architect and other installers to sufficiently understand the design intent for each system.
    5. Include at least the following in the plan:
        a. List of all air flow, water flow, sound level, system capacity and efficiency measurements to be performed and a description of specific test procedures, parameters, formulas to be used.
        b. Copy of field checkout sheets and logs to be used, listing each piece of equipment to be tested, adjusted and balanced with the data cells to be gathered for each.
        c. Identification and types of measurement instruments to be used and their most recent calibration date.

d. Final test report forms to be used.
e. Detailed step-by-step procedures for TAB work for each system and issue, including:
    1. Terminal flow calibration (for each terminal type).
    2. Diffuser proportioning.
    3. Branch/submain proportioning.
    4. Total flow calculations.
    5. Rechecking.
    6. Diversity issues.
f. Expected problems and solutions, etc.
g. Criteria for using air flow straighteners or relocating flow stations and sensors; analogous explanations for the water side.
h. Details of how TOTAL flow will be determined; for example:
    1. Air: Sum of terminal flows via control system calibrated readings or via hood readings of all terminals, supply (SA) and return air (RA) pitot traverse, SA or RA flow stations.
i. Confirmation of understanding of the outside air ventilation criteria under all conditions.
j. Method of verifying and setting minimum outside air flow rate will be verified and set and for what level (total building, zone, etc.).
k. False loading of systems to complete TAB work, if specified.
l. Exhaust fan balancing and capacity verifications, including any required room pressure differentials.
m. Procedures for field technician logs of discrepancies, deficient or uncompleted work by others, contract interpretation requests and lists of completed tests (scope and frequency).
n. Procedures for formal progress reports, including scope and frequency.
o. Procedures for formal deficiency reports, including scope, frequency and distribution.

D. Control System Coordination Reports: Communicate in writing to the controls installer all setpoint and parameter changes made or problems and discrepancies identified during TAB that affect, or could affect, the control system setup and operation.

E. Progress Reports.

F. Final Report: Indicate deficiencies in systems that would prevent proper testing, adjusting, and balancing of systems and equipment to achieve specified performance.
    1. Submit to the the Commissioning Authority within two weeks after completion of testing, adjusting, and balancing.
    2. Revise TAB plan to reflect actual procedures and submit as part of final report.
    3. Submit draft copies of report for review prior to final acceptance of Project. Provide final copies for Architect and for inclusion in operating and maintenance manuals.
    4. Provide reports in PDF formatcomplete with index page and indexing tabs, with cover identification at front and side. Include set of reduced drawings with air

outlets and equipment identified to correspond with data sheets, and indicating thermostat locations.

5. Include actual instrument list, with manufacturer name, serial number, and date of calibration.
6. Form of Test Reports: Where the TAB standard being followed recommends a report format use that; otherwise, follow ASHRAE Std 111.
7. Units of Measure: Report data in I-P (inch-pound) units only.
8. Include the following on the title page of each report:
   a. Name of Testing, Adjusting, and Balancing Agency.
   b. Address of Testing, Adjusting, and Balancing Agency.
   c. Telephone number of Testing, Adjusting, and Balancing Agency.
   d. Project name.
   e. Project location.
   f. Project Architect.
   g. Project Engineer.
   h. Project Contractor.
   i. Project altitude.
   j. Report date.

G. Project Record Documents: Record actual locations of flow measuring stations and balancing valves and rough setting.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.1. GENERAL REQUIREMENTS

A. Perform total system balance in accordance with one of the following:
   1. AABC (NSTSB), AABC National Standards for Total System Balance.
   2. ASHRAE Std 111, Practices for Measurement, Testing, Adjusting and Balancing of Building Heating, Ventilation, Air-Conditioning, and Refrigeration Systems.

B. Begin work after completion of systems to be tested, adjusted, or balanced and complete work prior to Substantial Completion of the project.

C. Where HVAC systems and/or components interface with life safety systems, including fire and smoke detection, alarm, and control, coordinate scheduling and testing and inspection procedures with the authorities having jurisdiction.

D. TAB Agency Qualifications:
   1. Company specializing in the testing, adjusting, and balancing of systems specified in this section.
   2. Having minimum of three years documented experience.

E. TAB Supervisor and Technician Qualifications: Certified by same organization as TAB agency.

F. TAB Supervisor Qualifications: Professional Engineer licensed in Oregon.

G. Pre-Qualified TAB Agencies:

1. Northwest Engineering Service, Inc.
2. Air Balancing Specialty.
3. Neudorfer Engineers.
4. Precision Test and Balance, Inc.
5. Accurate Balancing, Inc.
6. Substitutions: See Section 01 60 00 - Materials and Equipment.

3.2. EXAMINATION

A. Verify that systems are complete and operable before commencing work. Ensure the following conditions:
   1. Systems are started and operating in a safe and normal condition.
   2. Temperature control systems are installed complete and operable.
   3. Proper thermal overload protection is in place for electrical equipment.
   4. Final filters are clean and in place. If required, install temporary media in addition to final filters.
   5. Duct systems are clean of debris.
   6. Fans are rotating correctly.
   7. Fire and volume dampers are in place and open.
   8. Air coil fins are cleaned and combed.
   9. Access doors are closed and duct end caps are in place.
   10. Air outlets are installed and connected.
   11. Duct system leakage is minimized.

B. Submit field reports. Report defects and deficiencies that will or could prevent proper system balance.

C. Beginning of work means acceptance of existing conditions.

3.3. PREPARATION

A. Hold a pre-balancing meeting at least one week prior to starting TAB work.
   1. Require attendance by all installers whose work will be tested, adjusted, or balanced.

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

C. Provide additional balancing devices as required.

3.4. ADJUSTMENT TOLERANCES

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

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

C. Hydronic Systems: Adjust to within plus or minus 10 percent of design.

3.5. RECORDING AND ADJUSTING

A. Field Logs: Maintain written logs including:
   1. Running log of events and issues.
   2. Discrepancies, deficient or uncompleted work by others.
   3. Contract interpretation requests.
   4. Lists of completed tests.
B. Ensure recorded data represents actual measured or observed conditions.
C. Permanently mark settings of valves, dampers, and other adjustment devices allowing settings to be restored. Set and lock memory stops.
D. Mark on drawings the locations where traverse and other critical measurements were taken and cross reference the location in the final report.
E. After adjustment, take measurements to verify balance has not been disrupted or that such disruption has been rectified.
F. Leave systems in proper working order, replacing belt guards, closing access doors, closing doors to electrical switch boxes, and restoring thermostats to specified settings.
G. At final inspection, recheck random selections of data recorded in report. Recheck points or areas as selected and witnessed by the Owner.
H. Check and adjust systems approximately six months after final acceptance and submit report.

3.6. AIR SYSTEM PROCEDURE

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

K. Where modulating dampers are provided, take measurements and balance at extreme conditions. Balance variable volume systems at maximum air flow rate, full cooling, and at minimum air flow rate, full heating.

L. Measure building static pressure and adjust supply, return, and exhaust air systems to provide required relationship between each to maintain approximately 0.03 inches positive static pressure near the building entries.

M. For variable air volume system powered units set volume controller to air flow setting indicated. Confirm connections properly made and confirm proper operation for automatic variable air volume temperature control.

3.7. COMMISSIONING

A. See Sections 01 91 13 - General Commissioning Requirements.

B. Perform prerequisites prior to starting commissioning activities.

C. Fill out Prefunctional Checklists for:
   1. Air side systems.
   2. Water side systems.

D. Furnish to the Commissioning Authority, upon request, any data gathered but not shown in the final TAB report.

E. Re-check minimum outdoor air intake flows and maximum and intermediate total airflow rates for 25 percent of the air handlers plus a random sample equivalent to 5 percent of the final TAB report data as directed by Commissioning Authority.
   1. Original TAB agency shall execute the re-checks, witnessed by the Commissioning Authority.
   2. Use the same test instruments as used in the original TAB work.
   3. Failure of more than 10 percent of the re-checked items of a given system shall result in the rejection of the system TAB report; rebalance the system, provide a new system TAB report, and repeat random re-checks.
   4. For purposes of re-check, failure is defined as follows:
      a. Air Flow of Supply and Return: Deviation of more than 10 percent of instrument reading.
      b. Minimum Outside Air Flow: Deviation of more than 20 percent of instrument reading; for inlet vane or VFD OSA compensation system using linear proportional control, deviation of more than 30 percent at intermediate supply flow.
      c. Temperatures: Deviation of more than one degree F.
      d. Air and Water Pressures: Deviation of more than 10 percent of full scale of test instrument reading.
   5. For purposes of re-check, a whole system is defined as one in which inaccuracies will have little or no impact on connected systems; for example, the air distribution system served by one air handler or the hydronic chilled water supply system served by a chiller or the condenser water system.

F. In the presence of the Commissioning Authority, verify that:
   1. Final settings of all valves, splitters, dampers and other adjustment devices have been permanently marked.

2. The air system is being controlled to the lowest possible static pressure while still meeting design loads, less diversity; this shall include a review of TAB methods, established control setpoints, and physical verification of at least one leg from fan to diffuser having all balancing dampers wide open and that during full cooling of all terminal units taking off downstream of the static pressure sensor, the terminal unit on the critical leg has its damper 90 percent or more open.
3. The water system is being controlled to the lowest possible pressure while still meeting design loads, less diversity; this shall include a review of TAB methods, established control setpoints, and physical verification of at least one leg from the pump to the coil having all balancing valves wide open and that during full cooling the cooling coil valve of that leg is 90 percent or more open.

G. No seasonal tests are required.
H. No further monitoring is required.
I. No deferred testing is required.

3.8. SCOPE

A. Test, adjust, and balance the following:
1. Plumbing Pumps.
2. Packaged Roof Top Heating/Cooling Units.
3. Air Coils.
4. Evaporative Humidifier.
5. Air Handling Units.
6. Fans.
7. Air Filters.
8. Air Terminal Units.
9. Air Inlets and Outlets.
10. Ductless Split Systems

3.9. MINIMUM DATA TO BE REPORTED

A. Electric Motors:
1. Manufacturer.
2. Model/Frame.
3. HP/BHP.
4. Phase, voltage, amperage; nameplate, actual, no load.
5. RPM.
6. Service factor.
7. Starter size, rating, heater elements.
8. Sheave Make/Size/Bore.

B. V-Belt Drives:
1. Identification/location.
2. Required driven RPM.
3. Driven sheave, diameter and RPM.
4. Belt, size and quantity.
5. Motor sheave diameter and RPM.

6. Center to center distance, maximum, minimum, and actual.

C. Pumps:
1. Identification/number.
2. Manufacturer.
3. Size/model.
4. Service.
5. Design flow rate, pressure drop, BHP.
6. Actual flow rate, pressure drop, BHP.
7. Discharge pressure.
8. Suction pressure.
9. Total operating head pressure.

D. Cooling Coils:
1. Identification/number.
2. Location.
3. Service.
4. Manufacturer.
5. Air flow, design and actual.
6. Entering air DB temperature, design and actual.
7. Entering air WB temperature, design and actual.
8. Leaving air DB temperature, design and actual.
9. Leaving air WB temperature, design and actual.
10. Saturated suction temperature, design and actual.
11. Air pressure drop, design and actual.

E. Heating Coils:
1. Identification/number.
2. Location.
3. Service.
4. Manufacturer.
5. Air flow, design and actual.
6. Entering air temperature, design and actual.
7. Leaving air temperature, design and actual.
8. Air pressure drop, design and actual.

F. Electric Duct Heaters:
1. Manufacturer.
2. Identification/number.
3. Location.
4. Model number.
5. Design kW.
6. Number of stages.
7. Phase, voltage, amperage.
8. Test voltage (each phase).
9. Test amperage (each phase).
10. Air flow, specified and actual.
11. Temperature rise, specified and actual.

G. Air Moving Equipment:

1. Location.
2. Manufacturer.
3. Model number.
4. Serial number.
5. Arrangement/Class/Discharge.
6. Air flow, specified and actual.
7. Return air flow, specified and actual.
8. Outside air flow, specified and actual.
9. Total static pressure (total external), specified and actual.
10. Inlet pressure.
11. Discharge pressure.
12. Sheave Make/Size/Bore.
13. Number of Belts/Make/Size.
14. Fan RPM.

H. Return Air/Outside Air:
1. Identification/location.
2. Design air flow.
3. Actual air flow.
4. Design return air flow.
5. Actual return air flow.
6. Design outside air flow.
7. Actual outside air flow.
8. Return air temperature.
9. Outside air temperature.
10. Required mixed air temperature.
11. Actual mixed air temperature.
12. Design outside/return air ratio.
13. Actual outside/return air ratio.

I. Exhaust Fans:
1. Location.
2. Manufacturer.
3. Model number.
4. Serial number.
5. Air flow, specified and actual.
6. Total static pressure (total external), specified and actual.
7. Inlet pressure.
8. Discharge pressure.
9. Sheave Make/Size/Bore.
10. Number of Belts/Make/Size.
11. Fan RPM.

J. Duct Traverses:
1. System zone/branch.
2. Duct size.
3. Area.
4. Design velocity.

5. Design air flow.
6. Test velocity.
7. Test air flow.
8. Duct static pressure.
9. Air temperature.
10. Air correction factor.

K. Duct Leak Tests:
1. Description of ductwork under test.
2. Duct design operating pressure.
3. Duct design test static pressure.
4. Duct capacity, air flow.
5. Maximum allowable leakage duct capacity times leak factor.
6. Test apparatus:
   a. Blower.
   b. Orifice, tube size.
   c. Orifice size.
   d. Calibrated.
7. Test static pressure.
8. Test orifice differential pressure.
9. Leakage.

L. Terminal Unit Data:
1. Manufacturer.
2. Type, constant, variable, single, dual duct.
3. Identification/number.
4. Location.
5. Model number.
6. Size.
7. Minimum static pressure.
8. Minimum design air flow.
9. Maximum design air flow.
10. Maximum actual air flow.
11. Inlet static pressure.

M. Air Distribution Tests:
1. Air terminal number.
2. Room number/location.
3. Terminal type.
4. Terminal size.
5. Area factor.
6. Design velocity.
7. Design air flow.
8. Test (final) velocity.
9. Test (final) air flow.
10. Percent of design air flow.

END OF SECTION

DUCT INSULATION

PART 1 GENERAL

1.1. SECTION INCLUDES
A. Duct insulation.

1.2. RELATED REQUIREMENTS
A. Section 07 84 00 - Firestopping.
B. Section 09 90 00 - Painting and Coating: Painting insulation jackets.
C. Section 23 05 53 - Identification for HVAC Piping and Equipment.
D. Section 23 31 00 - HVAC Ducts and Casings: Glass mineral wool ducts.

1.3. REFERENCE STANDARDS
A. ASTM C518 - Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus; 2017.
B. ASTM C553 - Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications; 2013.
C. ASTM C612 - Standard Specification for Mineral Fiber Block and Board Thermal Insulation; 2014.
D. ASTM C916 - Standard Specification for Adhesives for Duct Thermal Insulation; 2014.
E. ASTM C1071 - Standard Specification for Fibrous Glass Duct Lining Insulation (Thermal and Sound Absorbing Material); 2016.
F. ASTM C 1338 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2010.
G. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2018.
H. ASTM E96/E96M - Standard Test Methods for Water Vapor Transmission of Materials; 2016.
I. ASTM G21 - Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi; 2015.
J. SMACNA (DCS) - HVAC Duct Construction Standards Metal and Flexible; 2005 (Revised 2009).
K. American Society of Heating, Refrigerating, and Air Conditioning Engineers, Inc. (ASHRAE).
L. North American Insulation Manufacturers Association (NAIMA).
M. National Fire Protection Association (NFPA).
N. Underwriter's Laboratories (UL Environment).
O. Underwriter's Laboratories Environmental (UL Environment).

1.4. SUBMITTALS
A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Product Data: Provide product description, thermal characteristics, list of materials and thickness for each service, and locations.

C. Manufacturer's Instructions: Indicate installation procedures necessary to ensure acceptable workmanship and that installation standards will be achieved.

1.5. QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing products of the type specified in this section with not less than three years of documented experience.
B. Applicator Qualifications: Company specializing in performing the type of work specified in this section.
C. Surface-Burning Characteristics: For insulation and related materials, UL/ULC Classified per UL 723 or meeting ASTM E 84, by a testing and inspecting 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.
D. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
E. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.
F. Formaldehyde Free: Third party certified with UL Environment Validation.
G. Biosoluble: As determined by research conducted by the International Agency for Research on Cancer (IARC) and supported by revised reports from the National Toxicology Program (NTP) and the California Office of Environmental Health Hazard Assessment. Certified by European Certification Board for Mineral Wool Products (EUCEB).

1.6. DELIVERY, STORAGE, AND HANDLING

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

1.7. FIELD CONDITIONS

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

1.8. DEFINITIONS

A. Thermal Conductivity (K value): Units of Btu-inch/hour per square foot per degree F.
B. UL GREENGUARD: Provides independent third-party, Indoor Air Quality (IAQ) certification of products for emissions of respirable particles and Volatile Organic Compounds (VOC's), including formaldehyde and other specific product-related pollutants. Certification is based upon criteria used by EPA, OSHA, and WHO.
C. ASJ+: All Service Jacket composed of aluminum foil reinforced with glass scrim bonded to a kraft paper interleaving with an outer film layer leaving no paper exposed.

D. ASJ: All Service Jacket (no outer film).
E. SSL+: Self-Sealing Lap with Advanced Closure System.
F. SSL: Self-Sealing Lap.
G. FSK: Foil Scrim Kraft; jacketing.
H. PSK: Poly Scrim Kraft; jacketing.
I. PVC: PolyVinyl Chloride.
J. Glass Mineral Wool: Interchangeable with fiber glass, but replacing the term in the attempt to disassociate and differentiate Glass Mineral Wool from the potential health and safety of special purpose or reinforcement products that do not meet the bio solubility criteria of insulation made from glass. Rock Mineral Wool will replace the traditional Mineral Wool label. Both are used in lieu of the Mineral Mineral Wool label.
K. UL Environment Claims Validation (ECV): service and label tests a manufacturer's product and validates that the environmental claims they make in their marketing and packaging materials are factual. This Environmental Claims Validation (ECV) service will allow manufacturers to verify that their products contain a quantifiable amount of recycled content and, as such, help limit raw material extraction and reduce landfill waste. It also will enable products to qualify for LEED® points under Pilot Credit 43: MR - Certified Products.
L. Polybrominated diphenyl ethers (PBDE) such as Penta-BDE, Octa-BDE or Deca-BDE fire retardants: have been linked to adverse health effects after exposure in low concentrations.
M. UL Classified: UL has tested and evaluated samples of the product with respect to certain properties of the product. UL Classifies products to:
    1. Applicable UL requirements.
    2. Standards for safety.
    3. Standards of other National and International organizations.

PART 2 PRODUCTS

2.1. REQUIREMENTS FOR ALL PRODUCTS OF THIS SECTION

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

2.2. DUCT WRAP, FLEXIBLE

A. Manufacturer:
    1. Knauf Insulation; Atmosphere Duct Wrap with Ecose Technology: www.knaufusa.com.
    2. Johns Manville; "Microlite FSK": www.jm.com.
    3. Owens Corning Corporation; "SOFTR" or "EcoTouch": www.ocbuildingspec.com/#sle.
    4. CertainTeed Corporation; "Soft Touch": www.certainteed.com/#sle.
    5. Substitutions: See Section 01 60 00 - Materials and Equipment.
B. Insulation: ASTM C553; flexible, noncombustible blanket.

1. 'K' value: 0.29 at 75 degrees F, when tested in accordance with ASTM C177.
2. Maximum Service Temperature: 250 degrees F.
3. Maximum Water Vapor Sorption: <5.0 percent by weight per ASTM C1104.

C. Vapor Barrier Jacket:
1. Kraft paper with glass fiber yarn and bonded to aluminized film (FSK).
2. Moisture Vapor Permeability: 0.02 perm inch, when tested in accordance with ASTM E96/E96M.
3. Secure with pressure sensitive tape.

D. Vapor Barrier Tape:
1. Kraft paper reinforced with glass fiber yarn and bonded to aluminized film, with pressure sensitive rubber based adhesive.

E. Outdoor Vapor Barrier Mastic:
1. Vinyl emulsion type acrylic or mastic, compatible with insulation, black color.

F. Tie Wire: Annealed steel, 16 gage.

2.3. GLASS FIBER, RIGID

A. Manufacturer:
1. Knauf Insulation; Model "Rigid Plenum Liner": www.knaufusa.com.
2. Johns Manville Corporation; Permacote Linacoustic R-300": www.jm.com.
3. CertainTeed Corporation; Model "ToughGard® Rigid Liner Board": www.certainteed.com.
4. Substitutions: See Section 01 60 00 - Materials and Equipment.

B. Insulation: ASTM C612; rigid, noncombustible blanket.
1. ASTM C1071, Type II.
2. 'K' value: 0.24 at 75 degrees F, when tested in accordance with ASTM C518.
3. Maximum service temperature: 450 degrees F.
4. Maximum Water Vapor Sorption: 5.0 percent.
5. Maximum Density: 8.0 lb/cu ft.

C. Vapor Barrier Jacket:
1. Kraft paper with glass fiber yarn and bonded to aluminized film.
2. Moisture Vapor Permeability: 0.02 perm inch, when tested in accordance with ASTM E96/E96M.
3. Secure with pressure sensitive tape.

D. Vapor Barrier Tape:
1. Kraft paper reinforced with glass fiber yarn and bonded to aluminized film, with pressure sensitive rubber based adhesive.

E. Indoor Vapor Barrier Finish:
1. Cloth: Untreated; 9 oz/sq yd weight, glass fabric.
2. Vinyl emulsion type acrylic, compatible with insulation, black color.

F. UL/ULC Classified per UL 723. Comply with ASTM C 1071 Type I and Type II, NFPA 90A, and NFPA 90B; and with NAIMA AH124, "Fibrous Glass Duct Liner Standard." UL GREENGUARD Certified does not support the growth of mold, fungi, or bacteria per ASTM C 1338 and meets UL Environment GREENGUARD Microbial Resistance

Listing per UL 2824-"GREENGUARD Certification Program Method for Measuring Microbial Resistance ". UL/E validated to be formaldehyde free. DecaBDP Free.

2.4. DUCT LINER

A. Manufacturers:
   1. Knauf Insulation: www.knaufinsulation.com.
   2. Johns Manville: www.jm.com.
   3. Owens Corning Corp: www.owenscorning.com.
   4. CertainTeed Corporation; Model "ToughGard® Duct Liner": www.certainteed.com.
   5. Substitutions: See Section 01 60 00 - Materials and Equipment.

B. Insulation: Non-corrosive, incombustible glass mineral wool complying with ASTM C 1071; mat faced air stream surface and edges coated with acrylic polymer.
   1. Fungi Resistance: ASTM G 21.
   2. UL GREENGUARD Certified does not support the growth of mold, fungi, or bacteria per ASTM C 1338
   3. Meets UL Environment GREENGUARD Microbial Resistance Listing per UL
   4. 2824-"GREENGUARD Certification Program Method for Measuring Microbial Resistance "
   5. DecaBDP Free.
   6. Apparent Thermal Conductivity: Maximum of 0.31 at 75 degrees F.
   7. Service Temperature: Up to 250 degrees F.
   8. Rated Velocity on Coated Air Side for Air Erosion: 5,000 fpm, minimum.
   9. Minimum Noise Reduction Coefficients:
   10. 1/2 inch Thickness: 0.45.
   11. 1 inch Thickness: 0.70.
   12. 1-1/2 inches Thickness: 0.80.
   13. 2 inch Thickness: 0.85.

C. Liner Fasteners: Galvanized steel.

PART 3 EXECUTION

3.1. EXAMINATION

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

3.2. INSTALLATION

A. Install in accordance with manufacturer's instructions.
B. Install in accordance with NAIMA National Insulation Standards.
C. Insulated Ducts Conveying Air Below Ambient Temperature:
   1. Provide insulation with integral vapor barrier jackets.
   2. Finish with tape and vapor barrier jacket.
   3. Continue insulation through walls, sleeves, hangers, and other duct penetrations.

4. Insulate entire system, including fittings, joints, flanges, fire dampers, flexible connections, and expansion joints.

D. Insulated Ducts Conveying Air Above Ambient Temperature:
1. Provide with or without standard vapor barrier jacket.
2. Insulate fittings and joints. Where service access is required, bevel and seal ends of insulation.

E. Exterior Applications: Provide board insulation with vapor barrier jacket. Cover with with calked aluminum jacket with seams located on bottom side of horizontal duct section.

F. External Duct Insulation Blanket or Board Application:
1. Secure insulation with vapor barrier with mechanical fasteners and seal jacket joints with vapor barrier tape to match jacket.
2. Secure board insulation without vapor barrier with mechanical fasteners (pins and speed washers).
3. Install without sag on underside of duct. Use mechanical fasteners where necessary to prevent sagging. Lift duct off trapeze hangers and insert spacers.
4. Seal vapor barrier penetrations by mechanical fasteners with vapor barrier adhesive or FSK tape made for duct wrap or FSK board.
5. Stop and point insulation around access doors and damper operators to allow operation without disturbing wrapping.

G. Duct and Plenum Liner Application:
1. Adhere insulation with adhesive for 100 percent coverage.
2. Secure insulation with mechanical liner fasteners. Refer to SMACNA (DCS) for spacing.
3. Seal and smooth joints. Seal and coat transverse joints.
4. Seal liner surface penetrations with adhesive.
5. Duct dimensions indicated are net inside dimensions required for air-flow. Increase duct size to allow for insulation thickness.
6. Refer to SMACNA publication for transverse edges for velocities over 2500 fpm.

3.3. SCHEDULES

A. Exhaust Ducts Within 10 ft of Exterior Openings:
1. Flexible Glass Mineral Wool Duct Insulation: Minimum 2 inches thick or R-Value of 8.

B. Outside Air Intake Ducts:
1. Flexible Glass Mineral Wool Duct Insulation: Minimum 2 inches thick or R-Value of 8.

C. Supply Ducts:
1. Flexible Glass Mineral Wool Duct Insulation: Minimum 1.5 inches thick or R-Value of 5.

D. Ducts Exposed to Outdoors:
1. Flexible or Rigid Glass Mineral Wool Duct Insulation: Minimum 2 inches thick or R-Value of 8.

END OF SECTION

INSTRUMENTATION AND CONTROL DEVICES FOR HVAC

PART 1 GENERAL

1.1. SECTION INCLUDES

A. Control Panels.
B. Air Supply.
C. Control Valves.
D. Dampers.
E. Time Clocks.
F. Input/Output Sensors.
G. Switches.
H. Relays.
I. Override Timers.
J. Humidistat.
K. Transmitters.
L. Transducers.
M. Transformers.
N. Power Monitors.

1.2. RELATED REQUIREMENTS

A. Section 23 00 00 - Basic HVAC Requirements.
B. Section 23 09 23 - Direct-Digital Control System for HVAC.
C. Section 23 09 93 - Sequence of Operations for HVAC Control.

1.3. REFERENCE STANDARDS

A. AMCA 500-D - Laboratory Methods of Testing Dampers for Rating; 2012.
B. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2014.
C. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); National Electrical Manufacturers Association; 2014.

1.4. ADMINISTRATIVE REQUIREMENTS

A. Preinstallation Meeting: Conduct a preinstallation meeting one week before starting work of this section; require attendance by all affected installers.

1.5. SUMMARY

A. Basic System and Scope:
   1. Furnish and install a complete DDC system that includes, but is not limited to; sensors, actuators, relays, electrical power, transformers, control panels, control wiring for all air-handling, terminal heating and cooling equipment, boiler/chiller plants and related equipment as shown on the plans and specified in this section.
   2. The control system shall be fully integrated and installed as a complete package of controls and instruments.

3. The system shall include all computer software and hardware, control unit hardware and software, operator input/output devices, sensors, control devices and the like required for complete operation and future modifications. Documentation for all software and hardware devices shall be provided. Two copies of the programming code (graphical or line code) shall be provided.
4. Provide engineering, installation, calibration, pre-commissioning, acceptance test overview, software programming and checkout for a complete and fully operational DDC control system.

1.6. SUBMITTALS

A. Product Data: Provide description and engineering data for each control system component. Include sizing as requested. Provide data for each system component and software module.
B. Shop Drawings: Indicate complete operating data, system drawings, wiring diagrams, and written detailed operational description of sequences. Submit schedule of valves indicating size, flow, and pressure drop for each valve. For automatic dampers indicate arrangement, velocities, and static pressure drops for each system.
C. Manufacturer's Instructions: Provide for all manufactured components.
D. Project Record Documents: Record actual locations of control components, including panels, thermostats, and sensors. Accurately record actual location of control components, including panels, thermostats, and sensors.
   1. Revise shop drawings to reflect actual installation and operating sequences.
E. Operation and Maintenance Data: Include inspection period, cleaning methods, recommended cleaning materials, and calibration tolerances.
F. Warranty: Submit manufacturer's warranty and ensure forms have been filled out in Owner's name and registered with manufacturer.
G. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
   1. See Section 01 60 00 - Product Requirements, for additional provisions.
   2. Extra Thermostats and Other Exposed Sensors: One of each type.

1.7. QUALITY ASSURANCE

A. Designer Qualifications: Design system under direct supervision of a Professional Engineer experienced in design of this work and licensed in the State of Oregon.
B. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum five years documented experience.
C. Installer Qualifications: Company specializing in performing the work of this section with minimum five years experience approved by manufacturer.
D. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc., as suitable for the purpose specified and indicated.

1.8. WARRANTY

A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.

PART 2 PRODUCTS

2.1. EQUIPMENT - GENERAL

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

2.2. CONTROL PANELS

A. Unitized cabinet type for each system under automatic control with relays and controls mounted in cabinet and temperature indicators, pressure gauges, pilot lights, push buttons and switches flush on cabinet panel face.
B. NEMA 250, general purpose utility enclosures with enameled finished face panel.
C. Provide common keying for all panels.

2.3. AIR SUPPLY

A. Manufacturers:
   1. BEC Controls Corp: www.beccontrols.com.
   2. Hanna Instruments, Inc.: www.hannainst.com.
   3. Sensus: www.sensu.com.
B. Control and Instrumentation Tubing:
   1. Copper Tube: ASTM B819 Type K, or ASTM B88 (ASTM B88M) Type K (A), seamless, H or O temper (drawn or annealed).
   2. Polyethylene Tubing: Black, flame retardant, virgin polyethylene, resistant to environmental stress-cracking when tested in accordance with ASTM D1693.
      a. Fittings: UL labeled, rod or forged brass rated to 200 psig at 100 degrees F.
      b. Joints: Compression or barbed type.

2.4. THERMOSTATS

A. Office Thermostats:
   1. Thermostat: Thermostats shall be wall-mounted with a touchscreen LCD display. Thermostat shall have a lockout function to prevent occupants from changing setpoint. Thermostat is capable of 0-10 Vdc or 4-20 mA signal. (Design Basis: Veris TW2TAXx)
B. Office Combination Thermostat/CO2 Sensor:
   1. Thermostat/CO2 sensors shall be wall-mounted with a touchscreen LCD display. It shall have a lockout function to prevent occupants from changing setpoint. It shall be capable of 0-10 Vdc or 4-20 mA signal. (Design Basis: Veris CW2TAXxV)
C. Line Voltage Thermostats:
   1. Integral manual on/off/auto selector switch, single or two pole as required.
   2. Dead Band: Maximum 2 degrees F.

3. Cover: Locking with set point adjustment, setpoint indication, and concealed setpoint, with thermometer.
4. Rating: Motor load.

D. Room Thermostat Accessories:
1. Thermostat Covers: Brushed aluminum.
2. Insulating Bases: For thermostats located on exterior walls.
3. Adjusting Key: As required for device.
4. Aspirating Boxes: Where indicated for thermostats requiring flush installation.

E. Outdoor Reset Thermostat:
1. Remote bulb or bimetal rod and tube type, proportioning action with adjustable throttling range, adjustable setpoint.
2. Scale Range: -10 to 70 degrees F.

F. Immersion Thermostat:
1. Remote bulb or bimetallic rod and tube type, proportional action with adjustable setpoint and adjustable throttling range.

G. Airstream Thermostats:
1. Remote bulb or bimetallic rod and tube type, proportional action with adjustable setpoint in middle of range and adjustable throttling range.
2. Averaging service remote bulb element: 7.5 feet.

H. Electric Low Limit Duct Thermostat:
1. Snap acting, single pole, single throw, manual or automatic reset switch that trips if temperature sensed across any 12 inches of bulb length is equal to or below setpoint.
2. Bulb Length: Minimum 20 feet.
3. Provide one thermostat for every 20 sq. ft. of coil surface.

I. Electric High Limit Duct Thermostat:
1. Snap acting, single pole, single throw, manual or automatic reset switch that trips if temperature sensed across any 12 inches of bulb length is equal to or above setpoint.
2. Bulb Length: Minimum 20 feet.
3. Provide one thermostat for every 20 sq. ft. of coil surface.

J. Fire Thermostats:
1. UL labeled, factory set in accordance with NFPA 90A.
2. Normally closed contacts, manual reset.

K. Heating/Cooling Valve Top Thermostats:
1. Proportional acting for proportional flow, molded rubber diaphragm, remote bulb liquid filled element, direct and reverse acting at differential pressure to 25 psig, cast housing with position indicator and adjusting knob.

L. Low-Voltage Space Thermostats: Low-voltage space thermostats shall be 24V, bimetal-operated, mercury-switch type, with adjustable or fixed anticipation heater, concealed setpoint adjustment, 13°C-30°C (55°F-85°F) setpoint range, 1°C (2°F) maximum differential, and vented ABS plastic cover.

M. Line-Voltage Space Thermostat: Line-voltage space thermostats shall be bi-metal actuated, open-contact type or bellows-actuated, enclosed, snap-switch type or equivalent solid-state type, with heat anticipator, UL listing for electrical rating, concealed setpoint

adjustment, 13°C-30°C (55°F-85°F) setpoint range, 1°C (2°F) maximum differential, and vented ABS plastic cover.

N. Low-Limit Thermostats: Low-limit airstream thermostats shall be UL listed, vapor pressure type. Element shall be at least 6 m (20 ft) long. Element shall sense temperature in each 30 cm (1ft) section and shall respond to lowest sensed temperature. Low-limit thermostat shall be manual reset only.

2.5. DAMPERS

A. Manufacturers:
   1. Ruskin Co.; Model Series CD/SD: www.ruskin.com.
   2. Greenheck: www.greenheck.com.
   3. Air Damper.
   4. Substitutions: See Section 01 60 00 - Product Requirements.

B. Performance: Test in accordance with AMCA 500-D.

C. Frames: Galvanized steel or extruded aluminum, welded or riveted with corner reinforcement, minimum 12 gage.

D. Blades: Galvanized steel or extruded aluminum, maximum blade size 8 inches wide, 48 inches long, minimum 22 gage, attached to minimum 1/2 inch shafts with set screws.

E. Blade Seals: Synthetic elastomeric mechanically attached, field replaceable.

F. Jamb Seals: Spring stainless steel.

G. Shaft Bearings: Oil impregnated sintered bronze.

H. Linkage Bearings: Oil impregnated sintered bronze.

I. Leakage: Less than one percent based on approach velocity of 2000 ft/min and 4 inches wg.

J. Maximum Pressure Differential: 6 inches wg.

K. Temperature Limits: -40 to 200 degrees F.

2.6. DAMPER OPERATORS

A. General: Provide smooth proportional control with sufficient power for air velocities 20 percent greater than maximum design velocity and to provide tight seal against maximum system pressures. Provide spring return for two position control and for fail safe operation.
   1. Provide sufficient number of operators to achieve unrestricted movement throughout damper range.
   2. Provide one operator for maximum 36 sq ft damper section.

B. Electric Operators:
   1. Electronic operators shall be as manufactured by Belimo.

2.7. TIME CLOCKS

A. Seven day programming switch timer with synchronous timing motor and seven day dial, continuously charged Ni-cad battery driven power failure 8 hour carry over and multiple switch trippers to control systems for minimum of two and maximum of eight signals per day with two normally open and two normally closed output switches.

B. Solid state programmable time control with 32 separate programs, 24 hour battery carry over, individual on/off/auto switches for each program, 365 day calendar with 20 programmable holidays, and system fault alarm.

2.8. BINARY TEMPERATURE DEVICES

A. Low-Voltage Space Thermostats: Low-voltage space thermostats shall be 24V, bimetal-operated, mercury-switch type, with adjustable or fixed anticipation heater, concealed setpoint adjustment, 13°C-30°C (55°F-85°F) setpoint range, 1°C (2°F) maximum differential, and vented ABS plastic cover.

B. Line-Voltage Space Thermostat: Line-voltage space thermostats shall be bimetal-actuated. open-contact type or bellows-actuated, enclosed, snap-switch type or equivalent solid-state type, with heat anticipator, UL listing for electrical rating, concealed setpoint adjustment, 13°C-30°C (55°F-85°F) setpoint range, 1°C (2°F) maximum differential, and vented ABS plastic cover.

C. Low-Limit Thermostats: Low-limit airstream thermostats shall be UL listed, vapor pressure type. Element shall be at least 6 m (20 ft) long. Element shall sense temperature in each 30 cm (1 ft) section and shall respond to lowest sensed temperature. Low-limit thermostat shall be manual reset only.

2.9. INPUT/OUTPUT SENSORS

A. Temperature Sensors:
   1. Thermister temperature detectors.
   2. Measuring current maximum 5 mA with maximum self-heat of 0.031 degrees F/mW in fluids and 0.014 degrees F/mW in air.
   3. Provide 3 lead wires and shield for input bridge circuit.
   4. Use insertion elements in ducts not affected by temperature stratification or smaller than one square meter. Use averaging elements where larger or prone to stratification sensor length 8 feet or 16 feet as required.
   5. Insertion elements for liquids shall be with brass socket with minimum insertion length of 2-1/2 inches.

B. Humidity Sensors:
   1. Elements: Accurate withing 5 percent full range with linear output.
   2. Room Sensors: With locking cover, span of 30 to 80 percent relative humidity.
   3. Duct and Outside Air Sensors: With element guard and mounting plate, range of 0-100 percent relative humidity.

C. Static Pressure Sensors:
   1. Unidirectional with ranges not exceeding 150 percent of maximum expected input.
   2. Temperature compensate with typical thermal error or 0.06 percent of full scale in temperature range of 40 to 100 degrees F.
   3. Accuracy: One percent of full scale with repeatability 0.3 percent.
   4. Output: 0-5 vdc with power at 12 to 28 vdc.

D. Equipment Operation Sensors:
   1. Status Inputs for Fans: Differential pressure switch with adjustable range of 0 to 5 inches wg.

2. Status Inputs for Pumps: Differential pressure switch piped across pump with adjustable pressure differential range of 8 to 60 psi.
3. Status Inputs for Electric Motors: Current sensing relay with current transformers, adjustable and set to 175 percent of rated motor current.

E. Damper Position Indication: Potentiometer mounted in enclosure with adjustable crank arm assembly connected to damper to transmit 0-100 percent damper travel.

F. Carbon Monoxide Detectors:
1. Single or multichannel dual level detectors, using solid state sensors with three year minimum life. Sensor replacement shall take maximum 15 minutes. Suitable over temperature range of 23 to 130 degrees F.
2. Provide individual indicator and contractor, initially calibrated for 700 ppm.
3. Maximum response time to 100 ppm CO calibration gas: Two minutes.

G. Oxygen Deficiency Sensor:
1. Oxygen deficiency sensor with LCD screen displaying O2 concentration and 3 relay outputs.
2. Sensor shall have local audible and visual alarm.
3. Mounting Location: 12" above finished floor.

H. Duct Temperature Sensor: Duct sensors shall be single point or averaging. Averaging sensors shall be a minimum of 1.5 m (5 ft) in length per 1 m² (10 ft²) of duct cross-section.

I. Immersion Temperature Sensors: Provide immersion sensors with a separable stainless steel well. Well pressure rating shall be consistent with system pressure it will be immersed in. Well shall withstand pipe design flow velocities.

J. Space Temperature Sensors: Space sensors shall have setpoint adjustment, override switch, display, and communication port.

K. Remote Combination Temperature and Humidity Sensor:
1. Provide temperature and humidity sensor combination with remote probes to be mounted in the space. (Design Basis: Vaisala HMT360)

2.10. SWITCHES

A. Current Switches: Current-operated switches shall be self-powered, solid-state with adjustable trip current. Select switches to match application current and DDC system output requirements.

B. Differential Pressure Switches: Differential pressure switches (air or water service) shall be UL listed, SPDT snap-acting, pilot duty rated (125 VA minimum) and shall have scale range and differential suitable for intended application and NEMA 1 enclosure unless otherwise specified.

2.11. RELAYS

A. Control Relays: Control relays shall be plug-in type, UL listed, and shall have dust cover and LED "energized" indicator. Contact rating, configuration, and coil voltage shall be suitable for application.

B. Time Delay Relays: Time delay relays shall be solid-state plug-in type, UL listed, and shall have adjustable time delay. Delay shall be adjustable to +/- 100% from setpoint

shown. Contact rating, configuration, and coil voltage shall be suitable for application. Provide NEMA 1 enclosure for relays not installed in local control panel.

2.12. OVERRIDE TIMERS

A. Unless implemented in control software, override timers shall be spring-wound line voltage, UL Listed, with contact rating and configuration required by application. Provide 0-6 hour calibrated dial unless otherwise specified. Flush mount timer on local control panel face or where shown.

2.13. HUMIDISTATS

A. Room Humidistats:
   1. Wall mounted, proportioning type.
   2. Throttling range: Adjustable ____ percent relative humidity.
   3. Operating range: 30 to 80 percent.
   4. Maximum temperature: 110 degrees F.
   5. Cover: Set point indication.

B. Limit Duct Humidistat:
   1. Insertion, two position type.
   2. Throttling range: Adjustable 2 percent relative humidity.
   3. Operating range: 20 to 80 percent.
   4. Maximum temperature: 150 degrees F.

2.14. TRANSMITTERS

A. AC current transmitters shall be self-powered, combination split-core current transformer type with built-in rectifier and high-gain servo amplifier with 4-20 mA two-wire output. Full-scale unit ranges shall be 10A, 20A, 50A, 100A, and 200A, with internal zero and span adjustment. Unit accuracy shall be +/- 1% full-scale at 500 ohm maximum burden.

B. Transmitter shall meet or exceed ANSI/ISA S50.0 requirements and shall be UL/CSA recognized.

C. Unit shall be split-core type for clamp-on installation on existing wiring.

D. Building Static Pressure Transmitter:
   1. One pipe, differential type with temperature compensation, scale range 0.01 to 6.0 inch wg positive or negative, and sensitivity of 0.0005 inch wg. Transmit electronic signal to receiver with matching scale range.

E. Pressure Transmitters:
   1. One pipe direct acting indicating type for gas, liquid, or steam service, range suitable for system, proportional electronic output.

F. Temperature Transmitters:
   1. One pipe, directly proportional output signal to measured variable, linearity within plus or minus 1/2 percent of range for 200 degrees F span and plus or minus 1 percent for 50 degree F span, with 50 or 100 degrees F temperature range, compensated bulb, averaging capillary, or rod and tube operation on 20 psig input pressure and 3 to 15 psig output.

G. Humidity Transmitters:
   1. One pipe, directly proportioned output signal to measured variable, linearity within plus or minus 1 percent for 70 percent relative humidity span, capable of withstanding 95 percent relative humidity without loss of calibration.

H. AC voltage transmitters shall be self-powered single-loop (two-wire) type, 4-20 mA output with zero and span adjustment.

I. Adjustable full-scale unit ranges shall be 100-130 Vac, 200-250 Vac, and 400-600 Vac. Unit accuracy shall be +/-1% full-scale at 500 ohm maximum burden.

J. Transmitters shall meet or exceed ANSI/ISA S50.0 requirements and shall be UL/CSA recognized at 600 Vac rating.

2.15. CURRENT TRANSFORMERS

A. AC current transformers shall be UL/CSA recognized and shall be completely encased (except for terminals) in approved plastic material.

B. Transformers shall be available in various current ratios and shall be selected for +/-1% accuracy at 5 A full-scale output.

C. Use fixed-core transformers for new wiring installation and split-core transformers for existing wiring installation.

2.16. VOLTAGE TRANSFORMERS

A. AC voltage transformers shall be UL/CSA recognized, 600 Vac rated, and shall have built-in fuse protection.

B. Transformers shall be suitable for ambient temperatures of 4°C-55°C (40°F-130°F) and shall provide +/-0.5% accuracy at 24 Vac and 5 VA load.

C. Windings (except for terminals) shall be completely enclosed with metal or plastic.

2.17. POWER MONITORS

A. Power monitors shall be three-phase type and shall have three-phase disconnect and shorting switch assembly, UL listed voltage transformers, and UL listed split-core current transformers.

B. Power monitors shall provide selectable output: rate pulse for kWh reading or 4-20 mA for kW reading. Power monitors shall operate with 5 A current inputs and maximum error of +/-2% at 1.0 power factor or +/-2.5% at 0.5 power factor.

2.18. CURRENT SWITCHES

A. Current-operated switches shall be self-powered, solid-state with adjustable trip current. Select switches to match application current and DDC system output requirements.

2.19. PRESSURE TRANSDUCERS

A. Transducers shall have linear output signal and field-adjustable zero and span.

B. Continuous operating conditions of positive or negative pressure 50% greater than calibrated span shall not damage transducer sensing elements.

C. Water pressure transducer diaphragm shall be stainless steel with minimum proof pressure of 1000 kPa (150psi). Transducer shall have 4-20 mA output, suitable mounting provisions, and block and bleed valves.
D. Water differential pressure transducer diaphragm shall be stainless steel with minimum proof pressure of 1000 kPa (150 psi.). Over-range limit (differential pressure) and maximum static pressure shall be 2000 kPa (300 psi.). Transducer shall have 4-20 mA output, suitable mounting provisions, and 5-valve manifold.

PART 3 EXECUTION

3.1. EXAMINATION

A. Verify existing conditions before starting work.
B. Verify that systems are ready to receive work.
C. Beginning of installation means installer accepts existing conditions.
D. Sequence work to ensure installation of components is complementary to installation of similar components in other systems.
E. Coordinate installation of system components with installation of mechanical systems equipment such as air handling units and air terminal units.

3.2. INSTALLATION

A. Install in accordance with manufacturer's instructions.
B. Check and verify location of thermostats and exposed control sensors with plans and room details before installation. Locate 48 inches above floor. Align with lighting switches .
C. Mount freeze protection thermostats using flanges and element holders.
D. Mount outdoor reset thermostats and outdoor sensors indoors, with sensing elements outdoors with sun shield.
E. Provide separable sockets for liquids and flanges for air bulb elements.
F. Provide thermostats in aspirating boxes in front entrances.
G. Provide guards on thermostats in entrances, public areas, and where indicated.
H. Provide valves with position indicators and with pilot positioners where sequenced with other controls.
I. Provide separate steam valves for each bank of coils. Provide two valves in parallel where steam load exceeds 1500 lb per hr with 1/3 to 2/3 load capacities sequenced with smaller valve opening first.
J. Provide mixing dampers of opposed blade construction arranged to mix streams.
K. Provide isolation (two position) dampers of parallel blade construction.
L. Install damper motors on outside of duct in warm areas. Do not install motors in locations at outdoor temperatures.
M. Mount control panels adjacent to associated equipment on vibration free walls or free standing angle iron supports. One cabinet may accommodate more than one system in same equipment room. Provide engraved plastic nameplates for instruments and controls inside cabinet and engraved plastic nameplates on cabinet face.

N. Install "hand/off/auto" selector switches to override automatic interlock controls when switch is in "hand" position.
O. Provide conduit and electrical wiring in accordance with Section 26 27 17. Electrical material and installation shall be in accordance with appropriate requirements of .

3.3. FIELD QUALITY CONTROL

A. After completion of installation, test and adjust control equipment. Submit data showing set points and final adjustments of controls.

3.4. DEMONSTRATION AND TRAINING

A. Demonstrate complete operation of systems, including sequence of operation prior to Date of Substantial Completion.

END OF SECTION

DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC

PART 1 GENERAL

1.1. SECTION INCLUDES

A. Description of Work.
B. Operator interface.
C. Controllers.
D. Power supplies and line filtering.
E. System software.
F. Controller software.
G. HVAC control programs.
H. Chiller control programs.

1.2. RELATED REQUIREMENTS

A. Section 23 00 00 - Basic HVAC Requirements.
B. Section 23 05 53 - Identification for HVAC Piping and Equipment.
C. Section 23 09 13 - Instrumentation and Control Devices for HVAC.
D. Section 23 09 93 - Sequence of Operations for HVAC Control.
E. Division 26 - Electrical characteristics and wiring connections.

1.3. REFERENCE STANDARDS

A. ANSI/CEA 709.1.D - Control Network Protocol Specification; 2014.
B. ASHRAE Std 135 - BACnet - A Data Communication Protocol for Building Automation and Control Networks; 2020.
C. CTA-709.1 - Control Network Protocol Specification; Revision D, 2014.
D. IEEE 802.11 - IEEE Standard for Information Technology--Telecommunications and Information Exchange Between Systems Local and Metropolitan Area Networks--Specific Requirements - Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications ; 2016, with Errata (2017).
E. MIL-STD-810 - Environmental Engineering Considerations and Laboratory Tests; 2019h.
F. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

1.4. ABBREVIATIONS AND SYMBOLS

A. All letter symbols and engineering unit abbreviations utilized in information displays ANSI/ISA S5.5 and printouts shall conform to ANSI 710.19/IEEE 260-letter symbols for SI and certain other units of measurement.
B. Specification Nomenclature - Acronyms used in this specification are as follows:

AAC	Advanced Application Controller
ASC	Application Specific Controller
BAS	Building Automation System
BC	Building Controller
BIBB	BACnet Interoperability Building Blocks

DDC	Direct Digital Controls
GUI	Graphical User Interface
HTTP	Hyper Text Transfer Protocol
LAN	Local Area Network
ODBC	Open Database Connectivity Protocol
OOT	Object Oriented Technology
OPC	Object linking and embedding for Process Control
OWS	Operator Workstation
PDA	Personnel Data Assistant device
PICS	Protocol Implementation Conformance Statement
PWS	Portable Workstation
SNVTS	Standard Network Variables Types
SQL	Standard Query Language
TCP/IP	Transmission Control Protocol / Internet Protocol
TCU	Terminal Control Unit
WAN	Wide Area Network
WAP	Wireless Application Protocol Device
WBI	Web Browser Interface
XML	Extensible Markup Language
XIF	External Interface Files

1.5. SYSTEM DESIGN

A. The system shall consist of a network of Building Controllers (BC), Advanced Application Controllers (AAC), Application Specific Controllers (ASC), and Smart Actuators (SA). Every device in the system which executes control logic and directly controls HVAC equipment must conform to a standard BACnet Device profile as specified in ANSI/ASHRAE 135.1-2013, BACnet Annex L. Unless otherwise specified, hardwired actuators and sensors may be used in lieu of BACnet Smart Actuators and Smart Sensors.

B. Systems utilizing gateways will not be considered. A gateway device is considered to be a device where only mapping of system points from one protocol to another occurs. A gateway device cannot perform higher-level energy management functions such as Outdoor Air Optimization, Electrical Demand Limiting and the like.

C. The Building Automation System software shall employ object-oriented technology (OOT) for representation of all data and control devices within the system. The supplied system must incorporate the ability to access all data using standard Web browsers without requiring proprietary operator interface and configuration programs. An Open Database Connectivity (ODBC) or Structured Query Language (SQL) compliant server database is required for all system database is required for all system database parameter storage. This data shall reside on a BAS server for all database access. Systems requiring proprietary database and user interface programs shall not be acceptable. No special software other than a Web browser shall be required to access graphics, point displays, and trends, configure trends, configure points, and controllers, or download programming

into the controllers. The BMS system shall allow an unlimited number of concurrent users.

D. A hierarchical topology is required to assure reasonable system response times and to manage the flow and sharing of data without unduly burdening the customer's internal Intranet network. Systems employing a flat single tiered architecture shall not be acceptable. Maximum acceptable response time from any alarm occurrence (at the point of origin) to the point of annunciation shall not exceed 5 seconds for network connected user interfaces. Maximum acceptable response time from any alarm occurrence (at the point of origin) to the point of annunciation shall not exceed 60 seconds for remote or dial-up connected user interfaces.

1.6. DESCRIPTION OF WORK

A. Furnish and install a complete Direct Digital Control System for the entire building as described in the specification, drawings, and control documents.

B. Provide an open protocol Building Automation System (BAS) utilizing native BACnet area, system and application controllers. Replace existing equipment pneumatic control panels with HVAC Equipment manufacturer recommended electronic.

C. Include computer software and hardware, operator input/output devices, control units, local area networks (LAN), sensors, control devices, actuators.

D. Include installation and calibration, supervision, adjustments, and fine tuning necessary for complete and fully operational system.

E. The BAS shall incorporate Direct Digital Control (DDC) equipment monitoring and control consisting of: A PC based Operator Work Station (OWS) with color graphic data displays; microcomputer based Building Controllers (BC) and Microcomputer based Advanced Application Controllers (AAC) and Application Specific Controllers (ASC) interfacing directly with sensors, actuators and environmental delivery systems (i.e Air Handlers, Boilers, Chillers, Terminal Units, etc.); electric controls and devices for all items indicated on the drawings provided including sensors, thermostats, dampers, damper actuators, valve actuators valves and panels.

F. Open protocols are to be BACnet (ASHRAE Standard 135- Annex J) Only. All BAS Controllers (BC, AAC, and ASC) are to be native BACnet (ASHRAE Standard 135-Annex J).

G. Systems utilizing gateways will not be considered. A gateway is a device where only mapping of system points from one protocol to another occurs.

1.7. ADMINISTRATIVE REQUIREMENTS

A. Preinstallation Meeting: Conduct a preinstallation meeting one week prior to the start of the work of this section; require attendance by all affected installers. Notify Downtown Development Group.

1.8. SUBMITTALS

A. See Section 23 00 00 - Basic HVAC Requirements, for submittal procedures.

B. Product Data: Provide data for each system component and software module.

C. Shop Drawings:
   1. Indicate trunk cable schematic showing programmable control unit locations, and trunk data conductors.
   2. List connected data points, including connected control unit and input device.
   3. Indicate system graphics indicating monitored systems, data (connected and calculated) point addresses, and operator notations. Provide demonstration digital media containing graphics.
   4. Show system configuration with peripheral devices, batteries, power supplies, diagrams, modems, and interconnections.
   5. Indicate description and sequence of operation of operating, user, and application software.

D. Manufacturer's Instructions: Indicate manufacturer's installation instructions for all manufactured components.

E. Designer's Qualification Statement.

F. Manufacturer's Qualification Statement.

G. Installer's Qualification Statement.

H. Project Record Documents: Record actual locations of control components, including control units, thermostats, and sensors.
   1. Revise shop drawings to reflect actual installation and operating sequences.
   2. Include submittals data in final "Record Documents" form.

I. Operation and Maintenance Data:
   1. Include interconnection wiring diagrams complete field installed systems with identified and numbered, system components and devices.
   2. Include keyboard illustrations and step-by-step procedures indexed for each operator function.
   3. Include inspection period, cleaning methods, cleaning materials recommended, and calibration tolerances.

J. Warranty: Submit manufacturer's warranty and ensure forms have been filled out in Owner s name and registered with manufacturer.

1.9. QUALITY ASSURANCE

A. Perform work in accordance with NFPA 70, applicable Oregon Codes, ANSI / ASHRAE 135; Data Communication Protocol for Building Automation and Control System (BACnet). All devices shall be UL or FM listed and labeled for the specific use, application and environment to which they are applied.

B. Designer Qualifications: Perform design of system using manufacturer's software under direct supervision of a Professional Engineer experienced in design of this type of work and licensed in Oregon.

C. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section with minimum five years of documented experience.

D. Installer Qualifications: Company specializing in performing work of the type specified and with minimum five years of documented experience.

E. Products Requiring Electrical Connection: Listed and classified by UL (DIR); testing firm acceptable to authorities having jurisdiction (AHJ) as suitable for purpose specified and indicated.

1.10. WARRANTY

A. Warrant work as follows:
   1. Warrant labor and materials for specified control system free from defects for a period of 12 months after final acceptance. Control system failures during warranty period shall be adjusted, repaired, or replaced at no additional cost or reduction in service to Owner. Respond during normal business hours within 24 hours of Owner's warranty service request.
   2. Work shall have a single warranty date, even if Owner receives beneficial use due to early system start-up. If specified work is split into multiple contracts or a multi-phase contract, each contract or phase shall have a separate warranty start date and period.
   3. If the engineer determines that equipment and systems operate satisfactorily at the end of final start-up, testing, and commissioning phase, the engineer will certify in writing that control system operation has been tested and accepted in accordance with the terms of this specification. Date of acceptance shall begin warranty period.
   4. All Manufacturer's software/firmware for web server/workstation and controllers shall be updated to the latest versions that are available from the manufacturer within 30 days from the date of end of the warranty. These updates shall be installed and checked out before the end of the warranty.
   5. Provide updates to web server software, project-specific software, graphic software, database software, and firmware that resolve the contractor-identified software deficiencies at no charge during warranty period. If available, Owner can purchase in-warranty service agreement to receive upgrades for functional enhancements associated with above-mentioned items. Do not install updates or upgrades without Owner's written authorization.
   6. Exception: Contractor shall not be required to warrant reused devices except those that have been rebuilt or repaired and factory recertified. Installation labor and materials shall be warranted. Demonstrate operable condition of reused devices at time of Engineer's acceptance.

B. Ownership of Proprietary Material
   1. Project-specific software and documentation shall become Owner's property. This includes, but is not limited to:
      a. Graphics.
      b. Record drawings.
      c. Database.
      d. Application programming code.
      e. Documentation.

1.11. PROTECTION OF SOFTWARE RIGHTS

A. Prior to delivery of software, the Owner and the party providing the software will enter into a software license agreement with provisions for the following:
   1. Limiting use of software to equipment provided under these specifications.
   2. Limiting copying.
   3. Preserving confidentiality.
   4. Prohibiting transfer to a third party.

PART 2 PRODUCTS

2.1. MANUFACTURERS

A. Automated Logic by Clima-Tech.
B. Alerton by Environmental Controls.
C. Honeywell. (As installed by Northwest Control Corp. (N.C.C)
D. Substitutions: Not Permitted.

2.2. OPERATOR INTERFACE

A. PC Based Work Station:
   1. Resides on high speed network with building controllers.
   2. Connected to server for full access to all system information.
B. Workstation, controllers, and control backbone to communicate using BACnet protocol and addressing.
C. BACnet protocol to comply with ASHRAE Std 135.
D. Hardware:
   1. Desktop:
      a. Computer(s) and display(s) to be provided by DDC controls manufacturer.
      b. Quantity: Provide allowance for 1 computer(s).
      c. Minimum RAM: 4 GB.
      d. Minimum Processing Speed: 3.0 GHz (Intel i5 Quad Core).
      e. Minimum Hard Drive Memory: 500 GB providing data at 100 MB/sec.
      f. Monitor: 24 inch, 24 bit color with minimum 1920x1080 resolution.
      g. Ports: Serial, parallel, and network communication with cables required for proper system operation.
      h. Location(s): As directed by the Owner.
      i. Network Connection:
         1. Ethernet interface card.
         2. Minimum Speed: 100 MB/sec.
E. Provide uninterruptable power supply (UPS) capable of providing at least 1 hour of backup power.

2.3. CONTROLLERS

A. Building Controllers (BC):
   1. General:
      a. Each BC shall have a minimum of 20% resource capacity. The BC shall be capable of transmitting all BAS LAN data connected to it within 10 seconds.
      b. Manage global strategies by one or more, independent, standalone, microprocessor based controllers.
      c. Provide sufficient memory to support controller's operating system, database, and programming requirements.
      d. Share data between networked controllers.
      e. Controller operating system manages input and output communication signals allowing distributed controllers to share real and virtual object information and allowing for central monitoring and alarms.
      f. Utilize real-time clock for scheduling.
      g. Continuously check processor status and memory circuits for abnormal operation.
      h. Controller to assume predetermined failure mode and generate alarm notification upon detection of abnormal operation.
      i. Communication with other network devices to be based on assigned protocol.
   2. Communication:
      a. Controller to reside on a BACnet network using ISO 8802-3 (ETHERNET) Data Link/Physical layer protocol.
      b. Perform routing when connected to a network of custom application and application specific controllers.
      c. Provide service communication port for connection to a portable operator's terminal or hand held device with compatible protocol.
   3. External Input-Output (I-O) Data Bus:
      a. Input only modules.
      b. Output only modules.
      c. Variable frequency drives (VFD's).
      d. Universal I-O module (configurable).
      e. Specific wired data integration modules.
      f. Multiple Input Output (I-O) Module:
         1. IAQ: Temperature, humidity, and CO2.
         2. Audio: Microphone, tone generator, and speaker.
         3. Input and output terminals to monitor or control local devices.
         4. Occupancy: Light and thermal sensing with multi-colored LED feedback.
   4. Anticipated Environmental Ambient Conditions:
      a. Outdoors and/or in Wet Ambient Conditions:
         1. Mount within waterproof enclosures.

2. Rated for operation at 40 to 150 degrees F.

b. Conditioned Space:

1. Mount within dustproof enclosures.
2. Rated for operation at 32 to 120 degrees F.

5. Local Keypad and Display for each Controller:
   a. Use for interrogating and editing data.
   b. System security password prevents unauthorized use.
6. Provisions for Serviceability:
   a. Diagnostic LEDs for power, communication, and processor.
   b. Make all wiring connections to field removable, modular terminal strips, or to a termination card connected by a ribbon cable.
7. Memory: In the event of a power loss, maintain all BIOS and programming information for a minimum of 72 hours.
8. Power and Noise Immunity:
   a. Maintain operation at 90 to 110 percent of nominal voltage rating.
   b. Perform orderly shutdown below 80 percent of nominal voltage.
   c. Operation protected against electrical noise of 5 to 120 Hz and from keyed radios up to 5 W. at 3 feet.
9. Provide uninterruptable power supply (UPS) capable of providing at least 1 hour of backup power.

B. Custom Application Controller (AAC):
1. General:
   a. Provide sufficient memory to support controller's operating system, database, and programming requirements.
   b. Share data between networked, microprocessor based controllers.
   c. Controller operating system manages input and output communication signals allowing distributed controllers to share real and virtual object information and allowing for central monitoring and alarms.
   d. Utilize real-time clock for scheduling.
   e. Continuously check processor status and memory circuits for abnormal operation.
   f. Controller to assume predetermined failure mode and generate alarm notification upon detection of abnormal operation.
   g. Communication with other network devices to be based on assigned protocol.
2. Communication:
   a. Controller to reside on a BACnet network using _____ protocol.
   b. Provide service communication port for connection to a portable operator's terminal or hand held device with compatible protocol.
3. Anticipated Environmental Ambient Conditions:
   a. Outdoors and/or in Wet Ambient Conditions:
      1. Mount within waterproof enclosures.
      2. Rated for operation at -20°F to 140°F degrees F..
   b. Conditioned Space:

1. Mount within dustproof enclosures.
2. Rated for operation at 32 to 120 degrees F.

4. Local Keypad and Display for each Controller:
   a. Use for interrogating and editing data.
   b. System security password prevents unauthorized use.
5. Provisions for Serviceability:
   a. Diagnostic LED's for power, communication, and processor.
   b. Make all wiring connections to field removable, modular terminal strips, or to a termination card connected by a ribbon cable.
6. Memory: In the event of a power loss, maintain all BIOS and programming information for a minimum of 72 hours.
7. Power and Noise Immunity:
   a. Maintain operation at 90 to 110 percent of nominal voltage rating.
   b. Perform orderly shutdown below 80 percent of nominal voltage.
   c. Operation protected against electrical noise of 5 to 120 Hz and from keyed radios up to 5 W. at 3 feet.

C. Application Specific Controllers (ASC):
1. General:
   a. Not fully user programmable, microprocessor based controllers dedicated to control specific equipment.
   b. Customized for operation within the confines of equipment served.
   c. Communication with other network devices to be based on assigned protocol.
2. Communication:
   a. Controller to reside on a BACnet network using ISO 8802-3 (Ethernet) Data Link / Physical Layer protocol with BACnet / IP addressing, or it shall reside on a BACnet network using the MS / TP Data Link / Physical layer protocol.
   b. Provide service communication port for connection to a portable operator's terminal or hand held device with compatible protocol.
3. Anticipated Environmental Ambient Conditions:
   a. Outdoors and/or in Wet Ambient Conditions:
      1. Mount within waterproof enclosures.
      2. Rated for operation at 40 to 150 degrees F.
   b. Conditioned Space:
      1. Mount within dustproof enclosures.
      2. Rated for operation at 32 to 120 degrees F.
4. Local Keypad and Display for each Controller:
   a. Use for interrogating and editing data.
   b. System security password prevents unauthorized use.
5. Provisions for Serviceability:
   a. Diagnostic LEDs for power, communication, and processor.
   b. Make all wiring connections to field removable, modular terminal strips, or to a termination card connected by a ribbon cable.

6. Memory: In the event of a power loss, maintain all BIOS and programming information for a minimum of 72 hours.
7. Power and Noise Immunity:
   a. Maintain operation at 90 to 110 percent of nominal voltage rating.
   b. Perform orderly shutdown below 80 percent of nominal voltage.
   c. Operation protected against electrical noise of 5 to 120 Hz and from keyed radios up to 5 W at 3 feet.
8. Smart Sensor (SS):
   a. Features: Built-in display and cool-warm adjust slider or knob.
   b. Inputs: 3-universal (configurable).
   c. Output: 0 to 10 VDC.
   d. Occupancy Feedback: LED, red; LED, green.
   e. Temperature Sensor: Platinum, 1,000 ohms RTD element inside insulated thermoplastic enclosure.
   f. Communications Protocol: BACnet MS/TP per ASHRAE Std 135.
   g. Certification: BACnet Testing Laboratory (BTL) certified device listed under the BACnet Smart Sensor (B-SS) device profile in compliance with ASHRAE Std 135.

D. Input/Output Interface:
1. Hardwired inputs and outputs tie into the DDC system through building, custom application, or application specific controllers.
2. All Input/Output Points:
   a. Protect controller from damage resulting from any point short-circuiting or grounding and from voltage up to 24 volts of any duration.
   b. Provide universal type for building and custom application controllers where input or output is software designated as either binary or analog type with appropriate properties.
3. Binary Inputs:
   a. Allow monitoring of On/Off signals from remote devices.
   b. Provide wetting current of 12 mA minimum, compatible with commonly available control devices and protected against the effects of contact bounce and noise.
   c. Sense dry contact closure with power provided only by the controller.
4. Pulse Accumulation Input Objects: Comply with all requirements of binary input objects and accept up to 10 pulses per second.
5. Analog Inputs:
   a. Allow for monitoring of low voltage 0 to 10 VDC, 4 to 20 mA current, or resistance signals (thermistor, RTD).
   b. Compatible with and field configurable to commonly available sensing devices.
6. Binary Outputs:
   a. Used for On/Off operation or a pulsed low-voltage signal for pulse width modulation control.
   b. Outputs provided with three position (On/Off/Auto) override switches.

c. Status lights for building and custom application controllers to be selectable for normally open or normally closed operation.

7. Analog Outputs:
   a. Monitoring signal provides a 0 to 10 VDC or a 4 to 20 mA output signal for end device control.
   b. Provide status lights and two position (AUTO/MANUAL) switch for building and custom application controllers with manually adjustable potentiometer for manual override on building and custom application controllers.
   c. Drift to not exceed 0.4 percent of range per year.
8. System Object Capacity:
   a. System size to be expandable to twice the number of input output objects required by providing additional controllers, including associated devices and wiring.
   b. Hardware additions or software revisions for the installed operator interfaces are not to be required for future, system expansions.

2.4. POWER SUPPLIES AND LINE FILTERING

A. Power Supplies:
1. Provide UL listed control transformers with Class 2 current limiting type or over-current protection in both primary and secondary circuits for Class 2 service as required by the NEC.
2. Limit connected loads to 80 percent of rated capacity.
3. Match DC power supply to current output and voltage requirements.
4. Unit to be full wave rectifier type with output ripple of 5.0 mV maximum peak to peak.
5. Regulation to be 1 percent combined line and load with 100 microsecond response time for 50 percent load changes.
6. Provide over-voltage and over-current protection to withstand a 150 percent current overload for 3 seconds minimum without trip-out or failure.
7. Operational Ambient Conditions: 32 to 120 degrees F.
8. EM/RF meets FCC Class B and VDE 0871 for Class B and MIL-STD-810 for shock and vibration.
9. Line voltage units UL recognized and CSA approved.

B. Power Line Filtering:
1. Provide external or internal transient voltage and surge suppression component for all workstations and controllers.
2. Minimum surge protection attributes:
   a. Dielectric strength of 1000 volts minimum.
   b. Response time of 10 nanoseconds or less.
   c. Transverse mode noise attenuation of 65 dB or greater.
   d. Common mode noise attenuation of 150 dB or greater at 40 to 100 Hz.

2.5. LOCAL AREA NETWORK (LAN)

A. Provide communication between control units over local area network (LAN).
B. LAN Capacity: Not less than 60 stations or nodes.
C. Break in Communication Path: Alarm and automatically initiate LAN reconfiguration.
D. LAN Data Speed: Minimum 19.2 Kb.
E. Communication Techniques: Allow interface into network by multiple operation stations and by auto-answer/auto-dial modems. Support communication over telephone lines utilizing modems.
F. Transmission Median: Fiber optic or single pair of solid 24 gauge twisted, shielded copper cable.
G. Network Support: Time for global point to be received by any station, shall be less than 3 seconds. Provide automatic reconfiguration if any station is added or lost. If transmission cable is cut, reconfigure two sections with no disruption to system's operation, without operator intervention.

2.6. SYSTEM SOFTWARE

A. Operating System. Web server shall have an industry-standard professional-grade operating system. Operating system shall meet or exceed the BMS manufacturer's minimum requirements for their software. Acceptable systems include Microsoft Windows 8.1 or 10, Windows Server 2012 R2 or 2016 or 2019 or 2020, Red Hat Enterprise Linux 8.3, or Ubuntu Desktop 18.04 or 20.04 TLS.
B. Security. The web server application shall support Transport Layer Security (TLS) 1.3 capable of encryption of up to 256 bit elliptical curve for transmitting private information over the Internet using HTTPS. Additionally, the web server shall have SHA-2 certificate support capability.
C. Database. System shall support any JDBC (Java DataBase Connectivity) compliant engine. This includes MS SQL, My SQL, Apache Derby, PostgreSQL, and Oracle.
D. The BMS system shall allow an unlimited number of concurrent users.
E. The BMS manufacturer shall provide all software and tools necessary to provide the following capabilities:
    1. Create and/or edit any programming used in controllers
    2. Create and/or edit any graphics used in the system
    3. Software shall not be subscription based and be given to owner at time of turnover. If software is subscription based, manufacturer shall include 10 years of subscription service.
    4. The owner shall have the ability to install software on a minimum of five (5) additional owner furnished computers without additional licenses or fees.
F. System Graphics. The operator interface software shall be graphically based and shall include at least one graphic per piece of equipment or occupied zone, graphics for each chilled water and hot water system, and graphics that summarize conditions on each floor of each building included in this contract. Indicate thermal comfort on floor plan summary graphics using dynamic colors to represent zone temperature relative to zone setpoint.

1. Minimum graphics resolution shall be 1920 x1080 for display of detailed system graphics.
2. Floor Plan Graphics. Floor plan graphics shall be Scalable Vector Graphics (SVG) capable of allowing the floor plan graphic to dynamically size relative to the end user's monitor resolution.
3. Functionality. Graphics shall allow operator to monitor system status, to view a summary of the most important data for each controlled zone or piece of equipment, to use point-and-click navigation between zones or equipment, an d to edit setpoints and other specified parameters.
4. Animation. Graphics shall be able to animate by displaying different image files for changed object status.
5. Alarm Indication. Indicate areas or equipment in an alarm condition using color or other visual indicator.
6. Format. Graphics shall be saved in an industry-standard format such as BMP, JPEG, PNG, GIF, or SVG. Web-based system graphics shall be viewable on browsers compatible with World Wide Web Consortium browser standards. Web graphic format shall require no plug-in) or shall only require widely available no-cost plug-ins (such as Active-X or Adobe Flash).

G. Custom Graphics. Custom graphic files shall be created with the use of a graphics generation package furnished with the system. The graphics generation package shall be a graphically based system to create and modify graphics that are saved in the same formats as are used for system graphics..

H. Graphics Library. Furnish a complete library of standard HVAC equipment graphics such as chillers, boilers, air handlers, terminals, fan coils, and unit ventilators. This library also shall include standard symbols for other equipment including fans, pumps, coils, valves, piping, dampers, and ductwork. The library shall be furnished in a file format compatible with the graphics generation package program.

I. System Applications. System shall provide the following functionality to authorized operators as an integral part of the operator interface or as stand-alone software programs. If furnished as part of the interface, the tool shall be available from each workstation or web browser interface. If furnished as a stand-alone program, software shall be installable on standard PC type personal computer with no limit on the number of copies that can be installed under the system license.

1. Automatic System Database Configuration. Each workstation or web server shall store on its hard disk a copy of the current system database, including controller firmware and software. Stored database shall be automatically updated with each system configuration or controller firmware or software change.
2. Manual Controller Memory Download. Operators shall be able to download memory from the system database to each controller.
3. System Configuration. The workstation software shall provide a method of configuring the system. This shall allow for future system changes or additions by users under proper password.
4. On-Line Help. Provide a context-sensitive, on-line help system to assist the operator in operating and editing the system. On-line help shall be available for all

applications and shall provide the relevant data for that particular screen. Additional help information shall be available through the use of hypertext.

5. Video Training. Provide on-line video support to supplement on-line help assistance. Video content shall be relevant and support existing system documentation.
6. Security. Each operator shall be required to log on to the system with a user name and password in order to view, edit, add, or delete data.
    a. Operator Access. The user name and password combination shall define accessible viewing, editing, adding, and deleting privileges for that operator. Users with system administrator rights shall be able to create new users and edit the privileges of all existing users. System Administrators shall also be able to vary and deny each operator's privileges based on the geographic location, such as the ability to edit operating parameters in Building A, to view but not edit parameters in Building B, and to not even see equipment in Building C.
    b. Password Policy Rules. System administrator shall invoke policies for minimum password strength, including number of characters, special characters and numbers, upper and lower case, etc.
    c. Automatic Log Out. Automatically log out each operator if no keyboard or mouse activity is detected. This auto log off time shall be user adjustable.
    d. Encrypted Security Data. Store system security data including operator passwords in an encrypted format. System shall not display operator passwords.
7. System Diagnostics. The system shall automatically monitor the operation of all building management panels and controllers. The failure of any device shall be annunciated to the operator
8. Alarm Processing. System input and status objects shall be configurable to alarm on departing from and on returning to normal state. Operator shall be able to enable or disable each alarm and to configure alarm limits, alarm limit differentials, alarm states, and alarm reactions for each system object. Configure and enable alarm points as required by sequences of operation. Alarms shall be BACnet alarm objects and shall use BACnet alarm services. BMS system shall be capable of assigning alarm sources to categories such as HVAC Critical, or HVAC General. The BMS shall include at a minimum HVAC and FDD categories. BMS system shall allow user to create custom alarm categories.
9. Alarm Messages. Alarm messages shall use the English language descriptor for the object in alarm in such a way that the operator will be able to recognize the source, location, and nature of the alarm without relying on acronyms or mnemonics.
10. Alarm Reactions. Operator shall be able to configure (by object) what, if any actions are to be taken during an alarm. As a minimum, the workstation or web server shall be able to log, print, start programs, display messages, send e-mail, send SMS text, and audibly annunciate.
11. Alarm and Event log. Operators shall be able to view all system alarms and changes of state from any location in the system. Events shall be listed

chronologically. An operator with the proper security level may acknowledge and delete alarms, and archive closed alarms to the workstation or web server hard.

12. Trend Logs. The operator shall be able to configure trend sample or change of value (COV) interval, start time, and stop time for each system data object and shall be able to retrieve data for use in spreadsheets and standard database programs. Controller shall sample and store trend data and shall be able to archive data to the hard disk. Configure trends as required by the sequences of operations. Trends shall be BACnet trend objects. As a minimum, all physical points in the system shall be trended within the local controller (AAC, ASC, BC) for at least 277 samples per point. Selected points, as desired, shall be available for historical archiving within the server. The historical archiving capability cannot be less than 2 years.
13. Object and Property Status and Control. Provide a method for the operator to view, and edit if applicable, the status of any object or property in the system. The status shall be available by menu, on graphics, or through custom programs.
14. Reports and Logs. Operator shall be able to select, to modify, to create, and to print reports and logs. Operator shall be able to store report data in a format accessible by standard spreadsheet and word processing programs.
15. Audit and Security Detail. All users accessing the system shall have their actions recorded. Information recorded shall include:
    a. login/logout time and date
    b. system modifications – with before and after values
    c. ability to report user activity based on individual and/or date and time.
16. Standard Reports. Furnish the following standard system reports:
    a. Objects. System objects and current values filtered by object type, by status (in alarm, locked, normal), by equipment, by geographic location, or by combination of filter criteria.
    b. Alarm Summary. Current alarms and closed alarms. System shall retain closed alarms for an adjustable period.
    c. Logs. System shall log the following to a database or text file and shall retain data for an adjustable period:
        1. Alarm History.
        2. Trend Data. Operator shall be able to select trends to be logged.
17. Custom Reports. Operator shall be able to create custom reports that retrieve data, including archived trend data, from the system, that analyze data using common algebraic calculations, and that present results in tabular or graphical format. Reports shall be launched from the operator interface. Operator shall be able to schedule reports to automatically run and be emailed to recipients on a recurring basis from the BMS system.
18. Logic Page. System shall allow operator to view all application software in real time for all controllers furnished and installed by BMS manufacturer.
19. Environmental Index. System shall monitor all occupied zones and compile an index that provides a numerical indication of the environmental comfort within the zone. As a minimum, this indication shall be based upon the deviation of the zone temperature from the heating or cooling setpoint. If humidity is being measured

within the zone then the environmental index shall be adjusted to reflect a lower comfort level for high or low humidity levels. Similarly, if carbon dioxide levels are being measured as an indication of ventilation effectiveness then the environmental index shall be adjusted to indicate degraded comfort at high carbon dioxide levels. Other adjustments may be made to the environmental index based upon additional measurements. The system shall maintain a trend of the environmental index for each zone in the trend log. The system shall also compute an average comfort index for every building included in this contract and maintain trend logs of these building environmental indices. Similarly, the system shall compute the percentage of occupied time that comfortable conditions were maintained within the zones. Through the UI the user shall be able to add a weighting factor to adjust the contribution of each zone to the average index based upon the floor area of the zone, importance of the zone, or other static criteria.

20. Indoor Environmental Quality Index (IEQ)
    a. System shall monitor up to ten building conditions and compile an index that provides a numerical indication of the overall building environmental quality and health. A graphical dashboard indicating each measured building condition name, a description of each measured building condition, the current value of each measured building condition, and the overall building IEQ value. In addition, an historical trend graph of the IEQ Index and/or individual health components shall also be displayed The IEQ numerical value indication shall be 0-100 with 0 being the worst and 100 the best. The IEQ shall be calculated using an algorithm that aggregates all of the selected building conditions and allows the user to define the acceptable ranges for each monitored building condition. In addition, the user shall have the ability assign a weighting/importance factor to each building condition that determines the impact the monitored building condition has on the overall IEQ index calculation. The IEQ value graphical representation shall have the ability to display one of a minimum of four (4) colors based on the IEQ value and the user adjustable range for each color. The default IEQ ranges and colors shall be as follows:
        1. Less than 85 = Red
        2. 85 to 89.9 = Orange
        3. 90 to 94.9 = Yellow
        4. 95 to 100 = Green
    b. The system shall allow the user to select from one of the following ten building conditions:
        1. Temperature, average area
        2. Humidity, average area
        3. Carbon Dioxide, average area
        4. Volatile Organic Compounds, average area
        5. % Dirty Filters, % dirty filter switches
        6. % Occupied, of expected occupants
        7. Air Purifiers, Total counted purifiers
        8. % OA of Design, % Total OA cfm of buildings design.

9. CFM per Person, Average outside air flow per occupant
10. % Time Above minimum, % of time outside air dampers are above the minimum when occupied (average of all).

21. Time Lapse Graphic Replay. Operator shall be able to "replay" any graphic in the system to see how key values changed over an operator-selected period of time. Operator shall be able to select the starting date/time for this display and the end date/time or the display period. System shall then display the graphic as it would have looked at the beginning of that period, displaying key data, dynamic colors, etc. based upon values recorded at the start time. When the operator starts the replay the graphics and key values shall dynamically change to produce the effect of "fast forwarding" through the designated period of time. Once the system has been operational for at least 30 days, the contractor shall demonstrate that up to 24 hours of data from within the last 30 days can be replayed on any graphic page. Owner's representative shall choose the graphic pages for this demonstration at the time of the demonstration.
22. Semantic Tagging. The BMS system shall include a semantic tagging engine that uses the Project Haystack library of descriptive tagging for building equipment and systems used in the BMS. The Project Haystack naming tags used by the BMS shall be a library that includes a comprehensive list of standard tag names to address common equipment, building systems, and device types. The library tag of names shall include at a minimum the tag names listed in ASHRAE Standard 223P.
23. Network Health Monitoring.
    a. The BAS shall allow for monitoring of the network system health through the use of a remote cloud based analytics platform. The BAS vendor shall provide to the owner a baseline report of the building network health at project completion and then once again at the end of the warranty period. The health monitoring application provides insights into the health of the BAS system for system maintenance and usage. This application will provide at a minimum the following information for the BAS network:
        1. BAS Server
            a. Online status/availability
            b. CPU and memory usage
            c. JAVA Container Health: Memory usage patterns and allocation to overall server resources
        2. BACnet Controllers
            a. Memory usage: Controller flash and database utilization
            b. Critical errors: Controller and watchdog errors
            c. Network communications health: Transmit and receive patterns and identification of controllers that may be causing errors
        3. Network System Inventory
            a. BAS Server software version
            b. Controller driver versions
            c. Controller upgrade requirements

b. At the completion of the warranty period, the owner shall have the option of continuing the remote network health monitoring service as part of an ongoing service contract negotiated with the BAS provider for an additional fee.

24. VAV Auto-Commissioning. The BMS system shall provide an auto-commissioning tool to commission single duct, dual duct, parallel and series flow fan powered VAV terminal units with or without hot water reheat.
    a. This tool shall be available for use during the construction phase of the project.
    b. The auto-commissioning tool shall run a set of functional tests to automatically exercise dampers and reheat valves in the VAV system.
    c. The user shall be able to schedule when the functional testing of a VAV system is to be done.
    d. The auto-commissioning tool shall be capable of detecting the following faults:
        1. Obstruction
        2. Over-Stroking
        3. Under Stroking
        4. Leakage
        5. Stuck
        6. Sensor Issue
        7. Reverse Stroking
        8. AHU Pressure Error
        9. Data Inconsistent
        10. Actuation Range Insufficient
        11. Data Insufficient
        12. Data Unavailable
        13. Expert Diagnosis Required
        14. Maximum Airflow Error
        15. Minimum Airflow Error
    e. The tool shall be capable of exporting an excel file or printing a file in PDF format that provides a detailed report.
    f. A baseline commissioning report shall be provided for all VAV systems at the completion of the project.

2.7. CONTROLLER SOFTWARE

A. All controller software applications shall reside and operate in the system controllers.

B. All application software in controllers furnished by BMS manufacturer shall be editable through operator workstation, web browser interface, or workstation.

C. Each controller furnished by BMS manufacturer shall have all of its local on board software applications backed up and saved to the BMS web server. In the event of a controller failure, the BMS server shall download backed up software applications to replacement controller. Controllers furnished by others and integrated into the BMS are not required to be backed up to BMS server.

D. Furnish the following applications for building and energy management:
   1. System Security.
   2. Scheduling. Provide the capability to execute control functions according to a user created or edited schedule. Each schedule shall provide the following schedule options as a minimum:
   3. Weekly Schedule. Provide separate schedules for each day of the week. Each schedule shall be able to include up to 5 occupied periods (5 start-stop pairs or 10 events).
   4. Exception Schedules. Provide the ability for the operator to designate any day of the year as an exception schedule. Exception schedules may be defined up to a year in advance. Once an exception schedule has executed, the system shall discard and replace the exception schedule with the standard schedule for that day of the week.
   5. Holiday Schedules. Provide the capability for the operator to define up to 24 special or holiday schedules These schedules will be repeated each year. The operator shall be able to define the length of each holiday period. System Coordination. Operator shall be able to group related equipment based on function and location and to use these groups for scheduling and other applications.
   6. Binary Alarms. Each binary object shall have the capability to be configured to alarm based on the operator-specified state. Provide the capability to automatically and manually disable alarming.
   7. Analog Alarms. Each analog object shall have both high and low alarm limits. The operator shall be able to enable or disable these alarms.
   8. Alarm Reporting. The operator shall be able to determine the action to be taken in the event of an alarm. An alarm shall be able to start programs, print, be logged in the event log, generate custom messages, and display on graphics.
   9. Remote Communication. System shall automatically contact operator workstation or server on receipt of critical alarms. If no network connection is available, system shall use a modem connection.
   10. Demand Limiting.
      a. The demand-limiting program shall monitor building power consumption from a building power meter (provided by others) which generates pulse signals or a BACnet communications interface. An acceptable alternative is for the system to monitor a watt transducer or current transformer attached to the building feeder lines.
      b. When power consumption exceeds adjustable levels, system shall automatically adjust setpoints, de-energize low-priority equipment, and take other programmatic actions to reduce demand as specified in sequences of operation. When demand drops below adjustable levels, system shall restore loads as specified.
   11. Maintenance Management. The system shall be capable of generating maintenance alarms when equipment exceeds adjustable runtime, equipment starts, or performance limits. Configure and enable maintenance alarms as specified in sequences of operations.

12. Sequencing. Application software shall sequence each piece of equipment as required by the specified sequences of operations.
13. PID Control. System shall provide direct- and reverse-acting PID (proportional-integral-derivative) algorithms. Each algorithm shall have anti-windup and selectable controlled variable, setpoint, and PID gains. Each algorithm shall calculate a time-varying analog value that can be used to position an output or to stage a series of outputs. The calculation interval, PID gains, and other tuning parameters shall be adjustable by a user with the correct security level.
14. Staggered Start. System shall stagger controlled equipment restart after power outage. Operator shall be able to adjust equipment restart order and time delay between equipment restarts.
15. Energy Calculations.
    a. The system shall accumulate and convert instantaneous power (kW) or flow rates (gpm) to energy usage data.
    b. The system shall calculate a sliding-window average (rolling average). Operator shall be able to adjust window interval to 15 minutes, 30 minutes, or 60 minutes.
16. Anti-Short Cycling. All binary output objects shall be protected from short cycling by means of adjustable minimum on-time and off-time settings.
17. On and Off Control with Differential. Provide an algorithm that allows a binary output to be cycled based on a controlled variable and a setpoint. The algorithm shall be direct-acting or reverse-acting.
18. Runtime Totalization. Provide software to totalize runtime for each binary input and output. Operator shall be able to enable runtime alarm based on exceeded adjustable runtime limit. Configure and enable runtime totalization and alarms as required by Sequence of Operations.
19. Fault Detection and Diagnostics (FDD). The system shall follow NIST and ASHRAE standards for enhanced monitoring and alarming. The FDD shall reside in the controller and be integral to the programming. Overlay software for primary FDD reporting is not acceptable. FDD capabilities shall include diagnostics for: Simultaneous Heating and Cooling; Continuous Operation; Fraction of Outdoor Air; Analog Output Cycling; Discrete Output Cycling; Sensor Failures; and Run Requests Analytics. These FDD alarms must be fully programmed, configured and active within the system. It is not acceptable for the system to have simply have the capability for FDD alarming, the alarming must be fully functional. The alarms shall be categorized and displayed on the BMS system. The FDD alarms shall categorized into one of the following four categories:
    a. FDD Comfort
    b. FDD Critical
    c. FDD Energy
    d. FDD Maintenance

E.

2.8. HVAC CONTROL PROGRAMS

A. General:
   1. Support Inch-pounds and SI (metric) units of measurement.
   2. Identify each HVAC Control system.

B. Optimal Run Time:
   1. Control start-up and shutdown times of HVAC equipment for both heating and cooling.
   2. Base on occupancy schedules, outside air temperature, seasonal requirements, and interior room mass temperature.
   3. Start-up systems by using outside air temperature, room mass temperatures, and adaptive model prediction for how long building takes to warm up or cool down under different conditions.
   4. Use outside air temperature to determine early shut down with ventilation override.
   5. Analyze multiple building mass sensors to determine seasonal mode and worse case condition for each day.
   6. Operator commands:
      a. Define term schedule.
      b. Add/delete fan status point.
      c. Add/delete outside air temperature point.
      d. Add/delete mass temperature point.
      e. Define heating/cooling parameters.
      f. Define mass sensor heating/cooling parameters.
      g. Lock/unlock program.
      h. Request optimal run time control summary.
      i. Request optimal run time mass temperature summary.
      j. Request HVAC point summary.
      k. Request HVAC saving profile summary.
   7. Control Summary:
      a. HVAC Control system begin/end status.
      b. Optimal run time lock/unlock control status.
      c. Heating/cooling mode status.
      d. Optimal run time schedule.
      e. Start/Stop times.
      f. Selected mass temperature point ID.
      g. Optimal run time system normal start times.
      h. Occupancy and vacancy times.
      i. Optimal run time system heating/cooling mode parameters.
   8. Mass temperature summary:
      a. Mass temperature point type and ID.
      b. Desired and current mass temperature values.
      c. Calculated warm-up/cool-down time for each mass temperature.

d. Heating/cooling season limits.
e. Break point temperature for cooling mode analysis.

9. HVAC point summary:
   a. Control system identifier and status.
   b. Point ID and status.
   c. Outside air temperature point ID and status.
   d. Mass temperature point ID and point.
   e. Calculated optimal start and stop times.
   f. Period start.

C. Supply Air Reset:
1. Monitor heating and cooling loads in building spaces, both hot deck and cold deck temperatures on dual duct systems, single zone unit discharge temperatures.
2. Adjust discharge temperatures to most energy efficient levels satisfying measured load by:
   a. Raising cooling temperatures to highest possible value.
   b. Reducing heating temperatures to lowest possible level.
3. Operator commands:
   a. Add/delete fan status point.
   b. Lock/unlock program.
   c. Request HVAC point summary.
   d. Add/Delete discharge controller point.
   e. Define discharge controller parameters.
   f. Add/delete air flow rate.
   g. Define space load and load parameters.
   h. Request space load summary.
4. Control summary:
   a. HVAC control system status (begin/end).
   b. Supply air reset system status.
   c. Optimal run time system status.
   d. Heating and cooling loop.
   e. High/low limits.
   f. Deadband.
   g. Response timer.
   h. Reset times.
5. Space load summary:
   a. HVAC system status.
   b. Optimal run time status.
   c. Heating/cooling loop status.
   d. Space load point ID.
   e. Current space load point value.
   f. Control heat/cool limited.
   g. Gain factor.
   h. Calculated reset values.
   i. Fan status point ID and status.

j. Control discharge temperature point ID and status.
k. Space load point ID and status.
l. Air flow rate point ID and status.

D. Enthalpy Switchover:
1. Calculate outside and return air enthalpy using measured temperature and relative humidity; determine energy expended and control outside and return air dampers.
2. Operator commands:
a. Add/delete fan status point.
b. Add/delete outside air temperature point.
c. Add/delete discharge controller point.
d. Define discharge controller parameters.
e. Add/delete return air temperature point.
f. Add/delete damper switch.
g. Add/delete minimum outside air.
h. Add/delete atmospheric pressure.
i. Add/delete heating override switch.
j. Add/delete evaporative cooling switch.
k. Add/delete air flow rate.
l. Define enthalpy deadband.
m. Lock/unlock program.
n. Request control summary.
o. Request HVAC point summary.
3. Control summary:
a. HVAC control system begin/end status.
b. Enthalpy switchover optimal system status.
c. Optimal return time system status.
d. Current outside air enthalpy.
e. Calculated mixed air enthalpy.
f. Calculated cooling cool enthalpy using outside air.
g. Calculated cooling cool enthalpy using mixed air.
h. Calculated enthalpy difference.
i. Enthalpy switchover deadband.
j. Status of damper mode switch.

PART 3 EXECUTION

3.1. EXAMINATION

A. Verify existing conditions before starting work.
B. Verify that conditioned power supply is available to the control units and to the operator work station. Verify that field end devices and wiring, is installed prior to installation proceeding.

3.2. INSTALLATION

A. Install control units and other hardware in position on permanent walls where not subject to excessive vibration.

B. Install software in control units and in operator work station. Implement all features of programs to specified requirements and appropriate to sequence of operation. Refer to Section 23 09 93.

C. Provide with 120v AC, 15 amp dedicated emergency power circuit to each programmable control unit.

D. Provide conduit and electrical wiring in accordance with Division 26. Electrical material and installation shall be in accordance with manufacturer's recommendations.

E. Install Class 1 (line voltage) wiring in approved UL listed raceway.

F. Install wiring in raceway where subject to mechanical damage and at levels below 10 feet in mechanical, electrical or service rooms.

G. Install Class 1 and Class 2 wiring in separate raceways.

H. Install wiring in raceway where subject to mechanical damage and at levels below 10 feet in mechanical, electrical or service rooms.

I. Install Class 1 and Class 2 wiring in separate raceways.

J. Use structural members to support or anchor electrical wiring systems. Raceways and pull boxes shall not be hung on or attached to duct work, electrical raceways, piping or ceiling suspension systems.

K. Use color coded conductors throughout.

L. Conceal raceways except within mechanical, electrical or service rooms. Maintain minimum clearance of 6 inches between raceways and high-temperature equipment such as steam pipes or flues.

3.3. MANUFACTURER'S FIELD SERVICES

A. Start and commission systems. Allow sufficient time for start-up and commissioning prior to placing control systems in permanent operation.

B. Provide service engineer to instruct Owner's representative in operation of systems plant and equipment for 3 day period (24 hours).

C. Provide basic operator training for 2 persons on data display, alarm and status descriptors, requesting data, execution of commands and request of logs. Include a minimum of 40 hours dedicated instructor time. Provide training on site.

3.4. DEMONSTRATION AND INSTRUCTIONS

A. Demonstrate complete and operating system to Owner.

3.5. MAINTENANCE

A. Provide service and maintenance of energy management and control systems for two years from Date of Substantial Completion.

B. Provide two complete inspections, one in each season, to inspect, calibrate, and adjust controls as required, and submit written reports.

C. Provide complete service of systems, including call backs. Make minimum of 4 complete normal inspections of approximately 4 hours duration in addition to normal service calls to inspect, calibrate, and adjust controls, and submit written reports.
D. Include systematic examination, adjustment, and lubrication of unit, and controls checkout and adjustments.
E. Perform work without removing units from service during building normal occupied hours.
F. Provide emergency call back service at all hours for this maintenance period.
G. Maintain locally, near Place of the Work, adequate stock of parts for replacement or emergency purposes. Have personnel available to ensure fulfillment of this maintenance service, without unreasonable loss of time.
H. Perform maintenance work using competent and qualified personnel under supervision and in direct employ of manufacturer or original installer.
I. Do not assign or transfer maintenance service to agent or subcontractor without prior written consent of the Owner.

END OF SECTION

SEQUENCE OF OPERATIONS FOR HVAC CONTROL

PART 1 GENERAL

1.1. SECTION INCLUDES

A. This section defines the manner and method by which controls function. Requirements for each type of control system operation are specified. Equipment, devices, and system components required for control systems are specified in other sections.

B. Sequence of operation for:
   1. Air conditioning unit/condensing unit.
   2. Air terminal units.
   3. Central fan systems.
   4. Circulating pumps.
   5. Exhaust fans.
   6. Dehumidification Unit.
   7. Packaged Rooftop Unit.
   8. Humidification Unit.

1.2. RELATED REQUIREMENTS

A. Section 01 91 13 - General Commissioning Requirements: Commissioning requirements that apply to all types of work.

B. Section 23 09 23 - Direct-Digital Control System for HVAC.

C. Section 23 09 13 - Instrumentation and Control Devices for HVAC.

D. Division 26: Electrical characteristics and wiring connections.

1.3. SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements for submittal procedures.

B. Sequence of Operation Documentation: Submit written sequence of operation for entire HVAC system and each piece of equipment.
   1. Preface: 1 or 2 paragraph overview narrative of the system describing its purpose, components and function.
   2. State each sequence in small segments and give each segment a unique number for referencing in Functional Test procedures; provide a complete description regardless of the completeness and clarity of the sequences specified in Contract Documents.
   3. Include at least the following sequences:
      a. Start-up.
      b. Warm-up mode.
      c. Normal operating mode.
      d. Unoccupied mode.
      e. Shutdown.
      f. Capacity control sequences and equipment staging.
      g. Temperature and pressure control, such as setbacks, setups, resets, etc.
      h. Detailed sequences for all control strategies, such as economizer control, optimum start/stop, staging, optimization, demand limiting, etc.

i. Effects of power or equipment failure with all standby component functions.
j. Sequences for all alarms and emergency shut downs.
k. Seasonal operational differences and recommendations.
l. Interactions and interlocks with other systems.

4. Include initial and recommended values for all adjustable settings, setpoints and parameters that are typically set or adjusted by operating staff; and any other control settings or fixed values, delays, etc. that will be useful during testing and operating the equipment.
5. For packaged controlled equipment, include manufacturer's furnished sequence of operation amplified as required to describe the relationship between the packaged controls and the control system, indicating which points are adjustable control points and which points are only monitored.
6. Include schedules, if known.

C. Control System Diagrams: Submit graphic schematic of the control system showing each control component and each component controlled, monitored, or enabled.
1. Label with settings, adjustable range of control and limits.
2. Include flow diagrams for each control system, graphically depicting control logic.
3. Include the system and component layout of all equipment that the control system monitors, enables or controls, even if the equipment is primarily controlled by packaged or integral controls.
4. Include draft copies of graphic displays indicating mechanical system components, control system components, and controlled function status and value.
5. Include all monitoring, control and virtual points specified in elsewhere.
6. Include a key to all abbreviations.

D. Points List: Submit list of all control points indicating at least the following for each point.
1. Name of controlled system.
2. Point abbreviation.
3. Point description; such as dry bulb temperature, airflow, etc.
4. Display unit.
5. Control point or setpoint (Yes / No); i.e. a point that controls equipment and can have its setpoint changed.
6. Monitoring point (Yes / No); i.e. a point that does not control or contribute to the control of equipment but is used for operation, maintenance, or performance verification.
7. Intermediate point (Yes / No); i.e. a point whose value is used to make a calculation which then controls equipment, such as space temperatures that are averaged to a virtual point to control reset.
8. Calculated point (Yes / No); i.e. a “virtual” point generated from calculations of other point values.

E. Project Record Documents: Record actual locations of components and setpoints of controls, including changes to sequences made after submission of shop drawings.

1.4. QUALITY ASSURANCE

A. Design system under direct supervision of a Professional Engineer experienced in design of this work and licensed at Oregon.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.1. AIR CONDITIONING UNIT/CONDENSING UNIT (FC-1/CU-1 & FC-2/CU-2)

A. Unit is controlled by manufacturer's thermostat.

B. Monitor room temperature - Signal alarm if room temperature rises above 80° F (adjustable).

C. Display:
   1. System graphic.
   2. Zone air temperature indication.
   3. Room over temperature alarm.

3.2. AIR TERMINAL UNITS

A. Single Duct Variable Volume Air Terminal Units (with Heating Coil):
   1. Occupied Cycle: On rise in space temperature above cooling setpoint, air terminal unit damper modulates open to maximum air quantity. As space temperature drops below cooling setpoint, air terminal unit damper modulates closed to its minimum air quantity. As space temperature continues to fall to heating setpoint, air terminal unit damper modulates to heating minimum air quantity. Heating coil will stage on electric heat with SCR Control. For spaces with demand control ventilation, damper shall modulate to achieve CO2 setpoint of 700ppm (adj. at BMS).
   2. Unoccupied Cycle: Air terminal damper is normally closed. Heating is staged to maintain reduced space temperature.

3.3. CENTRAL FAN SYSTEMS (RTU-1 & RTU-2)

A. Time Schedule: Start and stop supply and return fans. Determine fan status by current sensing devices. If fan fails to start as commanded, signal alarm.

B. Safety Devices:
   1. Freeze Protection: Stop fans and close outside air dampers if temperature before supply fan is below 37 degrees F; signal alarm.
   2. High Temperature Protection: Stop fans and close outside dampers if temperature in return air is above 100 degrees F; signal alarm.
   3. Smoke Detector: Stop fans, close outside dampers, and close smoke dampers if smoke is detected; signal alarm.

C. Preheat Coil:

1. When fan is not running, and outside air temperature is below 40 degrees F, stage gas heat.
2. When fan is running, maintain constant supply air temperature of 55 degrees F by staging gas heating valve.

D. Outside Air Damper: When supply fan is running, open outside air damper to minimum position.

E. Outside, Return, and Relief Dampers:
1. When supply fan is not running, outside and relief dampers are closed and return damper is open.
2. When supply fan is running, dampers are controlled and operate with outside and relief dampers opening, and return damper closing.
3. For cooling and outside air temperatures below 55 degrees F, modulate dampers to maintain mixed air temperature of 55 degrees F or higher.
4. For cooling and outside air temperatures above 55 degrees F outside and relief dampers are open and return damper is closed.
5. For cooling and outside air temperatures above 55 degrees F compare return and outside air temperatures. If return air temperature is lower, drive outside damper to minimum, close relief damper, and open return damper.
6. For outside air temperatures above 79 degrees F, drive outside damper to minimum, close relief damper, and open return damper.
7. For heating, drive outside damper to minimum, close relief damper, and open return damper.

F. Modulate mixed air dampers, preheat coil gas valve, and DX cooling coil in sequence to maintain constant mixed air temperature.

G. Multizone System:
1. Dual temperature room thermostat set at 75 degrees F, modulates zone dampers and maintains constant space temperature during the day and 15 degrees F cooler at night.
2. Room calling for greatest heating modulates reheat coil valve. Room thermostat calling for greatest cooling modulated DX cooling coil.

H. Economizer:
1. When the economizer is enabled, the outside air temperature is below the changeover setpoint, and the differential enthalpy switch (if installed) is made, the economizer becomes the first stage of cooling. It will modulate to control to either the discharge air temperature (VAV) or space temperature (CV).
2. Every 4 minutes, the unit can then either add mechanical cooling if the economizer is at 100% open, continue economizing, or if the control temperature is satisfied, return to minimum position and transition back to "Fan Only" mode.
3. If the enthalpy switch breaks or the outside air warms, the unit will exit economizing and continue to mechanically cool while returning to the minimum position for ventilation.

I. VAV System:
1. The RTUs shall support true multi-zone VAV operation and integrate with the building direct digital control (DDC) system. The DDC shall enable and disable each air handling system (RTU and associated VAV terminal units) according to

an occupancy schedule. The discharge air temperature and discharge static pressure shall reset as a function of terminal unit demand. The RTUs shall accept setpoint signals from the DDC system resetting the supply air temperature and duct static pressure setpoint. The DDC system shall control the economizer section for demand control ventilation (DCV), and shall measure the discharge air temperature and duct static pressure and pass these signals to the respective RTU. The RTU shall control the fan speed to meet the duct static pressure setpoint, stage on the refrigeration system in heating or cooling mode and modulate the auxiliary electric heat to maintain the discharge air temperature setpoint, modulate gas heat or modulate hot water heat and start and stop the powered exhaust fan.

2. Modes of operation shall include morning warm-up, morning cool-down occupied, and unoccupied setback mode. During morning warm-up, the RTU shall start the supply fan and operate the as in occupied mode. Exhaust fans associated with the RTU system shall start and modulate to the balanced setpoint. Variable air volume terminal units associated with the RTU shall modulate the primary air damper to maintain minimum primary air volume setpoint, and the electric heating coil shall modulate to maintain the discharge air temperature 15 degrees F above the zone temperature. Once the zone temperature set point is satisfied, the terminal unit mode of operation shall switch to occupied mode. Morning warm-up mode ends at the start of the occupancy schedule.
3. Morning cool-down works in the same way, except the terminal unit discharge air temperature differential limit is not in place.
4. During occupied mode, the RTU supply fan and exhaust runs continuously. Central exhaust fans start run at their respective balanced set points. Outside air dampers shall open and provide ventilation air as required. The outside air economizer and RTU heating and cooling are controlled to maintain the discharge air temperature setpoint. The supply fan speed shall be modulated to maintain the duct static pressure setpoint. Every 10 minutes, the DDC system shall evaluate how many zones are at maximum cooling, and if the space temperature is more than 2 degrees F above setpoint. If the discharge air temperature setpoint is not at minimum and two or more zones are at maximum cooling, then the discharge air temperature setpoint shall be reset downwards 1 degree F.
5. The discharge air temperature setpoint range shall be between 55 degrees F and 65 degrees F. If the discharge air temperature setpoint is at minimum and 2 or more zones are at maximum cooling, the duct static pressure setpoint shall be reset upwards by 0.2 inches of water column (IWC) within a range of 0.6 to 2.0 IWC. If only one zone is at maximum cooling, the discharge air temperature setpoint and duct static pressure setpoint will remain at the last commanded value. If the duct static pressure setpoint is not at minimum and no zones are at maximum cooling, the discharge static pressure setpoint shall be reset downwards by 0.2 IWC increments to a minimum of 0.6 IWC. If the duct static pressure setpoint is at minimum and no zones are at maximum cooling, the discharge air temperature setpoint shall be reset upwards by 1 degree F increments to a maximum of 65 degrees F. If a terminal unit is in heating mode, the primary air damper shall maintain the minimum primary air volume setpoint. The electric heating coil shall

modulate to maintain the zone temperature at the occupied heating setpoint. If a terminal unit is in cooling mode, the primary air damper shalI modulate between the minimum primary air volume setpoint and the maximum primary air volume setpoint to maintain the zone temperature at the occupied cooling setpoint. For zones with demand control ventilation (DCV) based on zone carbon dioxide (CO2) Ievels, reset the primary airflows upward in 20 CFM increments every 5 minutes to maintain the differential between the zone CO2 level and the outdoor COC level at setpoint (700 parts per million). If any terminal unit with COC control is operating at maximum primary air volume due to COC level for 5 minutes, reset the minimum outdoor air volume setpoint upwards in 200 CFM increments every 5 minutes. Final temperature, pressure, and damper positions shall be determined during balancing and commissioning.

6. At the end of the scheduled occupancy period, set the system in unoccupied mode. Stop the RTU supply and exhaust fan, shut the mixing and exhaust dampers to 0 percent outside air, and disable the RTU. Stop all associated exhaust fans. Disable the electric heating coil on associated terminal units. Start the RTU system in warm-up mode if any zone temperature falls to or below 55 degrees F. Stop this mode when the coldest zone reaches 60 degrees F. Zone temperature sensors shall be provided with temporary occupancy override pushbuttons that return the RTU system serving that zone to occupied mode for a time period.

J. Display:
1. System graphic.
2. System on/off indication.
3. System day/night mode.
4. System fan on/off indication.
5. Return fan on/off indication.
6. Outside air temperature indication.
7. Mixed air temperature indication.
8. Fan discharge air temperature indication.
9. Reheat zone air temperature indication.
10. Fan discharge temperature control point adjustment.
11. Reheat zone control point adjustment.
12. Supply static pressure indication.
13. Supply static pressure control point adjustment.
14. Building static pressure indication.
15. Building static pressure control point adjustment.
16. System on/off auto switch.
17. System day/night/auto switch.
18. Return air temperature.
19. Cooling coil discharge temperature.
20. Compressor Capacity - Command - AI.
21. Compressor Capacity - Current Capacity - AO.
22. Compressor Capacity - Status - DO.
23. Supply Fan - S/S - DI.
24. Supply Fan - Capacity - AI.

25. Exhaust Fan - Capacity - AI.
26. Exhaust Fan - S/S - DI.
27. Outdoor Air Damper - Command - AI.
28. Heating / Cooling - Mode - DI.
29. Heating - Modulating Capacity, 1st Stage - AI/DI.
30. Heating - Stage - DI.
31. Heat - S/S - DI.
32. Air Proving Switch - DI.
33. Compressor Fixed Speed Status - DO.
34. Compressor Availability - DO.
35. Defrost Status - DO.
36. Alarm Status - DO.
37. Alarm Reset - DI.
38. Hot Gas Reheat - Capacity - AI.
39. Air Flow Measuring Station - AO.
40. Outdoor Enthalpy Sensor - DO.
41. Dirty Filter - DO.
42. Return Air Temperature Indication - DO.
43. Supply Air Temperature Indication - DO.
44. Air Proving Switch - DO.
45. Condensate Overflow Alarm - DO.
46. Space CO2 - DO.
47. Smoke Detector Indication - DO.

3.4. CIRCULATING PUMPS (CP-1)

A. Time Schedule; Start and stop pumps. Determine pump status through auxiliary contactors in motor starter or by current sensing devices. If pump fails to start as commanded, signal alarm.

B. Display:
   1. System on/off indication
   2. System day/night mode.
   3. System on/off/auto switch.
   4. System day/night/auto switch.

3.5. EXHAUST FANS (EF-1, EF-2, EF-3)

A. Fans are to run during occupied times subject to building automation control system schedule.

B. Display:
   1. System graphic.
   2. Exhaust fan on/off indication.
   3. Exhaust fan on/off auto switch.

3.6. EXHAUST FAN (EF-4)

A. Normal Operation:
   1. Fan is to run continuously. Fan speed shall modulate to maintain a differential pressure of -0.02wg (adj.) between the space (powdered metal handling room) pressure and outdoor pressure.

B. Manual Shut off Sequence:
   1. Upon the manual shut off button being pressed, the exhaust fan shall shut down and sound an alarm.

C. Dirty Filter:
   1. Upon the pressure drop exceeding the setpoint, 0.3 in. wg (adj.), a local visual alarm shall be triggered, in addition to an alarm at the building automation control system.

D. Bearing Temperature:
   1. Upon the bearing temperature exceeding setpoint, 150° adj.), a local visual alarm shall be triggered in addition to an alarm at the building automation control system.

E. Power Failure:
   1. Fan shall continue to run on emergency power, continuously exhausting 1,700 CFM.

F. Display:
   1. System graphic.
   2. Exhaust on/off status.
   3. Filter status.
   4. Bearing temperature status.

3.7. EXHAUST FAN (EF-5, EF-6)

A. Fan shall run subject to oxygen deficiency sensor. Open exhaust motorized damper and both outside air motorized damper in the shop and energize fan to maintain room oxygen level at 21% (adj.). Provide building alarm status on a decrease of oxygen level below 20%.

B. Display:
   1. System graphic.
   2. Exhaust fan on/off indication.
   3. Exhaust fan on/off/auto switch.

3.8. EXHAUST FANS (EF-7)

A. Fan shall run subject to reverse acting adjustable thermostat. Open motorized damper at outside air louver and energize fan to maintain room temperature of 80 degrees F. Provide building automation control system alarm status on a rise of temperature above 85 degrees F.

B. Display:
   1. System graphic.

2. Exhaust fan on/off indication.
3. Exhaust fan on/off auto switch.

3.9. EXHAUST FAN (EF-8)

A. Fan shall energize upon activation of the fume hood switch. Fan shall de-energize upon deactivation of the fume hood switch.

B. Display:
1. System graphic.
2. Exhaust fan on/off indication.

3.10. EXHAUST FAN (EF-9)

A. Fan shall energize upon the sinter furnace being energized. Fan shall de-energize upon sinter furnace being de-energized.

B. Display:
1. System graphic.
2. Exhaust fan on/off indication.

3.11. ROOFTOP UNITS (RTU-3, RTU-4)

A. Morning Warmup Mode:
1. Supply fan shall start, if not already on, from unoccupied mode.
2. OSA damper shall remain in minimum unoccupied mode.
3. Heating stages and cooling stages shall cycle to reach occupied space temperature (70°dj.) prior to programmed time of occupancy.
4. Hot gas reheat valve shall modulate to achieve 30%-60%RH in the space.

B. Occupied Mode:
1. Supply fan shall start, if not already running from morning warmup mode, and run continuously during occupied hours.
2. At programmed time of occupancy, OSA damper opens to minimum occupied position.
3. Heating stages shall cycle on as required to maintain occupied heating space temperature setpoint (68° adj.).
4. Cooling stages shall cycle on as required to maintain occupied heating space temperature setpoint (72° adj.).
5. If the outside air temperature is less than the economizer lockout temperature setpoint (68°F adj.), the economizer shall be utilized as the first stage of cooling. The economizer shall modulate between minimum position (20% adj.) and 100% to maintain the occupied cooling temperature setpoint (72°F adj.).
6. If the outside air temperature is greater than the economizer lockout temperature setpoint (68°F adj.), or if the economizer dampers are 100% open and cannot maintain the occupied cooling space temperature setpoint (72°F adj.) the mechanical cooling stages cycle on as necessary to maintain the occupied cooling space temperature setpoint (72°F adj.).

7. Dehumidification stages shall cycle on as required to maintain space relative humidity set points (30%-50%RH) by cycling hot gas reheat and modulating outside air dampers.

C. Economizer:
1. When the economizer is enabled, the outside air temperature is below the changeover setpoint, and the differential enthalpy switch (if installed) is made, the economizer becomes the first stage of cooling. It will modulate to control to either the discharge air temperature (VAV or space temperature (CV).
2. Every 4 minutes, the unit can then either add mechanical cooling if the economizer is at 100% open, continue economizing, or if the control temperature is satisfied, return to minimum position and transition back to "Fan Only" mode.
3. If the enthalpy switch breaks or the outside air warms, the unit will exit economizing and continue to mechanically cool while returning to the minimum position for ventilation.

D. Unoccupied Mode:
1. Cycle RTU fan, hot gas reheat, heater, and/or DX coil to maintain set points between 60 deg. F (adj.) and 78 deg. F (adj.) and 30%RH-50%RH.
2. Economizer function is enabled.
3. OSA damper is normally at a minimum position to provide 1,700 CFM OSA between RTU-3 and RTU-4 for make-up air to DH-2.

E. Safety:
1. A supply air duct smoke detector shall disable the rooftop unit and alarm the fire alarm control panel (FACP) whenever activated. The building control system shall also notify owner that unit is off because of duct mounted smoke detector.
2. If room temperature is 5°F (adjustable) above setpoint, building control system shall notify owner.

F. Display:
1. System graphic.
2. System on/off indication.
3. System occupied/un-occupied mode.
4. System fan on/off indication.
5. Return fan on/off indication.
6. Outside air temperature indication.
7. Mixed air temperature indication.
8. Fan discharge air temperature indication.
9. System fan on/off/auto switch.
10. Return fan on/off/auto switch.
11. Space temperature.
12. Space humidity.
13. Return air temperature.
14. Compressor(s) status.
15. Outside air damper position indication.
16. Filter status.
17. Compressor Capacity - Command - AI.
18. Compressor Capacity - Current Capacity - AO.

19. Compressor Capacity - Status - DO.
20. Supply Fan - S/S - DI.
21. Supply Fan - Capacity - AI.
22. Exhaust Fan - Capacity - AI.
23. Exhaust Fan - S/S - DI.
24. Outdoor Air Damper - Command - AI.
25. Heating / Cooling - Mode - DI.
26. Heating - Modulating Capacity, 1st Stage - AI/DI.
27. Heating - Stage - DI.
28. Heat - S/S - DI.
29. Air Proving Switch - DI.
30. Compressor Fixed Speed Status - DO.
31. Compressor Availability - DO.
32. Defrost Status - DO.
33. Alarm Status - DO.
34. Alarm Reset - DI.
35. Hot Gas Reheat - Capacity - AI.
36. Air Flow Measuring Station - AO.
37. Outdoor Enthalpy Sensor - DO.
38. Dirty Filter - DO.
39. Return Air Temperature Indication - DO.
40. Supply Air Temperature Indication - DO.
41. Air Proving Switch - DO.
42. Condensate Overflow Alarm - DO.
43. Space CO2 - DO.
44. Smoke Detector Indication - DO.
45. Hot Gas Reheat Capacity - AI.

3.12. ROOFTOP UNITS (RTU-5)

A. Morning Warmup Mode:
   1. Supply fan shall start.
   2. OSA damper shall remain closed.
   3. Heating stages and cooling stages shall cycle to reach occupied space temperature (70°F adj.) prior to programmed time of occupancy.
   4. Hot gas reheat valve shall modulate to achieve 40%-60%RH in the space.

B. Occupied Mode:
   1. Supply fan shall start, if not already running from morning warmup mode, and run continuously during occupied hours.
   2. At programmed time of occupancy, OSA damper opens to minimum position.
   3. Heating stages, and hot gas bypass valves, shall cycle on as required to maintain occupied heating space temperature setpoint (66°F adj.).
   4. Cooling stages, and hot gas bypass valves, shall cycle on as required to maintain occupied heating space temperature setpoint (70°F adj.).

5. Dehumidification stages shall cycle on as required to maintain space relative humidity set points (40%RH-60%RH) by cycling hot gas reheat and modulating outside air dampers.

C. Unoccupied Mode:
1. Cycle RTU fan, hot gas reheat, heater, and/or DX coil to maintain set points between 55 deg. F (adj.) and 85 deg. F (adj.).
2. OSA damper is normally closed.

D. Safety:
1. If room temperature is 5°F (adjustable) above setpoint, building control system shall notify owner.

E. Display:
1. System graphic.
2. System on/off indication.
3. System occupied/un-occupied mode.
4. System fan on/off indication.
5. Return fan on/off indication.
6. Outside air temperature indication.
7. Mixed air temperature indication.
8. Fan discharge air temperature indication.
9. System fan on/off/auto switch.
10. Return fan on/off/auto switch.
11. Space temperature.
12. Space humidity.
13. Return air temperature.
14. Compressor(s) status.
15. Outside air damper position indication.
16. Filter Status.
17. Compressor Capacity - Command - AI.
18. Compressor Capacity - Current Capacity - AO.
19. Compressor Capacity - Status - DO.
20. Supply Fan - S/S - DI.
21. Supply Fan - Capacity - AI.
22. Exhaust Fan - Capacity - AI.
23. Exhaust Fan - S/S - DI.
24. Outdoor Air Damper - Command - AI.
25. Heating / Cooling - Mode - DI.
26. Heating - Modulating Capacity, 1st Stage - AI/DI.
27. Heating - Stage - DI.
28. Heat - S/S - DI.
29. Air Proving Switch - DI.
30. Compressor Fixed Speed Status - DO.
31. Compressor Availability - DO.
32. Defrost Status - DO.
33. Alarm Status - DO.
34. Alarm Reset - DI.

35. Hot Gas Reheat - Capacity - AI.
36. Air Flow Measuring Station - AO.
37. Outdoor Enthalpy Sensor - DO.
38. Dirty Filter - DO.
39. Return Air Temperature Indication - DO.
40. Supply Air Temperature Indication - DO.
41. Air Proving Switch - DO.
42. Condensate Overflow Alarm - DO.
43. Space CO2 - DO.
44. Smoke Detector Indication - DO.
45. Hot Gas Reheat Capacity - AI.

3.13. DEHUMIDIFICATION UNITS (DH-1, DH-2)

A. Continuous Operation:
1. Unit shall run continuously, 24/7.
2. Heating stages shall cycle on as required to maintain occupied heating space temperature setpoint (66°F adj.).
3. Cooling stages shall cycle on as required to maintain occupied heating space temperature setpoint (70°F adj.).
4. (DH-1 only) Upon EF-8 being energized, open shop air damper and close return air damper. Upon EF-8 being de-energized, close shop air damper and open return air damper.
5. Dewpoint Control: The system will automatically adjust the face and bypass damper position to allow air to bypass the wheel and mix with the dry air from the wheel to maintain the output/space dewpoint. If the dewpoint control output drives the bypass damper to the 100% open position for a period of time and the dewpoint is below the setpoint, the unit will enter economizer mode (react heat/fan and desiccant wheel turn off), and will stay there until the output of the bypass damper drops below 100% open.

B. Safety:
1. A supply air duct smoke detector shall disable the rooftop unit and alarm the fire alarm control panel (FACP) whenever activated. The building control system shall also notify owner that unit is off because of duct mounted smoke detector.
2. If room temperature is 5°F (adjustable) above setpoint, building control system shall notify owner.
3. Upon the manual shut off button being activated, the exhaust fan shall shut down and sound an alarm.

C. Power Failure (DH-2 Only):
1. Upon loss of utility power, only the process/supply fan shall continue to run to provide make up air.
2. Outside air dampers in shop area shall open up upon loss of power.

D. Digital Inputs:
1. System automatic selector switch.
2. System On selector switch.

3. System automatic run contact.
4. Condensing unit On selector switch.
5. Process fan running (Feedback from VFD).
6. React fan running (Feedback)
7. Desiccant wheel running (Feedback from VFD).
8. Reactivation heat over temperature switch.
9. Desiccant proof switch.
10. Process pressure switch.
11. Reactivation pressure switch.
12. Gas pressure switches.

E. Digital Outputs:
1. Process fan run.
2. React fan run.
3. Wheel motor run.
4. Reactivation heat contactor.
5. System running pilot light.
6. Cooling enabled light.
7. Alarm light.
8. Post cooling condensing unit enable relay.
9. Post cooling hot gas valve.
10. LED service lights.

F. Analog Inputs (4-20 mA):
1. Reactivation temperature.
2. Ambient temperature.
3. Post cooling temperature.
4. Pre-desiccant dewpoint.
5. Pre-desiccant temperature.
6. Post-desiccant dewpoint.
7. Post-desiccant temperature.
8. Conditioned space dewpoint.
9. Conditioned space temperature.

G. Analog Outputs (4-20mA):
1. Process fan speed.
2. Wheel motor speed.
3. Reactivation heat gas valve.
4. Face and bypass damper.

H. Display:
1. System graphic.
2. System on/off indication.
3. Return air damper position indication (DH-1 only).
4. Space humidity indication.
5. Space temperature indication.
6. Supply air temperature indication.
7. Shop air damper position indication (DH-1 only).

3.14. HUMIDIFICATION UNITS

A. Humidifier shall run subject to humidity sensor to maintain room humidity to the setpoints specified:
   1. H-1: 60%RH (adj.). Input signal from DH-1 pre-programmed PLC controller.
   2. H-2: 40%RH (adj.). Input signal from DH-2 pre-programmed PLC controller.
   3. H-3. H-4: 30%RH (adj.).
   4. H-5: 60%RH (adj.).

B. The following humidifiers shall run continuously; 24/7:
   1. H-2.
   2. H-3.
   3. H-4.

C. The following humidifiers shall run during scheduled occupancy:
   1. H-1.
   2. H-5.

D. Display:
   1. System graphic.
   2. System on/off indication.
   3. Space humidity indication.
   4. Space humidity setpoint.

END OF SECTION

FUEL PIPING

PART 1 GENERAL

1.1. SECTION INCLUDES

A. Pipe, pipe fittings, valves, and connections for piping systems.
B. Natural gas piping above grade.
C. Flexible pipe/connectors.
D. Unions and flanges.
E. Natural gas pressure regulators.

1.2. RELATED REQUIREMENTS

A. Section 07 84 00 - Firestopping.
B. Section 09 90 00 - Painting and Coating.
C. Section 23 05 48 - Vibration Isolation and Sound and Seismic Controls for HVAC Piping and Equipment.
D. Section 23 05 49 - HVAC Seismic Restraint.
E. Section 23 05 53 - Identification for HVAC Piping and Equipment.
F. Section 26: Electrical characteristics and wiring connections.

1.3. REFERENCE STANDARDS

A. ASME B16.3 - Malleable Iron Threaded Fittings; The American Society of Mechanical Engineers; 2013.
B. ASME B31.1 - Power Piping; The American Society of Mechanical Engineers; 2013 (ANSI/ASME B31.1).
C. ASME B31.9 - Building Services Piping; The American Society of Mechanical Engineers; 2013 (ANSI/ASME B31.9).
D. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless; 2013.
E. MSS SP-89 - Pipe Hangers and Supports - Fabrication and Installation Practices; Manufacturers Standardization Society of the Valve and Fittings Industry, Inc.; 2003.
F. NFPA 54 - National Fuel Gas Code; National Fire Protection Association; 2012.

1.4. SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Product Data: Provide data on pipe materials, pipe fittings, valves, and accessories. Provide manufacturers catalog information. Indicate valve data and ratings.
C. Project Record Documents: Record actual locations of valves.
D. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
    1. See Section 01 60 00 - Materials and Equipment, for additional provisions.

1.5. QUALITY ASSURANCE

A. Perform work in accordance with all applicable local codes and standards.
B. Valves: Manufacturer's name and pressure rating marked on valve body.

C. Identify pipe with marking including size, ASTM material classification, ASTM specification, water pressure rating.

1.6. REGULATORY REQUIREMENTS

A. Perform Work in accordance with applicable plumbing code.

1.7. DELIVERY, STORAGE, AND HANDLING

A. Accept valves on site in shipping containers with labeling in place. Inspect for damage.
B. Provide temporary protective coating on cast iron and steel valves.
C. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.
D. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system. Store pipe on sleepers, a minimum of 4 inches above surrounding grade, at all times.

PART 2 PRODUCTS

2.1. NATURAL GAS PIPING, ABOVE GRADE

A. Steel Pipe: ASTM A 53/A 53M Schedule 40 black.
   1. Fittings: ASME B16.3, malleable iron, or ASTM A 234/A 234M, wrought steel welding type.
   2. Joints: NFPA 54, threaded or welded to ASME B31.1.

2.2. STAINLESS STEEL GAS CONNECTORS

A. Manufacturers:
   1. Dormont, or approved equal.
B. Features and Specifications:
   1. Tubing: Annealed, 304 stainless steel (ASTM A240).
   2. Flare Nuts: Brass or plated steel.
   3. Adaptors: Brass or plated steel.
   4. Coating: Heavy-duty, antimicrobial, hot-dipped gray PVC (for 1⁄2" OD (21 series) and 5⁄8" OD (31 series only). Coating will not hold a flame.
   5. Approved for indoor/outdoor use with stationary gas appliances/equipment.
   6. Temperature rating of connector with adapters: -40°F to 150°F.
   7. Temperature rating with valves: -40°F to 125°F.
   8. 100% factory leak tested
   9. When installing a new appliance or when an existing appliance is moved to a new location a NEW gas connector must be used per manufacturer’s installation instructions and per product standards ANSI Z21.24/CSA 6.10 and ANSI Z21.75/CSA 6.27
   10. Designed for occasional movement after installation. Repeated bending, flexing or extreme vibration must be avoided. Normal operation of a clothes dryer, rooftop

HVAC unit or SIMILAR OUTDOOR APPLIANCE DOES NOT constitute extreme vibration or movement

C. Design Certifications and Approvals:
   1. ANSI Z21.24/CSA 6.10 - Connectors for Gas Appliances
   2. ANSI Z21.75/CSA 6.27 - Connectors for Outdoor Appliances and Manufactured Homes

2.3. PRESSURE REGULATORS

A. Manufacturers:
   1. Equimeter.
   2. American.
   3. Maxitrol.
   4. Sensus.

B. Product Description: Spring loaded, general purpose, self-operating service regulator including internal relief type diaphragm assembly and vent valve. Diaphragm case can be rotated 360 degrees in relation to body.
   1. Comply with ANSI Z21.80.
   2. Temperatures: Minus 20 degrees F to 150 degrees F.
   3. Body: Cast iron with neoprene gasket.
   4. Spring case, lowered diaphragm casing, union ring, seat ring and disk holder: Aluminum.
   5. Disk, Diaphragm, and O-Ring: Nitrile.
   6. Minimum Inlet Pressure: 2 psi.
   7. Furnish sizes 2 inches and smaller with threaded ends. Furnish sizes 2-1/2 inches and larger with flanged ends.

C. Incoming Service Pressure Regulators: Comply with ANSI Z21.80.
   1. Manufacturers:
      a. Equimeter.
      b. American.
      c. Maxitrol.
      d. Sensus.
   2. Body and Diaphragm Case: Cast iron or die-cast aluminum.
   3. Springs: Zinc-plated steel, interchangeable.
   4. Diaphragm Plate: Zinc-plated steel.
   5. Seat Disc: Nitrile rubber resistant to gas impurities, abrasion, and deformation at the valve port.
   6. Orifice: Aluminum; interchangeable.
   7. Seal Plug: Ultraviolet-stabilized, mineral-filled nylon.
   8. Single-port, self-contained regulator with orifice no larger than required at maximum pressure inlet, and no pressure sensing piping external to the regulator.
   9. Pressure regulator shall maintain discharge pressure setting downstream, and not exceed 150 percent of design discharge pressure at shutoff.
   10. Overpressure Protection Device: Factory mounted on pressure regulator.

11. Atmospheric Vent: Factory or field installed, stainless-steel screen in opening if not connected to vent piping.
12. Maximum Inlet Pressure: 60 psig.

2.4. VALVES

A. Manual Shut-off Valves Inside Building.
   1. Manufacturer:
      a. Nordstrom.
      b. Fisher
      c. Grinnel
   2. General Requirements for Metallic Valves, NPS 2 and Smaller: Comply with ASME B16.33.
      a. CWP Rating: 125 psig.
      b. Threaded Ends: Comply with ASME B1.20.1.
      c. Dryseal Threads on Flare Ends: Comply with ASME B1.20.3.
      d. Tamperproof Feature: Locking feature for valves where required by Con. Ed.
      e. Listing: Listed and labeled by an NRTL acceptable to authorities having jurisdiction for valves 1 inch and smaller.
      f. Service Mark: Valves 1-1/4 inches to NPS 2 shall have initials "WOG" permanently marked on valve body.
      g. Threaded cast iron body, 125 PSIG WOG.
   3. General Requirements for Metallic Valves, NPS 2-1/2 and Larger: Comply with ASME B16.38.
      a. CWP Rating: 125 psig.
      b. Flanged Ends: Comply with ASME B16.5 for steel flanges.
      c. Tamperproof Feature: Locking feature for valves where required by Con. Ed.
      d. Service Mark: Initials "WOG" shall be permanently marked on valve body.
      e. 2½ in. to 4-in.: Flanged cast iron body lubricated tapered plug type, 175 psig WOG.
      f. 6 in. and larger: Flanged cast iron body lubricated tapered plug type, 200 psig WOG, worm gear operated.
   4. Provide 2 wrenches for each size used.
      a. Attach wrench to each valve.

B. Ball Valves
   1. Manufacturer:
      a. Contromatics.
      b. Conbraco
      c. NIBCO

C. Two-Piece, Full-Port, Bronze Ball Valves with Bronze Trim: MSS SP-110.
   1. 2 inch and smaller: Threaded brass ball valves with full port TFE sears and blowout proof stem, 600 psig WOG, AGA approved.
   2. Manufacturers:

a. BrassCraft.
b. Conbraco.
c. NIBCO.

3. Body: Bronze, complying with ASTM B 584.
4. Ball: Chrome-plated bronze.
5. Stem: Bronze; blowout proof.
6. Seats: Reinforced TFE; blowout proof.
7. Packing: Threaded-body packnut design with adjustable-stem packing.
8. Ends: Threaded, flared, or socket.
9. CWP Rating: 600 psig.
10. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
11. Service: Suitable for natural-gas service with "WOG" indicated on valve body.

D. Bronze Plug Valves: MSS SP-78.
1. Manufacturers:
a. Hammond.
b. Lee Brass Company.
c. NIBCO.
2. Body: Bronze, complying with ASTM B 584.
3. Plug: Bronze.
4. Ends: Threaded, socket, or flanged.
5. Operator: Square head or lug type with tamperproof feature where indicated.
6. Pressure Class: 125 psig.
7. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction, AGA approved.
8. Service: Suitable for natural-gas service with "WOG" indicated on valve body.

E. Cast-Iron, Non-lubricated Plug Valves: MSS SP-78.
1. Manufacturers:
a. McDonald.
b. Mueller Co.
c. Xomox Corporation.
2. Body: Cast iron, complying with ASTM A126, Class B.
3. Plug: Bronze or nickel-plated cast iron.
4. Seat: Coated with thermoplastic.
5. Stem Seal: Compatible with natural gas.
6. Ends: Threaded or flanged as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
7. Operator: Square head or lug type with tamperproof feature where indicated.
8. Pressure Class: 125 psig.
9. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
10. Service: Suitable for natural-gas service with "WOG" indicated on valve body.

F. Cast Lubricated Plug Valves Inside Building:

1. 2-inch and smaller: Cast iron body, threaded, equal to Nordstrom Valves, Inc. Figure 114.
2. 2½ inch to 4-inch: Flanged cast iron body lubricated tapered plug type, 175 psig WOG, equal to Nordstrom Valves, Inc. Figure 115.
3. 6 inch and larger: Flanged cast iron body lubricated tapered plug type, 200 psig WOG, worm gear operated, equal to Nordstrom Valves, Inc. Figure 165.
4. Valves 2 ½ inch and larger shall be flanged.
5. Provide 2 wrenches for each size used.
6. Attach wrench to each valve.
7. Gas Cocks:
   a. Gas cocks shall be for use only as manual gas shut-off valves at each piece of gas burning equipment; shall be of the plug type, bronze construction with check, nut and washer bottom and tee handle.
   b. Gas cocks shall be Figure 10596 as manufactured by A.Y. McDonald Mfg. Co., or Series 52 as manufactured by Conbraco Industries, Inc.
   c. Gas cocks shall only be used on piping 1 inch and smaller.

2.5. EARTHQUAKE VALVES

A. Earthquake Valves: Comply with ASCE 25.
   1. Manufacturers:
      a. Pacific Seismic Products, Inc.
      b. Quake Defense, Inc.
      c. Strand Earthquake.
   2. Listing: Listed and labeled by an NRTL acceptable to authorities having jurisdiction.
   3. Maximum Operating Pressure: 60 psi.
   4. Cast-aluminum body with stainless-steel internal parts.
   5. Nitrile-rubber, reset-stem o-ring seal.
   6. Valve position, open or closed, indicator.
   7. Composition valve seat with clapper held by spring or magnet locking mechanism.
   8. Level indicator.
   9. End Connections: Threaded for valves NPS 2 inches and smaller; flanged for valves NPS 2-1/2 inches and larger.

2.6. 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: Bronze threaded nipple, minimum 3 inches long, with impervious isolation liner. Victaulic "Clearflow".

2.7. PIPE HANGERS AND SUPPORTS

A. Manufacturers:
   1. Tolco Inc.
   2. Anvil.
   3. Hubbard Enterprises/Holdrite.
   4. Michigan Hanger Company, Inc.
   5. PHD Manufacturing Co.
   6. Superstrut.
   7. Unistrut.
   8. Substitutions: See Section 01 60 00 - Materials and Equipment.

B. Fuel Piping:
   1. Conform to ASME B31.9.
   2. Hangers for Pipe Sizes 1/2 inch to 3 inches. Malleable iron, adjustable swivel, split ring.
   3. Multiple or Trapeze Hangers: Steel channels with welded supports or spacers and hanger rods.
   4. Use non-metallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.

2.8. ACCESSORIES

A. Hanger Rods: Mild steel, threaded both ends, threaded on one end, or continuous threaded.

2.9. INSERTS

A. Manufacturers:
   1. Anvil Fig. 281.
   2. PHD Fig 951.
   3. Michigan Hanger Model 355EG.
   4. Substitutions: See Section 01 60 00 - Materials and Equipment.

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

2.10. FLASHING

A. Metal Flashing: 26 gage thick galvanized steel.

B. Metal Counterflashing: 22 gage thick galvanized steel.

C. Lead Flashing:
   1. Waterproofing: 5 lb./sq.ft. sheet lead
   2. Soundproofing: 1 lb./sq.ft. sheet lead.

D. Flexible Flashing: 1.85 inch thick sheet butyl; compatible with roofing.

E. Caps: Steel, 22 gage minimum; 16 gage at fire resistant elements.

2.11. SLEEVES

A. Sleeves for Pipes Through Non-fire Rated Floors: 18 gage thick galvanized steel.
B. Sleeves for Pipes Through Non-fire Rated Beams, Walls, Footings, and Potentially Wet Floors: Steel pipe or 18 gage thick galvanized steel.
C. Sealant: Acrylic; refer to Section 07 90 05.

2.12. MECHANICAL SLEEVE SEALS

A. Manufacturers:
   1. Thunderline Link-Seal, Inc. Model Series LS.
   2. NMP Corporation.
   3. Substitutions: See Section 01 60 00 - Materials and Equipment.
B. Product Description: Modular mechanical type, consisting of interlocking synthetic rubber links shaped to continuously fill annular space between object and sleeve, connected with bolts and pressure plates causing rubber sealing elements to expand when tightened, providing watertight seal and electrical insulation.

2.13. FORMED STEEL CHANNEL

A. Manufacturers:
   1. Unistrut Model Series P1000.
   2. Superstrut Model Series 1200.
   3. Michigan Hanger “O-Strut” Model A-12.
   4. Substitutions: See Section 01 60 00 - Materials and Equipment.
B. Product Description: Galvanized 12 gage thick steel. With holes 1-1/2 inches on center.

2.14. FIRESTOPPING

A. Manufacturers:
   1. Specified Technology Inc. (STI) Model SpecSeal Series 100.
   2. Dow Corning Corp.
   3. Hilti Corp.
   4. International Protective Coating Corp.
   5. 3M fire Protection Products.
   6. Metacaulk Fire Stopping: www.rectorseal.com.
   7. Substitutions: See Section 01 60 00 - Materials and Equipment.
B. Product Description: Different types of products by multiple manufacturers are acceptable as required to meet specified system description and performance requirements; provide only one type for each similar application.
   1. Silicone Firestopping Elastomeric Firestopping: Single or multiple component silicone elastomeric compound and compatible silicone sealant.
   2. Foam Firestopping Compounds: Single or Multiple component foam compound.
   3. Formulated Firestopping Compound of Incombustible Fibers: Formulated compound mixed with incombustible non-asbestos fibers.

4. Fiber Stuffing and Sealant Firestopping: Composite of mineral or ceramic fiber stuffing insulation with silicone elastomer for smoke stopping.
5. Mechanical Firestopping Device with Fillers: Mechanical device with incombustible fillers and silicone elastomer, covered with sheet stainless steel jacket, joined with collars, penetration sealed with flanged stops.
6. Intumescent Firestopping: Intumescent putty compound which expands on exposure to surface heat gain.
7. Firestop Pillows: Formed mineral fiber pillows.

C. Color: As selected from manufacturer's full range of colors.

2.15. FIRESTOPPING ACCESSORIES

A. Primer: Type recommended by firestopping manufacturer for specific substrate surfaces and suitable for required fire ratings.

B. Dam Material: Permanent:
1. Mineral fiberboard.
2. Mineral fiber matting.
3. Sheet metal.
4. Plywood or particle board.
5. Alumina silicate fire board.

C. Installation Accessories: Provide clips, collars, fasteners, temporary stops or dams, and other devices required to position and retain materials in place.

D. General:
1. Furnish UL listed products.
2. Select products with rating not less than rating of wall or floor being penetrated.

E. Non-Rated Surfaces:
1. Stamped steel, chrome plated, hinged, split ring escutcheons or floor plates or ceiling plates for covering openings in occupied areas where piping is exposed.
2. For exterior wall openings below grade, furnish mechanical sealing device to continuously fill annular space between piping and cored opening or water-stop type wall sleeve.

PART 3 EXECUTION

3.1. EXAMINATION

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

3.2. PREPARATION

A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.

B. Remove scale and dirt, on inside and outside, before assembly.

C. Prepare piping connections to equipment with flanges or unions.

3.3. INSTALLATION

A. Install in accordance with manufacturer's instructions.
B. Route piping in orderly manner and maintain gradient. Route parallel and perpendicular to walls.
C. Install piping to maintain headroom, conserve space, and not interfere with use of space.
D. Group piping whenever practical at common elevations.
E. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.
F. Provide access where valves and fittings are not exposed. Coordinate size and location of access doors with Section 08 30 00.
G. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welding.
H. Provide support for utility meters in accordance with requirements of utility companies.
I. Prepare exposed, unfinished pipe, fittings, supports, and accessories ready for finish painting. Refer to Section 09 90 00.
J. Install valves with stems upright or horizontal, not inverted.
K. Sleeve pipes passing through partitions, walls and floors.
L. Pipe Hangers and Supports:
    1. Install in accordance with ASME B31.9 and MSS SP-89.
    2. Install hangers for horizontal steel piping with the following maximum spacing and minimum rod sizes:
        a. NPS 1 (DN 25) and Smaller: Maximum span, 96 inches (2438 mm); minimum rod size, 3/8 inch (10 mm).
        b. NPS 1-1/4 (DN 32): Maximum span, 108 inches (2743); minimum rod size, 3/8 inch (10 mm).
        c. NPS 1-1/2 and NPS 2 (DN 40 and DN 50): Maximum span, 10 feet (3 m); minimum rod size, 1/2 inch (13 mm).
        d. NPS 2-1/2 to NPS 3-1/2 (DN 65 to DN 90): Maximum span, 10 feet (3 m); minimum rod size, 1/2 inch (13 mm).
    3. Install hangars for horizontal, corrugated stainless-steel tubing with the following maximum spacing and minimum rod sizes:
        a. NPS 3/8 (DN 10): Maximum span, 48 inches (1220 mm); minimum rod size, 3/8 inch (10 mm).
        b. NPS 1/2 (DN 15): Maximum span, 72 inches (1830 mm); minimum rod size, 3/8 inch (10 mm).
        c. NPS 3/4 (DN 20) and Larger: Maximum span, 96 inches (2440 mm); minimum rod, 3/8 inch, (10 MM).
    4. Place hangers within 12 inches of each horizontal elbow.
    5. Use hangers with 1-1/2 inch minimum vertical adjustment. Design hangers for pipe movement without disengagement of supported pipe.
    6. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.

7. Prime coat exposed steel hangers and supports. Refer to Section 09 90 00. Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.
8. Provide hangers adjacent to motor driven equipment with vibration isolation; refer to Section 23 05 48.
9. Support of pipe tubing and equipment is to be accomplished by means of engineered products specific to each application. Makeshift field devised methods will not be allowed.

3.4. APPLICATION

A. Install unions downstream of valves and at equipment or apparatus connections.
B. Install gate or ball valves for shut-off and to isolate equipment, part of systems, or vertical risers.
C. Provide plug valves in natural gas systems for shut-off service.

3.5. SERVICE CONNECTIONS

A. Provide new gas service complete with gas meter and regulators. Gas service distribution piping to have initial minimum pressure of 2 psi. Provide regulators on each line serving gravity type appliances, sized in accordance with equipment.

END OF SECTION

HVAC DUCTS AND CASINGS

PART 1 GENERAL

1.1. SECTION INCLUDES

A. Metal ductwork.
B. Duct cleaning.
C. Duct systems have been designed for metal duct.

1.2. RELATED REQUIREMENTS

A. Section 07 84 00 - Firestopping.
B. Section 09 90 00 - Painting and Coating: Weld priming, weather resistant, paint or coating.
C. Section 23 05 48 - Vibration Isolation and Sound and Seismic Controls for HVAC Piping and Equipment.
D. Section 23 05 49 - HVAC Seismic Restraint.
E. Section 23 05 93 - Testing, Adjusting, and Balancing for HVAC.
F. Section 23 07 13 - Duct Insulation: External insulation and duct liner.
G. Section 23 33 00 - Air Duct Accessories.
H. Section 23 36 00 - Air Terminal Units.
I. Section 23 37 00 - Air Outlets and Inlets.

1.3. REFERENCE STANDARDS

A. ASHRAE (FUND) - ASHRAE Handbook - Fundamentals; Most Recent Edition Cited by Referring Code or Reference Standard.
B. ASTM A36/A36M - Standard Specification for Carbon Structural Steel; 2019.
C. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2020.
D. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2018.
E. NFPA 90B - Standard for the Installation of Warm Air Heating and Air-Conditioning Systems; 2018.
F. SMACNA (DCS) - HVAC Duct Construction Standards Metal and Flexible; 2005 (Revised 2009).

1.4. COORDINATION

A. The Drawings do not attempt to show exact details of all ductwork. No extra payment will be allowed for obstruction by work of other trades or local obstructions to the work which require offsets. Where diagrams have been made to show duct connections, the Contractor is cautioned that these diagrams must not be used for obtaining material quantities.
B. Changes in location of equipment or ductwork, advisable in the opinion of the Contractor, shall be submitted to the Engineer for review before proceeding with the work. All measurements and dimensions shall be verified at the site.

C. Duct sizes shown on the Drawings represent the nominal free area required for that service. Where changes in duct dimensions are necessary to coordinate the installation, the contractor is allowed, with prior permission from the project engineer, to use alternative equivalent sized ducts.

D. Coordination with Existing Conditions and with other Trades:
   1. Coordinate the installation of ductwork with existing conditions and the work of other trades to allow the installation of ductwork and the proper operation of dampers and operators.
   2. Where existing thread rod, strut material, miscellaneous supports, conduit, or piping under 1-inch diameter obstructs the passage of the ductwork, they shall be relocated by the Contractor at no additional cost to the Owner. Coordinate the work with other trades.

1.5. SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide data for duct materials, duct liner, duct connections, and duct fittings.

C. Shop Drawings: Submit duct fabrication drawings, drawn to scale not smaller than 1/4 inch equals 1 foot, on drawing sheets same size as Contract Documents, indicating:
   1. Fabrication, assembly, and installation details, including plans, elevations, sections, details of components, and attachments to other work.
   2. Duct layout, indicating pressure classifications and sizes in plan view.
   3. Fittings.
   4. Reinforcing details and spacing.
   5. Seam and joint construction details.
   6. Penetrations through fire rated and other walls.
   7. Terminal unit, coil, and humidifier installations.
   8. Hangers and supports, including methods for building attachment, vibration isolation, and duct attachment.

D. Manufacturer's Installation Instructions: Indicate special procedures for glass fiber ducts.

E. Manufacturer's Certificate: Certify that installation of glass fiber ductwork meet or exceed recommended fabrication and installation requirements.

F. Project Record Documents: Record actual locations of ducts and duct fittings. Record changes in fitting location and type. Show additional fittings used.

1.6. QUALITY ASSURANCE

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

B. Installer Qualifications: Company specializing in performing the type of work specified in this section, with minimum three years of documented experience.

1.7. REGULATORY REQUIREMENTS

A. Construct ductwork to NFPA 90B standards.

1.8. FIELD CONDITIONS

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

B. Maintain temperatures within acceptable range during and after installation of duct sealants.

PART 2 PRODUCTS

2.1. MATERIALS

A. Galvanized Steel for Ducts: Hot-dipped galvanized steel sheet, ASTM A653/A653M FS Type B, with G90/Z275 coating.

B. Joint Sealers and Sealants: Non-hardening, water resistant, mildew and mold resistant.
   1. Type: Heavy mastic or liquid used alone or with tape, suitable for joint configuration and compatible with substrates, and recommended by manufacturer for pressure class of ducts.
   2. VOC Content: Not more than 250 g/L, excluding water.
   3. Surface Burning Characteristics: Flame spread of zero, smoke developed of zero, when tested in accordance with ASTM E84.
   4. For Use With Flexible Ducts: UL labeled.
   5. Manufacturers:
      a. Duro-Dyne; Model DSW: www.durodyne.com.
      b. Hard Cast; Model RTA 50: www.hardcast.com.
      c. Hard Cast; Model "Versa-Grip" 102: www.hardcast.com.
      d. Sika; Model "Sikaflex": www.sika.com.
      e. Substitutions: See Section 01 60 00 - Materials and Equipment.

C. Hanger Rod: ASTM A36/A36M; steel, galvanized; threaded both ends, threaded one end, or continuously threaded.

D. All Ducts: G90 Galvanized steel, unless otherwise indicated. Provide SMACNA pressure class as indicated or at a minimum meet or exceed the pressure rating of the connected fan. In no case less that 1 inch w.g. permitted.

E. General Exhaust: 1 inch w.g. pressure class, galvanized steel.

F. Fume Hood Exhaust: 1 inch w.g. pressure class, galvanized steel, unless noted otherwise.

G. Outside Air Intake: 1 inch w.g. pressure class, galvanized steel.

H. Powdered Metal Storage / Handling Exhaust: Negative 8 inch w.g. pressure class, galvanized steel or pre-manufactured duct work.

2.2. DUCTWORK FABRICATION

A. Fabricate and support in accordance with SMACNA (DCS) and as indicated.

B. Transfer Air and Sound Boots: 1/2 inch w.g. pressure class, fibrous glass.

C. No variation of duct configuration or size permitted except by written permission. Size round duct installed in place of rectangular ducts in accordance with ASHRAE (FUND) Handbook - Fundamentals.

D. Duct systems have been designed for metal duct.
E. Provide duct material, gages, reinforcing, and sealing for operating pressures indicated.
F. Construct T's, bends, and elbows with radius of not less than 1-1/2 times width of duct on centerline. Where not possible and where rectangular elbows must be used, provide air foil turning vanes of perforated metal with glass fiber insulation.
G. Provide turning vanes of perforated metal with glass fiber insulation when acoustical lining is indicated.
H. Increase duct sizes gradually, not exceeding 15 degrees divergence wherever possible; maximum 30 degrees divergence upstream of equipment and 45 degrees convergence downstream.
I. Fabricate continuously welded round and oval duct fittings in accordance with SMACNA (DCS).
J. Provide standard 45 degree lateral wye takeoffs unless otherwise indicated where 90 degree conical tee connections may be used.
K. Where ducts are connected to exterior wall louvers and duct outlet is smaller than louver frame, provide blank-out panels sealing louver area around duct. Use same material as duct, painted black on exterior side; seal to louver frame and duct.

2.3. DUCT MANUFACTURERS

A. Streimer Sheet Metal: www.streimer.com.
B. General Sheet Metal: www.gsmw.com.
C. Arctic Sheet Metal: www.arcticsheetmetal.com.
D. CoolSys Sheet Metal: www.coolsys.com.
E. Robert Lloyd Sheet Metal: www.rlsm.net.
F. Just Right Heating and Cooling: www.justrightheat.com.

2.4. ROUND AND FLAT OVAL SPIRAL SEAM DUCT

A. Manufacture: Machine made from round spiral lock seam duct in accordance with SMACNA (DCS).
B. Fittings: Manufacture at least two gages heavier metal than duct.
    1. All fittings shall have rolled edges for added strength and rigidity.
    2. All takeoffs to be completely separate fitting; direct tabs are not allowed. Saddle fittings are not allowed except for retrofit installations when approved by project engineer.
    3. Branch takeoffs are to be 45 degree laterals or conical tees, 90 and 45 degree.
    4. Elbows shall be radiused at 1.5 times the diameter. 15, 30 and 60 degree elbows shall be 1.0 times the diameter.
    5. Joints are to be couplings with centering beads and double-lipped, U-profile EPDM rubber gasket. Use flange joints from 26 inch diameter and large. Crimped ends are prohibited except 8 inches and smaller.

2.5. RECTANGULAR HVAC DUCTWORK

A. Manufacture: Equal or exceed the minimum wall thickness and reinforcing as scheduled in the SMACNA rectangular duct construction schedule to comply with duct pressure classifications specified. Cross break or bead all duct widths over 14 inches and horizontal surfaces to prevent ballooning or breathing.

B. Fittings: Fabricate for easiest airflow.
   1. Branch tabs are to be 45 degrees entry with L = 1/4 W inches.

C. Joints:
   1. Longitudinal: Pittsburg lock flooded with mastic. Snaplock is not allowed.
   2. Traverse: Demountable joint such as Ductmate for 36 inch width and above. Seal corners prior to assembly.

2.6. MANUFACTURED DUCTWORK AND FITTINGS

A. Double Wall Insulated Round and Flat Oval Ducts: Machine made from round spiral lockseam duct.
   1. Manufacture in accordance with SMACNA (DCS).
   2. Fittings: Manufacture with solid inner wall.
   3. Inner Wall: Perforated galvanized steel.
   4. Insulation:
      a. Thickness: 1 inch fiberglass.

B. Flexible Ducts: UL 181, Class 1, aluminum laminate and polyester film with latex adhesive supported by helically wound spring steel wire.
   1. Insulation: Fiberglass insulation with polyethylene or aluminized vapor barrier film.
   2. Pressure Rating: 10 inches WG positive and 1.0 inches WG negative.
   3. Maximum Velocity: 4000 fpm.
   4. Temperature Range: -20 degrees F to 210 degrees F.
   5. Minimum Insulation: R-6
   6. Manufacturers:
      a. Thermaflex, M-KE.
      b. Substitutions: See Section 01 60 00 - Materials and Equipment.

PART 3 EXECUTION

3.1. INSTALLATION

A. Install, support, and seal ducts in accordance with SMACNA (DCS).

B. Install in accordance with manufacturer's instructions.

C. During construction provide temporary closures of metal or taped polyethylene on open ductwork to prevent construction dust from entering ductwork system.

D. Fibrous Glass Ducts: Install in accordance with SMACNA Fibrous Glass Duct Construction Standards.

E. Flexible Ducts: Connect to metal ducts with adhesive and draw bands

F. Use sealant on all lapped round duct joint connections. Seal all ducts in accordance with State Energy Code.
G. Duct sizes indicated are inside clear dimensions. For lined ducts, maintain sizes inside lining.
H. Provide openings in ductwork where required to accommodate thermometers and controllers. Provide pilot tube openings where required for testing of systems, complete with metal can with spring device or screw to ensure against air leakage. Where openings are provided in insulated ductwork, install insulation material inside a metal ring.
I. Locate ducts with sufficient space around equipment to allow normal operating and maintenance activities.
J. Use crimp joints with or without bead for joining round duct sizes 8 inch and smaller with crimp in direction of air flow.
K. Install duct hangers and supports in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible.
L. Use double nuts and lock washers on threaded rod supports.
M. Connect terminal units supply ducts rigidly without flexible duct.
N. Connect diffusers or light troffer boots to low pressure ducts with 5 feet maximum length of flexible duct held in place with strap or clamp.
O. At exterior wall louvers, seal duct to louver frame.
P. For exposed ductwork provide escutcheon or flange at wall penetrations.

3.2. CLEANING

A. Clean duct systems with high power vacuum machines. Protect equipment that could be harmed by excessive dirt with filters, or bypass during cleaning. Provide adequate access into ductwork for cleaning purposes.

END OF SECTION

AIR DUCT ACCESSORIES

PART 1 GENERAL

1.1. SECTION INCLUDES
A. Backdraft dampers - metal.
B. Combination fire and smoke dampers.
C. Duct access doors.
D. Duct test holes.
E. Flexible duct connectors.
F. Volume control dampers.

1.2. RELATED REQUIREMENTS
A. Section 07 84 00 - Firestopping.
B. Section 23 05 48 - Vibration Isolation and Sound and Seismic Controls for HVAC Piping and Equipment.
C. Section 23 31 00 - HVAC Ducts and Casings.
D. Section 23 36 00 - Air Terminal Units: Pressure regulating damper assemblies.
E. Division 26 - Electrical characteristics and wiring connections.

1.3. REFERENCE STANDARDS
A. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems; 2021.
B. SMACNA (DCS) - HVAC Duct Construction Standards Metal and Flexible; 2005 (Revised 2009).
C. UL 555 - Standard for Fire Dampers; Current Edition, Including All Revisions.
D. UL 555S - Standard for Smoke Dampers; Current Edition, Including All Revisions.

1.4. SUBMITTALS
A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Product Data: Provide for shop fabricated assemblies including volume control dampers, duct access doors, duct test holes, and hardware used. Include electrical characteristics and connection requirements.
C. Shop Drawings: Indicate for shop fabricated assemblies including volume control dampers, duct access doors, and duct test holes.
D. Manufacturer's Installation Instructions: Provide instructions for fire dampers and combination fire and smoke dampers.
E. Project Record Drawings: Record actual locations of access doors, test holes, fire dampers, and fire and smoke dampers.

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

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

1.6. DELIVERY, STORAGE, AND HANDLING

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

PART 2 PRODUCTS

2.1. TURNING VANES

A. Manufacturers:
   1. Elgen All-Tight.
   2. Duro-Dyne Type VR.
   3. Or approved equivalent.

B. Hat channel or embossed vane side rails with shop-fabricated, double-blade turning vanes of galvanized steel aligned in the short dimension. Individually adjustable.

2.2. BACKDRAFT DAMPERS - METAL

A. Manufacturers:
   1. PCI Industries, Inc.; Pottorff Brand Model Series BD60: www.pottorff.com.
   2. Cesco; Model BAP-1: www.cescoproducts.com.
   3. Greenheck; Model Series EM: www.greenheck.com.
   4. Ruskin Company; BD/BDR: www.ruskin.com.
   5. Nailor; Model 1370/1380: www.nailor.com.
   6. Tamco; Model BDD Series 7000 (aluminum): www.tamco.ca.
   7. Substitutions: See Section 01 60 00 - Materials and Equipment.

B. Gravity Backdraft Dampers, Size 18 by 18 inches or Smaller, Furnished with Air Moving Equipment: Air moving equipment manufacturer's standard construction.

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

2.3. COMBINATION FIRE AND SMOKE DAMPERS

A. Manufacturers:
   1. PCI Industries, Inc.; Pottorff Brand Model Series FSD: www.pottorff.com.
   2. Cesco; Model Series CG: www.cescoproducts.com.
   3. Greenheck; Model FSD-211: www.greenheck.com.
   4. Ruskin Company: www.ruskin.com.
   5. Nailor; 1220 Series: www.nailor.com.
   6. Substitutions: See Section 01 60 00 - Materials and Equipment.

B. Fabricate in accordance with NFPA 90A, UL 555, UL 555S, and as indicated.

C. Provide factory sleeve and collar for each damper.
D. Multiple Blade Dampers: Fabricate with 16 gage galvanized steel frame and blades, oil-impregnated bronze or stainless steel sleeve bearings and plated steel axles, stainless steel jamb seals, 1/8 x 1/2 inch plated steel concealed linkage, stainless steel closure spring, blade stops, and lock, and 1/2 inch actuator shaft.
E. Operators: UL listed and labelled spring return electric type suitable for 120 volts, single phase, 60 Hz. Provide end switches to indicate damper position. Locate damper operator on exterior of duct and link to damper operating shaft.
F. Normally Closed Smoke Responsive Fire Dampers: Curtain type, opening by gravity upon actuation of electro thermal link, flexible stainless steel blade edge seals to provide constant sealing pressure.
G. Normally Open Smoke Responsive Fire Dampers: Curtain type, closing upon actuation of electro thermal link, flexible stainless steel blade edge seals to provide constant sealing pressure, stainless steel springs with locking devices to ensure positive closure for units mounted horizontally.
H. Electro Thermal Link: Fusible link melting at 165 degrees F; 120 volts, single phase, 60 Hz; UL listed and labeled.

2.4. DUCT ACCESS DOORS

A. Manufacturers:
   1. Cesco; Model Series HF: www.cescoproducts.com.
   2. Greenheck; Model Series HAD/CAD: www.greenheck.com.
   3. Ruskin Company: www.ruskin.com.
   4. Streimer; Model Metu: www.streimer.com.
   5. Substitutions: See Section 01 60 00 - Materials and Equipment.
B. Fabrication: Rigid and close-fitting of galvanized steel with sealing gaskets and quick fastening locking devices. For insulated ducts, install minimum 1 inch thick insulation with sheet metal cover.
   1. Less Than 12 inches Square: Secure with sash locks.
   2. Up to 18 inches Square: Provide two hinges and two sash locks.
   3. Up to 24 x 48 inches: Three hinges and two compression latches with outside and inside handles.
   4. Larger Sizes: Provide an additional hinge.
C. Access doors with sheet metal screw fasteners are not acceptable.

2.5. DUCT TEST HOLES

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

2.6. FLEXIBLE DUCT CONNECTORS

A. Manufacturers:

1. Ventfabrics Ventlon.
2. Duro-Dyne Durolon.
3. Carlisle HVAC Products; Dynair Connector Plus G90 Steel Offset Seam Neoprene Fabric: www.carlislehvac.com/#sle.
4. Elgen Manufacturing: www.elgenmfg.com.
5. Substitutions: See Section 01 60 00 - Materials and Equipment.

B. Fabricate in accordance with SMACNA (DCS) and as indicated.

C. Flexible Duct Connections: Fabric crimped into metal edging strip.
1. Fabric: UL listed fire-retardant neoprene coated woven glass fiber fabric to NFPA 90A, minimum density 30 oz per sq yd.
a. Net Fabric Width: Approximately 3 inches wide.
2. Metal: 3 inches wide, 24 gage thick galvanized steel.

D. Leaded Vinyl Sheet: Minimum 0.55 inch thick, 0.87 lbs per sq ft, 10 dB attenuation in 10 to 10,000 Hz range.

E. Maximum Installed Length: 14 inch.

2.7. VOLUME CONTROL DAMPERS

A. Manufacturers:
1. Cesco; Model Series MGF/MGG: www.cescoproducts.com.
2. Greenheck; Model Series MBD/MBDR: www.greenheck.com.
3. Nailor: Model 1110/1120 galvanized: www.nailor.com.
4. Tamco: Series 1000 (aluminum): www.tamco.com.
5. Substitutions: See Section 01 60 00 - Materials and Equipment.

B. Fabricate in accordance with SMACNA (DCS) and as indicated.

C. Splitter Dampers:
1. Material: Same gage as duct to 24 inches size in either direction, and two gages heavier for sizes over 24 inches.
2. Blade: Fabricate of single thickness sheet metal to streamline shape, secured with continuous hinge or rod.
3. Operator: Minimum 1/4 inch diameter rod in self aligning, universal joint action, flanged bushing with set screw.
4. Manufacturers:
a. Krueger.

D. Single Blade Dampers: Fabricate for duct sizes up to 6 x 30 inch.
1. Fabricate for duct sizes up to 6 by 30 inch.
2. Blade: 24 gage, minimum.
3. Provide 1 1/2 inch standoff bracket with extended pin or approved equal.
4. Manufacturers:
a. Greenheck MBD-10 or approved equal..

E. Multi-Blade Damper: Fabricate of opposed blade pattern with maximum blade sizes 8 x 72 inch. Assemble center and edge crimped blades in prime coated or galvanized channel frame with suitable hardware.
1. Blade: 18 gage, minimum.
2. Provide 1 1/2 inch standoff bracket with extended pin or approved equal.

3. Manufacturers:
   a. Greenheck MBD-15 or approved equal for 2-inch pressure.

F. End Bearings: Except in round ducts 12 inches and smaller, provide end bearings. On multiple blade dampers, provide oil-impregnated nylon, thermoplastic elastomer, or sintered bronze bearings.
1. Product: 515A manufactured by Young Regulator.

G. Quadrants:
1. Provide locking, indicating quadrant regulators on single and multi-blade dampers.
2. On insulated ducts mount quadrant regulators on stand-off mounting brackets, bases, or adapters.
3. Where rod lengths exceed 30 inches provide regulator at both ends.
4. Manufacturers:
   a. 443 Valcalox Regulator manufactured by Young Regulator.
   b. Substitutions: See Section 01 60 00 - Materials and Equipment.

PART 3 EXECUTION

3.1. PREPARATION

A. Verify that electric power is available and of the correct characteristics.

3.2. INSTALLATION

A. Install accessories in accordance with manufacturer's instructions, NFPA 90A, and follow SMACNA (DCS). Refer to Section 23 31 00 for duct construction and pressure class.

B. Provide backdraft dampers on exhaust fans or exhaust ducts nearest to outside and where indicated.

C. Provide duct access doors for inspection and cleaning before and after filters, coils, fans, automatic dampers, at fire dampers, combination fire and smoke dampers, and elsewhere as indicated. Provide minimum 8 x 8 inch size for hand access, 18 x 18 inch size for shoulder access, and as indicated. Provide 4 x 4 inch for balancing dampers only. Review locations prior to fabrication.

D. Provide duct test holes where indicated and required for testing and balancing purposes.

E. Provide fire dampers, combination fire and smoke dampers, and smoke dampers at locations indicated, where ducts and outlets pass through fire rated components, and where required by Authorities Having Jurisdiction. Install with required perimeter mounting angles, sleeves, breakaway duct connections, corrosion resistant springs, bearings, bushings and hinges.

F. Install smoke dampers and combination smoke and fire dampers in accordance with NFPA 92.

G. Demonstrate re-setting of fire dampers to Owner's representative.

H. At fans and motorized equipment associated with ducts, provide flexible duct connections immediately adjacent to the equipment.

I. At equipment supported by vibration isolators, provide flexible duct connections immediately adjacent to the equipment.

J. Provide balancing dampers at points on supply, return, and exhaust systems where branches are taken from larger ducts as required for air balancing. Install minimum 2 duct widths from duct take-off.

K. Provide balancing dampers on high velocity systems where indicated. Refer to Section 23 36 00 - Air Terminal Units.

L. Provide balancing dampers on duct take-off to diffusers, grilles, and registers, regardless of whether dampers are specified as part of the diffuser, grille, or register assembly.

END OF SECTION

HVAC POWER VENTILATORS

PART 1 GENERAL

1.1. SECTION INCLUDES
A. Roof exhausters.
B. Ceiling exhaust fans.
C. In-line exhaust fans.

1.2. RELATED REQUIREMENTS
A. Section 23 05 48 - Vibration Isolation and Sound and Seismic Controls for HVAC Piping and Equipment.
B. Section 23 33 00 - Air Duct Accessories: Backdraft dampers.
C. Section 26 27 17 - Equipment Wiring: Electrical characteristics and wiring connections.

1.3. REFERENCE STANDARDS
A. AMCA 99 - Standards Handbook; 2016.
B. AMCA 204 - Balance Quality and Vibration Levels for Fans; 2005.
C. AMCA 210 - Laboratory Methods of Testing Fans for Certified Aerodynamic Performance Rating; 2016.
D. AMCA (DIR) - [Directory of] Products Licensed Under AMCA International Certified Ratings Program; Air Movement and Control Association International, Inc.; http://www.amca.org/certified/search/company.aspx.
E. AMCA 300 - Reverberant Room Method for Sound Testing of Fans; 2014.
F. AMCA 301 - Methods for Calculating Fan Sound Ratings from Laboratory Test Data; 2014.
G. UL 705 - Power Ventilators; Current Edition, Including All Revisions.

1.4. SUBMITTALS
A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Product Data: Provide data on fans and accessories including fan curves with specified operating point clearly plotted, power, RPM, sound power levels at rated capacity, and electrical characteristics and connection requirements.
C. Manufacturer's Instructions: Indicate installation instructions.
D. Maintenance Data: Include instructions for lubrication, motor and drive replacement, spare parts list, and wiring diagrams.
E. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
   1. See Section 01 60 00 - Materials and Equipment, for additional provisions.
   2. Extra Fan Belts: Two sets for each individual fan.

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

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

PART 2 PRODUCTS

2.1. POWER VENTILATORS - GENERAL

A. Static and Dynamically Balanced: AMCA 204 - Balance Quality and Vibration Levels for Fans.
B. Performance Ratings: Determined in accordance with AMCA 210 and bearing the AMCA Certified Rating Seal.
C. Sound Ratings: AMCA 301, tested to AMCA 300, and bearing AMCA Certified Sound Rating Seal.
D. Fabrication: Conform to AMCA 99.
E. UL Compliance: UL listed and labeled, designed, manufactured, and tested in accordance with UL 705.
F. Electrical Components: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.
G. Kitchen Hood Exhaust Fans: Comply with requirements of NFPA 96 and UL 762.

2.2. ROOF EXHAUSTERS

A. Manufacturers:
   1. Greenheck; Model G / GB or Cue / Cube: www.greenheck.com.
   2. Carnes: www.carnes.com.
   3. Loren Cook Company: www.lorencook.com.
   4. JenCoFan: www.jencofan.com.
   5. PennBarry: www.pennbarry.com.
   6. Twin City Fan Company: www.tcf.com.
   7. Acme: www.acmefan.com.
   8. Substitutions: See Section 01 60 00 - Materials and Equipment.
B. Fan Unit: V-belt or direct driven as indicated, with spun aluminum housing; resilient mounted motor; 1/2 inch mesh, 0.62 inch thick aluminum wire birdscreen; square base to suit roof curb with continuous curb gaskets.
C. Roof Curb: 12 inch high self-flashing of galvanized steel with continuously welded seams, built-in cant strips, insulation and curb bottom, interior baffle with acoustic insulation, curb bottom, and factory installed nailer strip.
D. Disconnect Switch: Factory wired, non-fusible, in housing for thermal overload protected motor and wall mounted multiple speed switch.
E. Backdraft Damper (where indicated on drawings): Gravity actuated, aluminum multiple blade construction, felt edged with offset hinge pin, nylon bearings, blades linked, and line voltage motor drive, power open, spring return.
F. Sheaves: Cast iron or steel, dynamically balanced, bored to fit shafts and keyed; variable and adjustable pitch motor sheave selected so required rpm is obtained with sheaves set at mid-position; fan shaft with self-aligning pre-lubricated ball bearings.
G. Accessories: See Drawings.

2.3. UTILITY SET EXHAUST FANS

A. Manufacturers:
   1. Greenheck; Model USF: www.greenheck.com.
   2. Carnes: www.carnes.com.
   3. Loren Cook Company: www.lorencook.com.
   4. JenCoFan: www.jencofan.com.
   5. PennBarry: www.pennbarry.com.
   6. Twin City Fan Company: www.tcf.com.
   7. Acme: www.acmefan.com.
   8. Substitutions: See Section 01 60 00 - Materials and Equipment.

B. Manufactures housing capable of withstanding up to -8 in. wg. pressure, 1/2 inch mesh, 0.62 inch thick aluminum wire birdscreen; mounting rails with direct-mount spring isolators with a minimum deflection of 1 inch.

C. Roof Curb: Provided by others.

D. Disconnect Switch: Factory wired, non-fusible, in housing for thermal overload protected motor and wall mounted multiple speed switch.

E. Sheaves: Cast iron or steel, dynamically balanced, bored to fit shafts and keyed; variable and adjustable pitch motor sheave selected so required rpm is obtained with sheaves set at mid-position; fan shaft with self-aligning pre-lubricated ball bearings.

F. Motor: V-belt, NEMA premium efficiency TEFC motor with at least Class B or greater insulation and shaft grounding.

G. Variable Frequency Drive: Provide variable frequency drive.

H. Bearings: L (10) Life of 80 hours.

I. Accessories (other than noted above): See Drawings.

2.4. IN-LINE EXHAUST FANS (BI WHEEL WITH HIGH VOL/STATIC)

A. Manufacturers:
   1. Greenheck; Model Series SQ/BSQ: www.greenheck.com.
   2. Carnes; Model Series VIDK/VIBK: www.carnes.com.
   3. Loren Cook Company; Model Series SQN: www.lorencook.com.
   4. JenCoFan; Model Series JID/JIB: www.jencofan.com.
   5. PennBarry; Model Centrex Inliner: www.pennbarry.com.
   6. Twin City Fan Company; Type DSI and BSI: www.tcf.com.
   7. Acme; Model Series XD/XB: www.acmefan.com.
   8. Substitutions: See Section 01 60 00 - Materials and Equipment.

B. Construction:
   1. Centrifugal Fan Unit: V-belt or direct driven backward incline wheel with galvanized steel housing and support lugs, lined with 1/2 inch acoustic insulation, resilient mounted motor, gravity backdraft damper in discharge.
   2. Disconnect Switch: Cord and plug in housing for thermal overload protected motor and wall mounted switch.
   3. Sheaves: Cast iron or steel, dynamically balanced, bored to fit shafts and keyed; variable and adjustable pitch motor sheaves selected so required rpm is obtained

with sheaves set at mid-position; fan shaft with self-aligning pre-lubricated ball bearings.

4. (EF-9 Only) Temperature: Unit must be able to withstand temperatures up to 180°F.

C. Performance:
   1. As indicated on the Drawing Schedule.

D. Electrical Characteristics and Components:
   1. Electrical Characteristics: In accordance with Division 26.
   2. Motors: In accordance with Section 22 05 13/23 05 13. Type: NEMA MG1.
   3. Controls: See Drawings and Section 23 09 93 - Sequence of Operations.
   4. Disconnect Switch: Factory mount disconnect switch on equipment.

E. Accessories: See Drawings.

PART 3 EXECUTION

3.1. INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Secure roof exhausters with cadmium plated steel lag screws to roof curb.

C. Extend ducts to roof exhausters into roof curb. Counterflash duct to roof opening.

D. Hung Cabinet Fans:
   1. Install fans with resilient mountings and flexible electrical leads. Refer to Section 23 05 48.
   2. Install flexible connections specified in Section 23 33 00 between fan and ductwork. Ensure metal bands of connectors are parallel with minimum one inch flex between ductwork and fan while running.

E. Provide sheaves required for final air balance.

F. Install backdraft dampers on inlet to roof and wall exhausters.

G. Provide backdraft dampers on outlet from cabinet and ceiling exhauster fans and as indicated.

END OF SECTION

AIR TERMINAL UNITS

PART 1 GENERAL

1.1. SECTION INCLUDES

A. Variable volume terminal units.
B. Integral sound attenuator.
C. Integral heating coils.
D. Integral damper motor operators.
E. Integral controls.

1.2. RELATED REQUIREMENTS

A. Section 23 05 48 - Vibration Isolation and Sound and Seismic Controls for HVAC Piping and Equipment.
B. Section 23 31 00 - HVAC Ducts and Casings.
C. Section 23 33 00 - Air Duct Accessories.
D. Section 23 37 00 - Air Outlets and Inlets.
E. Section 23 09 13 - Instrumentation and Control Devices for HVAC: Thermostats and Actuators.
F. Division 26: Electrical characteristics and wiring connections.

1.3. REFERENCE STANDARDS

A. ASTM A492 - Standard Specification for Stainless Steel Rope Wire; 1995 (Reapproved 2013).
B. ASTM A603 - Standard Specification for Zinc-Coated Steel Structural Wire Rope; 1998 (Reapproved 2014).
C. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems; 2021.
D. SMACNA (SRM) - Seismic Restraint Manual Guidelines for Mechanical Systems; 2008.
E. UL 181 - Standard for Factory-Made Air Ducts and Air Connectors; current edition, including all revisions.

1.4. SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
B. Product Data: Provide data indicating configuration, general assembly, and materials used in fabrication. Include catalog performance ratings that indicate air flow, static pressure, and NC designation. Include electrical characteristics and connection requirements.
C. Shop Drawings: Indicate configuration, general assembly, and materials used in fabrication, and electrical characteristics and connection requirements.
    1. Include schedules listing discharge and radiated sound power level for each of second through sixth octave bands at inlet static pressures of 1 to 4 inch wg.
D. Manufacturer's Installation Instructions: Indicate support and hanging details, installation instructions, recommendations, and service clearances required.

E. Project Record Documents: Record actual locations of units and locations of access doors required for access of valving.
F. Operation and Maintenance Data: Include manufacturer's descriptive literature, operating instructions, maintenance and repair data, and parts lists. Include directions for resetting constant-volume regulators.
G. Warranty: Submit manufacturer warranty and ensure forms have been completed in Owner's name and registered with manufacturer.
H. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
   1. See Section 01 60 00 - Materials and Equipment, for additional provisions.

1.5. QUALITY ASSURANCE
A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience.
B. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

1.6. WARRANTY
A. See Section 01 77 00 - Contract Closeout, for additional warranty requirements.

PART 2 PRODUCTS

2.1. MANUFACTURED UNITS
A. Ceiling mounted variable air volume supply air control terminals for connection to single duct, central air systems, with digital / electric variable volume controls, electric heating coils.
B. Identify each terminal unit with clearly marked identification label and air flow indicator. Include unit nominal air flow, maximum factory set airflow, minimum factory set air flow, and coil type.

2.2. SINGLE DUCT VARIABLE VOLUME UNITS
A. Manufacturers:
   1. Carnes; Model Series AV: www.carnes.com.
   2. Price; Model Series S-V: www.price-hvac.com.
   3. Titus; Model Series DESV: www.titus-hvac.com.
   4. Nailor; Model 3000 Series: www.nailor.com.
   5. Metalaire; Model Series TH: www.metalaire.com.
   6. Substitutions: See Section 01 60 00 - Materials and Equipment.
B. Basic Assembly:
   1. Casings: Minimum 22 gage galvanized steel.
   2. Lining: Minimum 3/4 inch thick neoprene or vinyl coated fibrous glass insulation, 1.5 lb/cu ft density, meeting NFPA 90A requirements and UL 181 erosion requirements.

3. Plenum Air Inlets: Round stub connections for duct attachment.
4. Plenum Air Outlets: S slip and drive connections.

C. Basic Unit:
1. Configuration: Air volume damper assembly inside unit casing. Locate control components inside protective metal shroud.
2. Volume Damper: Construct of galvanized steel with peripheral gasket and self lubricating bearings; maximum damper leakage: 2 percent of design air flow at 3 inches inlet static pressure.
3. Mount damper operator to position damper normally open.

D. Attenuator Section: Line attenuator sections with 2 inch thick insulation.

E. Multi Outlet Attenuator Section: With 8 inch diameter collars, each with butterfly balancing damper with lock.

F. Round Outlet: Discharge collar matching inlet size.

G. Electric Heating Coil:
1. Construction: UL listed, slip-in type, open coil design, integral control box factory wired and installed, with:
a. Primary and secondary over-temperature protection.
b. Minimum airflow switch.
c. Magnetic contactor for each step of control.
2. Electrical Characteristics:
a. Refer to Division 26.

H. Automatic Damper Operator:
1. Electric Actuator: 24 volt with remote temperature read and reset capability.

I. Thermostat: Refer to Section 23 09 13.

PART 3 EXECUTION

3.1. INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Install the inlets of air terminal units and air flow sensors a minimum of four duct diameters from elbows, transitions, and duct takeoffs.

C. Provide ceiling access doors or locate units above easily removable ceiling components.

D. Support units individually from structure with wire rope complying with ASTM A492 and ASTM A603 in accordance with SMACNA (SRM). See Section 23 05 48.

E. Do not support from ductwork.

F. Connect to ductwork in accordance with Section 23 31 00.

G. Provide minimum of 5 ft of 1 inch thick lined ductwork downstream of units.

H. Verify that electric power is available and of the correct characteristics.

3.2. ADJUSTING

A. Reset volume with damper operator attached to assembly allowing flow range modulation from 100 percent of design flow to zero percent full flow. Set units with heating coils for minimum 50 percent full flow.

END OF SECTION

AIR OUTLETS AND INLETS

PART 1 GENERAL

1.1. SECTION INCLUDES

1.2. RELATED REQUIREMENTS

A. Section 09 90 00 - Painting and Coating: Painting of ducts visible behind outlets and inlets.

1.3. REFERENCE STANDARDS

A. AMCA 500-L - Laboratory Methods of Testing Louvers for Rating; 2015.
B. ARI 890 - Standard for Air Diffusers and Air Diffuser Assemblies; Air-Conditioning and Refrigeration Institute; 2008.
C. ASHRAE Std 70 - Method of Testing the Performance of Air Outlets and Inlets; 2006 (Reaffirmed 2011).

1.4. SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Product Data: Provide data for equipment required for this project. Review outlets and inlets as to size, finish, and type of mounting prior to submission. Submit schedule of outlets and inlets showing type, size, location, application, and noise level.
C. Project Record Documents: Record actual locations of air outlets and inlets.

1.5. QUALITY ASSURANCE

A. Test and rate air outlet and inlet performance in accordance with ASHRAE Std 70.
B. Test and rate louver performance in accordance with AMCA 500-L.

1.6. QUALITY ASSURANCE

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

PART 2 PRODUCTS (ON THE DRAWINGS)

2.1. MANUFACTURERS

A. Carnes, a division of Carnes Company Inc.: www.carnes.com.
B. Krueger: www.krueger-hvac.com.
C. Price Industries: www.price-hvac.com.
D. Titus: www.titus-hvac.com.
E. Nailor; www.nailor.com.
F. Metalaire www.metalaire.com
G. Shoemaker; www.shoemakermfg.com.
H. Substitutions: Section 01 60 00 - Materials and Equipment.

PART 3 EXECUTION

3.1. INSTALLATION

A. Install in accordance with manufacturer's instructions.
B. Check location of outlets and inlets and make necessary adjustments in position to comply with architectural features, symmetry, and lighting arrangement.
C. Install diffusers to ductwork with air tight connection.
D. Provide balancing dampers on duct take-off to diffusers, and grilles and registers, despite whether dampers are specified as part of the diffuser, or grille and register assembly.
E. Paint ductwork visible behind air outlets and inlets matte black. Refer to Section 09 91 23.

END OF SECTION

PACKAGED OUTDOOR ROOFTOP UNITS - SMALL CAPACITY

PART 1 GENERAL

1.1. SECTION INCLUDES

A. Packaged roof top unit - heat pump.
B. Packaged roof top unit - gas heat.
C. Roof mounting curb.

1.2. RELATED REQUIREMENTS

A. Section 23 05 48 - Vibration Isolation and Sound and Seismic Controls for HVAC Piping and Equipment.
B. Section 23 05 49 - HVAC Seismic Restraint.
C. Section 23 09 13 - Instrumentation and Control Devices for HVAC.
D. Section 23 09 93 - Sequence of Operations for HVAC Controls.
E. Section 23 33 00 - Air Duct Accessories.
F. Division 26: Electrical characteristics and wiring connections.

1.3. REFERENCE STANDARDS

A. ANSI/AMCA Standard 500-D-07, "Laboratory Methods of Testing Dampers for Rating"; 2007.
B. ASTM B117 - Standard Practice for Operating Salt Spray (Fog) Apparatus; American Society for Testing and Materials.
C. NFPA 54 - National Fuel Gas Code; National Fire Protection Association.

1.4. SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Product Data: Provide capacity and dimensions of manufactured products and assemblies required for this project. Indicate electrical service with electrical characteristics and connection requirements, and duct connections.
C. Shop Drawings: Indicate capacity and dimensions of manufactured products and assemblies required for this project. Indicate electrical service with electrical characteristics and connection requirements, and duct connections.
D. Manufacturer's Instructions: Indicate assembly, support details, connection requirements, and include start-up instructions.
E. Operation and Maintenance Data: Include manufacturer's descriptive literature, operating instructions, installation instructions, maintenance and repair data, and parts listing.
F. Warranty: Submit manufacturer's warranty and ensure forms have been filled out in Owner's name and registered with manufacturer.
G. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
    1. See Section 01 60 00 - Materials and Equipment, for additional provisions.
    2. Extra Filters: One set for each unit.
    3. Fan Belts: One set for each unit.

1.5. QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum 10 years of documented experience.

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

1.6. DELIVERY, STORAGE, AND HANDLING

A. Protect units from physical damage by storing off site until roof mounting curbs are in place, ready for immediate installation of units.

1.7. WARRANTY

A. See Section 01 77 00 - Contract Closeout, for additional warranty requirements.

B. Provide a five year warranty to include coverage for refrigeration compressors and heat exchangers.

PART 2 PRODUCTS

2.1. ROOFTOP HEAT PUMP UNITS (RTU-5)

A. Manufacturers:
   1. Daikin Applied.
   2. Aaon Incorporated.
   3. Trane.
   4. Substitutions: See Section 01 60 00 - Materials and Equipment.

B. Product Description: Self-contained, packaged, factory assembled and wired, consisting of roof curb, cabinet, supply fan, refrigerant cooling coil, compressor, refrigeration circuit, condenser, gas-fired heating section, electric or hot water heating coil, air filters, mixed air casing, controls, and accessories.

C. Configuration: As indicated on Drawings.

D. Roof Mounting Curb: Seismically rated, spring-isolated curb for mounting under entire unit.

E. Cabinet:
   1. Designed for outdoor installation with weatherproof construction.
   2. Panels: Constructed of double-wall galvanized steel with baked enamel finish meeting salt spray test in accordance with ASTM B117. Furnish access doors or removable access panels.
   3. Insulation: Factory applied to exposed vertical and horizontal panels, 1-inch thick aluminum foil faced foam with edges protected from erosion.

F. Supply Fan: Forward curved centrifugal type, resiliently mounted with direct drive and high efficiency motor. Motor permanently lubricated with built-in thermal overload protection.

G. Evaporator Coil: Constructed of copper tubes expanded onto aluminum fins with e-coating. Stainless steel drain pan with piping connection. Factory leak tested under water.

H. Compressor: Variable capacity inverter-driven scroll compressor, hermetically sealed, resiliently mounted with positive lubrication, and internal motor overload protection. Furnish vibration isolators and short cycle protection.

I. Refrigeration circuit: Furnish the following for each circuit: Electronic expansion valve, filter-drier, suction, discharge, and liquid line service valves with gauge ports, high and low pressure safety controls. Dehydrate and factory charge each circuit with oil and refrigerant.

J. Condenser:
   1. Coil: Copper tube with aluminum or copper fin coil assembly. Factory leak tested under water.
   2. Condenser Fan: Direct drive propeller fans statically and dynamically balanced. Wired to operate with compressor. Motor permanently lubricated with built-in thermal overload protection. Furnish high efficiency fan motors.

K. Air Filters: 2 inch thick glass fiber disposable media in metal frames. MERV 8 based on ASHRAE 52.2 and 4 inch thick glass fiber disposable.

L. Media in metal frames (MERV 13 based on ASHRAE 52.2).

M. Mixed Air Casing:
   1. Damper Leakage: Furnish Class I motorized dampers with maximum leakage rate of 4 cfm per square foot at 1-inch water column pressure differential when tested in accordance with AMCA 500D.
   2. Economizer: Factory installed fully modulating motorized outside air and return air dampers controlled by dry bulb or enthalpy controller with minimum position setting. Outside air damper normally closed and return air damper normally open. Furnish barometric relief damper capable of closing by gravity (3 tons and under) and barometric relief damper with powered exhaust (above 3 tons). Furnish rain hood with screen.

N. Controls:
   1. Terminal strip for field mounted controls.

O. Accessories:
   1. Convenience Outlet: Factory installed, 115 volt, 15 amp, GFCI type, internally mounted.
   2. See Drawings for additional accessories.

P. Capacity:
   1. Refer to Drawing schedules.

Q. Provide modulating gas bypass valves for capacity control.

R. Hot Gas Reheat:
   1. Unit shall be equipped with a fully modulating hot gas reheat coil with hot gas coming from the unit condenser.
   2. Hot gas reheat coil shall be a Micro Channel design. The aluminum tube shall be a micro channel design with high efficiency aluminum fins. Fins shall be brazed to the tubing for a direct bond. The capacity of the reheat coil shall allow for a 20°F temperature rise at all operating conditions.

3. The modulating hot gas reheat systems shall allow for independent control of the cooling coil leaving air temperature and the reheat coil leaving air temperature. The cooling coil and reheat coil leaving air temperature setpoints shall be adjustable through the unit controller. During the dehumidification cycle the unit shall be capable of 100% of the cooling capacity. The hot gas reheat coil shall provide discharge temperature control with +/- 2°F.
4. Each coil shall be factory leak tested with high-pressure air under water.

S. Heat Pump Heating:
1. The evaporator coil, condenser coil, compressors and refrigerant circuit shall be designated for heatpump operation. The refrigerant circuit shall contain a 4 way reversing valve for the heatpump operation. The outdoor coil shall have an electronic expansion valve to control the refrigerant flow. The unit controller shall modulate the expansion valve to maintain compressor operation within the compressor operational envelope.
2. The refrigerant system shall have a pump-down cycle.
3. The unit shall have an electric resistance heating coil for auxiliary heating. When the heatpump operation cannot maintain the discharge air temperature setpoint the electric heating coil shall temper the airstream to the discharge air temperature setpoint.

2.2. ROOFTOP AIR CONDITIONING UNITS - GAS HEAT (RTU-2)

A. Manufacturers:
1. Daikin Applied.
2. Aaon Incorporated.
3. Trane.
4. Substitutions: See Section 01 60 00 - Product Requirements.

B. Product Description: Self-contained, packaged, factory assembled and wired, consisting of roof curb, cabinet, supply fan, refrigerant cooling coil, compressor, refrigeration circuit, condenser, gas-fired heating section, electric or hot water heating coil, air filters, mixed air casing, controls, and accessories.

C. Configuration: As indicated on Drawings.

D. Roof Mounting Curb: Seismically rated, spring-isolated curb for mounting under entire unit.

E. Cabinet:
1. Designed for outdoor installation with weatherproof construction.
2. Panels: Constructed of double-wall galvanized steel with baked enamel finish meeting salt spray test in accordance with ASTM B117. Furnish access doors or removable access panels.
3. Insulation: Factory applied to exposed vertical and horizontal panels, 1-inch thick aluminum foil faced foam with edges protected from erosion.

F. Supply Fan: Forward curved centrifugal type, resiliently mounted with direct drive high efficiency motor. Motor permanently lubricated with built-in thermal overload protection.

G. Evaporator Coil: Constructed of copper tubes expanded onto aluminum fins with e-coating. Stainless steel drain pan with piping connection. Factory leak tested under water.

H. Compressor: Variable capacity inverter-driven scroll compressor, hermetically sealed, resiliently mounted with positive lubrication, and internal motor overload protection. Furnish vibration isolators and short cycle protection.

I. Refrigeration circuit: Furnish the following for each circuit: fixed orifice control electronic expansion valve, filter-drier, suction, discharge, and liquid line service valves with gauge ports, high and low pressure safety controls. Dehydrate and factory charge each circuit with oil and refrigerant.

J. Condenser:
   1. Coil: Copper tube with aluminum or copper fin coil assembly. Factory leak tested under water.
   2. Condenser Fan: Direct drive propeller fans statically and dynamically balanced. Wired to operate with compressor. Motor permanently lubricated with built-in thermal overload protection. Furnish high efficiency fan motors.

K. Gas-Fired Heating Section:
   1. Fuel: Natural gas.
   2. Heat Exchangers: Stainless steel.
   3. Gas Burner: Modulating, 1:10 turndown, Induced draft type burner with adjustable combustion air supply, pressure regulator, gas valves, manual shut-off, intermittent spark or glow coil ignition and flame sensing device. Require unit fan operation before allowing gas valve to open.

L. Air Filters 2-inch thick glass fiber disposable media in metal frames, and 4 thick glass fiber disposable media in metal frames (MERV 13 based on ASHRAE 52.2).

M. Mixed Air Casing:
   1. Damper Leakage: Furnish Class I motorized dampers with maximum leakage rate of 4 cfm per square foot at 1-inch water column pressure differential when tested in accordance with AMCA 500D.
   2. Economizer: Factory installed fully modulating motorized outside air and return air dampers controlled by dry bulb or enthalpy controller with minimum position setting. Outside air damper normally closed and return air damper normally open. Furnish barometric relief damper capable of closing by gravity (3 tons and under) and barometric relief damper with powered exhaust (above 3 tons). Furnish rain hood with screen.

N. Controls:
   1. Terminal strip for field mounted controls.

O. Accessories:
   1. Convenience Outlet: Factory installed, 115 volt, 15 amp, GFCI type, internally mounted.
   2. See Drawings for additional accessories.

P. Capacity:
   1. Refer to Drawing schedules.

Q. Provide modulating gas bypass valves for capacity control.

R. Provide modulating gas reheat valves for dehumidification.

2.3. ELECTRICAL CHARACTERISTICS AND COMPONENTS

A. Electrical Characteristics: In accordance with Division 26.

B. Disconnect Switch: Factory mounted, non-fused type, interlocked with access door, accessible from outside unit, with power lockout capability.

PART 3 EXECUTION

3.1. EXAMINATION

A. Verify that roof is ready to receive work and opening dimensions are as indicated on shop drawings.

B. Verify that proper power supply is available.

3.2. INSTALLATION

A. Roof Curb:
   1. Assemble roof curb.
   2. Install roof curb level.
   3. Coordinate curb installation and flashing with Architect.
   4. Install units on roof curb providing watertight enclosure to protect ductwork and utility services.
   5. Install gasket material between unit base and roof curb.

B. Install units on vibration isolators. Refer to Section 23 05 48.

C. Connect units to supply and return ductwork with flexible connections. Refer to Section 23 33 00.

D. Install condensate piping with trap and route from drain pan to splash block on roof.

E. Install components furnished loose for field mounting.

F. Install electrical devices furnished loose for field mounting.

G. Install control wiring between unit and field installed accessories.

H. Remove from roof and dispose off-site panels removed from units during installation of economizer and dampers.

I. Locate remote panels as indicated on Drawings.

J. Provide fixed sheaves required for final air balance.

3.3. INSTALLATION - NATURAL GAS HEATING SECTION

A. Connect natural gas piping in accordance with NFPA 54.

B. Connect natural gas piping to unit, full size of unit gas train inlet. Arrange piping with clearances for burner service.

C. Install the following piping accessories on natural gas piping connections. Refer to Section 23 11 13.
   1. Strainer.
   2. Pressure gage.
   3. Shutoff valve.

4. Pressure reducing valve.

D. Install natural gas piping accessories above roof, within unit casing, or below roof.

3.4. CLEANING

A. Section 01 77 00 - Contract Closeout: Requirements for cleaning.
B. Vacuum clean coils and inside of unit cabinet.
C. Install temporary filters during construction period. Replace with permanent filters at Substantial Completion.

3.5. DEMONSTRATION

A. Section 01 77 00 - Contract Closeout: Requirements for demonstration and training.
B. Demonstrate unit operation and maintenance.
C. Furnish services of manufacturer's technical representative for one 8 hour day to instruct Owner's personnel in operation and maintenance of units. Schedule training with Owner, provide at least 7 days notice to Architect/Engineer of training date.

END OF SECTION

PACKAGED OUTDOOR CENTRAL-STATION ROOFTOP UNITS

PART 1 GENERAL

1.1. SECTION INCLUDES

A. Packaged roof top unit. (RTU-1, RTU-3, RTU-4)
B. Unit controls.

1.2. RELATED REQUIREMENTS

A. Section 23 05 48 - Vibration Isolation and Sound and Seismic Controls for HVAC Piping and Equipment.
B. Section 23 05 49 - HVAC Seismic Restraint.
C. Section 23 09 13 - Instrumentation and Control Devices for HVAC.
D. Section 23 09 93 - Sequence of Operations for HVAC Controls.
E. Section 23 33 00 - Air Duct Accessories.
F. Division 26: Electrical characteristics and wiring connections.

1.3. REFERENCE STANDARDS

A. ANSI/AMCA Standard 500-D-07, "Laboratory Methods of Testing Dampers for Rating"; 2007.
B. ASTM B117 - Standard Practice for Operating Salt Spray (Fog) Apparatus; American Society for Testing and Materials.
C. NFPA 54 - National Fuel Gas Code; National Fire Protection Association.

1.4. SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Product Data: Provide capacity and dimensions of manufactured products and assemblies required for this project. Indicate electrical service with electrical characteristics and connection requirements, and duct connections.
C. Shop Drawings: Indicate capacity and dimensions of manufactured products and assemblies required for this project. Indicate electrical service with electrical characteristics and connection requirements, and duct connections.
D. Manufacturer's Instructions: Indicate assembly, support details, connection requirements, and include start-up instructions.
E. Operation and Maintenance Data: Include manufacturer's descriptive literature, operating instructions, installation instructions, maintenance and repair data, and parts listing.
F. Warranty: Submit manufacturer's warranty and ensure forms have been filled out in Owner's name and registered with manufacturer.
G. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
    1. See Section 01 60 00 - Materials and Equipment, for additional provisions.
    2. Extra Filters: One set for each unit.
    3. Fan Belts: One set for each unit.

1.5. QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum 10 years of documented experience.

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

1.6. DELIVERY, STORAGE, AND HANDLING

A. Protect units from physical damage by storing off site until roof mounting curbs are in place, ready for immediate installation of units.

1.7. WARRANTY

A. See Section 01 78 00 - Contract Closeout, for additional warranty requirements.

B. Provide a five year warranty to include coverage for refrigeration compressors and heat exchangers.

PART 2 PRODUCTS

2.1. MANUFACTURERS

A. Daikin Applied.

B. Aaon Model Series : www.aaon.com.

C. Substitutions: See Section 01 60 00 - Materials and Equipment.

2.2. MANUFACTURED UNITS

A. General: Roof mounted units having gas burner and electric refrigeration.

B. Description: Self-contained, packaged, factory assembled and prewired, consisting of cabinet and frame, supply fan, return fan, variable frequency drives prewired, heat exchanger and burner, controls, air filters, refrigerant cooling coil and compressor, condenser coil and condenser fan.

C. Electrical Characteristics:

1. Refer to Division 26.

D. Disconnect Switch: Factory mounted, non-fused type, interlocked with access door, accessible from outside unit, with power lockout capability.

2.3. FABRICATION

A. Cabinet: Double-walled Galvanized steel with baked enamel finish, including access panels with screwdriver operated flush cam type fasteners. Structural members shall be minimum 18 gage, with access doors or panels of minimum 20 gage.

B. Insulation: 2 inch thick polyisocyanurate foam insulation with edges protected from erosion.

C. Heat Exchangers.

D. Supply and Return Fan: Forward curved centrifugal type, or direct drive. Refer to Section 23 05 48.
E. Supply Fan Modulation:
   1. (RTU-3, RTU-4): Controlled DDC based on space temperature / humidity space, temperature / humidity setpoint.
   2. (RTU-1 only) Controlled from duct static pressure by DDC. Static pressure sensed by duct mounted sensor.
   3. Furnish field adjustable duct high limit safety control to protect duct work from excessive duct pressure.
F. Air Filters: Glass fiber disposable media in metal frames.
   1. Filter Section:
      a. Location: Upstream of fan section.
      b. Furnish section with integral galvanized steel filter staggered rack contained within unit.
      c. Disposable filters: Frame mounted 2 inch thick MERV 8 (based on ASHRAE 52.2) and 4 inch thick MERV 13 (Based on ASHRAE 52.2).
G. Vibration Isolation Curb / Iso-Rail: 23 05 48.

2.4. BURNER

A. Gas Burner: Modulating, 10:1 turn down, atmospheric type burner with adjustable combustion air supply, pressure regulator, gas valves, manual shut-off, intermittent spark or glow coil ignition, flame sensing device, and automatic 100 percent shut-off pilot.
B. Gas Burner Safety Controls: Energize ignition, limit time for establishment of flame, prevent opening of gas valve until pilot flame is proven, stop gas flow on ignition failure, energize blower motor, and after air flow proven and slight delay, allow gas valve to open.
C. High Limit Control: Temperature sensor with fixed stop at maximum permissible setting, de-energize burner on excessive bonnet temperature and energize burner when temperature drops to lower safe value.
D. Supply Fan Control: Temperature sensor sensing bonnet temperatures and independent of burner controls, with provisions for continuous fan operation.

2.5. EVAPORATOR COIL

A. Provide copper tube aluminum fin coil assembly with Stainless steel drain pan and connection.
B. Provide electronic expansion valves.

2.6. COMPRESSOR

A. Provide at least (1) variable capacity, inverter-driven scroll compressor, 3600 rpm maximum, resiliently mounted with positive lubrication, crankcase heater, high and low pressure safety controls, motor overload protection, suction and discharge service valves and gauge ports, and filter drier.
B. Five minute timed off circuit to delay compressor start.

C. Outdoor thermostat to energize compressor above 35 degrees F ambient.

2.7. CONDENSER COIL

A. Provide copper tube aluminum fin coil assembly with subcooling rows and coil guard.
B. Provide direct drive propeller fans, resiliently mounted with fan guard, motor overload protection, wired to operate with compressor. Provide high efficiency fan motors.
C. Provide refrigerant pressure switches to cycle condenser fans.
D. Refrigeration circuit:
    1. Dehydrate and factory charge each circuit with oil and refrigerant.
    2. Furnish the following for each circuit:
        a. Thermal expansion device.
        b. Filter-drier.
        c. Replaceable core filter drier.
        d. Suction, discharge, and liquid line service valves with gauge ports.
        e. Sight glass.
        f. High and low pressure safety controls.
        g. Liquid line solenoid valve.
        h. Sub-cooler circuit to provide 15 degrees of liquid sub-cooling.
    3. Capacity control:
        a. By modulating compressor(s).
    4. Furnish control to provide low ambient cooling to 0 degrees F.

2.8. MIXED AIR CASING

A. Mixed Air Controls: Maintain selected supply air temperature and return dampers to minimum position on call for heating and above 75 degrees F ambient, or when ambient air temperature exceeds return air temperature.

2.9. OPERATING CONTROLS

A. Terminal strip for field mounted controls.

2.10. HOT GAS REHEAT (RTU-3 AND RTU-4 ONLY)

A. Unit shall be equipped with a fully modulating hot gas reheat coil with hot gas coming from the unit condenser.
B. Hot gas reheat coil shall be a Micro Channel design. The aluminum tube shall be a micro channel design with high efficiency aluminum fins. Fins shall be brazed to the tubing for a direct bond. The capacity of the reheat coil shall allow for a 20°zf temperature rise at all operating conditions.
C. The modulating hot gas reheat systems shall allow for independent control of the cooling coil leaving air temperature and the reheat coil leaving air temperature. The cooling oil and the reheat coil leaving air temperature setpoints shall be adjustable through the unit controller. During the dehumidification cycle the unit shall be capable of 100% of the

cooling capacity. The hot gas reheat coil shall provide discharge temperature control within +/- 2°F.

D. Each coil shall be factory leak tested with high-pressure air under water.

PART 3 EXECUTION

3.1. EXAMINATION

A. Verify that roof is ready to receive work and opening dimensions are as indicated on shop drawings.

B. Verify that proper power supply is available.

3.2. INSTALLATION

A. Roof Curb:

1. Assemble roof curb.
2. Install roof curb level.
3. Coordinate curb installation and flashing with Architect.
4. Install units on roof curb providing watertight enclosure to protect ductwork and utility services.
5. Install gasket material between unit base and roof curb.

B. Install units on vibration isolators. Refer to Section 23 05 48.

C. Connect units to supply and return ductwork with flexible connections. Refer to Section 23 33 00.

D. Install condensate piping with trap and route from drain pan to splash block on roof.

E. Install components furnished loose for field mounting.

F. Install electrical devices furnished loose for field mounting.

G. Install control wiring between unit and field installed accessories.

H. Remove from roof and dispose off-site panels removed from units during installation of economizer and dampers.

I. Locate remote panels as indicated on Drawings.

J. Provide fixed sheaves required for final air balance.

3.3. CLEANING

A. Section 01 77 00 - Contract Closeout: Requirements for cleaning.

B. Vacuum clean coils and inside of unit cabinet.

C. Install temporary filters during construction period. Replace with permanent filters at Substantial Completion.

3.4. DEMONSTRATION

A. Section 01 77 00 - Contract Closeout: Requirements for demonstration and training.

B. Demonstrate unit operation and maintenance.

C. Furnish services of manufacturer's technical representative for one 8 hour day to instruct Owner's personnel in operation and maintenance of units. Schedule training with Owner, provide at least 7 days notice to Architect/Engineer of training date.

END OF SECTION

CUSTOM OUTDOOR CENTRAL-STATION AIR HANDLING UNITS

PART 1 GENERAL

1.1. SECTION INCLUDES

A. Custom air handling units.
B. Roof curbs.

1.2. RELATED REQUIREMENTS

A. Section 23 05 49 - HVAC Seismic Restraint.
B. Section 23 05 48 - Vibration Isolation and Sound and Seismic Controls for HVAC Piping and Equipment.
C. Section 23 05 57 - HVAC Variable Frequency Controllers
D. Section 23 09 13 - Instrumentation and Control Devices for HVAC.
E. Section 23 09 93 - Sequence of Operation for HVAC Controls.
F. Division 26: Electrical characteristics and wiring connections.

1.3. REFERENCE STANDARDS

A. ABMA STD 9 - Load Ratings and Fatigue Life for Ball Bearings; American Bearing Manufacturers Association, Inc.; 1990 (Reapproved 2008).
B. ABMA STD 11 - Load Ratings and Fatigue Life for Roller Bearings; American Bearing Manufacturers Association, Inc.; 1990 (Reapproved 1999).
C. AMCA 210 - Laboratory Methods of Testing Fans for Aerodynamic Performance Rating; Air Movement and Control Association International, Inc.; 2007 (ANSI/AMCA 210, same as ANSI/ASHRAE 51).
D. AMCA 300 - Reverberant Room Method for Sound Testing of Fans; Air Movement and Control Association International, Inc.; 2008.
E. AMCA 301 - Methods for Calculating Fan Sound Ratings from Laboratory Test Data; Air Movement and Control Association International, Inc.; 2006.
F. AHRI 410 - Standard for Forced-Circulation Air-Cooling and Air-Heating Coils; Air-Conditioning, Heating, and Refrigeration Institute; 2001 (R2002) .
G. SMACNA (DCS) - HVAC Duct Construction Standards - Metal and Flexible; Sheet Metal and Air Conditioning Contractors' National Association; 2005.
H. UL 900 - Standard for Air Filter Units; Underwriters Laboratories Inc.; Current Edition, Including All Revisions.

1.4. SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Product Data:
    1. Published Literature: Indicate dimensions, weights, capacities, ratings, gages and finishes of materials, and electrical characteristics and connection requirements.
    2. Filters: Data for filter media, filter performance data, filter assembly, and filter frames.
    3. Fans: Performance and fan curves with specified operating point clearly plotted, power, RPM.

4. Sound Power Level Data: Fan outlet and casing radiation at rated capacity.
5. Electrical Requirements: Power supply wiring including wiring diagrams for interlock and control wiring, clearly indicating factory-installed and field-installed wiring.

C. Shop Drawings: Indicate assembly, unit dimensions, weight loading, required clearances, construction details, field connection details, and electrical characteristics and connection requirements.
D. Manufacturer's Instructions: Include installation instructions.
E. Maintenance Data: Include instructions for lubrication, filter replacement, motor and drive replacement, spare parts lists, and wiring diagrams.
F. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
1. See Section 01 60 00 - Materials and Equipment, for additional provisions.
2. Extra Fan Belts: Two sets for each unit.
3. Extra Filters: Two sets for each unit.

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

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

1.7. DELIVERY, STORAGE, AND HANDLING
A. Accept products on site in factory-fabricated protective containers, with factory-installed shipping skids and lifting lugs. Inspect for damage.
B. Store in clean dry place and protect from weather and construction traffic. Handle carefully to avoid damage to components, enclosures, and finish.
C. Do not operate units until ductwork is clean, filters are in place, bearings lubricated, and fan has been test run under observation.

PART 2 PRODUCTS

2.1. MANUFACTURERS
A. Innovative Air Technologies.
B. Climate by Design International.
C. Substitutions: See Section 01 60 00 - Materials and Equipment.

2.2. GENERAL
A. General Description:
1. The dehumidifier shall be capable of automatic continuous Outdoor operation. The desiccant wheel shall be rotary vertical desiccant wheel, sorption atmospheric type

capable of constant moisture output with a constant moisture inlet. All access panels shall be weather tight as to not allow temperature or moisture infiltration into the system. The dehumidifier shall be a complete factory assembled, tested unit that includes: Electric heaters for reactivation heat, TEFC motors on both process and reactivation fans, replaceable high capacity pleated filters, direct drive fans, desiccant wheel chain drive system, high capacity desiccant wheel, NEC rated electrical panel, access panels for all components, internal safeties and automatic controls. Refer to flow diagram on drawings for moisture removal quantity.

B. Construction Description:

1. The unit casing shall be constructed using a 1" Standard unitized, internal aluminum framing, covered, riveted and welded for torsional rigidity. External skin shall be provided with 16 gauge Galvaneal steel, primed and painted with industrial marine grade enamel for long term corrosion protection. Access panels shall be double wall construction and shall use heavy-duty hinges with ½ turn compression latches fully capable of being fully tightened against gasket surfaces. Panels without gaskets shall not be acceptable. Access panels shall be large enough to access all internal components to facilitate easy replacement or maintenance. Hinges shall be installed by locating hinges no more than 36 inches on center from hinge to hinge. All major components such as coils, filters, blowers, etc., within the air handling structure shall be easily removable through access panels without dismantling plenums. Equipment that requires disassembly of components rather than access through removable or hinged panels shall not be acceptable. All open air ducts shall have rainhoods and rodent screens to prevent any water penetrations or unnecessary debris from entering unit. Electrical enclosures to be NEMA 4 construction.

2.3. CONTROL PANEL

A. Provide Manufacturer's optional PLC control panel with BACnet/IP card.

2.4. DEHUMIDIFIER

A. Wheel Media:

1. The dehumidification desiccant wheel or "rotor" shall be uniform in nature, comprised of corrugated fiberglass with an “in situation” formed silica gel desiccant. Corrugations shall be 0.059” tall by 0.118” wide, with a wall thickness of 0.007” + 0.001”.Media shall be nominally 12 lb per cubic foot with “dry” (reactivated) desiccant concentration of not less than 80% of the total media mass. Not more than 4% of the media, including face coat, shall be of an organic material. Rotor media is rated for continuous service between –100 FDB and + 320 FDB. Media must withstand temperatures to 2000 FDB without mechanical failure. Rotor media shall be independently tested in accordance with ASHRAE guidelines for performance and independently tested in accordance with ASTM E-84 for flame resistance and smoke production. ASTM E-84 result must be 0/0

for both flame and smoke rounded indexes. Independent test results must be furnished by the manufacturer upon request.

B. Rotor Frame:
   1. Rotor Frame shall be comprised of thick wall "DOM" carbon steel tubing (stainless steel alternate), with welded 10 gage spokes and welded internal 10 gage media retention strips (stainless steel alternate). Spoke ends shall terminate with welded heavy duty coupling nuts for bolt attachment of outer rim. Outer rim shall be manufactured from not less than 14 gage 304 stainless steel. When applicable, 14 gage minimum type 304stainless steel flanges shall be stitch welded to the outer rim on 4" centers. Flanges shall be additionally sealed to the outer rim using 400 FDB rated silicone sealant. Rotor Frame shall include non-maintenance sealed bearings rated for 200,000 hours continuous duty.
   2. Rotor Perimeter shall be equipped with a carbon steel continuous perimeter sprocket (stainless steel alternate), rated for 87,600 hours of continuous use, and compatible with the specified drive system.

C. Cassette Frame:
   1. Framing shall be manufactured from welded 304 stainless steel tubing. All welds shall be reasonably ground and dressed for appearance. Structural welds shall be continuous and non-structural welds shall be on 4" centers. Cassette face panels shall be 304 stainless steel and welded in place. Cassette motor drive base plate shall be of 304 stainless steel and shall attached to the cassette via a bolted ½" shaft. Rotor shaft shall be manufactured from 4140 Cold Rolled steel (stainless steel alternate) and shall be bolted to the cassette via oversized Allen head socket type shoulder screws. Rotor movement on the drive shaft shall be prevented by the use of two (2) machined anti rotation plates, which shall additionally prevent the rotor shaft from turning.

D. Rotor Seals:
   1. Shall be of "twin contact" design and manufactured from Viton material. Seals shall be rated for 87,600 hours of continuous use. Seals shall not require adjustment during their operable lifetime, or rotor removal for replacement.

E. Rotor Drive:
   1. Shall include a parallel shaft gear reducer with hardened steel gears and drive motor suitable for both 50 and 60 hz operation. Motor to be TEFC type rated IP 54 minimum. Cast aluminum motor gear case shall be permanently lubricated. Gear Reducer drive shall be equipped with a #40 chain hardened carbon steel ANSI drive sprocket (stainless steel alternate), nickel plated corrosion resistant drive chain and spring type automatic chain tensioning device. Automatic tensioner shall have manual backup. Drive Base Plate shall be stainless steel.

2.5. ELECTRIC REACT HEAT

A. General Description:
   1. The reactivation shall consist of electric finned heaters. The total heat shall consist of 26 Kwh and consist of two stages, one stage that operates when the react fan

energizes, and one stage that operates via reactivation temperature controller. Electric heaters shall not be of the open Nichrome type.

B. Control Type:
   1. The reactivation heaters shall be controlled from the dehumidifier's on board temperature controller device.

2.6. POST HEATING COIL

A. General Description:
   1. The reactivation shall consist of electric finned heaters. The total heat shall consist of two stages, one stage that operates when the react fan energizes, and one stage that operates via reactivation temperature controller. Electric heaters shall not be of the open Nichrome type.

B. Control Type:

C. The reactivation heaters shall be controlled from the dehumidifier's on board temperature controller device.

2.7. PROCESS FILTER

A. The unit shall include removable filters at the inlet of both process and reactivation air streams. These filters shall be mounted on sliding racks and accessible through access panels. Filters are disposable 2" deep MERV 13 (as rated by ASHRAE 52.2), pleated disposable type with non-woven media held in place by a welded wire grid. Air velocity of 500 FPM shall be under maximum ASHRAE Standards. Filters are held in channels top and bottom with spacers and back-up plates to minimize bypass. Filter channels are welded and sealed in place to eliminate air bypass. Media shall be 100% synthetic media that does not support microbial growth. Filters shall have 100% recycled post consumer recycled expanded metal support grid bonded to the air exiting side of the filter to maintain pleat uniformity and prevent fluttering. Metal grid shall be recyclable. Filters shall be rated to withstand a continuous operating temperature of up to 150F.

B. React Filter:
   1. The unit shall include removable filters at the inlet of both process and reactivation air streams. These filters shall be mounted on sliding racks and accessible through access panels. Filters are disposable 2" deep MERV 13 (as rated by ASHRAE 52.2) , pleated disposable type with non-woven media held in place by a welded wire grid. Air velocity of 500 FPM shall be under maximum ASHRAE Standards. Filters are held in channels top and bottom with spacers and back-up plates to minimize bypass. Filter channels are welded and sealed in place to eliminate air bypass. Media shall be 100% synthetic media that does not support microbial growth. Filters shall have 100% recycled post consumer recycled expanded metal support grid bonded to the air exiting side of the filter to maintain pleat uniformity and prevent fluttering. Metal grid shall be recyclable. Filters shall be rated to withstand a continuous operating temperature of up to 150F.

2.8. POST COOLING COIL

A. General:
   1. Coilmaster fluid coils are intended for use with water, glycol, or other appropriate heat transfer fluids. Coils are to be designed to maximize performance under specified conditions with minimal air-side pressure drop.

B. Certification:
   1. All water coils designed with 1/2" or 5/8" tubes are to be ARI performance certified and shall bear the ARI symbol. Coils outside the scope of ARI's standard rating conditions or the manufacturer's certification program will be acceptable since the manufacturer is a current member of the ARI coil certification program, and coils will be rated in accordance with ARI Standard 410.

C. Tubes:
   1. Tubes and return bends shall be constructed from seamless UNS C12200 copper conforming to ASTM B224 and ASTM E527. Properties shall be O50 light annealed, with a maximum grain size of 0.040 mm. Tubes are to be mechanically expanded into fins (secondary surface) for maximum heat transfer. Materials are to be 3/8" diameter x (0.014, 0.022) wall thickness, 1/2" diameter x (0.016, 0.025) wall thickness, or 5/8" diameter x (0.020, 0.025, 0.035, 0.049) wall thickness.

D. Fins:
   1. Secondary surface (fins) shall be of the plate-fin design using aluminum or copper, with die-formed collars. Fin design to be flat, waffle, or sine-wave in a staggered tube pattern to meet performance requirements. Collars will hold fin spacing at specified density, and cover the entire tube surface. Aluminum properties are to be Alloy 1100 per ASTM B209, with O (soft) temper; copper is to be Alloy 11000 per ASTM B152-06 with soft (anneal) temper. Fins are to be free of oils and oxidation.

E. Headers & Connections:
   1. Headers are to be constructed of seamless UNS C12200, Type L (drawn) copper material sized to match specified connection size. Type K (drawn)copper headers and Schedule 40 steel headers shall be offered as optional materials. Connection material shall be copper, or Schedule 40 steel or red brass pipe. The type of connection is to be sweat type, MPT or FPT, grooved, or flanged as required.

F. Casing:
   1. Coil casing material shall be of G90 galvanized steel, 16 gauge minimum. Heavier material, stainless steel, copper, or aluminum casings are to be provided as required. Intermediate tube supports are to be provided on all coils 48" and longer fin length. Coil casings on top and bottom of coils are to have double-flange construction, allowing for vertical stacking of coils.

G. Pressure Testing & Operating Pressures and Temperatures:
   1. Coils shall be tested at 550 psig using dry nitrogen, submerged under water. Dual-operator verification shall determine that all coils are leak-free. Fluid coils shall be designed to withstand 300° F maximum operating fluid temperature, and 250 psig maximum operating pressure.

2.9. COOLING COIL

A. General:
   1. Coilmaster fluid coils are intended for use with water, glycol, or other appropriate heat transfer fluids. Coils are to be designed to maximize performance under specified conditions with minimal air-side pressure drop.

B. Certification:
   1. All water coils designed with 1/2” or 5/8” tubes are to be ARI performance certified and shall bear the ARI symbol. Coils outside the scope of ARI’s standard rating conditions or the manufacturer’s certification program will be acceptable since the manufacturer is a current member of the ARI coil certification program, and coils will be rated in accordance with ARI Standard 410.

C. Tubes:

D. Tubes and return bends shall be constructed from seamless UNS copper conforming to ASTM B224 and ASTM E527. Properties shall be O50 light annealed, with maximum grain size of 0.040mm. Tubes are to be mechanically expanded into fins (secondary surface) for maximum heat transfer. Materials are to be 3/8” diameter x (0.014, 0.022) wall thickness, 1/2” diameter x (0.016, 0.025) wall thickness, or 5/8” diameter x (0.020, 0.025, 0.035, 0.049) wall thickness.

E. Fins:
   1. Secondary surface (fins) shall be of the plate-fin design using aluminum or copper, with die-formed collars. Fin design to be flat, waffle, or sine-wave in a staggered tube pattern to meet performance requirements. Collars will hold fin spacing at specified density, and cover the entire tube surface. Aluminum properties are to be Alloy 1100 per ASTM B209, with O (soft) temper; copper is to be Alloy 11000 per ASTM B152-06 with soft (anneal) temper. Fins are to be free of oils and oxidation.

F. Headers & Connections:
   1. Headers are to be constructed of seamless UNS C12200, Type L (drawn) copper material sized to match specified connection size. Type K (drawn)copper headers and Schedule 40 steel headers shall be offered as optional materials. Connection material shall be copper, or Schedule 40 steel or red brass pipe. The type of connection is to be sweat type, MPT or FPT, grooved, or flanged as required.

G. Casing:
   1. Coil casing material shall be of G90 galvanized steel, 16 gauge minimum. Heavier material, stainless steel, copper, or aluminum casings are to be provided as required. Intermediate tube supports are to be provided on all coils 48” and longer fin length. Coil casings on top and bottom of coils are to have double-flange construction, allowing for vertical stacking of coils.

H. Pressure Testing & Operating Pressures and Temperatures:
   1. Coils shall be tested at 550 psig using dry nitrogen, submerged under water. Dual-operator verification shall determine that all coils are leak-free. Fluid coils shall be designed to withstand 300° F maximum operating fluid temperature, and 250 psig maximum operating pressure.

2.10. REACT FAN

A. General:
   1. The fan shall be SWSI AcF 7 in Arrangement 4, capable of operating over the entire range in accordance with the equipment schedule and as defined in AMCA Standard 99-2408, as designed and manufactured by IAT. Process Fan wheels shall utilize non overloading airfoil blades in all models. Flat, single thickness blades are not acceptable. Unless otherwise directed, fans shall be in compliance with the layout shown on the drawings and flow diagrams.

B. Performance:
   1. Fan ratings shall be based on tests made in accordance with AMCA Standard 210, and licensed to bear the AMCA Certified Ratings Seal for Air Performance. Process Fans not licensed to bear the AMCA Seal for performance shall be tested, at supplier's expense, in an accredited AMCA laboratory. (Option: Only AMCA certified fans will be accepted.) Fans shall have a sharply rising pressure characteristic extending throughout the operating range to assure quiet and stable operation from wide open to closed off.

C. Sound:
   1. Fan manufacturers shall provide sound power level ratings for fans tested and rated in accordance with AMCA Standards 300 and 301. Tests shall be performed in an accredited AMCA laboratory. Sound power ratings shall be in decibels (reference 10-12 watts) in eight octave bands. Sound power levels will be corrected for installation by the specifying engineer, >90 dBA levels are not acceptable.

D. Construction:
   1. Fan housings are to be heavy gauge, welded construction. Housings with lock seams are not acceptable. Slip outlet is included as standard. Housing inlet cones shall be aerodynamically designed and spun providing a minimum separation of air flow. Belt driven fans are not acceptable.

E. Balance and Run Test:
   1. All fan wheels shall be dynamically balanced on precision balancers. Prior to shipment, completed fans shall receive a final test balance at the specified operating speed.

2.11. PROCESS FAN

A. General:
   1. The fan shall be SWSI AcF 7 11/16 in Arrangement 4, capable of operating over the entire range in accordance with the equipment schedule and as defined in AMCA Standard 99-2408, as designed and manufactured by IAT. Process Fan wheels shall utilize non overloading airfoil blades in all models. Flat, single thickness blades are not acceptable. Unless otherwise directed, fans shall be in compliance with the layout shown on the drawings and flow diagrams.

B. Performance:

1. Fan ratings shall be based on tests made in accordance with AMCA Standard 210, and licensed to bear the AMCA Certified Ratings Seal for Air Performance. Process Fans not licensed to bear the AMCA Seal for performance shall be tested, at supplier's expense, in an accredited AMCA laboratory. (Option: Only AMCA certified fans will be accepted.) Fans shall have a sharply rising pressure characteristic extending throughout the operating range to assure quiet and stable operation from wide open to closed off.

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E. Balance and Run Test:
1. All fan wheels shall be dynamically balanced on precision balancers. Prior to shipment, completed fans shall receive a final test balance at the specified operating speed.

PART 3 EXECUTION

3.1. INSTALLATION

A. Install in accordance with AHRI 430.

B. Install flexible duct connections between fan inlet and discharge ductwork and air handling unit sections. Ensure that metal bands of connectors are parallel with minimum one inch flex between ductwork and fan while running.

C. Install assembled unit on vibration isolators. Install isolated fans with resilient mountings and flexible electrical leads. Install restraining snubbers as indicated. Refer to Section 23 05 48. Adjust snubbers to prevent tension in flexible connectors when fan is operating.

D. Provide fixed sheaves required for final air balance.

END OF SECTION

SMALL CAPACITY SPLIT-SYSTEM AIR CONDITIONERS

PART 1 GENERAL

1.1. SECTION INCLUDES

A. Air-source heat pumps.
B. Indoor ductless fan coil units.
C. Refrigerant piping.
D. Refrigerant Piping Insulation.
E. Controls.

1.2. RELATED REQUIREMENTS

A. Section 22 10 05 - Plumbing Piping : Includes indoor coil condensate drain, water supply for humidifier, and natural gas piping.
B. Section 22 30 00 - Plumbing Equipment: Cooling condensate removal pumps.
C. Section 23 09 13 - Instrumentation and Control Devices for HVAC: Thermostats, humidistats, time clocks.
D. Section 23 31 00 - HVAC Ducts and Casings.
E. Division 26: Electrical characteristics and wiring connections and installation and wiring of thermostats and other controls components.

1.3. REFERENCE STANDARDS

A. AHRI 210/240 - Standard for Performance Rating of Unitary Air-Conditioning and Air-Source Heat Pump Equipment; 2008, Including All Addenda.
B. AHRI 270 - Sound Performance Rating of Outdoor Unitary Equipment; 2015.
C. AHRI 520 - Performance Rating of Positive Displacement Condensing Units; 2004.
D. ASHRAE Std 15 - Safety Standard for Refrigeration Systems; 2013.
E. ASHRAE Std 23.1 - Methods of Testing for Rating the Performance of Positive Displacement Refrigerant Compressors and Condensing Units that Operate at Subcritical Temperatures of the Refrigerant; 2010.
F. ASHRAE Std 52.2 - Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size; 2017.
G. ASHRAE Std 90.1 I-P - Energy Standard for Buildings Except Low-Rise Residential Buildings; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
H. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems; 2021.
I. NFPA 90B - Standard for the Installation of Warm Air Heating and Air-Conditioning Systems; 2018.
J. UL 207 - Standard for Refrigerant-Containing Components and Accessories, Nonelectrical; Current Edition, Including All Revisions.

1.4. SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide rated capacities, weights, accessories, electrical nameplate data, and wiring diagrams.
C. Shop Drawings: Indicate assembly, required clearances, and location and size of field connections.
D. Design Data: Indicate refrigerant pipe sizing.
E. Manufacturer's Instructions: Indicate rigging, assembly, and installation instructions.
F. Sustainable Design Documentation: Submit manufacturer's product data on refrigerant used, showing compliance with specified requirements.
G. Project Record Documents: Record actual locations of components and connections.
H. Operation and Maintenance Data: Include manufacturer's descriptive literature, operating instructions, installation instructions, maintenance and repair data, and parts listing.
I. Warranty: Submit manufacturers warranty and ensure forms have been filled out in Owner s name and registered with manufacturer.
J. Project Record Documents: Record actual locations of components and connections.
K. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
1. See Section 01 60 00 - Materials and Equipment, for additional provisions.

1.5. QUALITY ASSURANCE

A. Units shall be listed by ETL (Engineering Testing Laboratory) and be evaluated in accordance with UL standard 1995, 4th. edition.
B. Units shall be listed in the AHRI directory.
C. All units shall meet the Federal minimum efficiency standards and be tested per AHRI 210/240 Standard.
D. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience.
E. Installer Qualifications: Company specializing in performing the work of this section with minimum five years of documented experience .

1.6. DELIVERY, STORAGE, AND HANDLING

A. Units shall be shipped in one piece and shall be stored and handled per unit manufacturer's recommendations.

1.7. WARRANTY

A. See Section 01 77 00 - Contract Closeout, for additional warranty requirements.
B. Provide five year manufacturers warranty for heat exchangers, condensing units, and compressors.

PART 2 PRODUCTS

2.1. SYSTEM DESIGN

A. Split-System Cooling Units: Self-contained, packaged, matched factory-engineered and assembled, pre-wired indoor and outdoor units; UL listed.

1. Heating and Cooling: Air-source electric heat pump located in outdoor unit with evaporator; indoors.

B. Performance Requirements: See Drawings for additional requirements.

C. Electrical Characteristics:
1. Refer to Mechanical Equipment Schedules and Electrical Drawings.
2. Disconnect Switch: Factory mount disconnect switch on equipment under provisions of Section 26 27 17.

2.2. HIGHWALL INDOOR UNITS FOR DUCTLESS SYSTEMS

A. Manufacturer:
1. Daikin: www.daikin.com.
2. LG: www.lghvac.com
3. Mitsubishi Electric: www.mrslim.com.

B. Indoor Units:
1. The indoor unit shall be factory assembled and pre-wired with all necessary electronic and refrigerant controls. Both liquid and suction lines must be individually insulated between the outdoor and indoor units.
2. Unit Cabinet:
   a. The indoor unit shall have a white, “flat screen” finish.
   b. The drain and refrigerant piping shall be accessible from six (6) positions for flexible installation (right side, right back, and right bottom; and left side, left back, and left bottom.
   c. The cabinet shall be supplied with a mounting plate to be installed onto a wall for securely mounting the cabinet.
   d. Provide with zero-position EEV for systems with variable flow/multiple indoor units.
3. Fan:
   a. The evaporator fan shall be an assembly consisting of a direct-driven fan by a single motor.
   b. The fan shall be statically and dynamically balanced and operate on a motor with permanent lubricated bearings.
4. Filter:
   a. The return air filter provided will be a mildew proof, removable and washable filter. Titanium apatite, photocatalytic air purifying filters are included as standard.
5. Coil:
   a. The evaporator coil shall be a nonferrous, aluminum fin on copper tube heat exchanger.
   b. All tube joints shall be brazed with silver alloy or phoscopper.
   c. All coils will be factory pressure tested.
   d. A condensate pan shall be provided under the coil with a drain connection.
6. Electrical:

a. The outdoor unit shall be powered with emergency power, 230 volts, 1 phase, and 60 hertz power. The indoor unit shall receive 208-230 volt, 1 phase, 60 hertz power from the outdoor unit.

7. Control:
   a. The unit shall have a backlit, wired controller. 7-day programmable with auto change over, independent heating and cooling setpoints.
8. Accessories: Condensate pump.

C. Indoor Units: Self-contained, packaged, factory assembled, pre-wired unit consisting of cabinet, supply fan, evaporator coil, and controls; wired for single power connection with control transformer.

D. Evaporator Coils: Copper tube aluminum fin assembly, galvanized or polymer drain pan sloped in all directions to drain, drain connection, refrigerant piping connections, restricted distributor or thermostatic expansion valve.
1. Construction and Ratings: In accordance with AHRI 210/240 and UL 207.
2. Manufacturer: System manufacturer.

2.3. OUTDOOR UNITS - HEAT PUMPS (INVERTER DRIVEN)

A. Manufacturers:
1. Daikin: www.daikin.com.
2. Mitsubishi Electric: www.mrslim.com.
3. LG: www.lghvac.com.

B. The outdoor unit shall be specifically matched to the corresponding indoor unit size. The outdoor unit shall be complete factory assembled and pre-wired with all necessary electronic and refrigerant controls.
1. Comply with AHRI 210 and AHRI 520.
   a. Refrigerant: R-410A
   b. Construction and ratings: In accordance with AHRI 210/240 with testing is accordance with ASHRAE Std 23 and UL 207 listed
   c. Sound ratings as scheduled when measured in accordance with AHRI 270.

C. Unit Cabinet:
1. The outdoor unit shall be completely weatherproof and corrosion resistant. The unit shall be constructed from rust-proofed mild steel panels coated with a baked enamel finish.

D. Fan:
1. The fan shall be a direct drive, propeller type fan.
   a. The motor shall be inverter driven, permanently lubricated type bearings, inherent.
   b. A fan guard is provided on the outdoor unit to prevent contact with fan operation.
   c. Airflow shall be horizontal discharge.

E. Coil:
1. The outdoor coil shall be nonferrous construction with corrugated fin tube.
   a. Refrigerant flow from the condenser will be controlled via a metering device.

F. Compressor:
   1. The compressor shall be a variable speed inverter driven scroll compressor.
      a. The outdoor unit shall have an accumulator.
      b. The compressor shall have an internal thermal overload.
      c. Comply with AHRI 520.
      d. Spring mounted.

G. Electrical:
   1. The electrical power requirement is 208-230 volt, 1-phase, and 60 Hz power.
      a. The outdoor shall be controlled by a microprocessor located in the outdoor and indoor units via commands from the infrared remote controller.

H. Low Ambient Kit: Provide refrigerant pressure switch to cycle condenser fan on when condenser refrigerant pressure is above 285 psig and off when pressure drops below 140 psig for operation to 0 degrees F.

2.4. SYSTEM REFRIGERANT PIPING

A. Refrigerant Piping:
   1. Copper Tube: ASTM B 280, Type ACR.
   2. Wrought-Copper Fittings: ASME B16.22.
   3. Brazing Filler Metals: AWS A5.8/A5.8M.
   4. Insulation: Insulate both heat pump refrigerant lines. Insulate all three refrigerant lines from heat recovery outdoor units to MCU.

B. Refrigerant Tubing Kits:
   1. Factory-rolled and -bundled, soft-copper tubing with tubing termination fittings at each end.
   2. Modular systems require outdoor refrigerant kits for module connections.
   3. Standard one-piece length for connecting to indoor units.
   4. Pre-insulated with flexible elastomeric insulation of thickness to comply with governing energy code and sufficient to eliminate condensation.
   5. Factory Charge: Dehydrated air or nitrogen.

C. Refrigerant Isolation Ball Valves:
   1. Description: Uni-body full port design, rated for maximum system temperature and pressure, and factory tested under pressure to ensure tight shutoff. Designed for valve operation without removing seal cap.
   2. Seals: Compatible with system refrigerant and oil. Seal service life of at least 20 years.
   3. Valve Connections: Flare or sweat depending on size.

2.5. PIPING AND TUBING INSULATION

A. Condensate Drain Piping and Tubing Insulation and Jacket Requirements:
   1. Flexible Elastomeric Insulation:
      a. Closed-cell, sponge- or expanded-rubber materials, complying with ASTM C 534, Type I for tubular materials.
      b. Thickness: Per Code.

B. Refrigerant Tubing Insulation and Jacket Requirements:
   1. Flexible Elastomeric Insulation:
      a. Closed-cell, sponge- or expanded-rubber materials, complying with ASTM C 534, Type I for tubular materials.
      b. Thickness: Per Code.

PART 3 EXECUTION

3.1. EXAMINATION
A. Verify that substrates are ready for installation of units and openings are as indicated on shop drawings.
B. Verify that proper power supply is available and in correct location.

3.2. INSTALLATION
A. Install in accordance with manufacturer's instructions and requirements of local authorities having jurisdiction.
B. Install in accordance with NFPA 90A and NFPA 90B.
C. Install refrigeration systems in accordance with ASHRAE Std 15.
D. Pipe drain from cooling coils and humidifiers to hub drain per drawings.
E. Consult with roofing manufacturer prior to installation of equipment base. Provide roofing material or rubber pads to protect roof as required by roofing manufacturers/

END OF SECTION

HUMIDIFIERS

PART 1 GENERAL

1.1. SECTION INCLUDES
A. Humidifier Units.
B. Spray Pumps.

1.2. RELATED REQUIREMENTS
A. Section 22 07 19 - Plumbing Piping Insulation.
B. Section 23 07 13 - Duct Insulation.
C. Section 23 07 19 - HVAC Piping Insulation.
D. Section 26 27 17 - Equipment Wiring: Electrical characteristics and wiring connections.

1.3. REFERENCE STANDARDS
A. AHRI 610 (I-P) - Performance Rating Of Central System Humidifiers for Residential Applications; 2014.
B. AHRI 611 (SI) - Performance Rating Of Central System Humidifiers for Residential Applications; 2014.
C. UL 900 - Standard for Air Filter Units; Current Edition, Including All Revisions.

1.4. SUBMITTALS
A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Product Data: Provide catalog sheets indicating general assembly, dimensions, weights, materials, and certified performance ratings.
C. Shop Drawings: Indicate general assembly, dimensions, weights, and materials.
D. Manufacturer's Instructions: Indicate recommended installation instructions.
E. Manufacturer's Instructions: Indicate recommended installation instructions.
F. Operation Data: Include assembly instructions, float adjustment, bleed rates, and electrical requirements.
G. Maintenance Data: Include instructions for lubrication, filter replacement, cleaning, and spare parts lists.
H. Warranty: Submit manufacturer warranty and ensure forms have been completed in Owner's name and registered with manufacturer.
I. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
    1. See Section 01 60 00 - Materials and Equipment, for additional provisions.
    2. Extra Filter Media: One set of each type and size.

1.5. QUALITY ASSURANCE
A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience.
B. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

1.6. WARRANTY
A. See Section 01 77 00 - Contract Closeout, for additional warranty requirements.
B. Provide five year manufacturer warranty for units.

PART 2 PRODUCTS

2.1. MANUFACTURERS
A. Condair.
B. Substitutions: See Section 01 60 00 - Materials and Equipment.

2.2. MANUFACTURED UNITS
A. Units: AHRI 610 (I-P); factory assembled consisting of casing, tank, filters, spray pumps, water and drain connections.

2.3. GENERAL DESCRIPTION
A. Provide resistive element humidifier generating mineral-free, sterile steam for use with potable, De-Ionized (DI), or Reverse Osmosis (RO) water. Packaged unit, wall mounted, atmospheric steam generation using resistive heating element. Electrode technology and boiler steam (pressure steam) technology not acceptable.

2.4. EQUIPMENT COMPONENTS
A. Unit(s) to be complete with:
   1. Touchscreen controller with standard building automation and Online connectivity:
      a. Intuitive touchscreen control with color graphic user interface.
      b. Standard building automation communication protocols BACnet IP, BACnet MSTP and Modbus. Additional hardware required for building automation communication not acceptable.
      c. Embedded web interface for easy configuration and remote monitoring from any computer with a web browser over a local area network (LAN) connection.
      d. USB interface for new software/feature upload and download of operational information.
      e. Single or dual channel analog signal acceptance, supporting both demand and transducer control. Ability to control setpoint from humidifier control when using transducer controls.
B. Packaged system with Condair resistive element technology:
   1. Incoloy based resistive heating element for steam production.
   2. Modulating output between 4% and 100% of rated capacity.
   3. Control accuracy of up to +/- 1% RH using optional Precision solid state relay control and high precision humidistat.

4. Separate scale collection chamber external from main boiling tank when using optional Scale Management system.
5. Dual magnetic electronic float system, located outside of the boiling water to ensure accurate water level control and reduced maintenance. Systems using conductivity probes or floats located within hot reservoir are not acceptable.
6. Self-diagnostics during start-up of system to prevent unsafe operation of the unit[s]:
   a. Fill valve check.
   b. Float level check.
   c. Drain pump check.
7. Durable powder coated steel cabinet with zero side clearance requirement for minimal footprint.
8. Insulating air gap between plumbing and electrical compartment for increased electronic reliability.
9. Standard internal drain water tempering to ensure maximum 140°F [60°C] drain water. External drain water cooler not acceptable.
10. Integral fill cup with minimum 1-inch [25 mm] air gap to prevent back siphoning.
11. Automatic off-season shut-down [after 3 days of "no call"] will completely drain the boiling tank[s] and automatically restart on call for humidity.
12. Programmable drain settings too allow cycling small water quantities during operation without interrupting steam production.
13. Integral design allowing easy installation and access for servicing.

2.5. REVERSE OSMOSIS UNIT

A. Manufacturer:
   1. Condair.
   2. Substitutions: See Section 01 60 00 - Product Requirements.

B. Operating Profile:
   1. Softener shall remove hardness to less than 1/2 gpg when operated in accordance with the operating instructions. The system shall include two tanks. This duplex configuration shall operate with one tank on-line during service. During regeneration cycles, one tank shall provide water to service and to the regenerating tank. A water meter shall initiate system regeneration. The water meter shall measure the processed volume and be adjustable. Service flow shall be upflow and regeneration flow shall be downflow.

C. Regeneration Control Valve:
   1. The regeneration control valve shall be top mounted (top of media tank), and manufactured from non-corrosive materials. Control valve shall not weigh more than four pounds. Control valve shall provide service and regeneration control for two media tanks. Inlet and outlet ports shall accept a quick connect, double O-ring sealed adapter. Interconnection between tanks shall be made through the regeneration valve with a quick connect adapter. Control valve shall operate using a minimum inlet pressure of 15 psi. Pressure shall be used to drive all valve functions. No electric hook-up shall be required. Control valve shall incorporate

four operational cycles including; service, brine draw, slow rinse, and a combined fast rinse and brine refill. Service cycle shall operate in an upflow direction. The brine cycle shall flow downflow, opposite the service flow, providing a countercurrent regeneration. Control valve shall contain a fixed orifice eductor nozzle and self-adjusting backwash flow control. The control valve will prevent the by-pass of hard water to service during the regeneration cycle.

D. Media Tanks:
   1. The tanks shall be designed for a maximum working pressure of 125 psi and hydrostatically tested at 300 psi. Tanks shall be made of engineered plastic with a 2.5 in. threaded top opening. Each tank shall be NSF approved. Upper distribution system shall be of a slot design. Lower distribution system shall be of a flat plate design. Distributors will provide even flow of regeneration water and the collection of processed water.

E. Conditioning Media:
   1. Each softener shall include standard mesh resin having a minimum exchange capacity of 30,000 grains/ft³ when regenerated with 15.0 lbs/ft³. The media shall be solid, of a proper particle size and shall contain no plates, shells, agglomerates or other shapes, which might interfere with the normal function of the water softener.

F. Brine System:
   1. A combination salt storage and brine production tank shall be manufactured of corrosion resistant, plastic. The brine tank shall have a chamber to house the brine valve assembly. The brine float assembly shall allow for adjustable salt settings and shall provide for a shutoff to the brine refill. The brine tank shall include a safety overflow connection to be plumbed to a suitable drain.

G. Low Flow Nozzle for Kinetico cc206, North America:
   1. This component adjusts the flow rate of the cc206 water softener to match the flow rate of an RO-A reverse osmosis system. It is mandatory for applications where the cc206 water softener will be used with an RO-A unit, and can be used to match the flow rate to various humidifiers.

PART 3 EXECUTION

3.1. INSTALLATION

A. Install in accordance with manufacturer's instructions.
B. Insulate exterior of unit same as specified for ductwork. Refer to Section 23 07 13.
C. Place unit on 2 inch thick rigid insulation board same size as unit tank. Flash and counterflash with 0.036 inch galvanized steel entering and leaving sides. Refer to Section 23 07 13.
D. Connect unit to water supply. Provide gate valve on water supply line. Provide 3/4 inch hose bibb accessible from interior.
E. Pipe drain and overflow to nearest floor drain.
F. Bolt spray pump directly to tank fitting. Insulate external spray piping. Refer to Section 22 07 19.

G. Bolt spray pump directly to tank fitting. Insulate external spray piping. Refer to Section 23 07 19.
H. Provide globe valve and solenoid valve in 1/2 inch bleed line from drain. Refer to Section 23 25 00.
I. Provide low water cut-off in drain pan to stop spray pump.

END OF SECTION

EXPIRES 12–31–22

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OMIC ADDITIVE MANUFACTURING CENTER

Scappoose, OR

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BASIC ELECTRICAL MATERIALS AND METHODS

PART 1 GENERAL

1.1. DESCRIPTION

A. Do all work in accordance with regulations of serving electrical utility, telephone utility, National Electrical Code, National Electrical Safety Code, National Fire Codes, International Building Code, and other applicable codes.

B. Whenever the requirements of the Electrical Specifications or Drawings exceed those of the applicable code or standard, the requirements of the Specifications and Drawings shall govern.

C. This Contractor is bound by the General Conditions, Supplementary Conditions, Special Conditions, and Division 1 bound herewith in addition to this Specification and accompanying Drawings.

D. Bidders shall view the site and shall include all costs incurred by existing conditions in the bid proposal.

1.2. QUALITY ASSURANCE

A. All materials shall be new, of manufacturer's latest design and of the best quality. The materials shall be manufactured in accordance with applicable standards of NEMA, ANSI, or UL and shall be UL listed.

B. Complete each system as shown and place in operation except where only rough-in or partial systems are called for. Each system shall be tested and Ieft in proper operation free of faults, shorts, or unintentional grounds.

C. Protect electrical work, wire and cable, materials and equipment installed under this Division against damage by other trades, weather conditions, or any other causes. Equipment found damaged or in other than new condition will be rejected as defective.

1.3. FEES

A. Secure and pay for all necessary permits and fees. Arrange for all required inspections.

PART 2 PRODUCTS

2.1. MATERIALS AND METHODS

A. Equipment and materials shall be new and free from defects. All material and equipment of the same or a similar type shall match that of the manufacturer and model number predominantly existing on the project. Standard production materials shall be used wherever possible.

B. Work under this division shall be conducted in a manner to cooperate with other trades and contracts involved with this project.

C. Consult all drawings and specifications for this project and verify the requirements of all equipment by other divisions, the Owner or by other contracts prior to installation and connection.

D. Consult the drawings of all other divisions to avoid conflicts with cabinets, counters, equipment, structural members, etc. Resolve any conflicts with the Architect prior to rough-in.
E. Verify connection requirements for equipment specified or shown and provide all materials and labor required to connect the equipment.
F. Provide painting of electrical items as required by the Architect.
G. Provide painting in accordance with Division 9 of these specifications.

2.2. INSTALLATION REQUIREMENTS

A. Electrical plans are diagrammatic. Verify exact equipment locations for all equipment. Coordinate with architectural drawings and installations to avoid conflicts. Equipment size and location of equipment is shown wherever possible. Make use of the data in the contract documents and verify this information against actual field conditions. As applicable to the work to be performed, the materials and installation shall conform to the available space, avoid obstruction, preserve headroom, maintain required accessibility, and satisfy the requirements of the governing codes and the standards of good practice. Coordinate with other divisions' drawings and installation to avoid conflicts.
B. All work shall be installed in a neat, inconspicuous, professional manner. Conduit runs shall parallel structural lines where exposed. Conduit shall run parallel to structural lines whenever possible and specifically when exposed. Whenever possible conduits shall be either concealed in the room ceiling, walls, floor, or exposed ceiling areas tight under the tip chord of the ceiling bar joist, or running parallel to the roof wide flange beams, mounted tight to the vertical webs. No conduit shall be run perpendicular to the ceiling roof beams under the bottom chords. No exposed conduit is allowed without prior approval of the Architect. Flexible conduit is allowed only with prior approval of the Architect or Engineer of record.
C. Existing raceways which are empty may be used whenever possible.
D. The site shall be left clean and free of dirt arid debris. Panels, fixtures, outlets and equipment shall be left clean and free of foreign materials and dirt.

2.3. COORDINATION

A. Work under this division shall be conducted in a manner to cooperate with other trades and contracts involved with this project.
B. Consult all drawings and specifications for this project and verify the requirements of all equipment by other divisions, the Owner, or by other contracts prior to installation and connection.
C. Consult all drawings of all other divisions to avoid conflicts with cabinets, counters, equipment, structural members, etc. Resolve any conflicts with the Architect prior to rough-in.
D. Contact the electrical utility companies associated with the project and coordinate the installation requirements with each utility. Acquire utility installation documents and include costs to provide electrical materials and labor noted by the utility to be provided by the Owner (or customer).

PART 3 EXECUTION

3.1. GUARANTEE

A. Guarantee the electrical installation against all defects in materials, equipment, and workmanship for one year after the date of acceptance of the work. Defects shall be properly remedied to the satisfaction of the Architect at no cost to the Owner.

END OF SECTION

GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1. SECTION INCLUDES

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

1.2. RELATED REQUIREMENTS

A. Section 26 05 19 - Low Voltage Electrical Power Conductors and Cables: Additional requirements for conductors for grounding and bonding, including conductor color coding.
B. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.

1.3. REFERENCE STANDARDS

A. IEEE 81 - IEEE Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Grounding System; 2012.
B. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2015.
C. NEMA GR 1 - Grounding Rod Electrodes and Grounding Rod Electrode Couplings; 2007.
D. NETA ATS - Acceptance Testing Specifications for Electrical Power Equipment and Systems; 2017.
E. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
F. NFPA 99 - Health Care Facilities Code; 2015.
G. UL 467 - Grounding and Bonding Equipment; Current Edition, Including All Revisions.

1.4. ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Verify exact locations of underground metal water service pipe entrances to building.
   2. Coordinate the work with other trades to provide steel reinforcement complying with specified requirements for concrete-encased electrode.
   3. Notify Architect of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.
B. Sequencing:
   1. Do not install ground rod electrodes until final backfill and compaction is complete.

1.5. SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittals procedures.
B. Product Data: Provide manufacturer's standard catalog pages and data sheets for grounding and bonding system connectors.
C. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.
D. Field quality control test reports.
E. Project Record Documents: Record actual locations of grounding electrode system components and connections.

1.6. QUALITY ASSURANCE

A. Conform to requirements of NFPA 70.
B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.
C. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years experience.

1.7. DELIVERY, STORAGE, AND HANDLING

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

PART 2 PRODUCTS

2.1. GROUNDING AND BONDING REQUIREMENTS

A. Existing Work: Where existing grounding and bonding system components are indicated to be reused, they may be reused only where they are free from corrosion, integrity and continuity are verified, and where acceptable to the authority having jurisdiction.
B. Do not use products for applications other than as permitted by NFPA 70 and product listing.
C. Unless specifically indicated to be excluded, provide all required components, conductors, connectors, conduit, boxes, fittings, supports, accessories, etc. as necessary for a complete grounding and bonding system.
D. Where conductor size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.
E. Grounding System Resistance:
    1. Achieve specified grounding system resistance under normally dry conditions unless otherwise approved by Architect. Precipitation within the previous 48 hours does not constitute normally dry conditions.
    2. Grounding Electrode System: Not greater than 5 ohms OR 25 ohms to ground, when tested according to IEEE 81 using "fall-of-potential" method.

3. Between Grounding Electrode System and Major Electrical Equipment Frames, System Neutral, and Derived Neutral Points: Not greater than 0.5 ohms, when tested according to IEEE 81 using "point-to-point" methods.

F. Grounding Electrode System:
   1. Provide connection to required and supplemental grounding electrodes indicated to form grounding electrode system.
      a. Provide continuous grounding electrode conductors without splice or joint.
      b. Install grounding electrode conductors in non-metallic raceway where exposed to physical damage.
   2. Metal Underground Water Pipe(s):
      a. Provide connection to underground metal domestic and fire protection (where present) water service pipe(s) that are in direct contact with earth for at least 10 feet at an accessible location not more than 5 feet from the point of entrance to the building.
      b. Provide bonding jumper(s) around insulating joints/pipes as required to make pipe electrically continuous.
      c. Provide bonding jumper around water meter of sufficient length to permit removal of meter without disconnecting jumper.
   3. Metal Building or Structure Frame:
      a. Provide connection to metal building or structure frame effectively grounded in accordance with NFPA 70 at nearest accessible location.
   4. Concrete-Encased Electrode:
      a. Provide connection to concrete-encased electrode consisting of not less than 20 feet of either steel reinforcing bars or bare copper conductor not smaller than 4 AWG embedded within concrete foundation or footing that is in direct contact with earth in accordance with NFPA 70.
   5. Ground Ring:
      a. Provide a ground ring encircling the building or structure consisting of bare copper conductor not less than 2 AWG in direct contact with earth, installed at a depth of not less than 30 inches.
      b. Where location is not indicated, locate ground ring conductor at least 24 inches outside building perimeter foundation.
      c. Provide connection from ground ring conductor to:
         1. Perimeter columns of metal building frame.
         2. Ground rod electrodes located as indicated, not more than 30 feet apart, and at each corner of the building/structure.
   6. Provide additional ground electrode(s) as required to achieve specified grounding electrode system resistance.
   7. Ground Bar: Provide ground bar, separate from service equipment enclosure, for common connection point of grounding electrode system bonding jumpers as permitted in NFPA 70. Connect grounding electrode conductor provided for service-supplied system grounding to this ground bar.
      a. Ground Bar Size: 1/4 by 4 by 12 inches unless otherwise indicated or required.

b. Where ground bar location is not indicated, locate in accessible location as near as possible to service disconnect enclosure.
c. Ground Bar Mounting Height: 18 inches above finished floor unless otherwise indicated.

8. Ground Riser: Provide common grounding electrode conductor not less than 3/0 AWG for tap connections to multiple separately derived systems as permitted in NFPA 70.

G. Service-Supplied System Grounding:
1. For each service disconnect, provide grounding electrode conductor to connect neutral (grounded) service conductor to grounding electrode system. Unless otherwise indicated, make connection at neutral (grounded) bus in service disconnect enclosure.
2. For each service disconnect, provide main bonding jumper to connect neutral (grounded) bus to equipment ground bus where not factory-installed. Do not make any other connections between neutral (grounded) conductors and ground on load side of service disconnect.

H. Grounding for Separate Building or Structure Supplied by Feeder(s) or Branch Circuits:
1. Provide grounding electrode system for each separate building or structure.
2. Provide equipment grounding conductor routed with supply conductors.
3. For each disconnecting means, provide grounding electrode conductor to connect equipment ground bus to grounding electrode system.
4. Do not make any connections and remove any factory-installed jumpers between neutral (grounded) conductors and ground.

I. Separately Derived System Grounding:
1. Separately derived systems include, but are not limited to:
a. Transformers (except autotransformers such as buck-boost transformers).
b. Uninterruptible power supplies (UPS), when configured as separately derived systems.
c. Generators, when neutral is switched in the transfer switch.
2. Provide grounding electrode conductor to connect derived system grounded conductor to nearest effectively grounded metal building frame OR nearest effectively grounded metal water pipe OR common grounding electrode conductor ground riser. Unless otherwise indicated, make connection at neutral (grounded) bus in source enclosure OR neutral (grounded) bus in first disconnecting means.
3. Provide bonding jumper to connect derived system grounded conductor to nearest metal building frame and nearest metal water piping in the area served by the derived system, where not already used as a grounding electrode for the derived system. Make connection at same location as grounding electrode conductor connection.
4. Where common grounding electrode conductor ground riser is used for tap connections to multiple separately derived systems, provide bonding jumper to connect the metal building frame and metal water piping in the area served by the derived system to the common grounding electrode conductor.

5. Outdoor Source: Where the source of the separately derived system is located outside the building or structure supplied, provide connection to grounding electrode at source in accordance with NFPA 70.
6. Provide system bonding jumper to connect system grounded conductor to equipment ground bus. Make connection at same location as grounding electrode conductor connection. Do not make any other connections between neutral (grounded) conductors and ground on load side of separately derived system disconnect.
7. Where the source and first disconnecting means are in separate enclosures, provide supply-side bonding jumper between source and first disconnecting means.

J. Bonding and Equipment Grounding:
1. Provide bonding for equipment grounding conductors, equipment ground busses, metallic equipment enclosures, metallic raceways and boxes, device grounding terminals, and other normally non-current-carrying conductive materials enclosing electrical conductors/equipment or likely to become energized as indicated and in accordance with NFPA 70.
2. Provide insulated equipment grounding conductor in each feeder and branch circuit raceway. Do not use raceways as sole equipment grounding conductor.
3. Where circuit conductor sizes are increased for voltage drop, increase size of equipment grounding conductor proportionally in accordance with NFPA 70.
4. Unless otherwise indicated, connect wiring device grounding terminal to branch circuit equipment grounding conductor and to outlet box with bonding jumper.
5. Terminate branch circuit equipment grounding conductors on solidly bonded equipment ground bus only. Do not terminate on neutral (grounded) or isolated/insulated ground bus.
6. Provide bonding jumper across expansion or expansion/deflection fittings provided to accommodate conduit movement.
7. Provide bonding for interior metal piping systems in accordance with NFPA 70. This includes, but is not limited to:
   a. Metal water piping where not already effectively bonded to metal underground water pipe used as grounding electrode.
   b. Metal gas piping.
   c. Metal process piping.
8. Provide bonding for interior metal air ducts.
9. Provide bonding for metal building frame where not used as a grounding electrode.
10. Provide bonding for metal siding not effectively bonded through attachment to metal building frame.
11. Provide bonding and equipment grounding for pools and fountains and associated equipment in accordance with NFPA 70.
12. Provide redundant grounding and bonding for patient care areas of health care facilities in accordance with NFPA 70 and NFPA 99.

K. Isolated Ground System:
1. Where isolated ground receptacles or other isolated ground connections are indicated, provide separate isolated/insulated equipment grounding conductors.

2. Connect isolated/insulated equipment grounding conductors only to separate isolated/insulated equipment ground busses.
3. Connect the isolated/insulated equipment grounding conductors to the solidly bonded equipment ground bus only at the service disconnect or separately derived system disconnect. Do not make any other connections between isolated ground system and normal equipment ground system on the load side of this connection.

L. Photovoltaic Systems.

2.2. GROUNDING AND BONDING COMPONENTS

A. General Requirements:
1. Provide products listed, classified, and labeled by Underwriter's Laboratories Inc. (UL) or testing firm acceptable to authority having jurisdiction as suitable for the purpose indicated.
2. Provide products listed and labeled as complying with UL 467 where applicable.

B. Conductors for Grounding and Bonding, in addition to requirements of Section 26 05 19:
1. Use insulated copper conductors unless otherwise indicated.
   a. Exceptions:
      1. Use bare copper conductors where installed underground in direct contact with earth.
      2. Use bare copper conductors where directly encased in concrete (not in raceway).
2. Factory Pre-fabricated Bonding Jumpers: Furnished with factory-installed ferrules; size braided cables to provide equivalent gauge of specified conductors.

C. Connectors for Grounding and Bonding:
1. Description: Connectors appropriate for the application and suitable for the conductors and items to be connected; listed and labeled as complying with UL 467.
2. Unless otherwise indicated, use exothermic welded connections for underground, concealed and other inaccessible connections.
   a. Exceptions:
      1. Use mechanical connectors for connections to electrodes at ground access wells.
3. Unless otherwise indicated, use mechanical connectors or exothermic welded connections for accessible connections.
   a. Exceptions:
      1. Use exothermic welded connections for connections to metal building frame.
4. Manufacturers - Mechanical and Compression Connectors:
   a. Burndy: www.burndy.com.
   b. Harger Lightning & Grounding: www.harger.com.
   c. Thomas & Betts Corporation: www.tnb.com.
   d. Substitutions: See Section 01 60 00 - Materials and Equipment.
5. Manufacturers - Exothermic Welded Connections:
   a. Burndy: www.burndy.com.

b. Cadweld, a brand of Erico International Corporation: www.erico.com/#sle.
c. ThermOweld, a brand of Continental Industries, Inc: www.thermoweld.com/#sle.
d. Substitutions: See Section 01 60 00 - Materials and Equipment.

D. Ground Bars:
1. Description: Copper rectangular ground bars with mounting brackets and insulators.
2. Size: As specified herein.
3. Holes for Connections: As indicated or as required for connections to be made.
4. Manufacturers:
a. Erico International Corporation: www.erico.com.
b. Harger Lightning & Grounding: www.harger.com.
c. ThermOweld, a brand of Continental Industries, Inc: www.thermoweld.com/#sle.
d. Substitutions: See Section 01 60 00 - Materials and Equipment.

E. Ground Rod Electrodes:
1. Comply with NEMA GR 1.
2. Material: Copper-bonded (copper-clad) steel.
3. Size: 5/8 inch diameter by 10 feet length, unless otherwise indicated.
4. Where rod lengths of greater than 10 feet are indicated or otherwise required, sectionalized ground rods may be used.
5. Manufacturers:
a. Erico International Corporation: www.erico.com.
b. Galvan Industries, Inc: www.galvanelectrical.com.
c. Harger Lightning & Grounding: www.harger.com.
d. Substitutions: See Section 01 60 00 - Materials and Equipment.

PART 3 EXECUTION

3.1. PREPARATION
A. Remove paint, rust, mill oils, and surface contaminants at connection points.

3.2. EXAMINATION
A. Verify that work likely to damage grounding and bonding system components has been completed.
B. Verify that field measurements are as shown on the drawings.
C. Verify that conditions are satisfactory for installation prior to starting work.

3.3. INSTALLATION
A. Install products in accordance with manufacturer's instructions.
B. Install grounding and bonding system components in a neat and workmanlike manner in accordance with NECA 1.

C. Ground Rod Electrodes: Unless otherwise indicated, install ground rod electrodes vertically. Where encountered rock prohibits vertical installation, install at 45 degree angle or bury horizontally in trench at least 30 inches (750 mm) deep in accordance with NFPA 70.
   1. Outdoor Installations: Unless otherwise indicated, install with top of rod 6 inches below finished grade.
   2. Indoor Installations: Unless otherwise indicated, install with 4 inches of top of rod exposed.

D. Make grounding and bonding connections using specified connectors.
   1. Remove appropriate amount of conductor insulation for making connections without cutting, nicking or damaging conductors. Do not remove conductor strands to facilitate insertion into connector.
   2. Remove nonconductive paint, enamel, or similar coating at threads, contact points, and contact surfaces.
   3. Exothermic Welds: Make connections using molds and weld material suitable for the items to be connected in accordance with manufacturer's recommendations.
   4. Mechanical Connectors: Secure connections according to manufacturer's recommended torque settings.

E. Identify grounding and bonding system components in accordance with Section 26 05 53.

3.4. FIELD QUALITY CONTROL

A. Perform inspection, testing, and adjusting in accordance with Section 01 40 00.

B. Inspect and test in accordance with NETA ATS except Section 4.

C. Perform inspections and tests listed in NETA ATS, Section 7.13.

D. Perform ground electrode resistance tests under normally dry conditions. Precipitation within the previous 48 hours does not constitute normally dry conditions.

E. Investigate and correct deficiencies where measured ground resistances do not comply with specified requirements.

F. Submit detailed reports indicating inspection and testing results and corrective actions taken.

END OF SECTION

HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1. SECTION INCLUDES

A. Conduit and equipment supports.
B. Anchors and fasteners.
C. Support and attachment components for equipment, conduit, cable, boxes, and other electrical work.

1.2. RELATED REQUIREMENTS

A. Section 03 30 00 - Cast-in-Place Concrete: Concrete equipment pads.
B. Section 05 50 00 - Miscellaneous Fabricated Steel: Materials and requirements for fabricated metal supports.
C. Section 26 05 34 - Conduit: Additional support and attachment requirements for conduits.
D. Section 26 05 37 - Boxes: Additional support and attachment requirements for boxes.
E. Section 26 51 00 - Interior & Exterior Lighting: Additional support and attachment requirements for interior luminaires.

1.3. REFERENCE STANDARDS

A. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products; 2017.
B. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware; 2016a.
C. ASTM B633 - Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel; 2015.
D. MFMA-4 - Metal Framing Standards Publication; 2004.
E. ICC-ES AC01 - Acceptance Criteria for Expansion Anchors in Masonry Elements; 2009.
F. ICC-ES AC106 - Acceptance Criteria for Predrilled Fasteners (Screw Anchors) in Masonry Elements; 2006
G. ICC-ES AC193 - Acceptance Criteria for Mechanical Anchors in Concrete Elements; 2010
H. ICC-ES AC308 - Acceptance Criteria for Post-Installed Adhesive Anchors in Concrete Elements; 2009.
I. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2015.
J. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
K. UL 5B - Strut-Type Channel Raceways and Fittings; Current Edition, Including All Revisions.

1.4. ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Coordinate sizes and arrangement of supports and bases with the actual equipment and components to be installed.

2. Coordinate the work with other trades to provide additional framing and materials required for installation.
3. Coordinate compatibility of support and attachment components with mounting surfaces at the installed locations.
4. Coordinate the arrangement of supports with ductwork, piping, equipment and other potential conflicts installed under other sections or by others.
5. Notify Architect of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.

B. Sequencing:
1. Do not install products on or provide attachment to concrete surfaces until concrete has fully cured in accordance with Section 03 30 00.

1.5. SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Product Data: Provide manufacturer's standard catalog pages and data sheets for metal channel (strut) framing systems, non-penetrating rooftop supports, and post-installed concrete and masonry anchors.
C. Shop Drawings: Include details for fabricated hangers and supports where materials or methods other than those indicated are proposed for substitution.
D. Evaluation Reports: For products specified as requiring evaluation and recognition by ICC Evaluation Service, LLC (ICC-ES), provide current ICC-ES evaluation reports upon request.
E. Product Data: Provide manufacturer’s catalog data for fastening systems.
F. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

1.6. QUALITY ASSURANCE

A. Comply with NFPA 70.
B. Products: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.
C. Comply with applicable building code.
D. Maintain at the project site a copy of each referenced document that prescribes execution requirements.

PART 2 PRODUCTS

2.1. SUPPORT AND ATTACHMENT COMPONENTS

A. General Requirements:
1. Provide all required hangers, supports, anchors, fasteners, fittings, accessories, and hardware as necessary for the complete installation of electrical work.
2. Provide products listed, classified, and labeled by Underwriter's Laboratories Inc. (UL) or Intertek (ETL) as suitable for the purpose indicated, where applicable.

3. Where support and attachment component types and sizes are not indicated, select in accordance with manufacturer's application criteria as required for the load to be supported with a minimum safety factor of 5. Include consideration for vibration, equipment operation, and shock loads where applicable.
4. Do not use products for applications other than as permitted by NFPA 70 and product listing.
5. Do not use wire, chain, perforated pipe strap, or wood for permanent supports unless specifically indicated or permitted.
6. Steel Components: Use corrosion resistant materials suitable for the environment where installed.
    a. Indoor Dry Locations: Use zinc-plated steel unless otherwise indicated.
    b. Outdoor and Damp or Wet Indoor Locations: Use galvanized steel or stainless steel unless otherwise indicated.
    c. Zinc-Plated Steel: Electroplated in accordance with ASTM B633.
    d. Galvanized Steel: Hot-dip galvanized after fabrication in accordance with ASTM A123/A123M or ASTM A153/A153M.

B. Materials for Metal Fabricated Supports: Comply with Section 05 50 00.

C. Conduit and Cable Supports: Straps, clamps, etc. suitable for the conduit or cable to be supported.
1. Conduit Straps: One-hole or two-hole type; steel or malleable iron.
2. Conduit Clamps: Bolted type unless otherwise indicated.
3. Manufacturers:
    a. Cooper Crouse-Hinds, a division of Eaton Corporation: www.cooperindustries.com/#sle.
    b. Erico International Corporation: www.erico.com.
    c. O-Z/Gedney, a brand of Emerson Industrial Automation: www.emersonindustrial.com/#sle.
    d. Thomas & Betts Corporation: www.tnb.com.
    e. Substitutions: See Section 01 60 00 - Materials and Equipment.

D. Outlet Box Supports: Hangers, brackets, etc. suitable for the boxes to be supported.
1. Manufacturers:
    a. Cooper Crouse-Hinds, a division of Eaton Corporation: www.cooperindustries.com/#sle.
    b. Erico International Corporation: www.erico.com/#sle.
    c. O-Z/Gedney, a brand of Emerson Industrial Automation: www.emersonindustrial.com/#sle.
    d. Thomas & Betts Corporation: www.tnb.com/#sle.
    e. Substitutions: See Section 01 60 00 - Materials and Equipment.

E. Metal Channel (Strut) Framing Systems: Factory-fabricated continuous-slot metal channel (strut) and associated fittings, accessories, and hardware required for field-assembly of supports.
1. Comply with MFMA-4.
2. Channel (Strut) Used as Raceway (only where specifically indicated): Listed and labeled as complying with UL 5B.

3. Channel Material:
    a. Indoor Dry Locations: Use zinc-plated steel or galvanized steel.
    b. Outdoor and Damp or Wet Indoor Locations: Use galvanized steel or stainless steel.
4. Minimum Channel Thickness: 14 gauge.
5. Minimum Channel Dimensions: 1-5/8 inch width by 13/16 inch height.
6. Manufacturers:
    a. Cooper B-Line, a division of Eaton Corporation: www.cooperindustries.com/#sle.
    b. Thomas & Betts Corporation: www.tnb.com.
    c. Unistrut, a brand of Atkore International Inc: www.unistrut.com.
    d. Substitutions: See Section 01 60 00 - Materials and Equipment.

F. Hanger Rods: Threaded zinc-plated steel unless otherwise indicated.
1. Minimum Size, Unless Otherwise Indicated or Required:
    a. Equipment Supports: 1/2 inch diameter.
    b. Single Conduit up to 1 inch (27mm) trade size: 1/4 inch diameter.
    c. Single Conduit larger than 1 inch (27mm) trade size: 3/8 inch diameter.
    d. Trapeze Support for Multiple Conduits: 3/8 inch diameter.
    e. Outlet Boxes: 1/4 inch diameter.
    f. Luminaires: 3/8 inch diameter.

G. Non-Penetrating Rooftop Supports for Low-Slope Roofs: Steel pedestals with thermoplastic or rubber bases that rest on top of roofing membrane, not requiring any attachment to the roof structure and not penetrating the roofing assembly, with support fixtures as specified.
1. Base Sizes: As required to distribute load sufficiently to prevent indentation of roofing assembly.
2. Attachment/Support Fixtures: As recommended by manufacturer, same type as indicated for equivalent indoor hangers and supports.
3. Mounting Height: Provide minimum clearance of 6 inches under supported component to top of roofing.
4. Manufacturers:
    a. Cooper B-Line, a division of Eaton Corporation: www.cooperindustries.com/#sle.
    b. Erico International Corporation: www.erico.com.
    c. PHP Systems/Design: www.phpsd.com.
    d. Unistrut, a brand of Atkore International Inc: www.unistrut.com.
    e. Substitutions: See Section 01 60 00 - Materials and Equipment.

H. Anchors and Fasteners:
1. Unless otherwise indicated and where not otherwise restricted, use the anchor and fastener types indicated for the specified applications.
2. Concrete: Use preset concrete inserts, expansion anchors, or screw anchors.
3. Solid or Grout-Filled Masonry: Use expansion anchors or screw anchors.
4. Hollow Masonry: Use toggle bolts.
5. Hollow Stud Walls: Use toggle bolts.

6. Steel: Use beam clamps, machine bolts, or welded threaded studs.
7. Sheet Metal: Use sheet metal screws.
8. Wood: Use wood screws.
9. Plastic and lead anchors are not permitted.
10. Powder-actuated fasteners are permitted only as follows:
    a. Where approved by Architect.
    b. Use only threaded studs; do not use pins.
11. Hammer-driven anchors and fasteners are permitted only as follows:
    a. Nails are permitted for attachment of nonmetallic boxes to wood frame construction (when specified).
    b. Staples are permitted for attachment of nonmetallic-sheathed cable to wood frame construction (when specified).
12. Preset Concrete Inserts: Continuous metal channel (strut) and spot inserts specifically designed to be cast in concrete ceilings, walls, and floors.
    a. Comply with MFMA-4.
    b. Channel Material: Use galvanized steel.
    c. Minimum Channel Thickness: 12 gauge.
    d. Manufacturer: Same as manufacturer of metal channel (strut) framing system.
13. Post-Installed Concrete and Masonry Anchors: Evaluated and recognized by ICC Evaluation Service, LLC (ICC-ES) for compliance with applicable building code.
14. Manufacturers - Mechanical Anchors:
    a. Hilti, Inc: www.us.hilti.com.
    b. ITW Red Head, a division of Illinois Tool Works, Inc: www.itwredhead.com/#sle.
    c. Powers Fasteners, Inc: www.powers.com.
    d. Simpson Strong-Tie Company Inc: www.strongtie.com.
    e. Substitutions: See Section 01 60 00 - Materials and Equipment.
15. Manufacturers - Powder-Actuated Fastening Systems:
    a. Hilti, Inc: www.us.hilti.com.
    b. ITW Ramset, a division of Illinois Tool Works, Inc: www.ramset.com/#sle.
    c. Powers Fasteners, Inc: www.powers.com.
    d. Simpson Strong-Tie Company Inc: www.strongtie.com.
    e. Substitutions: See Section 01 60 00 - Materials and Equipment.

2.2. MATERIALS

A. Hangers, Supports, Anchors, and Fasteners - General: Corrosion-resistant materials of size and type adequate to carry the loads of equipment and conduit, including weight of wire in conduit.

B. Supports: Fabricated of structural steel or formed steel members; galvanized.

C. Anchors and Fasteners:
    1. Obtain permission from Architect before using powder-actuated anchors.

2. Concrete Structural Elements: Use precast inserts, expansion anchors, or preset inserts.
3. Steel Structural Elements: Use beam clamps, steel spring clips, steel ramset fasteners, or welded fasteners.
4. Concrete Surfaces: Use self-drilling anchors or expansion anchors.
5. Hollow Masonry, Plaster, and Gypsum Board Partitions: Use toggle bolts or hollow wall fasteners.
6. Solid Masonry Walls: Use expansion anchors or preset inserts.
7. Sheet Metal: Use sheet metal screws.
8. Wood Elements: Use wood screws.

D. Fastener Types:
1. Concrete Wedge Expansion Anchors: Complying with ICC-ES AC193.
2. Masonry Wedge Expansion Anchors: Complying with ICC-ES AC01.
3. Concrete Screw Type Anchors: Complying with ICC-ES AC193.
4. Masonry Screw Type Anchors: Complying with ICC-ES AC106.
5. Concrete Adhesive Type Anchors: Complying with ICC-ES AC308.
6. Other Types: As required.
7. Manufacturers:
   a. Powers Fasteners, Inc: www.powers.com.
   b. Substitutions: See Section 01 60 00 - Materials and Equipment.

E. Formed Steel Channel:
1. Manufacturer: Kindorf, Unistrut, B-Line, or approved.
2. Substitutions: See Section 01 60 00 - Materials and Equipment.

F. Steel Spring Clips:
1. Manufacturer: Caddy, Raco, T&B, B-Line.
2. Substitutions: See Section 01 60 00 - Materials and Equipment.

G. Non-Penetrating Rooftop Supports for Low-Slope Roofs: Steel pedestals with thermoplastic or rubber bases that rest on top of roofing membrane, not requiring any attachment to the roof structure and not penetrating the roofing assembly, with support fixtures as specified.
1. Base Sizes: As required to distribute load sufficiently to prevent indentation of roofing assembly.
2. Steel Components: Stainless steel, or carbon steel hot-dip galvanized after fabrication in accordance with ASTM A123/A123M.
3. Attachment/Support Fixtures: As recommended by manufacturer, same type as indicated for equivalent indoor hangers and supports; corrosion resistant material.
4. Mounting Height: Provide minimum clearance of 6 inches under supported component to top of roofing.
5. Manufacturers:
   a. Cooper B-Line, a division of Cooper Industries: www.cooperindustries.com.
   b. PHP Systems/Design: www.phpsd.com.
   c. Unistrut, a brand of Atkore International Inc: www.unistrut.com.
   d. Substitutions: See Section 01 60 00 - Materials and Equipment.

PART 3 EXECUTION

3.1. EXAMINATION

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

3.2. INSTALLATION

A. Install hangers and supports as required to adequately and securely support electrical system components, in a neat and workmanlike manner, as specified in NECA 1.
   1. Do not fasten supports to pipes, ducts, mechanical equipment, or conduit.
   2. Obtain permission from Architect before drilling or cutting structural members.
B. Rigidly weld support members or use hexagon-head bolts to present neat appearance with adequate strength and rigidity. Use spring lock washers under all nuts.
C. Install surface-mounted cabinets and panelboards with minimum of four anchors.
D. In wet and damp locations use steel channel supports to stand cabinets and panelboards 1 inch off wall.
E. Use sheet metal channel to bridge studs above and below cabinets and panelboards recessed in hollow partitions.
F. Install products in accordance with manufacturer's instructions.
G. Install support and attachment components in a neat and workmanlike manner in accordance with NECA 1.
H. Install anchors and fasteners in accordance with ICC Evaluation Services, LLC (ICC-ES) evaluation report conditions of use where applicable.
I. Provide independent support from building structure. Do not provide support from piping, ductwork, or other systems.
J. Unless specifically indicated or approved by Architect, do not provide support from suspended ceiling support system or ceiling grid.
K. Unless specifically indicated or approved by Architect, do not provide support from roof deck.
L. Do not penetrate or otherwise notch or cut structural members without approval of Structural Engineer.
M. Field-Welding (where approved by Architect): Comply with Section 05 50 00.
N. Equipment Support and Attachment:
   1. Use metal fabricated supports or supports assembled from metal channel (strut) to support equipment as required.
   2. Use metal channel (strut) secured to studs to support equipment surface-mounted on hollow stud walls when wall strength is not sufficient to resist pull-out.
   3. Use metal channel (strut) to support surface-mounted equipment in wet or damp locations to provide space between equipment and mounting surface.
   4. Unless otherwise indicated, mount floor-mounted equipment on properly sized 3 inch high concrete pad constructed in accordance with Section 03 30 00.

5. Securely fasten floor-mounted equipment. Do not install equipment such that it relies on its own weight for support.

O. Conduit Support and Attachment: Also comply with Section 26 05 34.
P. Box Support and Attachment: Also comply with Section 26 05 37.
Q. Interior Luminaire Support and Attachment: Also comply with Section 26 51 00.
R. Preset Concrete Inserts: Use manufacturer provided closure strips to inhibit concrete seepage during concrete pour.
S. Secure fasteners according to manufacturer's recommended torque settings.
T. Remove temporary supports.
U. Identify independent electrical component support wires above accessible ceilings (only where specifically indicated or permitted) in accordance with NFPA 70.

3.3. FIELD QUALITY CONTROL

A. See Section 01 45 00 - Contractor's Quality Control Program, for additional requirements.
B. Inspect support and attachment components for damage and defects.
C. Repair cuts and abrasions in galvanized finishes using zinc-rich paint recommended by manufacturer. Replace components that exhibit signs of corrosion.
D. Correct deficiencies and replace damaged or defective support and attachment components.

END OF SECTION

CONDUIT

PART 1 GENERAL

1.1. SECTION INCLUDES

A. Galvanized steel rigid metal conduit (RMC).
B. Intermediate metal conduit (IMC).
C. Flexible metal conduit (FMC).
D. Liquidtight flexible metal conduit (LFMC).
E. Electrical metallic tubing (EMT).
F. Rigid polyvinyl chloride (PVC) conduit.
G. Liquidtight flexible nonmetallic conduit (LFNC).
H. Conduit fittings.
I. Accessories.

1.2. RELATED REQUIREMENTS

A. Section 03 30 00 - Cast-in-Place Concrete: Concrete encasement of conduits.
B. Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables: Metal clad cable (Type MC), armored cable (Type AC), and manufactured wiring systems, including uses permitted.
C. Section 26 05 26 - Grounding and Bonding for Electrical Systems.
   1. Includes additional requirements for fittings for grounding and bonding.
D. Section 26 05 29 - Hangers and Supports for Electrical Systems.
E. Section 26 05 37 - Boxes.
F. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.
G. Section 26 27 01 - Group Metering Equipment: Additional requirements for electrical service conduits.

1.3. REFERENCE STANDARDS

A. ANSI C80.1 - American National Standard for Electrical Rigid Steel Conduit (ERSC); 2005.
B. ANSI C80.3 - American National Standard for Steel Electrical Metallic Tubing (EMT); 2005.
C. ANSI C80.5 - American National Standard for Electrical Rigid Aluminum Conduit (ERAC); 2005.
D. ANSI C80.6 - American National Standard for Electrical Intermediate Metal Conduit (EIMC); 2005.
E. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2015.
F. NECA 101 - Standard for Installing Steel Conduits (Rigid, IMC, EMT); 2013.
G. NECA 111 - Standard for Installing Nonmetallic Raceways (RNC, ENT, LFNC); 2003.
H. NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing, and Cable; 2014.
I. NEMA RN 1 - Polyvinyl-Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit; 2005.

J. NEMA TC 2 - Electrical Polyvinyl Chloride (PVC) Conduit; 2013.
K. NEMA TC 3 - Polyvinyl Chloride (PVC) Fittings for Use with Rigid PVC Conduit and Tubing; 2015.
L. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
M. UL 1 - Flexible Metal Conduit; Current Edition, Including All Revisions.
N. UL 6 - Electrical Rigid Metal Conduit-Steel; Current Edition, Including All Revisions.
O. UL 6A - Electrical Rigid Metal Conduit-Aluminum, Red Brass, and Stainless Steel; Current Edition, Including All Revisions.
P. UL 360 - Liquid-Tight Flexible Steel Conduit; Current Edition, Including All Revisions.
Q. UL 514B - Conduit, Tubing, and Cable Fittings; Current Edition, Including All Revisions.
R. UL 651 - Schedule 40, 80, Type EB and A Rigid PVC Conduit and Fittings; Current Edition, Including All Revisions.
S. UL 797 - Electrical Metallic Tubing-Steel; Current Edition, Including All Revisions.
T. UL 1203 - Explosion-Proof and Dust-Ignition-Proof Electrical Equipment for Use in Hazardous (Classified) Locations; Current Edition, Including All Revisions.
U. UL 1242 - Electrical Intermediate Metal Conduit-Steel; Current Edition, Including All Revisions.
V. UL 1660 - Liquid-Tight Flexible Nonmetallic Conduit; Current Edition, Including All Revisions.

1.4. ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Coordinate minimum sizes of conduits with the actual conductors to be installed, including adjustments for conductor sizes increased for voltage drop.
   2. Coordinate the arrangement of conduits with structural members, ductwork, piping, equipment and other potential conflicts installed under other sections or by others.
   3. Verify exact conduit termination locations required for boxes, enclosures, and equipment installed under other sections or by others.
   4. Coordinate the work with other trades to provide roof penetrations that preserve the integrity of the roofing system and do not void the roof warranty.
   5. Notify Architect of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.
B. Sequencing:
   1. Do not begin installation of conductors and cables until installation of conduit is complete between outlet, junction and splicing points.
C. For projects with Post Tension (PT) slab construction, submit dimensioned plan showing all conduit sleeves & block out locations to Architect for review.

1.5. SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittals procedures.
B. Shop Drawings:

1. Indicate proposed arrangement for conduits to be installed within structural concrete slabs, where permitted.
2. Include proposed locations of roof penetrations and proposed methods for sealing.

C. Project Record Documents: Record actual routing for conduits installed underground, conduits embedded within concrete slabs, and conduits 2 inch (53 mm) trade size and larger.

1.6. QUALITY ASSURANCE

A. Conform to requirements of NFPA 70.

B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.

1.7. DELIVERY, STORAGE, AND HANDLING

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

PART 2 PRODUCTS

2.1. CONDUIT APPLICATIONS

A. Do not use conduit and associated fittings for applications other than as permitted by NFPA 70 and product listing.

B. Unless otherwise indicated and where not otherwise restricted, use the conduit types indicated for the specified applications.

C. Underground:

1. Under Slab on Grade: Use galvanized steel rigid metal conduit, intermediate metal conduit (IMC), PVC-coated galvanized steel rigid metal conduit, or rigid PVC conduit.
2. Exterior, Direct-Buried: Use galvanized steel rigid metal conduit, intermediate metallic conduit (IMC), or rigid PVC conduit.
3. Where rigid polyvinyl (PVC) conduit is provided, transition to galvanized steel rigid metal conduit or intermediate metal conduit (IMC) where emerging from underground.
4. Where rigid polyvinyl (PVC) conduit larger than 2 inch (53 mm) trade size is provided, use galvanized steel rigid metal conduit elbows or intermediate metal conduit (IMC) elbows or fiberglass for bends in runs over 100 feet. For shorter runs factory formed schedule 40 PVC elbows may be used.
5. 1.5 Inches Diameter and Smaller: For total conduit lengths between pull points over 100 ft., use rigid steel elbows. For shorter overall lengths, rigid steel or Schedule 40 PVC may be used.
6. Where steel conduit is installed in direct contact with earth use where soil has a resistivity of less than 2000 ohm-centimeters or is characterized as severely corrosive based on soils report or local experience to provide supplementary corrosion protection.

D. Embedded Within Concrete:
   1. Within Slab on Grade (within structural slabs only where approved by Structural Engineer): Use galvanized steel rigid metal conduit, intermediate metal conduit (IMC), or rigid PVC conduit.
   2. Within Slab Above Ground (within structural slabs only where approved by Structural Engineer): Use galvanized steel rigid metal conduit, intermediate metal conduit (IMC), electrical metallic tubing (EMT), or rigid PVC conduit.
   3. Within Concrete Walls Above Ground: Use galvanized steel rigid metal conduit, intermediate metal conduit (IMC), electrical metallic tubing (EMT), or rigid PVC conduit.
   4. Where rigid polyvinyl (PVC) conduit is provided, transition to galvanized steel rigid metal conduit or intermediate metal conduit (IMC) where emerging from concrete.
   5. Where electrical metallic tubing (EMT) emerges from concrete into salt air, use corrosion protection tape to provide supplementary corrosion protection for a minimum of 4 inches on either side of where conduit emerges.

E. Concealed Within Masonry Walls: Use galvanized steel rigid metal conduit, intermediate metal conduit (IMC), or electrical metallic tubing (EMT).

F. Concealed Within Hollow Stud Walls: Use galvanized steel rigid metal conduit, intermediate metal conduit (IMC), or electrical metallic tubing (EMT).

G. Concealed Above Accessible Ceilings: Use galvanized steel rigid metal conduit, intermediate metal conduit (IMC), or electrical metallic tubing (EMT).

H. Interior, Damp or Wet Locations: Use galvanized steel rigid metal conduit or intermediate metal conduit (IMC).

I. Exposed, Interior: Install intermediate metal conduit (IMC) where installed below the bottom chord of trusses, use EMT conduit where installed above cord of trusses.

J. Exposed, Exterior: Use galvanized steel rigid metal conduit, intermediate metal conduit (IMC), or PVC-coated galvanized steel rigid metal conduit.

K. Concealed, Exterior, Not Embedded in Concrete or in Contact With Earth: Use galvanized steel rigid metal conduit, intermediate metal conduit (IMC), or electrical metallic tubing (EMT).

L. Corrosive Locations Above Ground: Use rigid PVC conduit.
   1. Corrosive locations include, but are not limited to:
      a. Cooling towers.
      b. Swimming pool equipment rooms.

M. Hazardous (Classified) Locations: Use galvanized steel rigid metal conduit or intermediate metal conduit (IMC).

N. Connections to Luminaires Above Accessible Ceilings: Use flexible metal conduit.
   1. Maximum Length: 6 feet.

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

b. Motors.

P. Insulate conduits entering coolers at the first 48".

2.2. CONDUIT REQUIREMENTS

A. Existing Work: Where existing conduits are indicated to be reused, they may be reused only where they comply with specified requirements, are free from corrosion, and integrity is verified by pulling a mandrel through them.

B. Electrical Service Conduits/

C. Communications Systems Conduits.

D. Fittings for Grounding and Bonding: Also comply with Section 26 05 26.

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

F. Provide products listed, classified, and labeled by Underwriter's Laboratories Inc. (UL) or Intertek (ETL) as suitable for the purpose indicated.

G. Minimum Conduit Size, Unless Otherwise Indicated:
1. Branch Circuits: 1/2 inch (16 mm) trade size.
2. Branch Circuit Homeruns: 3/4 inch (21 mm) trade size.
3. Control Circuits: 1/2 inch (16 mm) trade size.
4. Flexible Connections to Luminaires: 1/2 inch (16 mm) trade size.
5. Underground, Interior: 3/4 inch (21 mm) trade size.
6. Underground, Exterior: 3/4 inch (21 mm) trade size.

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

2.3. GALVANIZED STEEL RIGID METAL CONDUIT (RMC)

A. Manufacturers:
1. Allied Tube & Conduit: www.alliedeg.com.
2. Republic Conduit: www.republic-conduit.com.
3. Wheatland Tube Company: www.wheatland.com.

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

C. Fittings:
1. Manufacturers:
a. Bridgeport Fittings Inc: www.bptfittings.com.
b. O-Z/Gedney, a brand of Emerson Industrial Automation: www.emersonindustrial.com/#sle.
c. Thomas & Betts Corporation: www.tnb.com.
2. Non-Hazardous Locations: Use fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
3. Hazardous (Classified) Locations: Use fittings listed and labeled as complying with UL 1203 for the classification of the installed location.
4. Material: Use steel or malleable iron.
a. Do not use die cast zinc fittings.

5. Connectors and Couplings: Use threaded type fittings only. Threadless set screw and compression (gland) type fittings are not permitted.

2.4. INTERMEDIATE METAL CONDUIT (IMC)

A. Manufacturers:
   1. Allied Tube & Conduit: www.alliedeg.com.
   2. Republic Conduit: www.republic-conduit.com.
   3. Wheatland Tube Company: www.wheatland.com.

B. Description: NFPA 70, Type IMC galvanized steel intermediate metal conduit complying with ANSI C80.6 and listed and labeled as complying with UL 1242.

C. Fittings:
   1. Manufacturers:
      a. Bridgeport Fittings Inc: www.bptfittings.com.
      b. O-Z/Gedney, a brand of Emerson Industrial Automation: www.emersonindustrial.com/#sle.
      c. Thomas & Betts Corporation: www.tnb.com.
   2. Non-Hazardous Locations: Use fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
   3. Hazardous (Classified) Locations: Use fittings listed and labeled as complying with UL 1203 for the classification of the installed location.
   4. Material: Use steel or malleable iron.
      a. Do not use die cast zinc fittings.
   5. Connectors and Couplings: Use threaded type fittings only. Threadless set screw and compression (gland) type fittings are not permitted.

2.5. FLEXIBLE METAL CONDUIT (FMC)

A. Manufacturers:
   1. AFC Cable Systems, Inc: www.afcweb.com.
   2. Electri-Flex Company: www.electriflex.com.
   3. International Metal Hose: www.metalhose.com.

B. Description: NFPA 70, Type FMC standard wall steel or standard wall aluminum flexible metal conduit listed and labeled as complying with UL 1, and listed for use in classified firestop systems to be used.

C. Fittings:
   1. Manufacturers:
      a. Bridgeport Fittings Inc: www.bptfittings.com.
      b. O-Z/Gedney, a brand of Emerson Industrial Automation: www.emersonindustrial.com/#sle.
      c. Thomas & Betts Corporation: www.tnb.com.
   2. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
   3. Material: Use steel, malleable iron, or aluminum.
      a. Do not use die cast zinc fittings.

2.6. LIQUIDTIGHT FLEXIBLE METAL CONDUIT (LFMC)

A. Manufacturers:
   1. AFC Cable Systems, Inc: www.afcweb.com.
   2. Electri-Flex Company: www.electriflex.com.
   3. International Metal Hose: www.metalhose.com.

B. Description: NFPA 70, Type LFMC polyvinyl chloride (PVC) jacketed steel or aluminum flexible metal conduit listed and labeled as complying with UL 360.

C. Fittings:
   1. Manufacturers:
      a. Bridgeport Fittings Inc: www.bptfittings.com.
      b. O-Z/Gedney, a brand of Emerson Industrial Automation: www.emersonindustrial.com/#sle.
      c. Thomas & Betts Corporation: www.tnb.com.
   2. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
   3. Material: Use steel, malleable iron, or aluminum.
      a. Do not use die cast zinc fittings.

2.7. ELECTRICAL METALLIC TUBING (EMT)

A. Manufacturers:
   1. Allied Tube & Conduit: www.alliedeg.com.
   2. Republic Conduit: www.republic-conduit.com.
   3. Wheatland Tube Company: www.wheatland.com.

B. Description: NFPA 70, Type EMT steel electrical metallic tubing complying with ANSI C80.3 and listed and labeled as complying with UL 797.

C. Fittings:
   1. Manufacturers:
      a. Bridgeport Fittings Inc: www.bptfittings.com.
      b. O-Z/Gedney, a brand of Emerson Industrial Automation: www.emersonindustrial.com/#sle.
      c. Thomas & Betts Corporation: www.tnb.com.
   2. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
   3. Material: Use steel.
      a. Do not use die cast zinc fittings.
   4. Connectors and Couplings: Use set-screw type except when embedded in concrete. Use concrete tight compression (gland) type in concrete.
      a. Do not use indenter type connectors and couplings.
   5. Damp or Wet Locations (where permitted): Use fittings listed for use in wet locations.
   6. Embedded Within Concrete (where permitted): Use fittings listed as concrete-tight. Fittings that require taping to be concrete-tight are not acceptable.

2.8. RIGID POLYVINYL CHLORIDE (PVC) CONDUIT

A. Manufacturers:
   1. Cantex Inc: www.cantexinc.com.
   2. Carlon, a brand of Thomas & Betts Corporation: www.carlon.com.
   3. JM Eagle: www.jmeagle.com.
   4. Allied Tube and Conduit: www.alliedtube.com.

B. Description: NFPA 70, Type PVC rigid polyvinyl chloride conduit complying with NEMA TC 2 and listed and labeled as complying with UL 651; Schedule 40 unless otherwise indicated, Schedule 80 where subject to physical damage; rated for use with conductors rated 90 degrees C.

C. Fittings:
   1. Manufacturer: Same as manufacturer of conduit to be connected.
   2. Description: Fittings complying with NEMA TC 3 and listed and labeled as complying with UL 651; material to match conduit.

D. Elbows:
   1. Use only factory formed Schedule 40 elbows. Field bends are not acceptable.
   2. 1.5 Inches Diameter and Smaller: For total conduit lengths between pull points over 100 ft., use rigid steel elbows. For shorter overall lengths, rigid steel or Schedule 40 PVC may be used.
   3. 2 Inches Diameter and Larger: For total conduit lengths between pull points over 100 ft., use long sweep rigid steel or fiberglass elbows. For shorter overall lengths, rigid steel, fiberglass, or Schedule 40 PVC elbows may be used.

2.9. LIQUIDTIGHT FLEXIBLE NONMETALLIC CONDUIT (LFNC)

A. Manufacturers:
   1. AFC Cable Systems, Inc: www.afcweb.com.
   2. Electri-Flex Company: www.electriflex.com.
   3. International Metal Hose: www.metalhose.com.

B. Description: NFPA 70, Type LFNC liquidtight flexible nonmetallic conduit listed and labeled as complying with UL 1660, Type A.

C. Fittings:
   1. Manufacturer: Same as manufacturer of conduit to be connected.
   2. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B; suitable for the type of conduit to be connected.

2.10. ACCESSORIES

A. Corrosion Protection Tape: PVC-based, minimum thickness of 10 mil.

B. Conduit Joint Compound: Corrosion-resistant, electrically conductive; suitable for use with the conduit to be installed.

C. Solvent Cement for PVC Conduit and Fittings: As recommended by manufacturer of conduit and fittings to be installed.

D. Pull Strings: Use nylon cord with average breaking strength of not less than 200 pound-force.
E. Sealing Compound for Sealing Fittings: Listed for use with the particular fittings to be installed.
F. Modular Seals for Conduit Penetrations: Rated for minimum of 40 psig; Suitable for the conduits to be installed.

PART 3 EXECUTION

3.1. EXAMINATION

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

3.2. INSTALLATION

A. Conduits to dock levelers may be routed in PVC below slab.
B. Install conduit in a neat and workmanlike manner in accordance with NECA 1.
C. Install galvanized steel rigid metal conduit (RMC) in accordance with NECA 101.
D. Install intermediate metal conduit (IMC) in accordance with NECA 101.
E. Install rigid polyvinyl chloride (PVC) conduit in accordance with NECA 111.
F. Install liquidtight flexible nonmetallic conduit (LFNC) in accordance with NECA 111.
G. Conduit Routing:
    1. Unless dimensioned, conduit routing indicated is diagrammatic.
    2. When conduit destination is indicated and routing is not shown, determine exact routing required.
    3. Conceal all conduits unless specifically indicated to be exposed.
    4. Conduits in the following areas may be exposed, unless otherwise indicated:
        a. Electrical rooms.
        b. Mechanical equipment rooms.
        c. Within joists in areas with no ceiling.
    5. Unless otherwise approved, do not route conduits exposed:
        a. Across floors.
        b. Across roofs.
        c. Across top of parapet walls.
        d. Across building exterior surfaces.
    6. Conduits installed underground or embedded in concrete may be routed in the shortest possible manner unless otherwise indicated. Route all other conduits parallel or perpendicular to building structure and surfaces, following surface contours where practical.
    7. Arrange conduit to maintain adequate headroom, clearances, and access.
    8. Arrange conduit to provide no more than the equivalent of three 90 degree bends between pull points.
    9. Arrange conduit to provide no more than 150 feet between pull points.

10. Route conduits above water and drain piping where possible.
11. Arrange conduit to prevent moisture traps. Provide drain fittings at low points and at sealing fittings where moisture may collect.
12. Maintain minimum clearance of 6 inches between conduits and piping for other systems.
13. Maintain minimum clearance of 12 inches between conduits and hot surfaces.
14. Group parallel conduits in the same area together on a common rack.

H. Conduit Support:
1. Secure and support conduits in accordance with NFPA 70 and Section 26 05 29 using suitable supports and methods approved by the authority having jurisdiction.
2. Provide independent support from building structure. Do not provide support from piping, ductwork, or other systems.
3. Installation Above Suspended Ceilings: Do not provide support from ceiling support system. Do not provide support from ceiling grid or allow conduits to lay on ceiling tiles.
4. Use conduit strap to support single surface-mounted conduit.
   a. Use clamp back spacer with conduit strap for damp and wet locations to provide space between conduit and mounting surface.
5. Use metal channel (strut) with accessory conduit clamps to support multiple parallel surface-mounted conduits.
6. Use conduit clamp to support single conduit from beam clamp or threaded rod.
7. Use trapeze hangers assembled from threaded rods and metal channel (strut) with accessory conduit clamps to support multiple parallel suspended conduits.
8. Use non-penetrating rooftop supports to support conduits routed across rooftops (only where specifically approved).
9. Use of spring steel conduit clips for support of conduits is permitted only as follows:
   a. Support of electrical metallic tubing (EMT) up to 1 inch (27 mm) trade size concealed above accessible ceilings and within hollow stud walls.
10. Use of wire for support of conduits is not permitted.
11. Where conduit support intervals specified in NFPA 70 and NECA standards differ, comply with the most stringent requirements.

I. Connections and Terminations:
1. Use approved zinc-rich paint or conduit joint compound on field-cut threads of galvanized steel conduits prior to making connections.
2. Where two threaded conduits must be joined and neither can be rotated, use three-piece couplings or split couplings. Do not use running threads.
3. Use suitable adapters where required to transition from one type of conduit to another.
4. Provide drip loops for liquidtight flexible conduit connections to prevent drainage of liquid into connectors.
5. Terminate threaded conduits in boxes and enclosures using threaded hubs or double lock nuts for dry locations and raintight hubs for wet locations.

6. Where spare conduits stub up through concrete floors and are not terminated in a box or enclosure, provide threaded couplings equipped with threaded plugs set flush with finished floor.
7. Provide insulating bushings or insulated throats at all conduit terminations to protect conductors.
8. Secure joints and connections to provide maximum mechanical strength and electrical continuity.

J. Penetrations:
1. Do not penetrate or otherwise notch or cut structural members, including footings and grade beams, without approval of Structural Engineer.
2. Make penetrations perpendicular to surfaces unless otherwise indicated.
3. Provide sleeves for penetrations as indicated or as required to facilitate installation. Set sleeves flush with exposed surfaces unless otherwise indicated or required.
4. Conceal bends for conduit risers emerging above ground.
5. Seal interior of conduits entering the building from underground at first accessible point to prevent entry of moisture and gases.
6. Provide suitable modular seal where conduits penetrate exterior wall below grade.
7. Where conduits penetrate waterproof membrane, seal as required to maintain integrity of membrane.
8. Make penetrations for roof-mounted equipment within associated equipment openings and curbs where possible to minimize roofing system penetrations. Where penetrations are necessary, seal as indicated or as required to preserve integrity of roofing system and maintain roof warranty.
9. Provide metal escutcheon plates for conduit penetrations exposed to public view.
10. Install firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Section 07 84 00.

K. Underground Installation:
1. Provide trenching and backfilling .
2. Minimum Cover, Unless Otherwise Indicated or Required:
   a. Underground, Exterior: 24 inches.
   b. Under Slab on Grade: 12 inches to bottom of slab.
3. Provide underground warning tape in accordance with Section 26 05 53 along entire conduit length for service entrance where not concrete-encased.

L. Embedment Within Structural Concrete Slabs (only where approved by Structural Engineer):
1. Include proposed conduit arrangement with submittals.
2. Maximum Conduit Size: 1 inch (27 mm) unless otherwise approved.
3. Minimum Conduit Spacing: Shall be as directed by Structural Engineer.
4. Install conduits within middle one third of slab thickness.
5. Secure conduits to prevent floating or movement during pouring of concrete.

M. Concrete Encasement: Where conduits not otherwise embedded within concrete are indicated to be concrete-encased, provide concrete in accordance with Section 03 30 00 with minimum concrete cover of 3 inches on all sides unless otherwise indicated.

N. Hazardous (Classified) Locations: Where conduits cross boundaries of hazardous (classified) locations, provide sealing fittings located as indicated or in accordance with NFPA 70.

O. Conduit Movement Provisions: Where conduits are subject to movement, provide expansion and expansion/deflection fittings or approved flexible connections to prevent damage to enclosed conductors or connected equipment. This includes, but is not limited to:
   1. Where conduits cross structural joints intended for expansion, contraction, or deflection.
   2. Where calculated in accordance with NFPA 70 for rigid polyvinyl chloride (PVC) conduit installed above ground to compensate for thermal expansion and contraction.
   3. Where conduits are subject to earth movement by settlement or frost.

P. Condensation Prevention: Where conduits cross barriers between areas of potential substantial temperature differential, provide sealing fitting or approved sealing compound at an accessible point near the penetration to prevent condensation. This includes, but is not limited to:
   1. Where conduits pass from outdoors into conditioned interior spaces.
   2. Where conduits pass from unconditioned interior spaces into conditioned interior spaces.
   3. Where conduits penetrate coolers or freezers.

Q. Provide pull string in all empty conduits and in conduits where conductors and cables are to be installed by others. Leave minimum slack of 12 inches at each end.

R. Provide grounding and bonding in accordance with Section 26 05 26.

S. Identify conduits in accordance with Section 26 05 53.

T. Do not cross conduits in slab.

U. Cut conduit square using saw or pipecutter; de-burr cut ends.

V. Bring conduit to shoulder of fittings; fasten securely.

W. Join nonmetallic conduit using cement as recommended by manufacturer. Wipe nonmetallic conduit dry and clean before joining. Apply full even coat of cement to entire area inserted in fitting. Allow joint to cure for 20 minutes minimum.

X. Use suitable caps to protect installed conduit against entrance of dirt and moisture.

Y. All elbows installed in primary and secondary power conduit runs shall be minimum 36-inch radius.

Z. Where conduit is shown stubbed into a telephone, computer or communication terminal area, conduit shall be stubbed up 6 inches below ceiling and terminated with insulating bushings.

AA. Where the contractor elects to utilize PVC in lieu of GRC, the contractor shall provide supplemental ground bus in terminating switch and panelboards, and green ground wire as per code rules.

AB. Conduit runs shall not exceed 100 feet without an accessible pull box installed in line.

AC. Communications system conduit run above the ceiling shall not be installed within 12 inches of a parallel run of current carrying conductors, transformers, feeder cables, motors, or lighting ballasts.

AD. Conduit connections between outlet boxes less than 24 inches apart on opposite sides of a wall shall be made with a loop of flexible conduit to limit sound transmission.

AE. Penetrations of Masonry and Concrete Constructions:

1. Ensure that the sound control performance of structures be maintained in accordance with the drawings and specifications. All penetrations shall be installed in a manner that results in complete air tightness through structure. If a condition occurs where penetration of the structure by a conduit is not shown clearly on the drawings (or described in the specifications), the Contractor shall ask immediately for clarification of the method necessary to install the particular item.

AF. Penetrations of Drywall Constructions:

1. Ensure that the sound control performance of structures be maintained in accordance with the drawings and specifications. All penetrations shall be installed in a manner that results in complete air tightness through structure. If a condition occurs where penetration of the structure by a conduit is not shown clearly on the drawings (or described in the specifications), the Contractor shall ask immediately for clarification of the method necessary to install the particular item.

AG. Install conduit to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Section 07 8400.

3.3. FIELD QUALITY CONTROL

A. See Section 01 45 00 - Contractor's Quality Control Program, for additional requirements.

B. Repair cuts and abrasions in galvanized finishes using zinc-rich paint recommended by manufacturer. Replace components that exhibit signs of corrosion.

C. Correct deficiencies and replace damaged or defective conduits.

3.4. CLEANING

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

3.5. PROTECTION

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

END OF SECTION

BOXES

PART 1 GENERAL

1.1. SECTION INCLUDES

A. Outlet and device boxes up to 100 cubic inches, including those used as junction and pull boxes.
B. Cabinets and enclosures, including junction and pull boxes larger than 100 cubic inches.
C. Boxes for hazardous (classified) locations.
D. Floor boxes.
E. Underground boxes/enclosures.

1.2. RELATED REQUIREMENTS

A. Section 03 30 00 - Cast-in-Place Concrete.
B. Section 26 05 26 - Grounding and Bonding for Electrical Systems.
C. Section 26 05 29 - Hangers and Supports for Electrical Systems.
D. Section 26 05 34 - Conduit:
    1. Conduit bodies and other fittings.
    2. Additional requirements for locating boxes to limit conduit length and/or number of bends between pulling points.
E. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.
F. Section 26 27 01 - Wall Mounted Group Metering Equipment: Metering transformer cabinets.
G. Section 26 27 26 - Wiring Devices:
    1. Wall plates.

1.3. REFERENCE STANDARDS

A. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2015.
B. NECA 130 - Standard for Installing and Maintaining Wiring Devices; 2010.
C. NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing, and Cable; 2014.
D. NEMA OS 1 - Sheet-Steel Outlet Boxes, Device Boxes, Covers, and Box Supports; 2013.
E. NEMA OS 2 - Nonmetallic Outlet Boxes, Device Boxes, Covers and Box Supports; 2013.
F. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2014.
G. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
H. SCTE 77 - Specification for Underground Enclosure Integrity; 2017.
I. UL 50 - Enclosures for Electrical Equipment, Non-Environmental Considerations; Current Edition, Including All Revisions.
J. UL 50E - Enclosures for Electrical Equipment, Environmental Considerations; Current Edition, Including All Revisions.
K. UL 508A - Industrial Control Panels; 2013.
L. UL 514A - Metallic Outlet Boxes; Current Edition, Including All Revisions.

M. UL 514C - Nonmetallic Outlet Boxes, Flush-Device Boxes, and Covers; Current Edition, Including All Revisions.

1.4. ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Coordinate the work with other trades to avoid placement of ductwork, piping, equipment, or other potential obstructions within the dedicated equipment spaces and working clearances for electrical equipment required by NFPA 70.
   2. Coordinate arrangement of electrical equipment with the dimensions and clearance requirements of the actual equipment to be installed.
   3. Coordinate minimum sizes of boxes with the actual installed arrangement of conductors, clamps, support fittings, and devices, calculated according to NFPA 70.
   4. Coordinate minimum sizes of pull boxes with the actual installed arrangement of connected conduits, calculated according to NFPA 70.
   5. Coordinate the placement of boxes with millwork, furniture, devices, equipment, etc. installed under other sections or by others.
   6. Coordinate the work with other trades to preserve insulation integrity.
   7. Coordinate the work with other trades to provide walls suitable for installation of flush-mounted boxes where indicated.
   8. Notify Architect of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.

1.5. SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency.
C. Project Record Documents: Record actual locations for outlet and device boxes, pull boxes, cabinets and enclosures, floor boxes, and underground boxes/enclosures.
D. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
   1. See Section 01 60 00 - Materials and Equipment, for additional provisions.
   2. Keys for Lockable Enclosures: Two of each different key.

1.6. QUALITY ASSURANCE

A. Conform to requirements of NFPA 70.
B. Products: Provide products listed and classified by Underwriters Laboratories Inc., as suitable for the purpose specified and indicated.
C. Electrical boxes shall be sized according to NEC requirements unless otherwise noted in the contract documents.
D. Maintain integrity of insulation materials where flush boxes are installed in insulated spaces.
E. Maintain at the project site a copy of each referenced document that prescribes execution requirements.

1.7. DELIVERY, STORAGE, AND HANDLING

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

PART 2 PRODUCTS

2.1. BOXES

A. General Requirements:
   1. Do not use boxes and associated accessories for applications other than as permitted by NFPA 70 and product listing.
   2. Provide all boxes, fittings, supports, and accessories required for a complete raceway system and to accommodate devices and equipment to be installed.
   3. Provide products listed, classified, and labeled by Underwriter's Laboratories Inc. (UL) or Intertek (ETL) as suitable for the purpose indicated.
   4. Where box size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.
   5. Provide grounding terminals within boxes where equipment grounding conductors terminate.

B. Outlet and Device Boxes Up to 100 cubic inches, Including those used as Junction and Pull Boxes:
   1. Use sheet-steel boxes for dry locations unless otherwise indicated or required.
   2. Use cast iron boxes or cast aluminum boxes for damp or wet locations unless otherwise indicated or required; furnish with compatible weatherproof gasketed covers.
   3. Use cast iron boxes or cast aluminum boxes where exposed galvanized steel rigid metal conduit or exposed intermediate metal conduit (IMC) is used.
   4. Use cast aluminum boxes where aluminum rigid metal conduit is used.
   5. Use nonmetallic boxes where exposed rigid PVC conduit is used.
   6. Use suitable concrete type boxes where flush-mounted in concrete.
   7. Use suitable masonry type boxes where flush-mounted in masonry walls.
   8. Use raised covers suitable for the type of wall construction and device configuration where required.
   9. Use shallow boxes where required by the type of wall construction.
   10. Do not use "through-wall" boxes designed for access from both sides of wall.
   11. Sheet-Steel Boxes: Comply with NEMA OS 1, and list and label as complying with UL 514A.
   12. Cast Metal Boxes: Comply with NEMA FB 1, and list and label as complying with UL 514A; furnish with threaded hubs.
   13. Nonmetallic Boxes: Comply with NEMA OS 2, and list and label as complying with UL 514C, permitted in residential units only.

14. Boxes for Supporting Luminaires and Ceiling Fans: Listed as suitable for the type and weight of load to be supported; furnished with fixture stud to accommodate mounting of luminaire where required.
15. Boxes for Ganged Devices: Use multigang boxes of single-piece construction. Do not use field-connected gangable boxes.
16. Minimum Box Size, Unless Otherwise Indicated:
    a. Wiring Devices (Other Than Communications Systems Outlets): 4 inch square by 1-1/2 inch deep (100 by 38 mm) trade size.
    b. Communications Systems Outlets: Comply with Section 27 10 00.
    c. Ceiling Outlets: 4 inch octagonal or square by 1-1/2 inch deep (100 by 38 mm) trade size.
17. Wall Plates: Comply with Section 26 27 26.
18. Manufacturers:
    a. Cooper Crouse-Hinds, a division of Eaton Corporation: www.cooperindustries.com/#sle.
    b. Hubbell Incorporated; Bell Products: www.hubbell-bell.com.
    c. Hubbell Incorporated; RACO Products: www.hubbell-raco.com.
    d. O-Z/Gedney, a brand of Emerson Industrial Automation: www.emersonindustrial.com/#sle.
    e. Thomas & Betts Corporation: www.tnb.com.
    f. Appleton Electric.
    g. Substitutions: See Section 01 60 00 - Materials and Equipment.

C. Cabinets and Enclosures, Including Junction and Pull Boxes Larger Than 100 cubic inches:
1. Comply with NEMA 250, and list and label as complying with UL 50 and UL 50E, or UL 508A.
2. NEMA 250 Environment Type, Unless Otherwise Indicated:
    a. Indoor Clean, Dry Locations: Type 1, painted steel.
    b. Outdoor Locations: Type 3R, painted steel.
3. Junction and Pull Boxes Larger Than 100 cubic inches:
    a. Provide screw-cover or hinged-cover enclosures unless otherwise indicated.
    b. Boxes 6 square feet and Larger: Provide hinged-cover enclosures.
4. Cabinets and Hinged-Cover Enclosures, Other Than Junction and Pull Boxes:
    a. Provide lockable hinged covers, all locks keyed alike unless otherwise indicated.
    b. Back Panels: Painted steel, removable (where applicable).
5. Finish for Painted Steel Enclosures: Manufacturer's standard grey unless otherwise indicated.
6. Manufacturers:
    a. Cooper B-Line, a division of Eaton Corporation: www.cooperindustries.com/#sle.
    b. Hoffman, a brand of Pentair Technical Products: www.hoffmanonline.com/#sle.

c. Hubbell Incorporated; Wiegmann Products: www.hubbell-wiegmann.com/#sle.
d. Substitutions: See Section 01 60 00 - Materials and Equipment.

D. Electrical Outlet Box Pad:
1. Electrical outlet box pads shall be applied where called out on the drawings or specifications. Its function is to seal box openings, increase mass, and provide damping to reduce air-transmitted sound through party walls. It shall consist of polybutene-butyl and inert fillers. Material shall provide good adhesion to metal and plastic. Pads shall be applied to the backs of installed electrical boxes, molded to box, and folded around conduit cable entering the box. Pads shall not be used in areas subject to temperatures above 200 degrees F.
2. The following are acceptable, subject to the above:
a. Lowry's outlet box pads from Harry A. Lowry & Associates, Inc., Sun Valley, California, (800) 225-8231.
b. SpecSeal firestop putty pads (fire-rated) from Specified Technologies, Incorporated, Somerville, New Jersey, (800) 992-1180.
c. Or approved equal.

E. In-Ground Cast Metal Box: NEMA 250, Type 6, flanged, recessed cover box for flush mounting:

PART 3 EXECUTION

3.1. EXAMINATION

A. Verify exact location of floor boxes with Architect.
B. Verify that mounting surfaces are ready to receive boxes.
C. Verify that conditions are satisfactory for installation prior to starting work.

3.2. INSTALLATION

A. Install products in accordance with manufacturer's instructions.
B. Perform work in a neat and workmanlike manner in accordance with NECA 1 and, where applicable, NECA 130, including mounting heights specified in those standards where mounting heights are not indicated.
C. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and NFPA 70.
D. Provide separate boxes for emergency power and normal power systems.
E. Unless otherwise indicated, provide separate boxes for line voltage and low voltage systems.
F. Flush-mount boxes in finished areas unless specifically indicated to be surface-mounted.
G. Unless otherwise indicated, boxes may be surface-mounted where exposed conduits are indicated or permitted.
H. Box Locations:
1. Locate boxes to be accessible. Provide access panels as required where approved by the Architect.

a. Coordinate exact location of infloor boxes with Architect.
b. Adjust box locations up to 10 feet if required to accommodate intended purpose, at no additional cost to the owner.

2. Unless dimensioned, box locations indicated are approximate.
3. Locate boxes as required for devices installed under other sections or by others.
   a. Switches, Receptacles, and Other Wiring Devices: Comply as indicated on drawings.
   b. Communications Systems Outlets: Comply as indicated on drawings.
4. Locate boxes so that wall plates do not span different building finishes.
5. Locate boxes so that wall plates do not cross masonry joints.
6. Unless otherwise indicated, where multiple outlet boxes are installed at the same location at different mounting heights, install along a common vertical center line.
7. Do not install flush-mounted boxes on opposite sides of walls back-to-back; provide minimum 24 inches horizontal separation.
8. Fire-Resistance-Rated Walls: Install flush-mounted boxes such that the required fire-resistance will not be reduced.
   a. Do not install flush-mounted boxes on opposite sides of walls back-to-back; provide minimum 24 inches separation where wall is constructed with individual noncommunicating stud cavities protect both boxes with listed putty pads.
   b. Do not install flush-mounted boxes with area larger than 16 square inches or such that the total aggregate area of openings exceeds 100 square inches for any 100 square feet of wall area.
9. Locate junction and pull boxes as indicated, as required to facilitate installation of conductors, and to limit conduit length and/or number of bends between pulling points in accordance with Section 26 05 34.
10. Locate junction and pull boxes in the following areas, unless otherwise indicated or approved by the Architect:
    a. Concealed above accessible suspended ceilings.
    b. Within joists in areas with no ceiling.
    c. Electrical rooms.
    d. Mechanical equipment rooms.

I. Box Supports:
1. Secure and support boxes in accordance with NFPA 70 and Section 26 05 29 using suitable supports and methods approved by the authority having jurisdiction.
2. Provide independent support from building structure except for cast metal boxes (other than boxes used for fixture support) supported by threaded conduit connections in accordance with NFPA 70. Do not provide support from piping, ductwork, or other systems.
3. Installation Above Suspended Ceilings: Do not provide support from ceiling grid or ceiling support system.
4. Use far-side support to secure flush-mounted boxes supported from single stud in hollow stud walls. Repair or replace supports for boxes that permit excessive movement.

J. Install boxes plumb and level.
K. Flush-Mounted Boxes:
   1. Install boxes in noncombustible materials such as concrete, tile, gypsum, plaster, etc. so that front edge of box or associated raised cover is not set back from finished surface more than 1/4 inch or does not project beyond finished surface.
   2. Install boxes in combustible materials such as wood so that front edge of box or associated raised cover is flush with finished surface.
   3. Repair rough openings around boxes in noncombustible materials such as concrete, tile, gypsum, plaster, etc. so that there are no gaps or open spaces greater than 1/8 inch at the edge of the box.
L. Floor-Mounted Cabinets: Mount on properly sized 3 inch high concrete pad constructed in accordance with Section 03 30 00.
M. Install boxes as required to preserve insulation integrity.
N. Metallic Floor Boxes: Install box level at the proper elevation to be flush with finished floor.
O. Nonmetallic Floor Boxes: Cut box flush with finished floor after concrete pour.
P. Install permanent barrier between ganged wiring devices when voltage between adjacent devices exceeds 300 V.
Q. Install firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods specified.
R. Close unused box openings.
S. Install blank wall plates on junction boxes and on outlet boxes with no devices or equipment installed or designated for future use.
T. Provide grounding and bonding in accordance with Section 26 05 26.
U. Identify boxes in accordance with Section 26 05 53.
   1. Adjust box locations up to 10 feet if required to accommodate intended purpose, at no additional cost to Owner.
V. Orient boxes to accommodate wiring device orientation as specified in Section 26 27 26.
W. Maintain headroom and present neat mechanical appearance.
X. Install pull boxes and junction boxes above accessible ceilings and in unfinished areas only.
Y. Inaccessible Ceiling Areas: Install outlet and junction boxes no more than 6 inches from ceiling access panel or from removable recessed luminaire.
Z. Coordinate mounting heights and locations of outlets mounted above counters, benches, and backsplashes.
AA. Locate outlet boxes to allow luminaires positioned as shown on reflected ceiling plan.
AB. Align adjacent wall mounted outlet boxes for switches, thermostats, and similar devices.
   1. Acoustic rated walls.
      a. In a single stud wall, there shall be a separation of 24 inches between centerlines of outlet boxes or receptacles set into opposite sides of the wall. When these boxes are of dimensions exceeding 4 inches wide, this dimension (24 inches) shall be clear between the side walls, providing a full 24-inch separation regardless of the box size. Conduit connecting such boxes shall be flexible and shall provide 6 inches slack per 24 inches of run.

b. In a double stud wall, boxes in opposite sides of the wall shall be located 24 inches on center, minimum. Effectively, this means that boxes on the same side of the wall will be 48 inches apart if there is a box between them on the other side of the wall. Conduit, in the case of a double wall, shall home run to a point outside of the partition before connecting to cable and conduit connecting boxes on the other side. Conduit, which shall be flexible, may thread through the studs on its own side but shall under no circumstances interface with the stud on the other side of the wall.

c. The boxes shall be treated to reduce sound transmission. All unused knock-out holes shall be plugged with knock-out caps. The openings or cutouts in the walls to receive the boxes/receptacles shall be made no more than 1-1/4 inches oversize to allow a gap all around of 1-1/8 inches. The flanges shall be perimeter sealed with acoustical caulking, prior to the boxes/receptacles being inserted.

d. An outlet box pad, which acts to increase mass and provides damping, shall be applied to the backs of back-to-back electrical boxes separated by less than 24 inches, or where the box is installed in acoustical barrier walls. Refer to architectural wall types.

AC. Use stamped steel bridges to fasten flush mounting outlet box between studs.

AD. Use adjustable steel channel fasteners for hung ceiling outlet box.

AE. Support boxes independently of conduit, except cast box that is connected to two rigid metal conduits both supported within 12 inches of box.

AF. Locate outlet boxes so that the wall plates do not cross masonry joints or span different building finishes.

3.3. CLEANING

A. Clean interior of boxes to remove dirt, debris, plaster and other foreign material.

B. Clean exposed surfaces and restore finish.

3.4. PROTECTION

A. Immediately after installation, protect boxes from entry of moisture and foreign material until ready for installation of conductors.

3.5. INTERFACE WITH OTHER PRODUCTS

A. Coordinate installation of outlet box with products furnished under other sections of these specifications.

B. Coordinate locations and sizes of required access doors.

C. Locate flush mounting box in masonry wall to require cutting of masonry unit corner only. Coordinate masonry cutting to achieve neat opening.

D. Coordinate mounting heights and locations of outlets mounted above counters, benches, and backsplashes with architectural drawings.

END OF SECTION

IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1. SECTION INCLUDES
A. Electrical identification requirements.
B. Identification nameplates and labels.
C. Wire and cable markers.
D. Underground warning tape.

1.2. RELATED REQUIREMENTS
A. Section 09 90 00 - Painting and Coating.
B. Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables: Color coding for power conductors and cables 600 V and less; vinyl color coding electrical tape.

1.3. REFERENCE STANDARDS
A. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
B. NFPA 70E - Standard for Electrical Safety in the Workplace; 2017.

1.4. ADMINISTRATIVE REQUIREMENTS
A. Coordination:
   1. Verify final designations for equipment, systems, and components to be identified prior to fabrication of identification products.
B. Sequencing:
   1. Do not conceal items to be identified, in locations such as above suspended ceilings, until identification products have been installed.
   2. Do not install identification products until final surface finishes and painting are complete.

1.5. QUALITY ASSURANCE
A. Conform to requirements of NFPA 70.

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

PART 2 PRODUCTS

2.1. IDENTIFICATION REQUIREMENTS
A. Existing Work: Unless specifically excluded, identify existing elements to remain whose designations are changed as part of the new work.
B. Identification for Equipment:

1. Use identification nameplate to identify each piece of electrical distribution and control equipment and associated sections, compartments, and components.
   a. Switchboards:
      1. Identify ampere rating.
      2. Identify voltage and phase.
      3. Identify power source.
      4. Use identification nameplate to identify main overcurrent protective device.
      5. Use identification nameplate to identify load(s) served for each branch device. Identify spares.
   b. Panelboards:
      1. Identify ampere rating.
      2. Identify voltage and phase.
      3. Identify power source.
      4. Identify main overcurrent protective device. Use identification label for panelboards with a door. For power distribution panelboards without a door, use identification nameplate.
      5. Use typewritten circuit directory to identify load(s) served for panelboards with a door. Identify spares and spaces. Identify load type, circuit number, breaker size and number of poles, and circuit load in volt-amps.
      6. For power panelboards without a door, use identification nameplate to identify load(s) served for each branch device. Identify spares.
   c. Transformers:
      1. Identify kVA rating.
      2. Identify voltage and phase for primary and secondary.
      3. Identify power source.
      4. Identify load(s) served.
   d. Enclosed switches, circuit breakers, and motor controllers:
      1. Identify voltage and phase.
      2. Identify power source.
      3. Identify load(s) served.
   e. Busway:
      1. Identify ampere rating.
      2. Identify voltage and phase.
      3. Identify power source.
      4. Provide identification at maximum intervals of 40 feet, minimum of one label per floor.
      5. Use identification nameplate to identify load(s) served for each plug-in unit.
   f. Time Switches:
      1. Identify load(s) served and associated circuits controlled. Include location.
   g. Enclosed Contactors:
      1. Identify voltage and phase.

2. Identify configuration, e.g., E.O.E.H. (electrically operated, electrically held) or E.O.M.H. (electrically operated, mechanically held).
3. Identify coil voltage.
4. Identify load(s) and associated circuits controlled. Include location.

2. Service Equipment:
   a. Use identification nameplate to identify each service disconnecting means.
   b. For buildings or structures supplied by more than one service, or any combination of branch circuits, feeders, and services, use identification nameplate acceptable to authority having jurisdiction at each service disconnecting means to identify all other services, feeders, and branch circuits supplying that building or structure. Verify format and descriptions with authority having jurisdiction.
   c. Use identification nameplate or identification label at each piece of service equipment to identify the available fault current and the date calculations were performed.
3. Emergency System Equipment:
   a. Use identification nameplate to identify emergency system equipment in accordance with NFPA 70.
   b. Use identification nameplate or identification label at each piece of service equipment to identify type and location of on-site emergency power sources.
   c. Use identification nameplate or identification label to identify emergency operating instructions for emergency system equipment.
4. Use voltage marker or identification label to identify highest voltage present for each piece of electrical equipment with voltage 480 V or higher.
5. Use identification nameplate or identification label to identify equipment utilizing series ratings, where permitted, in accordance with NFPA 70.
6. Use identification nameplate to identify disconnect location for equipment with remote disconnecting means.
7. Use identification label, identification nameplate, or handwritten text using indelible marker on inside of door at each motor controller to identify nameplate horsepower, full load amperes, code letter, service factor, voltage, and phase of motor(s) controlled.
8. Arc Flash Hazard Warning Labels: Use warning labels to identify arc flash hazards for electrical equipment, such as switchboards, panelboards, industrial control panels, meter socket enclosures, and motor control centers that are likely to require examination, adjustment, servicing, or maintenance while energized.
   a. Minimum Size: 5 by 7 inches.
   b. Legend: Include orange header that reads "WARNING", followed by the word message "Arc Flash and Shock Hazard; Appropriate PPE Required; Do not operate controls or open covers without appropriate personal protection equipment; Failure to comply may result in injury or death; Refer to NFPA 70E for minimum PPE requirements" or approved equivalent.

c. Legend: Provide custom legend in accordance with NFPA 70E based on equipment-specific data as indicated on the drawings:
   1. Include orange header that reads "WARNING" where calculated incident energy is less than 40 calories per square cm.
   2. Include red header that reads "DANGER" where calculated incident energy is 40 calories per square cm or greater.
   3. Include the text "Arc Flash and Shock Hazard; Appropriate PPE Required" or approved equivalent.
   4. Include the following information:
      a. Arc flash protection boundary.
      b. Incident energy.
      c. Hazard/risk category.
      d. PPE (personnel protective equipment) requirements.
      e. Nominal voltage.
      f. Shock hazard condition.
      g. Limited approach boundary.
      h. Restricted approach boundary.
      i. Prohibited approach boundary.
      j. Equipment identification.
      k. Date calculations were performed.

C. Identification for Conductors and Cables:
   1. Color Coding for Power Conductors 600 V and Less: Comply with Section 26 05 19.

      480/277V, 3 Phase, 4 Wire System
      Phase A - Brown
      Phase B - Orange
      Phase C - Yellow
      Neutral - Gray
      Ground - Green

      Less than 250 Volts Between Phases:
      Phase A - Black
      Phase B - Red
      Phase C - Blue
      Neutral - White
      Ground - Green

   2. Identification for Communications Conductors and Cables: Comply with Section 27 10 00.
   3. Use wire and cable markers to identify circuit number or other designation indicated for power, control, and instrumentation conductors and cables at the following locations:

a. At each source and load connection.
b. Within boxes when more than one circuit is present.
c. Within equipment enclosures when conductors and cables enter or leave the enclosure.

4. Use wire and cable markers to identify connected grounding electrode system components for grounding electrode conductors.
5. Use underground warning tape to identify direct buried cables.

D. Identification for Raceways:
1. Use underground warning tape to identify underground raceways.

E. Identification for Boxes:
1. Fire Alarm System: Red.
2. For exposed boxes in public areas, do not color code.
3. Use handwritten text using indelible marker to identify circuits enclosed.
a. For exposed boxes in public areas, provide identification on inside face of cover.

F. Identification for Devices:
1. Identification for Communications Devices: Comply with Section 27 10 00.
2. Use identification label to identify serving branch circuit for all receptacles.
3. Use identification label to identify receptacles protected by upstream GFI protection, where permitted.

2.2. IDENTIFICATION NAMEPLATES AND LABELS

A. Identification Nameplates:
1. Manufacturers:
a. Brimar Industries, Inc: www.brimar.com.
b. Kolbi Pipe Marker Co: www.kolbipipemarkers.com.
c. Seton Identification Products: www.seton.com.
d. Substitutions: See Section 01 60 00 - Materials and Equipment.
2. Materials:
a. Indoor Clean, Dry Locations: Use plastic nameplates.
b. Outdoor Locations: Use plastic, stainless steel, or aluminum nameplates suitable for exterior use.
3. Plastic Nameplates: Two-layer or three-layer laminated electrically non-conductive phenolic with beveled edges; minimum thickness of 1/16 inch; engraved text.
a. Exception: Provide minimum thickness of 1/8 inch when any dimension is greater than 4 inches.
4. Stainless Steel Nameplates: Minimum thickness of 1/32 inch; engraved or laser-etched text.
5. Aluminum Nameplates: Anodized; minimum thickness of 1/32 inch; engraved or laser-etched text.
6. Mounting Holes for Mechanical Fasteners: Two, centered on sides for sizes up to 1 inch high; Four, located at corners for larger sizes.

B. Identification Labels:

1. Manufacturers:
    a. Brady Corporation: www.bradyid.com.
    b. Brother International Corporation: www.brother-usa.com.
    c. Panduit Corp: www.panduit.com.
    d. Substitutions: See Section 01 60 00 - Materials and Equipment.
2. Materials: Use self-adhesive laminated plastic labels; UV, chemical, water, heat, and abrasion resistant.
    a. Use only for indoor locations.
3. Text: Use factory pre-printed or machine-printed text. Do not use handwritten text unless otherwise indicated.

2.3. WIRE AND CABLE MARKERS

A. Manufacturers:
    1. Brady Corporation: www.bradyid.com.
    2. HellermannTyton: www.hellermanntyton.com.
    3. Panduit Corp: www.panduit.com.
    4. Substitutions: See Section 01 60 00 - Materials and Equipment.
B. Markers for Conductors and Cables: Use wrap-around self-adhesive vinyl cloth, wrap-around self-adhesive vinyl self-laminating, heat-shrink sleeve, plastic sleeve, or vinyl split sleeve type markers suitable for the conductor or cable to be identified.
    1. Do not use self-adhesive type markers.
C. Markers for Conductor and Cable Bundles: Use plastic marker tags secured by nylon cable ties.
D. Legend: Power source and circuit number or other designation indicated.
E. Text: Use factory pre-printed or machine-printed text, all capitalized unless otherwise indicated.
    1. Do not use handwritten text.
F. Minimum Text Height: 1/8 inch.
G. Color: Black text on white background unless otherwise indicated.

2.4. UNDERGROUND WARNING TAPE

A. Manufacturers:
    1. Brady Corporation: www.bradyid.com.
    2. Brimar Industries, Inc: www.brimar.com.
    3. Seton Identification Products: www.seton.com.
    4. Substitutions: See Section 01 60 00 - Materials and Equipment.
B. Materials: Use non-detectable type OR foil-backed detectable type polyethylene tape suitable for direct burial, unless otherwise indicated.
    1. Exception: Use foil-backed detectable type tape where required by serving utility or as noted.
        a. Non-detectable Type Tape: 3 inches wide, with minimum thickness of 4 mil.
    2. Foil-backed Detectable Type Tape: 3 inches wide, with minimum thickness of 5 mil, unless otherwise required for proper detection.

C. Legend: Type of service, continuously repeated over full length of tape.
D. Color:
   1. Tape for Buried Power Lines: Black text on red background.
   2. Tape for Buried Communication, Alarm, and Signal Lines: Black text on orange background.

PART 3 EXECUTION

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

3.2. INSTALLATION
A. Install products in accordance with manufacturer's instructions.
B. Install identification products to be plainly visible for examination, adjustment, servicing, and maintenance. Unless otherwise indicated, locate products as follows:
   1. Surface-Mounted Equipment: Enclosure front.
   2. Flush-Mounted Equipment: Inside of equipment door or enclosure front.
   3. Free-Standing Equipment: Enclosure front; also enclosure rear for equipment with rear access.
   4. Elevated Equipment: Legible from the floor or working platform.
   5. Branch Devices: Adjacent to device.
   6. Interior Components: Legible from the point of access.
   7. Conduits: Legible from the floor.
   8. Boxes: Outside face of cover unless otherwise noted.
   9. Conductors and Cables: Legible from the point of access.
   10. Devices: Outside face of cover.
C. Install identification products centered, level, and parallel with lines of item being identified.
D. Secure nameplates to exterior surfaces of enclosures using stainless steel screws, rivets, self-adhesive backing, or epoxy cement and to interior surfaces using self-adhesive backing or epoxy cement.
   1. Do not use adhesives on exterior surfaces except where substrate can not be penetrated.
E. Install self-adhesive labels and markers to achieve maximum adhesion, with no bubbles or wrinkles and edges properly sealed.
F. Install underground warning tape above buried lines with one tape per trench at 6 inches below finished grade. For trenches over 18 inches wide, install additional marker tape such that they are not over 10 inches apart (edge to edge) over the entire width of the trench.
G. Secure rigid signs using stainless steel screws.
H. Mark all handwritten text, where permitted, to be neat and legible.

3.3. FIELD QUALITY CONTROL

A. See Section 01 45 00 - Contractor's Quality Control Program, for additional requirements.

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

END OF SECTION

LOW-VOLTAGE TRANSFORMERS

PART 1 GENERAL

1.1. SECTION INCLUDES
A. Shielded transformers.

1.2. RELATED REQUIREMENTS
A. Section 26 05 26 - Grounding and Bonding for Electrical Systems.
B. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.

1.3. REFERENCE STANDARDS
A. IEEE C57.94 - IEEE Recommended Practice for Installation, Application, Operation, and Maintenance of Dry-Type Distribution and Power Transformers; 2015.
B. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2015.
C. NECA 409 - Standard for Installing and Maintaining Dry-Type Transformers; 2015.
D. NEMA ST 20 - Dry-Type Transformers for General Applications; 2014.
E. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2014.
F. NEMA TP 1 - Guide for Determining Energy Efficiency for Distribution Transformers; National Electrical Manufacturers Association; 2002.
G. NEMA TP 2 - Standard Test Method for Measuring the Energy Consumption of Distribution Transformers; National Electrical Manufacturers Association; 2005.
H. NEMA TP 3 - Standard for the Labeling of Distribution Transformer Efficiency; National Electrical Manufacturers Association; 2000.
I. NETA ATS - Acceptance Testing Specifications for Electrical Power Equipment and Systems; 2017.
J. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
K. UL 506 - Standard for Specialty Transformers; Current Edition, Including All Revisions.
L. UL 1561 - Standard for Dry-Type General Purpose and Power Transformers; Current Edition, Including All Revisions.

1.4. ADMINISTRATIVE REQUIREMENTS
A. Coordination: Coordinate the work with placement of support framing and anchors required for mounting of transformers.

1.5. SUBMITTALS
A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Product Data: Include voltage, kVA, impedance, tap configurations, insulation system class and rated temperature rise, efficiency, sound level, enclosure ratings, outline and support point dimensions, weight, required clearances, service condition requirements, and installed features.
   1. Vibration Isolators: Include attachment method and rated load and deflection.

2. Shielded Transformers: Include shielding method and noise attenuation performance.
3. Small Power Centers: Include panelboard bus ampacity, integrated short circuit ampere rating, and circuit breaker sizes and ampere ratings.

C. Shop Drawings: Provide dimensioned plan and elevation views of transformers and adjacent equipment with all required clearances indicated.
1. Small Power Centers: Include panel arrangements.

D. Source Quality Control Test Reports: Include reports for tests designated in NEMA ST 20 as design and routine tests.

E. Field Quality Control Test Reports.

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

G. Maintenance Data: Include recommended maintenance procedures and intervals.

H. Project Record Documents: Record actual locations of transformers.

1.6. QUALITY ASSURANCE

A. Conform to requirements of NFPA 70.

B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.

1.7. DELIVERY, STORAGE, AND HANDLING

A. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.

B. Handle in accordance with manufacturer's written instructions. Lift only with lugs provided for the purpose. Handle carefully to avoid damage to transformer internal components, enclosure, and finish.

1.8. FIELD CONDITIONS

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

1.9. WARRANTY

A. See Section 01 77 00 - Contract Closeout, for additional warranty requirements.

PART 2 PRODUCTS

2.1. MANUFACTURERS

A. Eaton Corporation: www.eaton.com.

B. General Electric Company: www.geindustrial.com/#sle.

C. Schneider Electric; Square D Products: www.schneider-electric.us/#sle.

D. Siemens.
E. Source Limitations: Furnish transformers produced by the same manufacturer as the other electrical distribution equipment used for this project and obtained from a single supplier.

2.2. SHIELDED TRANSFORMERS

A. Description: Self-cooled, two winding, shielded isolation transformers listed and labeled as complying with UL 506 or UL 1561; ratings as indicated on the drawings.
B. Primary Voltage: As indicated on Drawings.
C. Secondary Voltage: As indicated on Drawings.
D. Insulation System and Allowable Average Winding Temperature Rise:
   1. Less than 15 kVA: Class 185 degrees C insulation system with 115 degrees C average winding temperature rise.
   2. 15 kVA and Larger: Class 220 degrees C insulation system with 150 degrees C average winding temperature rise.
E. Coil Conductors: Continuous aluminum windings with terminations brazed or welded.
F. Winding Taps:
   1. Less than 3 kVA: None.
   2. 3 kVA through 15 kVA: Two 5 percent full capacity primary taps below rated voltage.
   3. 15 kVA through 300 kVA: Two 2.5 percent full capacity primary taps above and four 2.5 percent full capacity primary taps below rated voltage.
   4. 500 kVA and Larger: Two 2.5 percent full capacity primary taps above and two 2.5 percent full capacity primary taps below rated voltage.
G. Energy Efficiency: Standard efficiency complying with NEMA TP 1.
   1. Test efficiency according to NEMA TP 2.
   2. Label transformer according to NEMA TP 3.
H. Sound Levels: Standard sound levels complying with NEMA ST 20.
I. Winding Shield: Electrostatic, with separate insulated grounding connection.
J. Mounting Provisions:
   1. Less than 15 kVA: Suitable for wall mounting.
   2. 15 kVA through 75 kVA: Suitable for wall, floor, or trapeze mounting.
   3. Larger than 75 kVA: Suitable for floor mounting.
K. Transformer Enclosure: Comply with NEMA ST 20.
   1. Environment Type per NEMA 250: Unless otherwise indicated, as specified for the following installation locations:
      a. Indoor clean, dry locations: Type 2.
      b. Outdoor locations: Type 3R.
   2. Construction: Heavy gage steel.
      a. Less than 15 kVA: Totally enclosed, non-ventilated.
      b. 15 kVA and Larger: Ventilated.
   3. Finish: Manufacturer's standard grey, suitable for outdoor installations.
   4. Provide lifting eyes or brackets.
L. Accessories:

1. Mounting Brackets: Provide manufacturer's standard brackets.
2. Weathershield Kits: Provide for ventilated transformers installed outdoors to provide a listed NEMA 250, type 3R assembly.
3. Lug Kits: Sized as required for termination of conductors as indicated on the drawings.

M. All lugs shall be field replaceable compression type.

2.3. SOURCE QUALITY CONTROL

A. Factory test transformers according to NEMA ST 20.

B. Sound Level Tests: Perform factory test designated in NEMA ST 20 as "design" test on each production unit.

PART 3 EXECUTION

3.1. EXAMINATION

A. Verify that field measurements are as shown on the drawings.

B. Verify that suitable support frames and anchors are installed where required and that mounting surfaces are ready to receive transformers.

C. Perform pre-installation tests and inspections on transformers per manufacturer's instructions and as specified in NECA 409. Correct deficiencies prior to installation.

D. Verify that conditions are satisfactory for installation prior to starting work.

3.2. INSTALLATION

A. Perform work in a neat and workmanlike manner in accordance with NECA 1.

B. Install transformers in accordance with manufacturer's instructions.

C. Install transformers in accordance with NECA 409 and IEEE C57.94.

D. Use flexible conduit, under the provisions of Section 26 05 34, 2 feet minimum length, for connections to transformer case. Make conduit connections to side panel of enclosure.

E. Arrange equipment to provide minimum clearances as specified on transformer nameplate and in accordance with manufacturer's instructions and NFPA 70.

F. Set transformers plumb and level.

G. Mount wall-mounted transformers using integral flanges or accessory brackets furnished by the manufacturer.

H. Mount floor-mounted transformers on properly sized 3 inch high concrete pad constructed.

I. Mount floor-mounted transformers using vibration isolators suitable for isolating the transformer noise from the building structure.

J. Mount trapeze-mounted transformers as indicated.

K. Provide seismic restraints.

L. Provide grounding and bonding in accordance with Section 26 05 26.

M. Remove shipping braces and adjust bolts that attach the core and coil mounting bracket to the enclosure according to manufacturer's recommendations in order to reduce audible noise transmission.
N. Where not factory-installed, install lugs sized as required for termination of conductors as shown on the drawings.
O. Where furnished as a separate accessory, install transformer weathershield per manufacturer's instructions.
P. Identify transformers in accordance with Section 26 05 53.

3.3. FIELD QUALITY CONTROL

A. Perform field inspection, testing, and adjusting in accordance with Section 01 40 00.
B. Inspect and test in accordance with NETA ATS, except Section 4.
C. Perform inspections and tests listed in NETA ATS Sections 7.2.1.1 and 7.2.1.2. Tests and inspections listed as optional are not required.
    1. 167 kVA single phase, 500 kVA three phase and smaller:
        a. Perform turns ratio tests at all tap positions.
    2. Larger than 167 kVA single phase and 500 kVA three phase:
        a. Verify that control and alarm settings on temperature indicators are as specified.
        b. Perform excitation-current tests on each phase.
        c. Measure the resistance of each winding at each tap connection.
        d. Perform an applied voltage test on all high- and low-voltage windings-to-ground.

3.4. ADJUSTING

A. Measure primary and secondary voltages and make appropriate tap adjustments.
B. Adjust tightness of mechanical and electrical connections to manufacturer's recommended torque settings.

3.5. CLEANING

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

END OF SECTION

SWITCHBOARDS

PART 1 GENERAL

1.1. SECTION INCLUDES
A. Switchboards.
B. Metering transformer cabinets.
C. Meter bases.

1.2. RELATED REQUIREMENTS
A. Section 03 30 00 - Cast-in-Place Concrete: Concrete for supporting foundations and pads.
B. Section 26 05 26 - Grounding and Bonding for Electrical Systems.
C. Section 26 05 29 - Hangers and Supports for Electrical Systems.

1.3. REFERENCE STANDARDS
A. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2015.
B. NEMA KS 1 - Heavy Duty Enclosed and Dead-Front Switches (600 Volts Maximum); 2013.
C. NEMA PB 2 - Deadfront Distribution Switchboards; 2011.
D. NEMA PB 2.1 - General Instructions for Proper Handling, Installation, Operation, and Maintenance of Deadfront Distribution Switchboards Rated 600 Volts or Less; 2013.
E. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
F. UL 891 - Standard for Safety Switchboards; Underwriters Laboratories, Inc.; 2005.

1.4. SUBMITTALS
A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Product Data: Provide electrical characteristics including voltage, frame size and trip ratings, fault current withstand ratings, and time-current curves of all equipment and components.
C. Shop Drawings: Indicate front and side views of enclosures with overall dimensions shown; conduit entrance locations and requirements; nameplate legends; size and number of bus bars per phase, neutral, and ground; and switchboard instrument details.
D. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.
E. Project Record Documents: Record actual locations of switchboards.
F. Maintenance Data: Recommended maintenance procedures and intervals.
G. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
    1. See Section 01 60 00 - Materials and Equipment, for additional provisions.
    2. Enclosure Keys: Two of each different key.

1.5. QUALITY ASSURANCE
A. Conform to requirements of NFPA 70.

B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section.
C. Perform work in accordance with utility company written requirements and NFPA 70.
   1. Maintain one copy of each document on site.
D. Products: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

1.6. DELIVERY, STORAGE, AND HANDLING

A. Deliver in 48 inch maximum width shipping splits, individually wrapped for protection and mounted on shipping skids.
B. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.
C. Handle in accordance with NEMA PB 2.1 and manufacturer's written instructions. Lift only with lugs provided for the purpose. Handle carefully to avoid damage to switchboard internal components, enclosure, and finish.

PART 2 PRODUCTS

2.1. MANUFACTURERS

A. Eaton Electrical: www.eatonelectrical.com.
B. General Electric Company: www.geindustrial.com.
C. Schneider Electric; Square D Products: www.schneider-electric.us.
D. Siemens: www.sea.siemens.com.

2.2. SWITCHBOARDS

A. Description: NEMA PB 2 switchboard with electrical ratings and configurations as indicated and specified.
B. Ratings:
   1. Voltage and bus ampacity rating: As indicated on drawings.
   2. Integrated Equipment Rating: Rating shall exceed available utility fault current.
   3. Main service board shall be service entrance rated.
C. Bus Material: Copper or aluminum with tin plating, standard size.
D. Bus Connections: Bolted, accessible from front for maintenance.
E. Ground Bus: Extend length of switchboard.
F. Insulated Ground Bus: Extend length of switchboard.
G. Fusible Switch Assemblies: NEMA KS 1, load interrupter enclosed knife switch with externally operable handle. Provide interlock to prevent opening front cover with switch in ON position. Handle lock in OFF position. Fuse clips: Designed to accommodate Class R or Class J fuses, type as specified.
H. Fusible Switch Assemblies, 800 Amperes and Larger: Bolted pressure contact switches. Fuse clips: Designed to accommodate Class L fuses.

I. Molded Case Circuit Breakers: Integral thermal and instantaneous magnetic trip in each pole.
   1. Provide circuit breakers UL listed as Type HACR for air conditioning equipment branch circuits.
   2. Include shunt trip where indicated.

J. Line and Load Terminations: Accessible from the front only of the switchboard, suitable for the conductor materials and sizes indicated.

K. Metering Transformer Compartment: For utility company's use; compartment size, bus spacing and drilling, door, and locking and sealing requirements in accordance with utility company's requirements.

L. Future Provisions: Fully equip spaces for future devices with bussing and bus connections, suitably insulated and braced for short circuit currents. Provide continuous current rating as indicated.

M. Pull Box: Removable top and sides, same construction as switchboard.
   1. Size as shown on Drawings.
   2. Set front back sufficient distance to accommodate circuit breaker lifting devices.
   3. Provide insulating, fire-resistive bottom with separate openings for each circuit to pass into switchboard.

N. Enclosure: Type 1 - General Purpose.
   1. Align sections at rear only.
   2. Switchboard Height: 90 inches, excluding floor sills, lifting members and pull boxes.
   3. Finish: Manufacturer's standard light gray enamel over external surfaces. Coat internal surfaces with minimum one coat corrosion-resisting paint, or plate with cadmium or zinc.

2.3. COMPONENTS

A. Metering Transformer Cabinets: Sheet metal cabinet with hinged door, conforming to utility company requirements, with provisions for locking and sealing.
   1. Size: As required by utility.

B. Meter Base: As required by utility company.

C. Provide a voltage and KW demand digital meter for each switchboard.

D. Provide external TVSS devices for each switchboard.

2.4. SOURCE QUALITY CONTROL

A. Shop inspect and test switchboard according to NEMA PB 2.

PART 3 EXECUTION

3.1. PREPARATION

A. Provide concrete housekeeping pad under the provisions of Section 03 30 00.

B. Arrange with utility company to obtain permanent electric service to the Project.

C. Verify that field measurements are as instructed by manufacturer and as indicated on utility company drawings.

3.2. INSTALLATION

A. Install products in accordance with manufacturer's instructions.
B. Install switchboards in accordance with NECA 1 (general workmanship), NECA 400, and NEMA PB 2.1.
C. Arrange equipment to provide required clearances and maintenance access, including accommodations for any drawout devices.
D. Where switchboard is indicated to be mounted with inaccessible side against wall, provide minimum clearance of 1/2 inch between switchboard and wall.
E. Provide required support and attachment components in accordance with Section 26 05 29.
F. Install switchboards plumb and level.
G. Unless otherwise indicated, mount switchboards on properly sized 4 inch high concrete pad constructed in accordance with Section 03 30 00.
H. Provide grounding and bonding in accordance with Section 26 05 26.
I. Install all field-installed devices, components, and accessories.
J. Where accessories are not self-powered, provide control power source as indicated or as required to complete installation.
K. Provide filler plates to cover unused spaces in switchboards.
L. Install switchboard in locations shown on drawings, according to NEMA PB 2.1.
M. Install transformer pad and/or vault, metering transformer cabinets, and meter base as required by utility company.
N. Install in a neat and workmanlike manner, as specified in NECA 400.
O. Tighten accessible bus connections and mechanical fasteners after placing switchboard.
P. Install fuses in each switch.

3.3. FIELD QUALITY CONTROL

A. Perform field testing in accordance with Section 01 40 00.

3.4. ADJUSTING

A. Adjust all operating mechanisms for free mechanical movement.
B. Tighten bolted bus connections in accordance with manufacturer's instructions.
C. For systems with adjustable trip circuit breakers, provide coordination study for review. Adjust circuit breaker trip and time delay settings to values indicated on coordination study. Submit to Architect for review.

3.5. CLEANING

A. Touch up scratched or marred surfaces to match original finish.

END OF SECTION

PANELBOARDS

PART 1 GENERAL

1.1. SECTION INCLUDES

A. Power distribution panelboards.
B. Overcurrent protective devices for panelboards.

1.2. RELATED REQUIREMENTS

A. Section 26 05 26 - Grounding and Bonding for Electrical Systems.
B. Section 26 05 26 - Grounding and Bonding for Electrical Systems.
C. Section 26 05 29 - Hangers and Supports for Electrical Systems.
D. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.

1.3. REFERENCE STANDARDS

A. FS W-C-375 - Circuit Breakers, Molded Case; Branch Circuit and Service; Federal Specification; Revision E, 2013.
B. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2015.
C. NECA 407 - Standard for Installing and Maintaining Panelboards; 2009.
D. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2014.
E. NEMA PB 1 - Panelboards; 2011.
F. NEMA PB 1.1 - General Instructions for Proper Installation, Operation and Maintenance of Panelboards Rated 600 Volts or Less; 2013.
G. NETA ATS - Acceptance Testing Specifications for Electrical Power Equipment and Systems; 2017.
H. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
I. UL 50 - Enclosures for Electrical Equipment, Non-Environmental Considerations; Current Edition, Including All Revisions.
J. UL 50E - Enclosures for Electrical Equipment, Environmental Considerations; Current Edition, Including All Revisions.
K. UL 67 - Panelboards; Current Edition, Including All Revisions.
L. UL 489 - Molded-Case Circuit Breakers, Molded-Case Switches and Circuit Breaker Enclosures; Current Edition, Including All Revisions.
M. UL 869A - Reference Standard for Service Equipment; Current Edition, Including All Revisions.
N. UL 943 - Ground-Fault Circuit-Interrupters; Current Edition, Including All Revisions.
O. UL 1053 - Ground-Fault Sensing and Relaying Equipment; Current Edition, Including All Revisions.
P. UL 1699 - Arc-Fault Circuit-Interrupters; Current Edition, Including All Revisions.

1.4. ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Coordinate the work with other trades to avoid placement of ductwork, piping, equipment, or other potential obstructions within the dedicated equipment spaces and working clearances for electrical equipment required by NFPA 70.
2. Coordinate arrangement of electrical equipment with the dimensions and clearance requirements of the actual equipment to be installed.
3. Coordinate the work with other trades to provide walls suitable for installation of flush-mounted panelboards where indicated.
4. Verify with manufacturer that conductor terminations are suitable for use with the conductors to be installed.
5. Notify Architect of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.

1.5. SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide manufacturer's standard catalog pages and data sheets for panelboards, enclosures, overcurrent protective devices, and other installed components and accessories.

C. Shop Drawings: Indicate outline and support point dimensions, voltage, main bus ampacity, overcurrent protective device arrangement and sizes, short circuit current ratings, conduit entry locations, conductor terminal information, and installed features and accessories.

D. Field Quality Control Test Reports.

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

F. Project Record Documents: Record actual installed locations of panelboards and actual installed circuiting arrangements.

G. Maintenance Data: Include information on replacement parts and recommended maintenance procedures and intervals.

H. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
   1. See Section 01 60 00 - Materials and Equipment, for additional provisions.
   2. Panelboard Keys: One for each panelboard installed.

1.6. QUALITY ASSURANCE

A. Conform to requirements of NFPA 70.

B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.

C. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section.

1.7. DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store panelboards in accordance with manufacturer's instructions and NECA 407.

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

1.8. FIELD CONDITIONS

A. Maintain ambient temperature within the following limits during and after installation of panelboards:
   1. Panelboards Containing Circuit Breakers: Between 23 degrees F and 104 degrees F.

PART 2 PRODUCTS

2.1. MANUFACTURERS

A. Eaton Corporation; Cutler-Hammer Products: www.eaton.com.
B. General Electric Company: www.geindustrial.com.
C. Schneider Electric; Square D Products: www.schneider-electric.us.
D. Siemens.
E. Substitutions: See Section 01 60 00 - Materials and Equipment.
F. Source Limitations: Furnish panelboards and associated components produced by the same manufacturer as the other electrical distribution equipment used for this project and obtained from a single supplier.

2.2. ALL PANELBOARDS

A. Provide products listed and labeled by Underwriters Laboratories Inc. as suitable for the purpose indicated.
B. Unless otherwise indicated, provide products suitable for continuous operation under the following service conditions:
   1. Altitude: Less than 6,600 feet.
   2. Ambient Temperature:
      a. Panelboards Containing Circuit Breakers: Between 23 degrees F and 104 degrees F.
C. Short Circuit Current Rating:
   1. Provide panelboards with listed short circuit current rating not less than the available fault current at the installed location.
   2. Listed series ratings are acceptable, except where not permitted by motor contribution according to NFPA 70, acceptable only where specifically indicated, or not acceptable.
   3. Label equipment utilizing series ratings as required by NFPA 70.
D. Panelboards Used for Service Entrance: Listed and labeled as suitable for use as service equipment according to UL 869A.
E. All panelboards shall have door-in-door type front covers

F. Branch Overcurrent Protective Devices: Replaceable without disturbing adjacent devices.
G. Bussing: Sized in accordance with UL 67 temperature rise requirements.
   1. Provide fully rated neutral bus, with a suitable lug for each feeder or branch circuit requiring a neutral connection.
   2. Provide 200 percent rated neutral bus and lugs where oversized neutral conductors are provided.
   3. Provide solidly bonded equipment ground bus in each panelboard, with a suitable lug for each feeder and branch circuit equipment grounding conductor.
   4. Provide separate isolated/insulated ground bus where indicated.
H. Conductor Terminations: Suitable for use with the conductors to be installed.
I. Enclosures: Comply with NEMA 250, and list and label as complying with UL 50 and UL 50E.
   1. Environment Type per NEMA 250: Unless otherwise indicated, as specified for the following installation locations:
      a. Indoor Clean, Dry Locations: Type 1.
      b. Outdoor Locations: Type 3R.
   2. Boxes: Galvanized steel unless otherwise indicated.
      a. Provide wiring gutters sized to accommodate the conductors to be installed.
      b. Increase gutter space as required where sub-feed lugs, feed-through lugs, gutter taps, or oversized lugs are provided.
      c. Provide removable end walls for NEMA Type 1 enclosures.
      d. Provide painted steel boxes for surface-mounted panelboards, finish to match fronts.
   3. Fronts:
      a. Fronts for Surface-Mounted Enclosures: Same dimensions as boxes.
      b. Finish for Painted Steel Fronts: Manufacturer's standard grey unless otherwise indicated.
   4. Lockable Doors: All locks keyed alike unless otherwise indicated.
J. Future Provisions: Prepare all unused spaces for future installation of devices including bussing, connectors, mounting hardware and all other required provisions.
K. Ground Fault Protection: Where ground-fault protection is indicated, provide system listed and labeled as complying with UL 1053.
   1. Where electronic circuit breakers equipped with integral ground fault protection are used, provide separate neutral current sensor where applicable.
   2. Where accessory ground fault sensing and relaying equipment is used, equip companion overcurrent protective devices with ground-fault shunt trips.
      a. Use zero sequence ground fault detection method unless otherwise indicated.
      b. Provide test panel and field-adjustable ground fault pick-up and delay settings.
L. Selectivity: Where the requirement for selectivity is indicated, furnish products as required to achieve selective coordination.
M. Provide the following features and accessories where indicated or where required to complete installation:

1. Feed-through lugs.
2. Main breaker.
3. Double lugs.

2.3. POWER DISTRIBUTION PANELBOARDS

A. Description: Panelboards complying with NEMA PB 1, power and feeder distribution type, circuit breaker type, and listed and labeled as complying with UL 67; ratings, configurations and features as indicated on the drawings.

B. Conductor Terminations:
   1. Main and Neutral Lug Material: Aluminum, suitable for terminating aluminum or copper conductors.
   2. Main and Neutral Lug Type: Compression.

C. Bussing:
   1. Phase and Neutral Bus Material: Aluminum or copper.
   2. Ground Bus Material: Copper.

D. Circuit Breakers:
   1. Provide bolt on type.
   2. Provide thermal magnetic circuit breakers unless otherwise indicated.

E. Enclosures:
   1. Provide surface-mounted enclosures as indicated.
   2. Fronts: Provide trims to cover access to load terminals, wiring gutters, and other live parts, with exposed access to overcurrent protective device handles.

2.4. OVERCURRENT PROTECTIVE DEVICES

A. Molded Case Circuit Breakers:
   1. Description: Quick-make, quick-break, over center toggle, trip-free, trip-indicating circuit breakers listed and labeled as complying with UL 489, and complying with FS W-C-375 where applicable; ratings, configurations, and features as indicated on the drawings.
   2. Interrupting Capacity:
      a. Provide circuit breakers with interrupting capacity as required to provide the short circuit current rating indicated, but not less than:
         1. 10,000 rms symmetrical amperes at 240 VAC or 208 VAC.
         2. 14,000 rms symmetrical amperes at 480 VAC.
      b. Fully Rated Systems: Provide circuit breakers with interrupting capacity not less than the short circuit current rating indicated.
      c. Series Rated Systems: Provide circuit breakers listed in combination with upstream devices to provide interrupting rating not less than the short circuit current rating indicated.
   3. Conductor Terminations:
      a. Provide mechanical lugs for circuit breaker frame sizes less than 400 amperes.
      b. Provide compression lugs for circuit breaker frame sizes 400 amperes and above.

c. Lug Material: Aluminum, suitable for terminating aluminum or copper conductors of full breaker ampacity rating.

4. Thermal Magnetic Circuit Breakers: For each pole, furnish thermal inverse time tripping element for overload protection and magnetic instantaneous tripping element for short circuit protection.
   a. Provide field-adjustable magnetic instantaneous trip setting for circuit breaker frame sizes 225 amperes and larger.
   b. Provide interchangeable trip units for circuit breaker frame sizes 400 amperes and larger.
5. Multi-Pole Circuit Breakers: Furnish with common trip for all poles.
6. Provide the following circuit breaker types where indicated:
   a. Ground Fault Circuit Interrupter (GFCI) Circuit Breakers: Listed as complying with UL 943, class A for protection of personnel.
   b. Ground Fault Equipment Protection Circuit Breakers: Designed to trip at 30 mA for protection of equipment.
   c. Arc-Fault Circuit Interrupter (AFCI) Circuit Breakers: Combination type listed as complying with UL 1699. Provide where required by applicable cable.
7. Provide listed switching duty rated circuit breakers with SWD marking for all branch circuits serving lighting.
8. Provide listed high intensity discharge lighting rated circuit breakers with HID marking for all branch circuits serving HID lighting.
9. Do not use tandem circuit breakers.
10. Do not use handle ties in lieu of multi-pole circuit breakers.

2.5. SOURCE QUALITY CONTROL

A. Factory test panelboards according to NEMA PB 1.

PART 3 EXECUTION

3.1. EXAMINATION

A. Verify that field measurements are as shown on the drawings.
B. Verify that the ratings and configurations of the panelboards and associated components are consistent with the indicated requirements.
C. Verify that mounting surfaces are ready to receive panelboards.
D. Verify that conditions are satisfactory for installation prior to starting work.

3.2. INSTALLATION

A. Install products in accordance with manufacturer's instructions.
B. Install panelboards securely, in a neat and workmanlike manner in accordance with NECA 1 (general workmanship), NECA 407 (panelboards), and NEMA PB 1.1.
C. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and NFPA 70.

D. Provide required supports in accordance with Section 26 05 29.
E. Install panelboards plumb.
F. Install flush-mounted panelboards so that trims fit completely flush to wall with no gaps and rough opening completely covered.
G. Mount panelboards such that the top of panelboard is 6 feet 6 inches above the floor or working platform. Install panelboards taller than 6 feet with bottom no more than 4 inches above the floor.
H. Mount floor-mounted power distribution panelboards on properly sized 3 inch or 4 inch high concrete pad constructed in accordance with Section 03 30 00.
I. Provide spare 1 inch trade size conduits out of each flush-mounted panelboard stubbed into accessible space above ceiling.
    1. 1 empty 1 inch for every 6 spare breaker pole spaces and spare breakers.
J. Provide grounding and bonding in accordance with Section 26 05 26.
    1. Terminate branch circuit equipment grounding conductors on solidly bonded equipment ground bus only. Do not terminate on isolated/insulated ground bus.
    2. Terminate branch circuit isolated grounding conductors on isolated/insulated ground bus only. Do not terminate on solidly bonded equipment ground bus.
K. Install all field-installed branch devices, components, and accessories.
L. Multi-Wire Branch Circuits: Group grounded and ungrounded conductors together in the panelboard as required by NFPA 70.
M. Set field-adjustable circuit breaker tripping function settings as required.
N. Set field-adjustable ground fault protection pickup and time delay settings as required.
O. Provide filler plates to cover unused spaces in panelboards.
P. Provide circuit breaker lock-on devices to prevent unauthorized personnel from de-energizing essential loads where indicated. Also provide for the following:
    1. Emergency and night lighting circuits.
    2. Fire detection and alarm circuits.
    3. Communications equipment circuits.
    4. Intrusion detection and access control system circuits.
    5. Video surveillance system circuits.
Q. Identify panelboards in accordance with Section 26 05 53.
R. Provide computer-generated circuit directory for each lighting and appliance panelboard and each power distribution panelboard provided with a door, clearly and specifically indicating the loads served. Identify spares and spaces.
S. Provide minimum four (4) spares and four (4) spaces per 42-circuit panelboard.

3.3. FIELD QUALITY CONTROL

A. Perform inspection, testing, and adjusting in accordance with Section 01 40 00.
B. Inspect and test in accordance with NETA ATS, except Section 4.
C. Molded Case Circuit Breakers: Perform inspections and tests listed in NETA ATS, Section 7.6.1.1 for all main circuit breakers and circuit breakers larger than 800 amperes. Tests listed as optional are not required.
    1. Perform insulation-resistance tests on all control wiring with respect to ground.
    2. Test functions of the trip unit by means of secondary injection.

D. Ground Fault Protection Systems: Test in accordance with manufacturer's instructions as required by NFPA 70.
   1. Perform inspections and tests listed in NETA ATS, Section 7.14. The insulation-resistance test on control wiring listed as optional is not required.
E. Test GFCI circuit breakers to verify proper operation.
F. Test AFCI circuit breakers to verify proper operation.
G. Test shunt trips to verify proper operation.
H. Procure services of a qualified manufacturer's representative to observe installation and assist in inspection, testing, and adjusting. Include manufacturer's reports with field quality control submittals.
I. Correct deficiencies and replace damaged or defective panelboards or associated components.

3.4. ADJUSTING

A. Adjust tightness of mechanical and electrical connections to manufacturer's recommended torque settings.
B. Adjust alignment of panelboard fronts.
C. Load Balancing: For each panelboard, rearrange circuits such that the difference between each measured steady state phase load does not exceed 20 percent and adjust circuit directories accordingly. Maintain proper phasing for multi-wire branch circuits.

3.5. CLEANING

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

END OF SECTION

EQUIPMENT WIRING

PART 1 GENERAL

1.1. SECTION INCLUDES
A. Electrical connections to equipment.

1.2. RELATED REQUIREMENTS
A. Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables.
B. Section 26 05 34 - Conduit.
C. Section 26 05 37 - Boxes.
D. Section 26 27 26 - Wiring Devices.
E. Section 26 28 16.16 - Enclosed Switches.

1.3. REFERENCE STANDARDS
A. NEMA WD 1 - General Color Requirements for Wiring Devices; 1999 (R 2010).
B. NEMA WD 6 - Wiring Devices - Dimensional Specifications; 2012.
C. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

1.4. ADMINISTRATIVE REQUIREMENTS
A. Coordination:
   1. Obtain and review shop drawings, product data, manufacturer's wiring diagrams, and manufacturer's instructions for equipment furnished under other sections.
   2. Determine connection locations and requirements.
   3. Conduit, wire and circuit breaker sizes for mechanical equipment and equipment furnished under other Divisions are based on the equipment ratings of one manufacturer. The equipment actually furnished may have different electrical characteristics. Conduit, wire, and circuit breakers shall not be ordered or installed until exact electrical requirements are obtained. Responsibility for this coordination shall rest with the Contractor.
   4. Verify special purpose outlet NEMA configuration and ampere rating with equipment supplier prior to ordering devices and coverplates.
B. Sequencing:
   1. Install rough-in of electrical connections before installation of equipment is required.
   2. Make electrical connections before required start-up of equipment.

1.5. SUBMITTALS
A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Product Data: Provide wiring device manufacturer’s catalog information showing dimensions, configurations, and construction.

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

1.6. QUALITY ASSURANCE

A. Conform to requirements of NFPA 70.
B. Products: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

PART 2 PRODUCTS

2.1. MATERIALS

A. Cords and Caps: NEMA WD 6; match receptacle configuration at outlet provided for equipment.
   1. Colors: Conform to NEMA WD 1.
   2. Cord Construction: NFPA 70, Type SO, multiconductor flexible cord with identified equipment grounding conductor, suitable for use in damp locations.
   3. Size: Suitable for connected load of equipment, length of cord, and rating of branch circuit overcurrent protection.
B. Enclosed Switches: As specified in Section 26 2818.
C. Wiring Devices: As specified in Section 26 27 26.
D. Flexible Conduit: As specified in Section 26 05 34.
E. Wire and Cable: As specified in Section 26 05 19.
F. Boxes: As specified in Section 26 05 37.

2.2. EQUIPMENT CONNECTIONS

A. As indicated on Drawings

PART 3 EXECUTION

3.1. EXAMINATION

A. Verify that equipment is ready for electrical connection, wiring, and energization.

3.2. ELECTRICAL CONNECTIONS

A. Make electrical connections in accordance with equipment manufacturer's instructions.
B. Make conduit connections to equipment using flexible conduit. Use liquidtight flexible conduit with watertight connectors in damp or wet locations.
C. Connect heat producing equipment using wire and cable with insulation suitable for temperatures encountered.
D. Provide receptacle outlet to accommodate connection with attachment plug.
E. Provide cord and cap where field-supplied attachment plug is required.

EQUIPMENT WIRING

F. Install suitable strain-relief clamps and fittings for cord connections at outlet boxes and equipment connection boxes.
G. Install disconnect switches, controllers, control stations, and control devices to complete equipment wiring requirements.
H. Install terminal block jumpers to complete equipment wiring requirements.
I. Install interconnecting conduit and wiring between devices and equipment to complete equipment wiring requirements.
J. All equipment is to be grounded with equipment grounding conductor per NEC requirements.
K. Provide conduit for low voltage control cables/conductors.

END OF SECTION

WIRING DEVICES

PART 1 GENERAL

1.1. SECTION INCLUDES

A. Wall switches.
B. Wall dimmers.
C. Fan speed controllers.
D. Receptacles.
E. Wall plates.
F. Occupancy sensors.

1.2. RELATED REQUIREMENTS

A. Section 26 05 33.23 - Surface Raceways: Surface raceway systems, including multioutlet assemblies.
B. Section 26 05 37 - Boxes.
C. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.
D. Section 26 27 17 - Equipment Wiring: Cords and plugs for equipment.

1.3. REFERENCE STANDARDS

A. FS W-C-596 - Connector, Electrical, Power, General Specification for; Federal Specification; Revision G, 2001.
B. FS W-S-896 - Switches, Toggle (Toggle and Lock), Flush-mounted (General Specification); Federal Specification; Revision F, 1999.
C. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2015.
D. NECA 130 - Standard for Installing and Maintaining Wiring Devices; 2010.
E. NEMA WD 1 - General Color Requirements for Wiring Devices; 1999 (R 2010).
F. NEMA WD 6 - Wiring Devices - Dimensional Specifications; 2012.
G. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
H. UL 20 - General-Use Snap Switches; Current Edition, Including All Revisions.
I. UL 498 - Attachment Plugs and Receptacles; Current Edition, Including All Revisions.
J. UL 514D - Cover Plates for Flush-Mounted Wiring Devices; Current Edition, Including All Revisions.
K. UL 943 - Ground-Fault Circuit-Interrupters; Current Edition, Including All Revisions.
L. UL 1472 - Solid-State Dimming Controls; Current Edition, Including All Revisions.
M. UL 1917 - Solid-State Fan Speed Controls; Current Edition, Including All Revisions.

1.4. ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Coordinate the placement of outlet boxes with millwork, furniture, equipment, etc. installed under other sections or by others.
   2. Coordinate wiring device ratings and configurations with the electrical requirements of actual equipment to be installed.

3. Coordinate the placement of outlet boxes for wall switches with actual installed door swings.
4. Coordinate the installation and preparation of uneven surfaces, such as split face block, to provide suitable surface for installation of wiring devices.
5. Coordinate the core drilling of holes for poke-through assemblies with the work covered under other sections.
6. Notify Architect of any conflicts or deviations from the contract documents to obtain direction prior to proceeding with work.

B. Sequencing:
1. Do not install wiring devices until final surface finishes and painting are complete.

1.5. SUBMITTALS

A. See Section 01 60 00 - Materials and Equipment, for submittal procedures.
B. Product Data: Provide manufacturer's catalog information showing dimensions, colors, and configurations.
1. Wall Dimmers: Include derating information for ganged multiple devices.
C. Samples: One for each type and color of device and wall plate specified, if requested.
D. Field Quality Control Test Reports.
E. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.
F. Operation and Maintenance Data:
1. Wall Dimmers: Include information on operation and setting of presets.
2. GFI Receptacles: Include information on status indicators and testing procedures and intervals.
G. Project Record Documents: Record actual installed locations of wiring devices.
H. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
1. See Section 01 60 00 - Materials and Equipment, for additional provisions.
2. Screwdrivers for Tamper-Resistant Screws: Two for each type of screw.
3. Extra Keys for Locking Switches: Five of each type.

1.6. QUALITY ASSURANCE

A. Conform to requirements of NFPA 70.
B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.
C. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

1.7. DELIVERY, STORAGE, AND PROTECTION

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

PART 2 PRODUCTS

2.1. MANUFACTURERS

A. Hubbell Incorporated: www.hubbell-wiring.com. Part numbers indicated are Hubbell; equals by other manufacturers are acceptable, unless otherwise noted.
B. Leviton Manufacturing Company, Inc.: www.leviton.com.
C. Lutron Electronics Company, Inc.: www.lutron.com.
D. Pass & Seymour, a brand of Legrand North America, Inc.: www.legrand.us
E. Cooper Wiring Devices: www.cooperwiringdevices.com.
F. Substitutions: See Section 01 60 00 - Materials and Equipment.
G. Source Limitations: Where possible, for each type of wiring device furnish products produced by a single manufacturer and obtained from a single supplier.

2.2. APPLICATIONS

A. Provide wiring devices suitable for intended use and with ratings adequate for load served.
B. For single receptacles installed on an individual branch circuit, provide receptacle with ampere rating not less than that of the branch circuit.
C. Provide weather resistant GFI receptacles with specified weatherproof covers for all receptacles installed outdoors or in damp or wet locations.
D. Provide tamper resistant receptacles for all receptacles installed in dwelling units.
E. Provide GFI protection for all receptacles installed within 6 feet of sinks.
F. Provide GFI protection for all receptacles installed to serve the countertop surfaces in residential kitchens andall 15A and 20A, 125V receptacles in non-dwelling type kitchens.
G. Provide GFI protection for all receptacles serving electric drinking fountains.
H. Unless noted otherwise, do not use combination switch/receptacle devices.
I. For flush floor service fittings, use tile rings for installations in tile floors.
J. For flush floor service fittings, use carpet flanges for installations in carpeted floors.

2.3. ALL WIRING DEVICES

A. Provide products listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.
B. Finishes:
    1. All Wiring Devices: Color as selected by Architect with wall plate as specified in wall plates section, unless otherwise indicated.
    2. Wiring Devices Installed in Finished Spaces: Color as selected by Architect with wall plate as specified in wall plates section, unless otherwise indicated.
    3. Wiring Devices Installed in Unfinished Spaces: Color as selected by Architect with wall plate as specified in wall plates section, unless otherwise indicated.
    4. Wiring Devices Installed in Wet or Damp Locations: Color as selected by Architect, with specified weatherproof cover unless otherwise indicated.

2.4. WALL SWITCHES

A. Manufacturers:
   1. Hubbell Incorporated: www.hubbell-wiring.com. Part numbers indicated are Hubbell; equals by other manufacturers are acceptable, unless otherwise noted.
   2. Leviton Manufacturing Company, Inc.: www.leviton.com.
   3. Pass & Seymour, a brand of Legrand North America, Inc.: www.legrand.us
   4. Cooper Wiring Devices: www.cooperwiringdevices.com.
   5. Substitutions: See Section 01 60 00 - Materials and Equipment.

B. Standard Wall Switches: Commercial specification grade, 20 A, 120/277 V with standard toggle type switch actuator and maintained contacts; switch type as indicated on the drawings.

C. Residential Wall Switches: Residential specification grade, 15A, 120V with standard toggle type switch actuator and maintained contacts; switch type as indicated on the drawings.

2.5. WALL DIMMERS

A. Manufacturers:
   1. Leviton Manufacturing Company, Inc.: www.leviton.com.
   2. Lutron Electronics Company, Inc.: www.lutron.com. Part numbers indicated are Lutron; equals by other manufacturers are acceptable, unless otherwise noted.
   3. Pass & Seymour, a brand of Legrand North America, Inc.: www.legrand.us
   4. Hubbell Incorporated: www.hubbell-wiring.com.
   5. Substitutions: See Section 01 60 00 - Materials and Equipment.

B. All Wall Dimmers: Solid-state with continuous full-range even control following square law dimming curve, integral radio frequency interference filtering, power failure preset memory, air gap switch accessible without removing wall plate, complying with NEMA WD 1 and NEMA WD 6, and listed as complying with UL 1472; types and ratings suitable for load controlled as indicated on the drawings.

C. Incandescent Wall Dimmers: 120 V AC, slide control type with separate on/off switch; single pole or three way as indicated on the drawings.
   1. Power Rating: Match load indicated on the drawings; 1000 watts minimum.
   2. Provide locator light, illuminated with load off.
   3. Products:
      a. Lutron Skylark Series or approved equal.

D. Provide accessory wall switches to match dimmer appearance when installed adjacent to each other.

2.6. FAN SPEED CONTROLLERS

A. Manufacturers:
   1. Leviton Manufacturing Company, Inc.: www.leviton.com.
   2. Lutron Electronics Company, Inc.: www.lutron.com. Part numbers indicated are Lutron; equals by other manufacturers are acceptable, unless otherwise noted.

3. Pass & Seymour, a brand of Legrand North America, Inc.: www.legrand.us
4. Hubbell Incorporated: www.hubbell-wiring.com.
5. Substitutions: See Section 01 60 00 - Materials and Equipment.

B. Description: 120 V AC, solid-state, three speed, slide control type with slide on/off control, with integral radio frequency interference filtering, fan hum elimination circuitry, power failure preset memory, complying with NEMA WD 1 and NEMA WD 6, and listed as complying with UL 1917.
1. Current Rating: 1.5 A unless otherwise indicated or required to control the load indicated on the drawings.
2. Products:
a. Lutron Skylark Series or approved equal.

2.7. RECEPTACLES

A. Manufacturers:
1. Hubbell Incorporated: www.hubbell-wiring.com.
2. Leviton Manufacturing Company, Inc.: www.leviton.com.
3. Pass & Seymour, a brand of Legrand North America, Inc.: www.legrand.us
4. Cooper Wiring Devices: www.cooperwiringdevices.com.
5. Substitutions: See Section 01 60 00 - Materials and Equipment.

B. All Receptacles: Self-grounding, complying with NEMA WD 1 and NEMA WD 6, and listed as complying with UL 498, and where applicable, FS W-C-596; types as indicated on the drawings.
1. Wiring Provisions: Terminal screws for side wiring and screw actuated binding clamp for back wiring with separate ground terminal screw.
2. NEMA configurations specified are according to NEMA WD 6.

C. Convenience Receptacles:
1. Standard Convenience Receptacles in Commercial Areas: Commercial specification grade, 20A, 125V, NEMA 5-20R and/or 15A, 125V, NEMA 5-15R; type as indicated on the drawings.
2. Standard Convenience Receptacles in Residential Areas: Residential grade, 20A, 125V, NEMA 5-20R and/or 15A, 125V, NEMA 5-15R; type as indicated on the drawings.
3. Weather Resistant Convenience Receptacles: Commercial specification grade, 20A, 125V, NEMA 5-20R and/or 15A, 125V, NEMA 5-15R, , listed and labeled as weather resistant type complying with UL 498 Supplement SE suitable for installation in damp or wet locations; type as indicated on the drawings.
4. Tamper Resistant Convenience Receptacles: Residential grade, 20A, 125V, NEMA 5-20R and/or 15A, 125V, NEMA 5-15R, , listed and labeled as tamper resistant type; type as indicated on the drawings.
5. Tamper Resistant and Weather Resistant Convenience Receptacles: Commercial specification grade, 20A, 125V, NEMA 5-20R and/or 15A, 125V, NEMA 5-15R, , listed and labeled as tamper resistant type and as weather resistant type complying with UL 498 Supplement SE suitable for installation in damp or wet locations; type as indicated on the drawings.

D. GFI Receptacles:
   1. All GFI Receptacles: Provide with feed-through protection, light to indicate ground fault tripped condition and loss of protection, and list as complying with UL 943, class A.
      a. Provide test and reset buttons of same color as device.
   2. Standard GFI Receptacles: Residential grade, duplex, 20A, 125V, NEMA 5-20R and/or 15A, 125V, NEMA 5-15R.
   3. Weather Resistant GFI Receptacles: Commercial specification grade, duplex, 20A, 125V, NEMA 5-20R and/or 15A, 125V, NEMA 5-15R, listed and labeled as weather resistant type complying with UL 498 Supplement SE suitable for installation in damp or wet locations.
   4. Tamper Resistant GFI Receptacles: Residential grade, duplex, 20A, 125V, NEMA 5-20R and/or 15A, 125V, NEMA 5-15R, listed and labeled as tamper resistant type.
   5. Tamper Resistant and Weather Resistant GFI Receptacles: Commercial specification grade, duplex, 20A, 125V, NEMA 5-20R and/or 15A, 125V, NEMA 5-15R, listed and labeled as tamper resistant type and as weather resistant type complying with UL 498 Supplement SE suitable for installation in damp or wet locations.

E. Locking Receptacles: Industrial specification grade, configuration as indicated on the drawings.
   1. Standard Locking Convenience Receptacles: Single, 20A, 125V, NEMA L5-20R.

2.8. WALL PLATES

A. Manufacturers:
   1. Hubbell Incorporated: www.hubbell-wiring.com.
   2. Leviton Manufacturing Company, Inc.: www.leviton.com.
   3. Pass & Seymour, a brand of Legrand North America, Inc.: www.legrand.us
   4. Substitutions: See Section 01 60 00 - Materials and Equipment.

B. All Wall Plates: Comply with UL 514D.
   1. Configuration: One piece cover as required for quantity and types of corresponding wiring devices.
   2. Size: Standard.
   3. Screws: Metal with slotted heads finished to match wall plate finish.
   4. Provide screwless wallplates with concealed mounting hardware where indicated.

C. Nylon Wall Plates: Smooth finish, high-impact thermoplastic.

D. Galvanized Steel Wall Plates: Rounded corners and edges, with corrosion resistant screws.

E. Weatherproof Covers for Wet or Damp Locations: Gasketed, cast aluminum, with hinged lockable cover and corrosion-resistant screws; listed as suitable for use in wet locations while in use with attachment plugs connected. Hubbell WP26M Series.

2.9. OCCUPANCY SENSORS

A. Manufacturers:

1. Wattstopper: www.wattstopper.com. Part numbers indicated are Wattstopper; equals by other manufacturers are acceptable, unless otherwise noted.
2. Hubbell Incorporated: www.hubbell-wiring.com.
3. Sensor Switch: www.sensorswitch.com.
4. Greengate: www.cooperindustries.com.
5. Lutron Electronics Company, Inc.: www.lutron.com.
6. Leviton Manufacturing Company, Inc.: www.leviton.com.
7. Substitutions: See Section 01 60 00 - Materials and Equipment.

B. Sensors to be dual technology type with integral 24-volt dry contact for use with energy management system, unless otherwise indicated.

C. Sensors to have manual-on operation.

D. Sensors to be provided with coverage pattern and mounting as shown on drawings.

E. The drawings show approximate locations of detectors and are diagrammatic only. Exact locations of detectors are to be field verified with the factory representative prior to mounting.

F. Provide power pack as required for low voltage occupancy sensors. Wattstopper BZ-150 Series.

G. Wall Switch:
1. Dual Technology: Wattstopper DW-100 Series.
   a. Coverage area up to 1,000 sq. ft. with 180 degrees field of view.
2. Passive Infrared: Wattstopper WS-250 Series.
   a. Coverage area up to 900 sq. ft. with 180 degrees field of view.
3. Ultrasonic: Wattstopper UW-100 Series.
   a. Coverage area up to 400 sq. ft. with 180 degrees field of view.

H. Ceiling Mount (360 degrees):
1. Dual Technology: Wattstopper DT-300 Series.
   a. Coverage area up to 1,000 sq. ft. with 360 degrees field of view.
2. Passive Infrared: Wattstopper CI-300 Series.
   a. Coverage area up to 1,200 sq. ft. with 360 degrees field of view.
3. Ultrasonic: Wattstopper VT300-3 Series.
   a. Coverage area up to 2,000 sq. ft. with 360 degrees field of view.

I. Ceiling/Wall Mount (Directional):
1. Dual Technology: Wattstopper DT-200 Series.
   a. Coverage area up to 2,000 sq. ft..
2. Passive Infrared: Wattstopper CX-100 Series.
   a. Coverage area up to 1,000 sq. ft.

PART 3 EXECUTION

3.1. EXAMINATION

A. Verify that field measurements are as shown on the drawings.

B. Verify that outlet boxes are installed in proper locations and at proper mounting heights and are properly sized to accommodate devices and conductors in accordance with NFPA 70.

C. Verify that wall openings are neatly cut and will be completely covered by wall plates.
D. Verify that final surface finishes are complete, including painting.
E. Verify that floor boxes are adjusted properly.
F. Verify that branch circuit wiring installation is completed, tested, and ready for connection to wiring devices.
G. Verify that openings in access floor are in proper locations.
H. Verify that conditions are satisfactory for installation prior to starting work.

3.2. PREPARATION

A. Provide extension rings to bring outlet boxes flush with finished surface.
B. Clean dirt, debris, plaster, and other foreign materials from outlet boxes.

3.3. INSTALLATION

A. Perform work in a neat and workmanlike manner in accordance with NECA 1 and, where applicable, NECA 130, including mounting heights specified in those standards unless otherwise indicated.
B. Coordinate locations of outlet boxes provided under Section 26 05 37 as required for installation of wiring devices provided under this section.
    1. Mounting Heights: As indicated on the drawings.
    2. Orient outlet boxes for vertical installation of wiring devices unless otherwise indicated.
    3. Where multiple receptacles, wall switches, or wall dimmers are installed at the same location and at the same mounting height, gang devices together under a common wall plate.
    4. Locate wall switches on strike side of door with edge of wall plate 3 inches from edge of door frame. Where locations are indicated otherwise, notify Architect to obtain direction prior to proceeding with work.
    5. Locate receptacles for electric drinking fountains concealed behind drinking fountain according to manufacturer's instructions.
C. Install wiring devices in accordance with manufacturer's instructions.
D. Install permanent barrier between ganged wiring devices when voltage between adjacent devices exceeds 300 V.
E. Connect wiring devices by wrapping conductor clockwise 3/4 turn around screw terminal or inserting conductor screw-actuated in binding clamp and tightening to proper torque specified by the manufacturer. Where present, do not use push-in pressure terminals that do not rely on screw-actuated binding.
F. Unless otherwise indicated, connect wiring device grounding terminal to branch circuit equipment grounding conductor and to outlet box with bonding jumper.
G. Unless otherwise indicated, GFI receptacles may be connected to provide feed-through protection to downstream devices. Label such devices to indicate they are protected by upstream GFI protection.
H. Where split-wired duplex receptacles are indicated, remove tabs connecting top and bottom receptacles.
I. Install wiring devices plumb and level with mounting yoke held rigidly in place.

J. Install wall switches with OFF position down.
K. Install wall dimmers to achieve full rating specified and indicated after derating for ganging as instructed by manufacturer.
L. Install vertically mounted receptacles with grounding pole on bottom and horizontally mounted receptacles with grounding pole on right.
M. Install wall plates to fit completely flush to wall with no gaps and rough opening completely covered without strain on wall plate. Repair or reinstall improperly installed outlet boxes or improperly sized rough openings. Do not use oversized wall plates in lieu of meeting this requirement.
N. Install blank wall plates on junction boxes and on outlet boxes with no wiring devices installed or designated for future use.

3.4. FIELD QUALITY CONTROL

A. Perform field inspection, testing, and adjusting in accordance with Section 01 40 00.
B. Inspect each wiring device for damage and defects.
C. Operate each wall switch, wall dimmer, and fan speed controller with circuit energized to verify proper operation.
D. Test each receptacle to verify operation and proper polarity.
E. Test each GFCI receptacle for proper tripping operation according to manufacturer's instructions.
F. Correct wiring deficiencies and replace damaged or defective wiring devices.

3.5. ADJUSTING

A. Adjust devices and wall plates to be flush and level.

3.6. CLEANING

A. Clean exposed surfaces to remove dirt, paint, or other foreign material and restore to match original factory finish.

END OF SECTION

FUSES AND CIRCUIT BREAKERS

PART 1 GENERAL

1.1. SECTION INCLUDES

A. Fuses.
B. Circuit breakers.

1.2. REFERENCE STANDARDS

A. NEMA FU 1 - Low Voltage Cartridge Fuses; 2012.
B. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

1.3. SUBMITTALS

A. See Section 01 60 00 - Materials and Equipment, for submittal procedures.
B. Product Data: Provide data sheets showing electrical characteristics, including time-current curves.
C. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
   1. See Section 01 60 00 - Materials and Equipment, for additional provisions.
   2. Extra Fuses: Three of each type and size.
   3. Fuse Pullers: Two.

1.4. QUALITY ASSURANCE

A. Conform to requirements of NFPA 70.
B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section.
C. Products: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

PART 2 PRODUCTS

2.1. MANUFACTURERS

A. Fuses:
   1. Bussmann, a division of Eaton Corporation: www.cooperindustries.com.
   2. Ferraz Shawmut, Inc.: www.ferrazshawmut.com.
   3. Littelfuse, Inc: www.littelfuse.com.
B. Circuit Breakers:
   1. Eaton Corporation; Cutler-Hammer Products: www.eaton.com.
   2. General Electric Company: www.geindustrial.com.
   3. Schneider Electric; Square D Products: www.schneider-electric.us.
   4. Siemens: www.sea.siemens.com.

2.2. FUSES - GENERAL

A. Dimensions and Performance: NEMA FU 1, Class as specified or indicated.
B. Voltage: Rating suitable for circuit phase-to-phase voltage.
C. Main Service Switches Larger than 600 amperes: Class L (time delay).
D. Main Service Switches: Class RK1 (time delay).
E. Power Load Feeder Switches Larger than 600 amperes: Class L (time delay).
F. Power Load Feeder Switches: Class RK1 (time delay) or J (time delay).
G. Motor Load Feeder Switches: Class RK1 (time delay) or J (time delay).

2.3. CLASS RK1 (TIME DELAY) FUSES

A. Manufacturers:
   1. Bussmann LPS-RK (600V) or LPN-RK (250V): www.bussmann.com.
   2. Ferraz Shawmut: www.ferrazshawmut.com.
   3. Littelfuse: www.littelfuse.com.

2.4. CLASS J (TIME DELAY) FUSES

A. Manufacturers:
   1. Bussmann LPJ-SP: www.bussmann.com.
   2. Ferraz Shawmut: www.ferrazshawmut.com.
   3. Littelfuse: www.littelfuse.com.

2.5. CLASS L (TIME DELAY) FUSES

A. Manufacturers:
   1. Bussmann KRP-C: www.bussmann.com.
   2. Ferraz Shawmut: www.ferrazshawmut.com.
   3. Littelfuse: www.littelfuse.com.

2.6. CIRCUIT BREAKERS

A. Circuit breakers shall be molded case, bolt-on, trip free, quick make, quick break, thermal magnetic type.
B. Circuit breakers shall be calibrated to carry 80% rated current in an ambient temperature of 40 degrees C.
C. Handles shall clearly indicate rating and position "On", "Off", or "Tripped".
D. Multi-pole circuit breakers shall be common trip such that an overload or short circuit on any one pole will result in all poles opening simultaneously.
E. Circuit breakers shall have an interrupting rating not less than the available fault duty at the breaker. Minimum rating shall be 10,000A for 250 volt panels. Circuit breakers shall be fully rated to exceed the available 3 phase fault current.
F. Circuit breakers shall be switch duty rated and full size, tandem units are not approved.

G. Provide with handle "lock-on" device for breakers serving time switches, night lights, emergency lighting unit equipment, fire alarm, security, data racks, servers, and other circuits as identified on the drawings.
H. Provide combination circuit breakers and ground fault interrupters where indicated on the drawings or required by the National Electrical Code.
I. All circuit breakers rated 250A and above shall be provided with adjustable magnetic trip elements.
J. Circuit breakers shall conform to NEMA standard AB1.
K. Provide products suitable for use as service entrance equipment where applicable.

PART 3 EXECUTION

3.1. INSTALLATION

A. Install fuses with label oriented such that manufacturer, type, and size are easily read.
B. Install enclosed circuit breakers where indicated, in accordance with manufacturer's instructions.
C. Install enclosed circuit breakers plumb. Provide support and labeling in accordance with these specifications.
D. In dwelling areas, as required by NEC 210.12, provide arc-fault circuit breakers to protect all branch circuits such that the complete circuit is protected.

3.2. FIELD QUALITY CONTROL

A. Perform field inspection and testing in accordance with Section 01 40 00.
B. Inspect and test each circuit breaker.
C. Inspect each circuit breaker visually.
D. Perform several mechanical ON-OFF operations on each circuit breaker.
E. Verify circuit continuity on each pole in closed position.
F. Determine that circuit breaker will trip on overcurrent condition, with tripping time to NEMA AB 1 requirements.
G. Include description of testing and results in test report.

3.3. ADJUSTING

A. Adjust trip settings so that circuit breakers coordinate with other overcurrent protective devices in circuit.
B. Adjust trip settings to provide adequate protection from overcurrent and fault currents.

END OF SECTION

ENCLOSED TRANSFER SWITCHES

PART 1 - GENERAL

1.1. SECTION INCLUDES
A. Automatic transfer switch.

1.2. RELATED SECTIONS
A. Section 26 32 13 - Packaged Propane Vapor Generator: Testing requirements.

1.3. REFERENCES
A. NFPA 70 - National Electrical Code.
B. NEMA ICS 1 - General Standards for Industrial Control and Systems.
C. NEMA ICS 2 - Standards for Industrial Control Devices, Controllers, and Assemblies.
D. NEMA ICS 6 - Enclosures for Industrial Controls and Systems.
E. NETA ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.

1.4. SUBMITTALS
A. Submit under provisions of Section 01 33 00.
B. Product Data: Provide catalog sheets showing voltage, switch size, ratings and size of switching and overcurrent protective devices, operating logic, short circuit ratings, dimensions, and enclosure details.
C. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by Product testing agency specified under Regulatory Requirements. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of Product.

1.5. OPERATION AND MAINTENANCE DATA
A. Submit under provisions of Section 01 78 23.
B. Operation Data: Include instructions for operating equipment. Include instructions for operating equipment under emergency conditions when engine generator is running.
C. Maintenance Data: Include routine preventative maintenance and lubrication schedule. List special tools, maintenance materials, and replacement parts.

1.6. QUALIFICATIONS
A. Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum three years experience, and with service facilities within 50 miles of Project.
B. Supplier: Authorized distributor of specified manufacturer with minimum three years experience.

1.7. REGULATORY REQUIREMENTS
A. Conform to requirements of NFPA 70.
B. Furnish products listed and classified by UL as suitable for purpose specified and indicated.

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

1.9. FIELD MEASUREMENTS
A. Verify that field measurements are as indicated on shop drawings.

1.10. MAINTENANCE SERVICE
A. Furnish service and maintenance of transfer switch for one year from Date of Substantial Completion.

1.11. MAINTENANCE MATERIALS
A. Provide maintenance materials under provisions of Section 01 78 23.
B. Provide two of each special tool required for maintenance.

PART 2 - PRODUCTS

2.1. MANUFACTURERS
A. ONAN.
B. Pacific Detroit Diesel.
C. CATERPILLAR.
D. ASCO.
E. Katolight.

2.2. AUTOMATIC TRANSFER SWITCH
A. Description: NEMA ICS 2, automatic transfer switch.
B. Configuration: Electrically operated, mechanically held transfer switch.
C. Open Transition.

2.3. SERVICE CONDITIONS

A. Service Conditions: NEMA ICS 1.
B. Temperature: 90 degrees F.
C. Altitude: 1000 feet.

2.4. RATINGS

A. Voltage: As noted on drawings.
B. Switched Poles: 3.
C. Load Inrush Rating: Combination.
D. Continuous Rating: As noted on drawings.
E. Interrupting Capacity: 100 percent of continuous rating.
F. Withstand Current Rating: Shall meet or exceed available 3 phase fault current.

2.5. PRODUCT OPTIONS AND FEATURES

A. Indicating Lights: Mount in cover of enclosure to indicate NORMAL SOURCE AVAILABLE, ALTERNATE SOURCE AVAILABLE, SWITCH POSITION.
B. Test Switch: Mount in cover of enclosure to simulate failure of normal source.
C. Return to Normal Switch: Mount in cover of enclosure to initiate manual transfer from alternate to normal source.
D. Transfer Switch Auxiliary Contacts: 1 normally open; 1 normally closed.
E. Normal Source Monitor: Monitor each line of normal source voltage and frequency; initiate transfer when voltage drops below 85 percent or frequency varies more than 3 percent from rated nominal value.
F. Alternate Source Monitor: Monitor alternate source voltage and frequency; inhibit transfer when voltage is below 85 percent or frequency varies more than 3 percent from rated nominal value.

2.6. AUTOMATIC SEQUENCE OF OPERATION

A. Initiate Time Delay to Start Alternate Source Engine Generator: Upon initiation by normal source monitor.
B. Time Delay To Start Alternate Source Engine Generator: 0 to 30 seconds, adjustable.
C. Initiate Transfer Load to Alternate Source: Upon initiation by normal source monitor and permission by alternate source monitor.
D. Time Delay Before Transfer to Alternate Power Source: 0 to 30 seconds, adjustable.
E. Initiate Retransfer Load to Normal Source: Upon permission by normal source monitor.
F. Time Delay Before Transfer to Normal Power: 0 to 30 seconds, adjustable; bypass time delay in event of alternate source failure.
G. Time Delay Before Engine Shut Down: 0 to 30 minutes, adjustable, of unloaded operation.
H. Engine Exerciser: Start engine every 30 days; run for 30 minutes before shutting down. Bypass exerciser control if normal source fails during exercising period.

I. Alternate System Exerciser: Transfer load to alternate source during engine exercising period.

2.7. ENCLOSURE

A. Enclosure: ICS 6, Type 1.

B. Finish: Manufacturer's standard enamel.

PART 3 - EXECUTION (NOT USED)

END OF SECTION

PHOTOVOLTAIC COLLECTORS

PART 1 GENERAL

1.1. SECTION INCLUDES

A. Photovoltaic system requirements.
B. Photovoltaic modules.
C. Photovoltaic inverters.
D. Monitoring system.

1.2. RELATED REQUIREMENTS

A. Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables.
B. Section 26 05 26 - Grounding and Bonding for Electrical Systems.
C. Section 26 05 29 - Hangers and Supports for Electrical Systems.
D. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.
E. Section 26 28 18 - Enclosed Switches.

1.3. REFERENCE STANDARDS

A. ASCE 7 - Minimum Design Loads for Buildings and Other Structures; 2010, with 2013 Supplements and Errata.
B. IEC 61215 - Crystalline Silicon Terrestrial Photovoltaic (PV) Modules - Design Qualification and Type Approval; 2005.
C. IEEE 1547 - IEEE Standard for Interconnection and Interoperability of Distributed Energy Resources with Associated Electric Power Systems Interfaces; 2018.
D. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2015.
E. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2014.
F. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
G. UL 790 - Standard for Standard Test Methods for Fire Tests of Roof Coverings; Current Edition, Including All Revisions.
H. UL 1449 - Standard for Surge Protective Devices; Current Edition, Including All Revisions.
I. UL 1703 - Flat Plate Photovoltaic Modules and Panels; Current Edition, Including All Revisions.
J. UL 1741 - Inverters, Converters, Controllers and Interconnection System Equipment for Use With Distributed Energy Resources; Current Edition, Including All Revisions.
K. UL 2579 - Low-Voltage Fuses - Fuses for Photovoltaic Systems; Current Edition, Including All Revisions.

1.4. ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Coordinate the work with other trades to avoid placement of ductwork, piping, equipment or other potential obstructions within the spaces dedicated for photovoltaic system components.

2. Coordinate arrangement of electrical equipment with the dimensions and clearance requirements of the actual equipment to be installed.
3. Roof-Mounted Arrays: Coordinate the work with other trades to provide roof penetrations that preserve the integrity of the roofing system and do not void the roof warranty.
4. Notify Architect of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.

B. Preinstallation Meeting: Convene one week prior to commencing work of this section; require attendance of all affected installers. Include adequate instruction on the electrical hazards associated with photovoltaic systems and appropriate safety procedures to be followed.

C. Rebates and Incentives: Assist in preparing and submitting documentation as required for Owner to secure funds from available federal, state, and utility company rebate and incentive programs. Notify Owner of any time constraints affecting program qualification.
1. Include copies of documentation with submittals.

D. Utility Interconnection:
1. Assist in preparing and submitting documentation as required for securing utility interconnection agreement between Owner and Utility Company.
a. Include copies of documentation with submittals.
2. Preinstallation Meeting: Convene one week prior to commencing work of this section to review interconnection requirements and details with Utility Company representative.
3. Coordinate with Utility Company to provide utility metering suitable for system requirements.
4. Arrange for inspections and secure permits necessary to obtain Utility Company approval of system.

1.5. SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

B. Design Documents: Prepare and submit all information required for plan review and permitting by authorities having jurisdiction, including but not limited to floor plans, riser diagrams, details, and description of operation.

C. Product Data: Provide manufacturer's standard catalog pages and data sheets for each product. Include ratings, configurations, standard wiring diagrams, outline and support point dimensions, finishes, weights, service condition requirements, and installed features.

D. Shop Drawings: Include dimensioned plan views and sections indicating locations of system components, required clearances, attachment locations and details, and proposed size, type, and routing of conduits and cables. Include system interconnection schematic diagrams showing all factory and field connections.
1. Include proposed locations of penetrations and proposed methods for sealing.

E. Design Data:
1. Include structural calculations, certified by structural engineer, for equipment and mounting system.

2. Include electrical calculations, certified by electrical engineer, for array and associated equipment other than the basis of design products and configuration.

F. Certify that products of this section meet or exceed specified requirements.

G. Installer's Qualifications: Include evidence of compliance with specified requirements.

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

I. Manufacturer’s detailed field testing procedures.

J. Manufacturer's detailed startup procedures.

K. Rebate and incentive documentation.

L. Utility interconnection documentation.

M. Source quality control test reports.

N. Field quality control test reports.

1. Include manufacturer's field reports.

O. Operation and Maintenance Data: Include detailed information on system operation, equipment programming and setup, replacement parts, and recommended maintenance procedures and intervals.

1. Include contact information for entity that will be providing contract maintenance and trouble call-back service.

P. Warranty: Submit sample of manufacturer's warranty and documentation of final executed warranty completed in Owner's name and registered with manufacturer.

Q. Maintenance contracts.

R. Project Record Documents: Record actual locations of system components, installed circuiting arrangements and routing, and final equipment settings.

S. Software: One copy of software provided under this section.

1.6. QUALITY ASSURANCE

A. Comply with NFPA 70.

B. Comply with Utility Company requirements for interconnection.

C. Maintain at the project site a copy of each referenced document that prescribes execution requirements.

D. Structural Designer Qualifications: Registered structural engineer licensed in Oregon.

E. Electrical Designer Qualifications: Registered electrical engineer licensed in Oregon experienced in the design of photovoltaic systems.

F. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

G. Installer Qualifications: Company specializing in performing the work of this section with minimum five years documented experience with photovoltaic systems of similar size, type, and complexity.

1. Licensed in Oregon to install photovoltaic systems.
2. Manufacturer's authorized installer.
3. Supervisor: North American Board of Certified Energy Practitioners (NABCEP) certified PV Installer.
4. Installer Personnel: At least 2 years of experience installing photovoltaic systems.

1.7. DELIVERY, STORAGE, AND HANDLING

A. Store products in manufacturer's unopened packaging, keep dry and protect from damage until ready for installation.

1.8. WARRANTY

A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.
B. Specified warranties indicate minimum requirements. Provide additional warranties or extended warranty periods where required to qualify for rebate and incentive programs.
C. Photovoltaic Modules:
   1. Provide minimum five year manufacturer warranty covering repair or replacement due to defective materials or workmanship.
   2. Provide linear manufacturer warranty guaranteeing minimum 90 percent of rated power output for 10 years.
D. Photovoltaic Combiner Boxes: Provide minimum five year manufacturer warranty covering repair or replacement due to defective materials or workmanship.
E. Photovoltaic Inverters: Provide minimum five year manufacturer warranty covering repair or replacement due to defective materials or workmanship.
F. Charge Controllers: Provide minimum five year manufacturer warranty covering repair or replacement due to defective materials or workmanship.

PART 2 PRODUCTS

2.1. MANUFACTURERS

A. Photovoltaic Modules - Basis of Design: As indicated under product article below.
B. Photovoltaic Modules, Five (5) Smart Flower Solar Arrays:
   1. 3800 watts, 480V. Output per Array.
C. Photovoltaic Inverters:
   1. SMA America, LLC: www.sma-america.com.
   2. Solectria Renewables, LLC: www.solectria.com.
   3. Advanced Energy.
   4. Substitutions: See Section 01 60 00 - Product Requirements.
D. Charge Controllers:
   1. Outback Power Technologies, Inc: www.outbackpower.com.
   2. Substitutions: See Section 01 60 00 - Product Requirements.
E. Monitoring System:
   1. SMA America, LLC: www.sma-america.com.
   2. Solectria Renewables, LLC: www.solren.com.
   3. Advanced Energy.
   4. Substitutions: See Section 01 60 00 - Product Requirements.
F. Source Limitations: For each type of component, furnish products produced by a single manufacturer and obtained from a single supplier.

2.2. PHOTOVOLTAIC SYSTEM REQUIREMENTS

A. Design and provide complete photovoltaic system consisting of photovoltaic modules and associated balance of system components necessary for connection to facility electrical system.

B. System Description:
   1. Photovoltaic Arrays on ground mounted on-site..
   2. Photovoltaic DC system is negative grounded.
   3. Coordinate net metering with utility.
   4. System includes DC system surge protection.
   5. System includes monitoring system.
   6. Owner intends to secure funds from available federal, state, and utility company rebate and incentive programs.

C. Capacity:
   1. Total Nominal Rated Power Output of Array: Equal to or greater than the rated output of the basis of design array.
   2. Nominal Rated Power Output of Individual Modules: Equal to or greater than the rated output of the basis of design module.

D. Size:
   1. Array: Designed to fit within the area designated on the drawings.

E. Appearance:
   1. Only systems with similar appearance to basis of design system will be considered.
   2. Arrange array such that modules are aligned with uniform spacing.
   3. Make no alterations affecting appearance of building exterior or interior without approval of Architect.
   4. Final determination of acceptable appearance is by Architect.

F. Provide photovoltaic system and associated components suitable for wind loads, snow loads, seismic loads, and other structural design considerations of the installed location.
   1. Comply with ASCE 7.
   2. Include structural calculations demonstrating compliance with submittals.

G. Provide photovoltaic system and associated components suitable for continuous operation under the service conditions at the installed location.

H. Provide products listed, classified, and labeled by Underwriter's Laboratories Inc. (UL) as suitable for the purpose indicated.

I. Provide photovoltaic system and associated components that qualify for available federal, state, and utility company rebate and incentive programs.

J. Unless specifically indicated to be excluded, provide all required equipment, conduit, boxes, wiring, connectors, hardware, supports, accessories, software, system programming, etc. as necessary for a complete operating system.

K. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and NFPA 70.

L. Arrange array to provide adequate access to rear of string(s) for maintenance.

M. Arrange array to minimize shading during peak production periods.

N. Roof-Mounted Arrays:

1. Arrange array such that normal roof drainage is not affected.
2. Arrange array to maintain required safety clearances from edges of roof as required by authority having jurisdiction.
3. Arrange array to maintain access and clearance requirements for other roof-mounted equipment.
4. Arrange array to avoid spanning of expansion joints.

2.3. PHOTOVOLTAIC MODULES

A. Acceptable Module Types: Either crystalline silicon or thin film modules complying with specified requirements will be considered for this project. Only crystalline silicon modules are acceptable. Thin film modules will not be considered for this project., or only thin film modules are acceptable. Crystalline silicon modules will not be considered for this project.

B. General Requirements:
   1. Photovoltaic Modules: Factory assembled; consisting of photovoltaic cells, frame, junction box, cables for series connection, and bypass diodes for shade tolerance; rated for 600 V DC; listed as complying with UL 1703.
   2. Crystalline Silicon Photovoltaic Modules: Comply with IEC 61215.
   3. Frame: Anodized aluminum.
   4. Factory-Installed Junction Box: Weatherproof, with factory-installed terminals and bypass diodes.
   5. Factory-Installed Cables: Type USE-2 or listed photovoltaic (PV) wire with polarized locking connectors.
   6. Fire Resistance Rating: UL 790, Class equal to or better than required fire rating of roof.
   7. Unless otherwise indicated, specified module performance characteristics are rated under Standard Test Conditions (STC).
   8. Power Rating Tolerance: Plus 10 or minus 5 percent.

C. NECA 412 - Standard for Installing and Maintaining Photovoltaic (PV) Power Systems; 2012.

D. Acceptable Product(s):
   1. Smart Flower "Fronius Primo" 3800W.

2.4. BALANCE OF SYSTEM COMPONENTS

A. Photovoltaic Combiner Boxes:
   1. Provide combiner box(es) for termination of strings as indicated or as required for the array configuration installed.
   2. Combiner Boxes: Rated for 600 V DC; current ratings suitable for connected strings; equipped with circuit breakers or fuseholders; listed as complying with UL 1741.
   3. Fuseholders: Touch-safe; suitable to accept fuses indicated.
   4. Number of Input Circuits: As indicated or as required for termination of strings, with minimum of 25 percent spare capacity for future expansion.

5. Enclosure: NEMA 250, CHOOSE ONE: Type 3R OR Type 4 OR Type 4X, unless otherwise indicated.
6. Provide integral load-break rated disconnect.
7. Provide with capability of current monitoring for individual strings.

B. Photovoltaic Inverters:
1. Provide inverter(s) as indicated or as required for connection of the photovoltaic array DC system to the AC system indicated.
2. Inverters: Suitable for the requirements of the connected array; output configuration compatible with connected system; listed as complying with UL 1741; furnished with the following features:
   a. Maximum power point tracking (MPPT).
   b. LCD display.
   c. Integral AC disconnect.
   d. Integral DC disconnect.
   e. Integral DC ground fault detection and interruption (GFDI).
   f. Communications Interface: As required for connection to system indicated.
3. Grid-Tied Inverters: Comply with IEEE 1547, including over/under grid voltage and frequency protection, and anti-islanding protection to automatically disconnect upon loss of utility power and to remain disconnected until utility power restoration has been maintained for five minutes.
4. Grounded Photovoltaic DC Systems: Furnish with integral isolation transformer. Transformerless inverters may be used if a separate isolation transformer is provide.
5. Total Harmonic Distortion: Less than five percent.
6. Enclosure Environment Type per NEMA 250: Unless otherwise indicated, as specified for the following installation locations:
   a. Indoor Clean, Dry Locations: Type 1.
   b. Outdoor Locations: Type 3R.

C. Enclosed Switches: In addition to requirements of Section 26 28 16.16, comply with the following:
1. Switches for DC System: Rated for 600 V DC.

D. Charge Controllers: Suitable for the requirements of the connected battery storage system; no readily accessible user adjusting means; listed as complying with UL 1741.

E. Surge Protective Devices: In addition to requirements of Section 26 43 00, comply with the following:
1. Surge Protective Devices for DC System:
   a. Rated for 600 V DC.
   b. Listed and labeled as complying with UL 1449, Type 1.
   c. Surge Current Rating: Not less than 50 kA per mode.
   d. UL 1449 Nominal Discharge Current (I-n): 20 kA.

F. Fuses: In addition to requirements of Section 26 28 13, comply with the following:
1. Fuses for DC System: Rated for 600 V DC.
2. Fuses for Protection of Photovoltaic Strings and Arrays: Use photovoltaic fuses listed as complying with UL 2579.

G. Monitoring System:
   1. Provide a system to monitor photovoltaic system performance including all sensors, dataloggers, connections, software, equipment and accessories necessary for a complete operating system.
   2. System communications interfaces to be wired or wireless, with compatible interconnected components.
      a. Provide suitable raceway, minimum 3/4 inch trade size, for all required wired connections.
   3. System to monitor and record, in 15 minute intervals:
      a. Inverter status.
      b. Instantaneous power (kW).
      c. Cumulative energy production (kWh).
      d. Irradiation.
      e. Ambient temperature.
      f. Module cell temperature.
      g. Wind speed and direction.
      h. Current monitoring for individual strings.
   4. Energy Production Meter: Revenue grade, with accuracy of plus or minus two percent.
   5. System real-time and historical data to be accessible from the following locations:
      a. Personal computer(s) via Internet connection.
      b. Remote public display(s), quantity and location as indicated on the drawings.
   6. System to provide alarm notification via e-mail or instant message.
   7. System to be compatible with third party monitoring service to be selected by Owner.

2.5. SOURCE QUALITY CONTROL

A. Factory test the following products to verify operation and performance characteristics. Include test reports with submittals.
   1. Photovoltaic modules.
   2. Photovoltaic inverters.
   3. Charge controllers.

PART 3 EXECUTION

3.1. EXAMINATION

A. Verify that field measurements are as shown on the drawings.
B. Verify that ratings and configurations of system components are consistent with the indicated requirements.
C. Verify that mounting surfaces are ready to receive system components.
D. Verify that conditions are satisfactory for installation prior to starting work.

3.2. PREPARATION

A. Use open circuiting, short circuiting, or opaque covering to disable modules, array or portions of array prior to installation and service.

3.3. INSTALLATION

A. Perform work in a neat and workmanlike manner in accordance with NECA 1 (general workmanship) and NECA 412.
B. Install products in accordance with manufacturer's instructions.
C. Provide required supports in accordance with Section 26 05 29.
D. Mount equipment such that the highest position of any operating handle for circuit breakers or switches does not exceed 79 inches above the floor, ground, or working platform.
E. Circuiting Requirements, in Addition to Requirements of Section 26 05 19:
    1. Wiring Methods:
        a. Unless otherwise indicated, use exposed module factory-installed cables (not routed inside building), exposed type USE-2/RHH/RHW-2 single-conductor cable (not routed inside building), or type USE-2/RHH/RHW-2 single-conductor cable in suitable raceway for module interconnections.
        b. Unless otherwise indicated, use exposed type USE-2/RHH/RHW-2 single-conductor cable (not routed inside building) or type USE-2/RHH/RHW-2 single-conductor cable in suitable raceway for wiring between string(s) and CHOOSE ONE: combiner box(es), transition junction box(es), inverter(s), or point of interconnection.
        c. Unless otherwise indicated, use type THHN/THWN-2 single-conductor building wire in suitable raceway.
        d. Secure exposed cables in accordance with NFPA 70. Where possible, conceal behind array.
        e. Install cables in suitable raceway where readily accessible or where required by authority having jurisdiction.
        f. Use suitable mechanical connectors or compression connectors for photovoltaic circuit splices and taps.
    2. Photovoltaic DC System Conductor Color Code:
        a. Negative Grounded System:
            1. Positive: Black.
            2. Negative/Grounded: White.
        b. Positive Grounded System:
            1. Positive/Grounded: White.
            2. Negative: Black.
        c. Ungrounded System:
            1. Positive: Red.
            2. Negative: Black.

3. Maintain separation of photovoltaic and non-photovoltaic circuits in accordance with NFPA 70.

F. Grounding and Bonding Requirements, in Addition to Requirements of Section 26 05 26:
1. Ensure that there is only one AC System bonding connection between grounding system and grounded/neutral conductor, including external connections and connections internal to equipment.
2. Grounded DC Systems: Ensure that there is only one point of system grounding connection to the grounded conductor, including external connections and connections internal to equipment.
3. Provide auxiliary electrodes for photovoltaic array grounding in accordance with NFPA 70.

G. Identification Requirements, in Addition to Those Specified in Section 26 05 53:
1. Color for Photovoltaic System Identification Nameplates and Labels: White text on black background.
2. Use identification nameplate or means of identification acceptable to authority having jurisdiction to identify the presence of multiple power sources and the location of main service disconnecting means and each photovoltaic system disconnecting means, as well as required rapid shutdown initiation method. Locate at main service disconnecting means, at each photovoltaic system disconnecting means, and at rapid shutdown initiation method. Verify format and descriptions with authority having jurisdiction.
3. Use identification nameplate to identify each photovoltaic system disconnecting means with text "PHOTOVOLTAIC SYSTEM DC DISCONNECT" or "PHOTOVOLTAIC SYSTEM AC DISCONNECT" as applicable.
4. Use identification nameplate complying with NFPA 70 to identify systems equipped with rapid shutdown with text "PHOTOVOLTAIC SYSTEM EQUIPPED WITH RAPID SHUTDOWN".
5. Use identification label to identify each photovoltaic system DC disconnecting means with the following information:
    a. Rated maximum power-point current (operating current).
    b. Rated maximum power-point voltage (operating voltage).
    c. Maximum system voltage.
    d. Short-circuit current.
    e. Maximum rated output current of the charge controller (if installed).
6. Use identification label to identify the interactive system point of interconnection at the disconnecting means as a power source and with the rated AC output current and the nominal operating AC voltage.
7. Where the inverter output connection is located in a panelboard on the opposite (load) end from the input feeder location or main circuit location in order to meet requirements of NFPA 70, use identification label to identify the overcurrent device with the word message "Warning; Inverter output connection; Do not relocate this overcurrent device".
8. Use warning labels to identify electrical hazards for photovoltaic system disconnecting means. Include the word message "Warning - Electric Shock

Hazard; Do not touch terminals; Terminals on both the line and load sides may be energized in the open position".

9. Use warning labels to identify electrical hazards for photovoltaic systems equipped with DC ground-fault protection in accordance with NFPA 70. Include the word message "Warning - Electric Shock Hazard; If a ground fault is indicated, normally grounded conductors may be ungrounded and energized".
10. Use wire and cable markers to identify photovoltaic system source, output, and inverter circuit conductors at all points of termination, connection, and splices.
11. Use identification labels or suitable permanent marking approved by authority having jurisdiction to identify exposed raceways, cable trays, pull boxes, junction boxes, and conduit bodies with the text "Photovoltaic Power Source" at maximum intervals of 10 feet in accordance with NFPA 70.

3.4. FIELD QUALITY CONTROL

A. See Section 01 40 00 - Quality Requirements, for additional requirements.

B. See article "SYSTEM STARTUP" below for additional requirements related to testing and inspection.

C. Provide services of a manufacturer's authorized representative to observe installation and assist in inspection and testing. Include manufacturer's detailed testing procedures and field reports with submittals.

D. Inspection and testing to include, at a minimum:

1. Inspect each system component for damage and defects.
2. Verify that equipment enclosures, boxes, and associated connections installed outdoors are weatherproof.
3. Verify proper wiring connections have been made and check for conductor continuity. Verify proper polarity.
4. Verify tightness of mechanical and electrical connections are according to manufacturer's recommended torque settings.
5. Perform insulation resistance tests.
   a. Disconnect surge protective devices (SPDs) prior to performing any high potential testing. Replace SPDs damaged by performing high potential testing with SPDs connected.
6. Measure and record ambient conditions, including date and time, ambient temperature, cell temperature, solar irradiance in the module plane, and wind speed.
7. Measure and record open circuit voltage of each string.
8. Measure and record voltages at the inverter AC and DC inputs.
9. Measure and record operating current for each string, sub-array, and array.
10. Measure and record AC output power.
11. Perform inverter functional test.
    a. Grid-Tied Inverters: Include simulation of loss of utility power and subsequent power restoration.
12. Verify proper operation of monitoring system.

E. Correct defective work, adjust for proper operation, and retest until entire system complies with contract documents.
F. Diagnostic Period: After successful completion of inspections and tests, operate system in normal mode for at least 14 days without any system or equipment malfunctions.
   1. Record all system operations and malfunctions.
   2. If a malfunction occurs, start diagnostic period over after correction of malfunction.
G. Submit detailed reports indicating inspection and testing results and corrective actions taken.

3.5. SYSTEM STARTUP

A. Provide services of a manufacturer's authorized representative to assist in performing system startup. Include manufacturer's detailed startup procedures with submittals.
B. Obtain Owner's approval prior to performing system startup.
C. Grid-Tied Systems: Obtain Utility Company's approval prior to performing system startup.
D. Prepare and start system in accordance with manufacturer's instructions.

3.6. CLEANING

A. Clean modules using only methods recommended by manufacturer to avoid scratches and other damage. Clean exposed surfaces on other components to remove dirt, paint, or other foreign material and restore to match original factory finish.

3.7. COMMISSIONING

A. See Section 01 91 13 for Commissioning Requirements.

3.8. CLOSEOUT ACTIVITIES

A. See Section 01 78 00 - Closeout Submittals, for closeout submittals.
B. See Section 01 79 00 - Demonstration and Training, for additional requirements.
C. Demonstration: Demonstrate proper operation of system to Owner, and correct deficiencies or make adjustments as directed.
D. Training: Train Owner's personnel on operation, adjustment, and maintenance of photovoltaic system.
   1. Use operation and maintenance manual as training reference, supplemented with additional training materials as required.
   2. Provide minimum of four hours of training.
   3. Instructor: Manufacturer's authorized representative.
   4. Location: At project site.

3.9. PROTECTION

A. Protect installed products from subsequent construction operations.

3.10. MAINTENANCE

A. See Section 01 70 00 - Execution Requirements, for additional requirements relating to maintenance service.

B. Provide to Owner, a proposal as an alternate to the base bid, a separate maintenance contract for the service and maintenance of photovoltaic system for two years from date of Substantial Completion, to include the work described below; Include a complete description of preventive maintenance, systematic examination, adjustment, cleaning, inspection, and testing, with a detailed schedule.

END OF SECTION

ENGINE GENERATORS

PART 1 GENERAL

1.1. SECTION INCLUDES

A. Packaged engine generator set.
B. Engine mount radiator.
C. Exhaust silencer and fittings.
D. Fuel fittings and day tank.
E. Fuel tank.
F. Remote control panel.
G. Battery and charger.
H. Weatherproof enclosure.
I. Remote fuel fill station.

1.2. RELATED REQUIREMENTS

A. Section 03 30 00 - Cast-in-Place Concrete: Concrete equipment pads.
B. Section 22 05 48 - Vibration and Seismic Controls for Plumbing Piping and Equipment.
C. Section 22 07 19 - Plumbing Piping Insulation.
D. Section 23 11 13 - Facility Fuel-Oil Piping:
   1. Diesel fuel piping.
E. Section 23 31 00 - HVAC Ducts and Casings.
F. Section 26 05 26 - Grounding and Bonding for Electrical Systems.
G. Section 26 05 29 - Hangers and Supports for Electrical Systems.
H. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.
I. Section 26 36 00 - Transfer Switches.

1.3. REFERENCE STANDARDS

A. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2015.
B. NECA/EGSA 404 - Standard for Installing Generator Sets; 2014.
C. NEMA MG 1 - Motors and Generators; 2017.
D. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); National Electrical Manufacturers Association; 2008.
E. NFPA 30 - Flammable and Combustible Liquids Code; 2018.
F. NFPA 37 - Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines; 2015.
G. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
H. NFPA 99 - Health Care Facilities Code; 2015.
I. NFPA 110 - Standard for Emergency and Standby Power Systems; 2013.
J. UL 142 - Steel Aboveground Tanks for Flammable and Combustible Liquids; Current Edition, Including All Revisions.
K. UL 1236 - Battery Chargers for Charging Engine-Starter Batteries; Current Edition, Including All Revisions.

L. UL 2200 - Stationary Engine Generator Assemblies; Current Edition, Including All Revisions.

1.4. ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Coordinate compatibility of generator sets to be installed with work provided under other sections or by others.
   2. Coordinate the work with other trades to avoid placement of ductwork, piping, equipment or other potential obstructions within the spaces dedicated for engine generator system.
   3. Coordinate arrangement of equipment with the dimensions and clearance requirements of the actual equipment to be installed.
   4. Coordinate the work to provide electrical circuits suitable for the power requirements of the actual auxiliary equipment and accessories to be installed.
   5. Notify Architect of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.

1.5. SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Provide NFPA 110 required documentation from manufacturer where requested by authorities having jurisdiction, including but not limited to:
   1. Certified prototype tests.
   2. Torsional vibration compatibility certification.
   3. NFPA 110 compliance certification.
   4. Certified rated load test at rated power factor.
C. Shop Drawings: Indicate electrical characteristics and connection requirements. Show plan and elevation views with overall and interconnection point dimensions, fuel consumption rate curves at various loads, ventilation and combustion air requirements, electrical diagrams including schematic and interconnection diagrams.
D. Product Data: Provide data showing dimensions, weights, ratings, interconnection points, and internal wiring diagrams for engine, generator, control panel, battery, battery rack, battery charger, exhaust silencer, vibration isolators, day tank, remote radiator, remote fuel fill station, and weather proof enclosures.
E. Test Reports: Indicate results of performance testing.
F. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of product.
G. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.
H. Manufacturer's Field Reports: Indicate procedures and findings.
I. Operation Data: Include instructions for normal operation.
J. Maintenance Data: Include instructions for routine maintenance requirements, service manuals for engine and day tank, oil sampling and analysis for engine wear, and emergency maintenance procedures.

K. Maintenance Materials and Tools: Furnish the following for Owner's use in maintenance of project.
   1. Extra Filter Elements: Two of each type, including fuel, oil and air.
   2. Tools: One set of tools required for preventative maintenance of the engine generator system. Package tools in adequately sized metal tool box.

1.6. QUALITY ASSURANCE

A. Comply with the following:
   1. NFPA 70 (National Electrical Code).
   2. NFPA 110 (Standard for Emergency and Standby Power Systems); meet requirements for Level 1 system.
   3. NFPA 101.
   4. NFPA 37 (Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines).
   5. NFPA 30 (Flammable and Combustible Liquids Code).
      a. Maintain at the project site a copy of each referenced document that prescribes execution requirements.

B. Products: Listed, classified, and labeled by Underwriter's Laboratories Inc. (UL) or testing firm acceptable to authorities having jurisdiction as suitable for the purpose indicated.

C. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years experience with service facilities within 50 miles of Project.

D. Supplier Qualifications: Authorized distributor of specified manufacturer with minimum three years experience.

E. Products: Furnish products listed and classified by Underwriters Laboratories as suitable for purpose specified and indicated.

1.7. DELIVERY, STORAGE, AND HANDLING

A. Accept unit on site on skids. Inspect for damage.

B. Protect equipment from dirt and moisture by securely wrapping in heavy plastic.

PART 2 PRODUCTS

2.1. MANUFACTURERS

A. Caterpillar Inc.: www.caterpillar.com.

B. Cummins : www.cummins.com.

C. Kohler: www.kohler.com.

2.2. PACKAGED ENGINE GENERATOR SYSTEM

A. Provide new engine generator system consisting of all required equipment, sensors, conduit, boxes, wiring, piping, supports, accessories, system programming, etc. as necessary for a complete operating system that provides the functional intent indicated.

B. System Description:
   1. Application: Emergency/standby.
   2. Configuration: Single packaged engine generator set operated independently (not in parallel).

C. Packaged Engine Generator Set:
   1. Type: Diesel (compression ignition).
   2. Power Rating: See One-Line Riser Diagram.
   3. Voltage: 277/480V 3 Phase.

D. Generator Set General Requirements:
   1. Prototype tested in accordance with NFPA 110 for Level 1 systems.
   2. Factory-assembled, with components mounted on suitable base.
   3. List and label engine generator assembly as complying with UL 2200.
   4. Power Factor: Unless otherwise indicated, specified power ratings are at 0.8 power factor for three phase voltages and 1.0 power factor for single phase voltages.
   5. Provide suitable guards to protect personnel from accidental contact with rotating parts, hot piping, and other potential sources of injury.

E. Service Conditions: Provide engine generator system and associated components suitable for operation under the service conditions at the installed location.

F. Starting and Load Acceptance Requirements:
   1. Cranking Method: Cycle cranking complying with NFPA 110 (15 second crank period, followed by 15 second rest period, with cranking limiter time-out after 3 cycles), unless otherwise required.
   2. Cranking Limiter Time-Out: If generator set fails to start after specified cranking period, indicate overcrank alarm condition and lock-out generator set from further cranking until manually reset.
   3. Start Time: Capable of starting and achieving conditions necessary for load acceptance within 10 seconds (NFPA 110, Type 10).
   4. Maximum Load Step: Supports 100 percent of rated load in one step.

G. Exhaust Emissions Requirements:
   1. Comply with federal (EPA), state, and local regulations applicable at the time of commissioning; include factory emissions certification with submittals.
   2. Do not make modifications affecting generator set factory emissions certification without approval of manufacturer and Engineer. Where such modifications are made, provide field emissions testing as necessary for certification.

H. System Capacity: As indicated on drawings at elevation of 500 feet above sea level, standby rating using engine-mounted radiator.

2.3. ENGINE AND ENGINE ACCESSORY EQUIPMENT

A. Provide engine with adequate horsepower to achieve specified power output at rated speed, accounting for alternator efficiency and parasitic loads.

B. Engine Fuel System - Diesel (Compression Ignition):
   1. Fuel Source: Diesel, ASTM D975 No. 2-D or approved cold weather diesel blends.
   2. Fuel Storage: Sub-base fuel tank.
   3. Engine Fuel Supply: Provide engine-driven, positive displacement fuel pump with replaceable fuel filter(s), water separator, check valve to secure prime, manual fuel priming pump, and relief-bypass valve. Provide fuel cooler where recommended by manufacturer.
   4. Engine Fuel Connections: Provide suitable, approved flexible fuel lines for coupling engine to fuel source.
   5. Sub-Base Fuel Tank:
      a. Provide sub-base mounted, double-wall fuel tank with secondary containment; listed and labeled as complying with UL 142.
      b. Tank Capacity: Size for minimum of 24 hours of continuous engine generator operation at 100 percent rated load, but not larger than permissible by applicable codes.
      c. Features:
         1. Direct reading fuel level gauge.
         2. Normal atmospheric vent.
         3. Emergency pressure relief vent.
         4. Fuel fill opening with lockable cap.
         5. Dedicated electrical conduit stub-up area.

C. Engine Starting System:
   1. System Type: Electric, with DC solenoid-activated starting motor(s).
   2. Battery(s):
      a. Battery Type: Lead-acid.
      b. Battery Capacity: Size according to manufacturer's recommendations for achieving starting and load acceptance requirements under worst case ambient temperature; capable of providing cranking through two complete periods of cranking limiter time-outs without recharging.
      c. Provide battery rack, cables, and connectors suitable for the supplied battery(s); size battery cables according to manufacturer's recommendations for cable length to be installed.
   3. Battery-Charging Alternator: Engine-driven, with integral solid-state voltage regulation.
   4. Battery Charger:
      a. Provide dual rate battery charger with automatic float and equalize charging modes and minimum rating of 10 amps; suitable for maintaining the supplied battery(s) at full charge without manual intervention.

b. Capable of returning supplied battery(s) from fully discharged to fully charged condition within 24 hours, as required by NFPA 110 for Level 1 applications while carrying normal loads.
c. Recognized as complying with UL 1236.
d. Furnished with integral overcurrent protection; current limited to protect charger during engine cranking; reverse polarity protection.
e. Provide integral DC output ammeter and voltmeter with five percent accuracy.
f. Provide alarm output contacts as necessary for alarm indications.

D. Engine Speed Control System (Governor):
1. Single Engine Generator Sets (Not Operated in Parallel): Provide electronic isochronous governor for controlling engine speed/alternator frequency.
2. Frequency Regulation, Electronic Isochronous Governors: No change in frequency from no load to full load; plus/minus 0.25 percent at steady state.

E. Engine Lubrication System:
1. System Type: Full pressure, with engine-driven, positive displacement lubrication oil pump, replaceable full-flow oil filter(s), and dip-stick for oil level indication. Provide oil cooler where recommended by manufacturer.

F. Engine Cooling System:
1. System Type: Closed-loop, liquid-cooled, with unit-mounted radiator/fan and engine-driven coolant pump; suitable for providing adequate cooling while operating at full load under worst case ambient temperature.
2. Fan Guard: Provide suitable guard to protect personnel from accidental contact with fan.

G. Engine Air Intake and Exhaust System:
1. Air Intake Filtration: Provide engine-mounted, replaceable, dry element filter.
2. Engine Exhaust Connection: Provide suitable, approved flexible connector for coupling engine to exhaust system.

H. Governor: Isochronous type to maintain engine speed within 0.5 percent, steady state, and 5 percent, no load to full load, with recovery to steady state within 2 seconds following sudden load changes. .

I. Engine Jacket Heater: Thermal circulation type water heater with integral thermostatic control, sized to maintain engine jacket water at 90 degrees F, and suitable for operation on 120 volts AC.

J. Radiator: Radiator using glycol coolant, with blower type fan, sized to maintain safe engine temperature in ambient temperature of 110 degrees F. Radiator air flow restriction 0.5 inches of water maximum.

2.4. ALTERNATOR (GENERATOR)

A. Alternator: 4-pole, 1800 rpm (60 Hz output) revolving field, synchronous generator complying with NEMA MG 1; connected to engine with flexible coupling; voltage output configuration as indicated, with reconnectable leads for 3 phase alternators.

B. Exciter:

1. Exciter Type: Brushless; provide permanent magnet generator (PMG) excitation system; self-excited (shunt) systems are not permitted.
2. PMG Excitation Short-Circuit Current Support: Capable of sustaining 300 percent of rated output current for 10 seconds.
3. Voltage Regulation (with PMG excitation): Plus/minus 0.5 percent for any constant load from no load to full load.

C. Temperature Rise: Comply with UL 2200.
D. Insulation System: NEMA MG 1, Class H; suitable for alternator temperature rise.
E. Enclosure: NEMA MG 1, drip-proof.
F. Total Harmonic Distortion: Not greater than five percent.
G. Rating: kW as indicated on drawings, at 0.8 power factor, voltage as indicated on drawings, 60 Hz at 1800 rpm.

2.5. GENERATOR SET CONTROL SYSTEM

A. Provide microprocessor-based control system for automatic control, monitoring, and protection of generator set. Include sensors, wiring, and connections necessary for functions/indications specified.
B. Control Panel:
1. Control Panel Mounting: Unit-mounted unless otherwise indicated; vibration isolated.
2. Generator Set Control Functions:
   a. Automatic Mode: Initiates generator set start/shutdown upon receiving corresponding signal from remote device (e.g. automatic transfer switch).
   b. Manual Mode: Initiates generator set start/shutdown upon direction from operator.
   c. Reset Mode: Clears all faults, allowing generator set restart after a shutdown.
   d. Emergency Stop: Immediately shuts down generator set (without time delay) and prevents automatic restarting until manually reset.
   e. Cycle Cranking: Programmable crank time, rest time, and number of cycles.
   f. Time Delay: Programmable for shutdown (engine cooldown) and start (engine warmup).
   g. Voltage Adjustment: Adjustable through range of plus/minus 5 percent.
3. Generator Set Status Indications:
   a. Voltage (Volts AC): Line-to-line, line-to-neutral for each phase.
   b. Current (Amps): For each phase.
   c. Frequency (Hz).
   d. Real power (W/kW).
   e. Reactive power (VAR/kVAR).
   f. Apparent power (VA/kVA).
   g. Power factor.
   h. Duty Level: Actual load as percentage of rated power.
   i. Engine speed (RPM).

j. Battery voltage (Volts DC).
k. Engine oil pressure.
l. Engine coolant temperature.
m. Engine run time.
n. Generator powering load (position signal from transfer switch).

4. Generator Set Protection and Warning/Shutdown Indications:
   a. Comply with NFPA 110; configurable for NFPA 110 Level 1 or Level 2, or NFPA 99 systems including but not limited to the following protections/indications:
      1. Overcrank (shutdown).
      2. Low coolant temperature (warning).
      3. High coolant temperature (warning).
      4. High coolant temperature (shutdown).
      5. Low oil pressure (shutdown).
      6. Overspeed (shutdown).
      7. Low fuel level (warning).
      8. Low coolant level (warning/shutdown).
      9. Generator control not in automatic mode (warning).
      10. High battery voltage (warning).
      11. Low cranking voltage (warning).
      12. Low battery voltage (warning).
      13. Battery charger failure (warning).
   b. In addition to NFPA 110 requirements, provide the following protections/indications:
      1. High AC voltage (shutdown).
      2. Low AC voltage (shutdown).
      3. High frequency (shutdown).
      4. Low frequency (shutdown).
      5. Overcurrent (shutdown).
   c. Provide contacts for local and remote common alarm.
   d. Provide lamp test function that illuminates all indicator lamps.
5. Other Control Panel Features:
   a. Event log.

2.6. ACCESSORIES

A. Exhaust Silencer: Critical type silencer, with muffler companion flanges and flexible stainless steel exhaust fitting, sized in accordance with engine manufacturer's instructions.
B. Battery Tray: Treated for electrolyte resistance, constructed to contain spillage.
C. Line Circuit Breaker: Molded case circuit breaker on generator output with integral thermal and instantaneous magnetic trip in each pole, sized in accordance with NFPA 70; UL listed. Include battery-voltage operated shunt trip, connected to open circuit breaker on engine failure. Unit mount in enclosure to meet NEMA 250, Type 1 requirements. Coordinate with electrical system per NEC 700.28 and 701.27.

D. Remote Annunciator Panel: Flush mounted panel with painted finish. Provide alarm horn, and indicators and alarms as follows:
   1. High battery voltage (alarm).
   2. Low battery voltage (alarm).
   3. Low fuel (alarm).
   4. System ready.
   5. Anticipatory-high water temperature.
   6. Anticipatory-low oil pressure.
   7. Low coolant temperature.
   8. Switch in off position (alarm).
   9. Overcrank (alarm).
   10. Emergency stop (alarm).
   11. High water temperature (alarm).
   12. Overspeed (alarm).
   13. Low oil pressure (alarm).
   14. Line power available.
   15. Generator power available.
   16. Lamp test and horn silence switch.

E. Weather-Protective Enclosure: Sound attenuated, reinforced steel housing allowing access to control panel and service points, with lockable doors and panels. Include fixed louvers, battery rack, and silencer.

F. Walk-In Enclosure: Pre-Fabricated, skid-mounted unit with engine generator, motorized air intake and exhaust louvers, controls, space heaters, and lighting fixtures. Provide 3 foot access aisle around engine-generator, with at least two doors for personnel access. Provide 7 feet clear height. Construct unit from insulated sheet metal panels to provide sound and thermal insulation.

G. Remote Fuel Fill Station: Weather proof painted steel enclosure with hinged door(s), with 2" CAMLOCK, 2" Ball Valve, and 2" Check Valve. Provide 90% fuel level and 95% fuel level alarms wired to a 2: solenoid valve. Fuel fill station PRYCO 230 series.

PART 3 EXECUTION

3.1. INSTALLATION

A. Perform work in a neat and workmanlike manner in accordance with NECA 1.

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

C. Install generator sets and associated accessories in accordance with NECA/EGSA 404.

D. Arrange equipment to provide minimum clearances and required maintenance access.

E. Unless otherwise indicated, mount generator set on properly sized 6 inch high concrete pad constructed in accordance with Section 03 30 00. Provide suitable vibration isolators, where not factory installed.

F. Provide required support and attachment in accordance with Section 26 05 29.

G. Use manufacturer's recommended oil and coolant, suitable for the worst case ambient temperatures.

H. Provide diesel fuel piping and venting in accordance with Section 23 21 13, where not factory installed.
I. Provide engine exhaust piping in accordance with Section 23 51 00, where not factory installed.
   1. Include piping expansion joints, piping insulation, thimble, condensation trap/drain, rain cap, hangers/supports, etc. as indicated or as required.
   2. Do not exceed manufacturer's maximum back pressure requirements.
J. Provide grounding and bonding in accordance with Section 26 05 26.
K. Identify system wiring and components in accordance with Section 26 05 53.

3.2. FIELD QUALITY CONTROL

A. See Section 01 45 00 - Contractor's Quality Control Program, for additional requirements.
B. Notify Owner and Architect at least two weeks prior to scheduled inspections and tests.
C. Notify authorities having jurisdiction and comply with their requirements for scheduling inspections and tests and for observation by their personnel.
D. Provide all equipment, tools, and supplies required to accomplish inspection and testing, including load bank and fuel.
E. Preliminary inspection and testing to include, at a minimum:
   1. Inspect each system component for damage and defects.
   2. Verify tightness of mechanical and electrical connections are according to manufacturer's recommended torque settings.
   3. Check for proper oil and coolant levels.
F. Prepare and start system in accordance with manufacturer's instructions.
G. Perform acceptance test in accordance with NFPA 110.
H. Provide field emissions testing where necessary for certification.
I. Correct defective work, adjust for proper operation, and retest until entire system complies with contract documents.
J. Provide the services of manufacturer's representative to prepare and start system.
K. Provide full load test utilizing portable test bank, if required, for four hours minimum. Simulate power failure including operation of transfer switch, automatic starting cycle, and automatic shutdown and return to normal. Provide fuel required for testing.
L. Record in 20 minute intervals during four hour test:
   1. Kilowatts.
   2. Amperes.
   3. Voltage.
   4. Coolant temperature.
   5. Room temperature.
   6. Frequency.
   7. Oil pressure.

3.3. ADJUSTING

3.4. CLEANING

A. Clean exposed surfaces to remove dirt, paint, or other foreign material and restore to match original factory finish.

3.5. CLOSEOUT ACTIVITIES

A. Demonstrate operation to Owner's operating personnel:
   1. Describe loads connected to emergency and standby system and restrictions for future load additions.
   2. Simulate power outage by interrupting normal source, and demonstrate that system operates to provide emergency and standby power.

B. Fill fuel tank to full level at Substantial Completion.

3.6. MAINTENANCE

A. See Section 01 77 00 - Contract Closeout, for additional requirements relating to maintenance service.

B. Provide service and maintenance of engine generator for one year from Date of Substantial Completion.

END OF SECTION

LIGHTING

PART 1 GENERAL

1.1. SECTION INCLUDES

A. Interior luminaires.
B. Ballasts.
C. Luminaire accessories.

1.2. RELATED REQUIREMENTS

A. Section 26 0526 - Grounding and Bonding for Electrical Systems.
B. Section 26 05 37 - Boxes.
C. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.

1.3. REFERENCE STANDARDS

A. ANSI C82.4 - American National Standard for Ballasts for High-Intensity-Discharge and Low-Pressure Sodium Lamps (Multiple-Supply Type); 2002.
B. ANSI O5.1 - American National Standard for Wood Poles - Specifications and Dimensions; 2008.
C. IESNA LM-63 - ANSI Approved Standard File Format for Electronic Transfer of Photometric Data and Related Information; 2002 (Reaffirmed 2008).
D. IESNA RP-8 - American National Standard Practice for Roadway Lighting; Illuminating Engineering Society of North America; 2000(R2005) (ANSI/IES RP8).
E. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2015.
F. NECA/IESNA 500 - Standard for Installing Indoor Commercial Lighting Systems; 2006.
G. NECA/IESNA 501 - Recommended Practice for Installing Exterior Lighting Systems; 2006.
H. NECA/IESNA 502 - Standard for Installing Industrial Lighting Systems; 2006.
I. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
J. NFPA 101 - Life Safety Code; 2015.
K. UL 844 - Luminaires for Use in Hazardous (Classified) Locations; Current Edition, Including All Revisions.
L. UL 924 - Emergency Lighting and Power Equipment; Current Edition, Including All Revisions.
M. UL 1029 - High-Intensity-Discharge Lamp Ballasts; Current Edition, Including All Revisions.

1.4. ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Coordinate the installation of luminaires with mounting surfaces installed under other sections or by others. Coordinate the work with placement of supports, anchors, etc. required for mounting. Coordinate compatibility of luminaires and associated trims with mounting surfaces at installed locations.

2. Coordinate the placement of luminaires with structural members, ductwork, piping, equipment, diffusers, fire suppression system components, and other potential conflicts installed under other sections or by others.
3. Notify Architect of any conflicts or deviations from the contract documents to obtain direction prior to proceeding with work.

1.5. SUBMITTALS

A. See Section 01 60 00 - Materials and Equipment, for submittal procedures.

B. Shop Drawings:
1. Indicate dimensions and components for each luminaire that is not a standard product of the manufacturer.

C. Product Data: Provide manufacturer's standard catalog pages and data sheets including detailed information on luminaire construction, dimensions, ratings, finishes, mounting requirements, listings, service conditions, photometric performance, installed accessories, and ceiling compatibility; include model number nomenclature clearly marked with all proposed features.
1. Provide electronic files of photometric data certified by a National Voluntary Laboratory Accreditation Program (NVLAP) lab or independent testing agency in IESNA LM-63 standard format upon request.
2. Ballasts: Include wiring diagrams and list of compatible lamp configurations.
3. Lamps: Include rated life, color temperature, color rendering index (CRI), and initial and mean lumen output.
4. Air Handling Luminaires: Include air handling performance data.

D. Certificates for Dimming Ballasts: Manufacturer's documentation of compatibility with dimming controls to be installed.

E. Coefficients of Utilization by an approved testing laboratory.

F. Lamp and ballast type for each fixture.

G. Groups of fixtures with the same lamp and ballast type may reference a single set of submittal documents.

H. Operation and Maintenance Data: Instructions for each product including information on replacement parts.

I. Project Record Documents: Record actual connections and locations of luminaires and any associated remote components.

1.6. FIELD CONDITIONS

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

1.7. WARRANTY

A. See Section 01 77 00 - Contract Closeout, for additional warranty requirements.

B. Provide five year manufacturer warranty for all linear fluorescent ballasts.

PART 2 PRODUCTS

2.1. LUMINAIRES

A. All luminaires shall have LED technology.

B. All luminaires in Warehouse, Shipping, or areas where there is an open structure shall be equipped with a integral occupancy sensor. Set to 20 minute intervals.

C. Lights at warehouse roof level shall be hung by chain to Clear Height as shown in Division 01 - Project Summary. Provide minimum 53" clearance below roof deck and avoid interference with ESFR sprinkler heads. Where minimum clearance, or clear height cannot be met, install lights above sprinkler heads at roof deck.

D. Coordinate warehouse lights with material handling systems and racking so that lights are centered in aisles, easily maintained, and not in conflict with ESFR sprinkler heads. Racked storage areas covers 350,000 SF of the building with a 10'-6" aisle. The 350,000 SF of racking includes 150,000 SF of 5 deep pushback rack and 200,000 SF of single selective and double deep rack.

E. Provide the following average eight levels measured at 36" AFF:

Open Warehouse	30 FC with a Max/Min Ratio of 2.0 and under.
Staging Area	30 FC with a Max/Min Ratio of 2.0 and under.
Battery Charging	30 FC with a Max/Min Ratio of 2.0 and under.
Maintenance Areas	50 FC with a Max/Min Ratio of 2.0 and under.
Rack Aisles	25 FC with a Max/Min Ratio of 2.0 and under.

F. Provide complete modular wiring system (Reloc) for all warehouse lighting. Branch circuiting can be either 277V or 480V.

G. All warehouse lighting shall have integral occupancy/photosensors.

H. Exterior Lighting:

1. Provide outside lighting utilizing LED "Shoe-box" type fixtures on 40 FT poles. Locate light poles for truck court areas a minimum of 12' being the trailer curb.
2. All pole lights in truck courts shall be mounted 36" diameter base, 48" above pavement/grade.
3. All pole lights in parking lot shall be mounted on 24" diameter base, 30" above pavement.
4. Minimum maintained foot-candle level shall be:

Auto Parking	2.5 FC average with 1.0 FC minimum.
Entrances	5.0 FC average.
Truck Courts	1.5 FC average with 0.5 FC minimum.

Trailer Storage Lots	1.0 FC average with 0.5 FC minimum.
Truck Drives	0.5 FC average with 0.3 FC minimum.
Guard House Apron	4.0 FC minimum.

5. Provide conduit will pull wire from building out to all future auto and trailer parking areas as required to provide power for future lighting.
6. Provide extra 1" PVC conduit with pull wire from the inside of the building with 24" of the roof deck to each light pole in the trailer staging lot for Occupier yard management system. Daisy chain of the light poles is acceptable.
7. Parking lot, truck courts, and incoming road lighting shall be controlled by a central time clock and photocell combination through relay panels.
8. All exterior lighting shall be dark sky compliant.

I. Provided products shall comply with NFPA 70.
J. Provide products listed and labeled by Underwriters UL 1598.
K. Recessed Luminaires:
   1. Ceiling Comparability: Comply with NEMA LE 4.
   2. Luminaires Recessed in Insulated Ceilings: Listed and labeled as IC-rated, suitable for direct contact with insulation and combustible materials.
   3. Luminaires Recessed in Sloped Ceilings: Provide suitable sloped ceiling adapters.
L. Fixtures - General:
   1. Finish shall be white baked enamel, unless otherwise specified with a minimum average reflectance of 85% on all exposed and light reflecting surfaces. Steel components shall be prepared for finishing with a 5-step zinc phosphating process.
   2. All fixtures mounted outdoors or in unheated spaces shall have 0 degree F ballasts.
M. If fixtures specified herein are discounted at the time the work is executed, provide suitable substitute fixtures, without additional cost, as directed by the engineer.
N. LED Luminaires: Listed and labeled as complying with UL 8750.
O. Electrical Characteristics:
   1. 277V - Office/
   2. 480V - Warehouse/Site.

2.2. ACCESSORIES
A. Provide accessory plaster frames for luminaires recessed in plaster ceilings.
B. Provide accessories such as plaster frames, stem, canopies, cords, toggle bolts, etc., necessary to mount fixture in a proper and approved method.

PART 3 EXECUTION

3.1. EXAMINATION
A. Verify that outlet boxes are installed in proper locations and at proper mounting heights and are properly sized to accommodate conductors in accordance with NFPA 70.
B. Verify that suitable support frames are installed where required.
C. Verify that branch circuit wiring installation is completed, tested, and ready for connection to luminaires.

D. Verify that conditions are satisfactory for installation prior to starting work.

3.2. INSTALLATION

A. Coordinate locations of outlet boxes provided under Section 26 05 37 as required for installation of luminaires provided under this section.
B. Install products according to manufacturer's instructions.
C. Install luminaires securely, in a neat and workmanlike manner, as specified in NECA 1 (general workmanship), NECA 500 (commercial lighting), and NECA 502 (industrial lighting). Coordinate with architectural reflected ceiling plans and mechanical plans.
D. Install luminaires plumb and square and aligned with building lines and with adjacent luminaires.
E. Square and rectangular fixtures shall be mounted with sides parallel to building lines and parallel with ceiling lines.
F. Properly support and align fixtures and provide all necessary steel shapes for support of the fixtures. Recessed fluorescent fixtures shall be supported at opposite corners by steel wire connected to building structure per IBC requirements. Coordinate complete fixture installation with the facility construction.
G. Surface Mounted Fixtures: Where fixtures are indicated for installation on low density ceiling material, mount on ceiling spacers as recommended by manufacturer unless UL approved for mounting directly to ceiling material.
H. Install accessories furnished with each luminaire.
I. Identify luminaires connected to emergency power system in accordance with Section 26 05 53.
J. Install lamps in each luminaire.
K. Verify all ceiling systems and coordinate fixture type and accessories prior to ordering fixtures.
L. Install fixtures as recommended by the manufacturer or as necessary to provide exact horizontal alignment, preventing horizontal or vertical deflection, or angular jointing of fixtures installed in continuous rows.
M. All lighting fixtures shall be furnished complete with lamps and all accessories necessary to provide a complete operable fixture.

3.3. FIELD QUALITY CONTROL

A. See Section 01 45 00 - Contractor's Quality Control Program, for additional requirements.
B. Inspect each product for damage and defects.
C. Operate each luminaire after installation and connection to verify proper operation.

3.4. ADJUSTING

A. Aim and position adjustable luminaires to achieve desired illumination as indicated or as directed by Architect. Secure locking fittings in place.

3.5. CLOSEOUT ACTIVITIES

A. See Section 01 77 00 - Contract Closeout, for closeout submittals.

B. Demonstration: Demonstrate proper operation of luminaires to Architect, and correct deficiencies or make adjustments as directed.

C. Just prior to Substantial Completion, replace all lamps that have failed.

3.6. PROTECTION

A. Protect installed luminaires from subsequent construction operations.

END OF SECTION

PATHWAYS FOR LOW VOLTAGE SYSTEMS CABLING

PART 1 GENERAL

1.1. SECTION INCLUDES

A. Low voltage cabling systems pathways.
B. Telecommunications & cable TV service entrance to building(s).
C. Communications pathways.
D. Pathways inside building(s).
E. Pathways connecting building(s).
F. Enclosures, backboards, and outlet boxes.
G. Grounding and bonding the low voltage cabling pathway system.

1.2. RELATED REQUIREMENTS

A. Section 07 84 00 - Firestopping.
B. Section 26 05 26 - Grounding and Bonding for Electrical Systems.
C. Section 26 05 34 - Conduit.
D. Section 26 05 53 - Identification for Electrical Systems.
E. Section 33 71 19 - Electrical Underground Ducts and Manholes.

1.3. PRICE AND PAYMENT PROCEDURES

A. See Section 01 23 00 - Alternatives, for product alternatives affecting this section.

1.4. REFERENCE STANDARDS

A. CEA-310 - Cabinets, Racks, Panels, and Associated Equipment; Consumer Electronics Association; Revision E, 2005.
B. TIA-568-C.1 - Commercial Building Telecommunications Cabling Standard; Telecommunications Industry Association; Rev C, 2009 (with Addenda; 2012).
C. TIA-568-C.2 - Commercial Building Telecommunications Cabling Standard - Part 2: Balanced Twisted Pair Cabling Components; Telecommunications Industry Association; Rev C, 2009.
D. TIA/EIA-568-B.3 - Commercial Building Telecommunications Cabling Standard - Part 3: Optical Fiber Cabling Components Standard, and Addendum 1 - Additional Transmission Performance Specifications for 50/125 um Optical Fiber Cables; Rev B, 2000; Addendum 1.
E. TIA-606-B - Administration Standard for the Telecommunications Infrastructure; Telecommunications Industry Association; Rev B, 2012.
F. UL 514C - Nonmetallic Outlet Boxes, Flush-Device Boxes, and Covers; Current Edition, Including All Revisions.

1.5. DELIVERY, STORAGE, AND HANDLING

A. Store products in manufacturer's unopened packaging until ready for installation.
B. Keep stored products clean and dry.

1.6. WARRANTY

A. See Section 01 77 00 - Contract Closeout, for additional warranty requirements.
B. Correct defective Work within a 1 year period after Date of Substantial Completion.

PART 2 PRODUCTS

2.1. SYSTEM DESIGN

A. Provide a complete permanent system of cabling pathways for low-voltage system cabling including but not limited to: Voice and data communications, fire alarm, intercom/paging, clock, intrusion detection, access control, video surveillance, audio/visual, lighting controls and HVAC controls, including conduits and wireways, pull wires, support structures, enclosures and cabinets, and outlet boxes.
B. Drawings may indicate specific raceway requirements for some locations. The contractor is responsible for including the specific raceway requirements indicated in addition to those required of this and related specification sections.
C. Provide conduit as indicated by related system device and/or equipment specification section to facilitate cable installation and as follows:
    1. Where cable is not allowed by applicable code to be routed in accessible ceiling spaces or in free-air.
    2. Where cable is allowed by applicable code to be routed in accessible ceiling spaces or in free-air.
        a. From the Intermediate Distribution Frame, (IDF)/Telecommunications Closet (TC), Main Distribution Frame (MDF), or Equipment Room (ER) into accessible ceiling space.
        b. From low voltage device outlet to an accessible ceiling space.
            1. For Voice and Data outlets:
                a. Provide minimum one inch conduit for Cat 5E cable, 1-1/4 inch conduit for Cat 6 cable, from outlet box to accessible ceiling. See drawings for additional requirements.
            2. For Audio/Visual outlets:
                a. See drawings.
            3. For Access Control, Intrusion Detection & Video Surveillance outlets:
                a. Provide minimum one 3/4 inch conduit from outlet box to accessible ceiling. See drawings for additional requirements.
            4. For Fire Alarm outlets:
                a. Provide minimum one 3/4 inch conduit from outlet box to accessible ceiling. See drawings for additional requirements.
            5. All other low-voltage device outlets:
                a. As indicated on the drawings.
    3. Where routing cable across inaccessible ceiling spaces longer than 10 feet:
        a. As indicated on drawings.

2.2. PATHWAYS

A. Conduit: As specified in Section 26 05 34.
B. Surface Raceway: As specified in Section 26 05 35.
C. Boxes: As specified in Section 26 05 37.
D. Cable Trays: As specified in Section 26 05 36.
E. Overhead Service Entrance: Weatherhead or service entrance fitting located on outside of building with galvanized rigid steel or intermediate metallic conduit running to entrance facility.
F. Underground Service Entrance: Rigid polyvinyl chloride (PVC) conduit, Schedule 40.

2.3. IDENTIFICATION PRODUCTS

A. Comply with TIA-606.
B. Comply with Section 26 05 53.

2.4. ENCLOSURES/BACKBOARDS

A. Backboards: Interior grade ACX or better plywood without voids, 3/4 inch thick; UL-labeled fire-retardant.
   1. Panel Size: 48 inches wide by 96 inches high. Provide minimum of one panel or quantity as necessary to accomplish coverage shown on drawings.
   2. Do not paint over UL label.
   3. Provide ground bus bar and #6 AWG CU ground conductor to service ground, as specified in Section 26 0526.

2.5. DEVICE OUTLET BOXES

A. Unless otherwise specified in related device's system section; flush mount outlet box depth shall be as required to accommodate cable manufacturer's recommended minimum conductor bend radius.
   1. Size, Unless Otherwise Indicated: 4 inches square by 2-1/8 inches deep.
   2. Wall-Mounted Telephones: 4 inches high by 2 inches wide by 2-1/8 inches deep.

PART 3 EXECUTION

3.1. INSTALLATION - GENERAL

A. Firestopping: Seal openings around pathway penetrations through fie-related walls, partitions, floors, and ceilings in accordance with Section 07 84 00.

3.2. INSTALLATION OF PATHWAYS

A. Underground Service Entrance: Install conduit at least 24 inches below finish grade.
B. Install with minimum clearances per Section 26 05 34.

C. In addition to as specified in Section 26 05 34, provide pull string in all conduits where there is available conduit fill capacity for future cable installation.

3.3. INSTALLATION OF DEVICE OUTLET BOXES

A. Install per Section 26 05 37.

B. Mounting heights: Unless otherwise indicated, as follows:

1. Voice and Data Outlets: 18 inches above finished floor.
2. Voice Outlets for Forward and Side-Reach Wall-Mounted Telephones: 45 inches above finished floor to top of telephone.

C. Orient outlet boxes for vertical installation of devices unless otherwise indicated.

END OF SECTION

CABLE TRAY SYSTEMS

PART 1 - GENERAL

1.1. SECTION INCLUDES
A. Continuous, rigid, welded steel wire mesh cable management system.

1.2. RELATED SECTIONS
A. Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables.
B. Section 26 05 29 - Hangers and Supports for Electrical Systems.
C. Section 26 05 37 - Boxes.
D. Section 26 27 26 - Wiring Devices.

1.3. REFERENCES
A. ASTM A 123 - Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
B. ASTM A 510 - General Requirements for Wire Rods and Coarse Round Wire, Carbon Steel.
C. ASTM B 633 - Electrodeposited Coatings of Zinc on Iron and Steel.

1.4. DESIGN REQUIREMENTS
A. Maximum deflection between supports: L/240.

1.5. SUBMITTALS
A. Comply with requirements of Section 01 30 00 - Administrative Procedures.
B. Product Data: Submit manufacturer's product data, including UL classification.
C. Shop Drawings: Submit shop drawings indicating materials, finish, dimensions, and accessories. Show layout, support, and installation details.
D. Manufacturer Qualifications: Submit manufacturer's certification indicating ISO 9002 quality certified.

1.6. QUALITY ASSURANCE
A. Manufacturer Qualifications: ISO 9002 quality certified.

1.7. DELIVERY, STORAGE, AND HANDLING
A. Delivery: Deliver materials to site in manufacture's original, unopened containers and packaging, with labels clearly indicating manufacture and material.
B. Storage: Store materials in a dry area indoors, protected from damage, and in accordance with manufacturer's instructions.
C. Handling: Protect materials and finishes during handling and installation to prevent damage.

PART 2 PRODUCTS

2.1. MANUFACTURER
A. Cablofil, Inc., E-Z Tray, and Flextray.

2.2. CABLE MANAGEMENT SYSTEM
A. Description: Cablofil EZ Tray continuous, rigid, welded steel wire mesh cable management system.
B. Mesh System: Permits continuous ventilation of cables and maximum dissipation of heat.
C. Safety Edge: Continuous safety edge T-welded wire lip.
D. Wire Mesh: Welded at all intersections.
E. UL Classification: Straight sections 4-inch deep by width as indicated on drawings, UL classified.
F. Material: Carbon steel wire, ASTM A 510, Grade 1008. Wire welded, bent, and surface treated after manufacturer.
   1. Finish for Carbon Steel Wire: Finish applied after welding and bending of mesh.
   2. Electro-Plated Zinc Galvanizing: ASTM B 633, Type III, SC-1.
G. Nominal Dimensions:
   1. Mesh: 2 x 4-inches (50 x 100 mm).
   2. Straight Section Lengths: 118 inches.
   3. Width: As indicated on drawings.
   4. Depth: 3 inches.
   5. Wire Diameter: 0.177 inch, minimum.
H. Fittings: Field fabricated in accordance with manufacturer's instructions from straight sections.
I. Support System:
   1. Trapeze mounting to slab below accessible floor: Provide standoffs to elevate cable tray 3 inches above slab.
   2. Ceiling Installation: Trapeze mount.
   3. Fasteners: As required by tray widths. Furnished by manufacturer.
J. Hardware: Hardware, including splice connectors and support components, furnished by manufacturer.
K. Manufacturers: Cablofil, Inc., E-Z Tray, and Flextray.

2.3. ACCESSORIES
A. Grounding: GTA-2-2 grounding lugs for attachment on tray of continuous ground conductor fixing system. Provide continuous grounding and bond to system ground.

2.4. LADDER RACKS - SERVER ROOM ONLY

A. Tubular steel bar type cable racks with 0.065” thick side rails. 1.50” high x 0.375” wide stringers. 1.50” wide x 0.375” high rungs set 12” on center. 24 inches wide. Manufacturers: CPI.

B. Complete with all necessary supports, hangars, connectors, nuts, bolts, etc. necessary for a complete installation.

C. Manufacturer: CPI, Inc.
   1. Part No: 10250-718 (18” wide rack).

D. Ladder racks shall be supported a minimum of every 5' on center and at the end of every ladder rack run, utilizing trapeze type supports (as recommended by the manufacturer), attached directly to the structure above. Provide wall angle support kits where ladder rack terminates at wall.

E. Provide end-closing Kits on all ladder rack ends.

F. Ladder racks shall be installed at 7'-0” AFF to underside of ladder, unless otherwise noted.

G. Coordinate placement of ladder racks and supports with duct work, conduits, piping, lighting fixtures, etc.

H. Provide ground jumpers and ground ladder racks to system grounds.

PART 3 EXECUTION

3.1. INSTALLATION

A. Install cable management system at locations indicated on the drawings and in accordance with manufacture's instructions.

B. Load Span Criteria: Install and support cable management system in accordance with span load criteria of L/240.

C. Cutting:
   1. Cut wires in accordance with manufacturer's instructions.
   2. Cut wires with side action bolt cutters to ensure integrity of galvanic protective layer.
   3. Cut each wire with 1 clean cut to eliminate grinding or touch-up.

D. Install cable management system using hardware, splice connectors, support components, and accessories furnished by manufacturer.

END OF SECTION

STRUCTURED CABLING FOR VOICE AND DATA

PART 1 GENERAL

1.1. SECTION INCLUDES

A. Cabling and pathways inside building(s).
B. Distribution frames, cross-connection equipment, enclosures, and outlets.
C. Grounding and bonding the telecommunications distribution system.

1.2. RELATED REQUIREMENTS

A. Section 07 84 00 - Firestopping.
B. Section 26 05 26 - Grounding and Bonding for Electrical Systems.
C. Section 26 05 34 - Conduit.
D. Section 26 05 36 - Cable Trays for Electrical Systems.
E. Section 26 05 37 - Boxes.
F. Section 27 05 28 - Pathways for Low-Voltage Systems Cabling.

1.3. SCOPE

A. This section describes the products and execution requirements relating to furnishing and installation of telecommunications cabling and termination components and related sub-systems as part of a structured cabling system. Vertical (backbone) and horizontal (station) cabling comprised of both copper and fiber optic cabling are covered under this document.
B. The horizontal (station) cabling system is based on the installation of Category 6, 4-pair Unshielded Twisted Pair (UTP) for both data and voice copper cables. The cables to be installed from the Telecommunications Outlet to the Intermediate Distribution Frame (IDF)/Telecommunications Closet (TC), Main Distribution Frame (MDF), or Equipment Room (ER) serving that area and terminated as specified in this document. This may be supplemented with cabling in selected areas.
C. Station cables to be installed in conduit, and/or free-air. Telecommunications Outlets to be mounted flush.
D. Backbone copper and fiber optic cables to be installed in conduit in building riser pathways and/or free-air as determined by the Project Coordinator or identified on the drawings. Backbone intra-building fiber optic cabling to be installed via inner duct conduit. Refer to the sub-section below which details inner duct requirements. Provide plenum rated cable when routing in plenum spaces.
E. Provide labor and materials necessary to construct the system as described herein and on the drawings. This includes, but is not limited to, furnishing and installing cable, cable supports, inner duct, racking and termination components, termination, testing, labeling and documentation. Installed system shall be fully functional and ready for use.

1.4. REFERENCE STANDARDS

A. BICSI TDM Manual - Telecommunications Distribution Methods Manual; Building Industry Consulting Service International, Inc.; 2009.

B. EIA-310 - Cabinets, Racks, Panels, and Associated Equipment; Electronic Industries Association; Revision D, 1992.
C. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
D. TIA-455-21 - FOTP-21 - Mating Durability of Fiber Optic Interconnecting Devices; Rev A, 1988(R 2002).
E. TIA-492AAAB-A - Detail Specification for 50-um Core Diameter/125-um Cladding Diameter Class Ia Graded-Index Multimode Optical Fibers; 2009.
F. TIA-492CAAA - Detail Specification for Class IVa Dispersion-Unshifted Single-Mode Optical Fibers; 1998 (R 2002).
G. TIA-526-7 - OFSTP-7 - Measurement of Optical Power Loss of Installed Single-Mode Fiber Cable Plant; 2002.
H. TIA-526-14 - OFSTP-14 - Optical Power Loss Measurements of Installed Multimode Fiber Cable Plant; Rev A, 1998(R2003).
I. TIA/EIA-568-B.1 - Commercial Building Telecommunications Cabling Standard - Part 1: General Requirements; Rev B, 2001; Addenda 1-7.
J. TIA/EIA-568-B.2 - Commercial Building Telecommunications Cabling Standard - Part 2: Balanced Twisted Pair Cabling Components; Rev B, 2001; Addenda 1-11.
K. TIA/EIA-568-B.3 - Commercial Building Telecommunications Cabling Standard - Part 3: Optical Fiber Cabling Components Standard, and Addendum 1 - Additional Transmission Performance Specifications for 50/125 um Optical Fiber Cables; Rev B, 2000; Addendum 1.
L. TIA-569 - Commercial Building Standard for Telecommunications Pathways and Spaces; 2009.
M. TIA/EIA-606 - Administration Standard for the Telecommunications Infrastructure; Rev A, 2002.
N. ANSI/J-STD-607 - Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications; Rev A, 2002.
O. UL 444 - Communications Cables; 2002.
P. UL 497 - Standard for Protectors for Paired-Conductor Communications Circuits; 2001.
Q. UL 514C - Standard for Nonmetallic Outlet Boxes, Flush-Device Boxes, and Covers; 1996.
R. UL 1581 - Reference Standard for Electrical Wires, Cables, and Flexible Cords; 2001.
S. UL 1863 - Standard for Communications-Circuit Accessories; 2004.

1.5. SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Product Data: Manufacturer's data sheets on each product to be used, including:
   1. Storage and handling requirements and recommendations.
   2. Installation methods.
C. Shop Drawings: Show compliance with requirements on isometric schematic diagram of network layout, showing cable routings, telecommunication closets, rack and enclosure layouts and locations, service entrance, and grounding.
D. Manufacturer Qualifications.

E. Installer Qualifications.
F. Test Plan: Complete and detailed plan, with list of test equipment and procedures for inspection and testing; submit at least 60 days prior to intended test date.
G. Field Test Reports: Provide one copy to Owner and one copy to engineer of record two weeks prior to final commissioning/observations.
H. Project Record Documents: Provide two sets, one for Owner and one for engineer of record of 1/8 inch = 1' 0" scale drawings.
   1. Record actual locations of outlet boxes and distribution frames.
   2. Show as-installed color coding, pair assignment, polarization, and cross-connect layout.
   3. Identify distribution frames and equipment rooms by room number on contract drawings.
   4. Identify all telecommunications locations per labeling in 3.03, F.
I. Operation and Maintenance Data: List of all components with part numbers, sources of supply, and operation and maintenance instructions; include copy of project record documents and shop drawings.

1.6. QUALITY ASSURANCE

A. Manufacturer Qualifications: At least 3 years experience manufacturing products of the type specified.
B. Installer Qualifications: A company having at least 3 years experience in the installation and testing of the type of system specified, and:
   1. Supervisors and installers factory certified by manufacturers of products to be installed.

1.7. DELIVERY, STORAGE, AND HANDLING

A. Store products in manufacturer's unopened packaging until ready for installation. In addition, cable must be stored in a location protected from vandalism and weather. If cable is stored outside, it must be covered with opaque plastic or canvas with provision for ventilation to prevent condensation and for protection from weather. If air temperature at cable storage location will be below 40 degrees F, the cable to be moved to a heated (50 degrees F minimum) location.
B. Keep stored products clean and dry. If necessary, cable to be stored off site at the Contractor's expense.

1.8. WARRANTY

A. See Section 01 77 00 - Contract Closeout, for additional warranty requirements.
B. The Contractor shall provide a system warranty covering the installed cabling system against defects in workmanship, components, and performance, and follow-on support after project completion.
C. The Contractor shall warrant the cabling system against defects in workmanship for a period of one year from the date of system acceptance. The warranty shall cover all labor and materials necessary to correct a failed portion of the system and to demonstrate

performance within the original installation specifications after repairs are accomplished. This warranty shall be provided at no additional cost to the Owner.

D. The Contractor shall facilitate a minimum 20-year system performance warranty between the manufacturer and the Owner. An extended component warranty shall be provided which warrants functionality of all components used in the system for a minimum of 20 years from the date of acceptance. The performance warranty shall warrant the installed 250 MHz horizontal copper, and both the horizontal and the backbone optical fiber portions of the cabling system. Copper links shall be warranted against the link performance minimum expected results defined in ANSI/TIA/EIA-568-B.2-1 (latest draft). Fiber optic links shall be warranted against the link and segment performance minimum expected results defined in ANSI/TIA/EIA-568-B.1.

E. The Contractor shall furnish an hourly rate with the proposal submittal which shall be valid for a period of one year from the date of acceptance. This rate will be used when cabling support is required to affect moves, adds, and changes to the system (MACs). MACs shall not void the Contractor's nor manufacturer's warranty.

PART 2 PRODUCTS

2.1. MANUFACTURERS

A. These specifications use a single manufacturer's name, model, or catalog number herein for the purpose of establishing a product set. An equivalent for the specified product set may be used upon approval by the architect or engineer of record.

B. Approved manufacturers:
   1. Panduit/General Cable: www.panduit.com/www.generalcable.com.
   2. Commscope Systimax: www.commscope.com/systimax.
   3. Hubbell/Draka Comteq: www.hubbell-premise.com/www.drakacomteq.us.

2.2. SYSTEM DESIGN

A. Provide a complete permanent system of cable and pathways for voice and data communications, including conduits and wireways, pull wires, support structures, enclosures and cabinets, rough-in boxes, and conduit sleeves.
   1. Comply with TIA/EIA-568 and TIA/EIA-569, latest editions.
   2. Provide fixed cables and pathways that comply with NFPA 70 and ANSI/J-STD-607 and are UL listed.
   3. Provide connection devices that are rated for operation under conditions of 32 to 140 degrees F at relative humidity of 0 to 95 percent, noncondensing.
   4. In this project, the term plenum is defined as return air spaces above ceilings, inside ducts, under raised floors, and other air-handling spaces.
   5. Capacity: As required to terminate all cables plus minimum 25 percent spare space.

2.3. PATHWAYS

A. As specified in Section 27 05 28 - Pathways for Low Voltage Systems Cabling.

2.4. BACKBONE CABLE

A. Fiber Optic Cable:
   1. Intra-building (premises cable):
      a. 24-strand fiber, multimode 50/125 um, multimode 62.5/125 um, and single mode 8/125 um; covered with orange cable jacket.
         1. In locations other than in plenums, provide NFPA 70 type OFNR nonconductive-riser-rated or type OFNP nonconductive-plenum-rated cable.
         2. In plenums, provide NFPA 70 type OFNP nonconductive-plenum-rated cable.
   2. Inter-building (indoor-outdoor cable):
      a. 24-strand fiber, multimode 50/125 um, multimode 62.5/125 um, and single mode 8/125 um; covered with orange cable jacket.
         1. In locations other than in plenums, provide NFPA 70 type OFNR nonconductive-riser-rated or type OFNP nonconductive-plenum-rated cable.
         2. In plenums, provide NFPA 70 type OFNP nonconductive-plenum-rated cable.

2.5. HORIZONTAL CABLE

A. Fiber Optic Cable:
   1. Two-fiber, multimode 50/125 um and 62.5/125 um; covered with orange single jacket.
      a. In locations other than in plenums, provide NFPA 70 type OFN nonconductive general purpose, OFNR nonconductive-riser-rated, or type OFNP nonconductive-plenum-rated cable.
      b. In plenums, provide NFPA 70 type OFNP nonconductive-plenum-rated cable.

B. Copper Cable (voice and data):
   1. TIA/EIA-568 Category 6 solid conductor unshielded twisted pair (UTP), __ AWG, individually twisted pairs; covered with blue jacket.
      a. In locations other than in plenums, provide NFPA 70 type CMG general purpose, CMR riser-rated, or type CMP plenum-rated cable.
      b. In plenums, provide NFPA 70 type CMP plenum-rated cable.

2.6. TELECOMMUNICATION OUTLETS

A. Faceplates:
   1. 3 port angled faceplate constructed of ABS moulding compound. Each port shall be provided with an icon to indicate its function. Faceplate shall accommodate two labels and provide a clear polycarbonate cover for each. All unused port positions shall have a blank insert installed. Faceplate ports shall be populated left to right, top to bottom.

2. Color: As selected by Architect.

B. Modular jacks:
1. All modular jacks shall be wired to the T568A or T568B wiring pattern. Modular jacks shall be constructed with a housing of polyphenylene oxide, 94V-0 rated. Modular jacks shall be terminated using a 110-style pc board connector (made of 94V-0 rated polycarbonate), color-coded for both T568A and T568B wiring. The 110 connector shall terminate 22-24 AWG solid conductors with a maximum insulation diameter of.05 inch. The modular jack contacts shall be plated with a minimum of 50 micro inches of gold in the contact area over a 50 micro inch minimum nickel underplate. Modular jacks shall be UL Listed.
2. Color: As selected by Owner.

C. Standard Configurations:
1. Unless otherwise noted, all locations shall be provided with 2 Category 6 UTP cables terminated on Category 6 modular RJ-45 jacks.
2. Wireless Access Point:
   a. 1 - Category 6 UTP cable terminated on Category 6 modular RJ-45 jacks.
3. Dedicated Phone:
   a. 1 - Category 6 UTP cable terminated on Category 6 modular RJ-45 jacks.

2.7. CROSS-CONNECTIONS AND ADAPTORS

A. Fiber Optic Terminal Enclosures:
1. Backbone Cable:
   a. Each fiber optic cable shall be terminated in the building MDF or IDF in appropriately sized rack mount patch enclosures (RMPE), providing protection for the terminated fibers. Contractor shall provide an appropriate number of RMPEs to accommodate project's installed fiber. The MDF enclosure shall accommodate project's installed fiber, plus an allowance for future growth equal to 50 percent of the installed capacity.

B. Fiber Optic Adaptors:
1. All fiber optic cable, whether single mode or multi-mode, shall be terminated using ST style fiber optic connectors.
2. For multi-mode applications, ST connectors shall be 50/125 µm or 62.5/125 µm (to match cable) multi-mode connectors, capable of terminating either 250 µm coated or 900 µm buffered fibers. The connectors shall be field-installable, requiring no epoxy or polishing.
3. For single mode applications, fiber shall be terminated using a fan-out kit or pigtail.

C. Patch Panels for Fiber Optic Cabling: Sized to fit EIA standard 19 inch wide equipment racks; 0.09 inch thick aluminum.
1. Adaptors: Maximum of 24 duplex adaptors per standard panel width.
2. Labels: Factory installed laminated plastic nameplates above each port, numbered consecutively; comply with TIA/EIA-606-A using encoded identifiers.
3. Provide incoming cable strain relief and routing guides on back of panel.
4. Provide rear cable management tray at least 8 inches deep with removable cover.

5. Provide dust covers for unused adaptors.

D. Copper Cross-Connection:
   1. Voice Connection Blocks:
      a. Manufacturer: CIRCA.
      b. Voice backbone cables shall be terminated using wall-mounted 110Connect XC wiring blocks located in each IDF. Wiring blocks shall employ field terminated 110Connect XC kits, which include wiring blocks with mounting legs, connecting blocks, and designation strips. Backbone wiring blocks shall employ 5-pair connecting blocks, and wiring blocks shall be marked black every fifth pair. Connecting block terminals shall be constructed of phosphor bronze, plated with a minimum of 150 microinches of tin-lead over a 50 microinch minimum nickel underplate. Mushroom style wire management spools shall be provided to manage voice circuit cross connections.
      c. All voice backbone cables routed from building exterior shall be terminated on wall-mounted overvoltage protection blocks immediately upon entering the building to protect telecommunications equipment from destructive transients. Protector blocks shall utilize 110-style connectors on both the input and output side. Protectors shall be solid state type.
   2. Patch Panels for Data Cabling: Sized to fit EIA standard 19 inch wide equipment racks; 0.09 inch thick aluminum; cabling terminated on Type 110 insulation displacement connectors; printed circuit board interface.
      a. Jacks: Non-keyed RJ-45, suitable for and complying with same standard as cable to be terminated; maximum 48 ports per standard width panel.
      b. Capacity: Provide ports sufficient for cables to be terminated plus 25 percent spare.
      c. Labels: Factory installed laminated plastic nameplates above each port, numbered consecutively; comply with TIA/EIA-606-A using encoded identifiers.

E. Patch Cord Assemblies:
   1. Patch cords used at the telecommunication rack and at the workstation shall be Category 6. Patch cords shall be factory-assembled by the manufacturer of the cabling system.
   2. End user workstations will require a Category 6 patch cord. Provide a sufficient number of 10-foot gray workstation patch cords (AMP Part No. 219885-1--0) to equip two thirds of the terminated Cat 6 wires, e.g., 90 terminated wires will require 60 patch cords.
   3. 5-foot and 7-foot patch cords shall be provided to cross-connect between the data patch panels and network equipment in the IDF. Provide IDF patch cords equal to the number of workstation patch cords calculated in the previous paragraph. The total quantity of IDF patch cords shall be equally divided between the two assembly lengths. Shielded patch cords shall be provided where required.
      a. Cat 6 Patch Cable, 5 feet, Gray
      b. Cat 6 Patch Cable, 7 feet, Gray

2.8. EQUIPMENT RACKS AND ENCLOSURES

A. Floor Mount (Open):
   1. Telecommunications Termination Rack: 7'H x 19"W; High strength lightweight aluminum construction E/W universal 5/8" - 5/8" - 1/2" alternating hole pattern. EIA channel: 6" x 1.25" x 1/4" thick flange, Base Angle: 3.5" x 6" x 3/8", Top Angle: 1.5" x 1.5" x 1/4", Top Bar: 1.5" x 1/4". Includes assembly and floor mounting hardware.
   2. Manufacturer: Chatsworth Products, Inc., or approved equivalent.

B. Wall Mount (Enclosed):
   1. 36"H x 24"W x 24"D. High strength, lightweight aluminum construction. Universal 5/8" - 5/8" - 1/2" alternating hole pattern. Swing out wall-mount enclosure system, 200 lb. load rating, locking front and rear door as part of a three-section construction. Enclosure to include knock-outs for conduit/cable entry. Front/main access door shall have plexiglass face. Painted finish: black.
   2. Provide two keys useable for all cabinets provided.
   3. Manufacturer: Chatsworth Products, Inc.; Model 12419-736 (36"H x 24"W x 24"D): www.chatsworth.com.

C. Wire Management:
   1. Provide wire management in the following equipment rack configurations:
      a. Floor mount (open):
         1. Vertical Wire Management: Chatsworth Products, Inc. black Combination Cabling Section (CCS). For single rack installations, mount a 6”W x 7'H x 12.24”D CCS (CPI part #30162-703) on each side of the rack. Where multiple racks abut, mount a 10”W x 7'H x 12.24”D CCS (CPI part #30163-703) between the racks and 6”W x 7'H x 12.24”D CCS (CPI part #30162-703) on each end of the ganged rack assembly.
         2. Horizontal Wiring Management: Chatsworth Products, Inc. black Universal Horizontal Cable Manager. Provide 19”W x 2U x 5.14”D cable managers (CPI Part #30130-719.
      b. Wall mount (open):
         1. Horizontal Wiring Management: Chatsworth Products, Inc. black Universal Horizontal Cable Manager. Provide 19”W x 2U x 5.14”D cable managers (CPI Part #30130-719.
      c. Floor mount (enclosed):
         1. Horizontal Wiring Management: Chatsworth Products, Inc. black Universal Horizontal Cable Manager. Provide 19”W x 2U x 5.14”D cable managers (CPI Part #30130-719.

D. Ladder Racks:
   1. Manufacturer:
      a. Chatsworth Products, Inc.; Model 10250-718 (18” wide rack): www.chatsworth.com.

2. Tubular steel bar type cable racks with 0.065” thick side rails. 1.5” high x 0.375” wide stringers. 1.5” wide x 0.375” high rungs set 12” on center. Widths as noted.
3. Complete with all necessary supports, hangars, connectors, nuts, bolts, etc., necessary for a complete installation.
4. Ladder racks shall be supported a minimum of every 5 feet on center and at the end of every ladder rack run, utilizing trapeze type supports (as recommended by the manufacturer), attached directly to the structure above. Provide wall angle support kits where ladder rack terminates at wall.
5. Provide end-closing kits on all ladder rack ends.
6. Ladder racks shall be installed at 7'0” AFF to underside of ladder, unless otherwise noted.
7. Coordinate placement of ladder racks and supports with duct work, conduits, piping, lighting fixtures, etc.

PART 3 EXECUTION

3.1. INSTALLATION - GENERAL

A. Comply with latest editions and addenda of TIA/EIA-568, TIA/EIA-569, ANSI/J-STD-607, NFPA 70, and SYSTEM DESIGN as specified in PART 2.

3.2. INSTALLATION OF EQUIPMENT AND CABLING

A. Cabling - General Requirements:
1. Do not install cable into conduits until conduit installation is complete.
2. Do not over-cinch or crush cables.
3. Do not exceed manufacturer's recommended cable pull tension and minimum bend radii.
4. When installing in conduit, use only lubricants approved by cable manufacturer and do not chafe or damage outer jacket.
5. Cable raceways shall not be filled greater than the NEC maximum fill for the particular raceway type.
6. Cables shall be installed in continuous lengths from origin to destination (no splices) unless specifically addressed in this document where cable splices are not allowed.
7. Cable shall be supported in conduit or cable tray where applicable. If a J-hook or trapeze system is used to support cable bundles, all horizontal cables shall be supported at a maximum of four-foot intervals. At no point shall cable(s) rest on acoustic ceiling grids or panels.
8. Cable shall be installed above fire-sprinkler and systems and shall not be attached to the system or any ancillary equipment or hardware. The cabling system and support hardware shall be installed so that it does not obscure any valves, fire alarm conduit, boxes, or other control devices.

9. Cables shall not be attached to ceiling grid or lighting support wires. Where light support for drop cable legs is required, the contractor shall install clips to support the cabling.
10. Any cable damaged or exceeding recommended installation parameters during installation shall be replaced by the contractor prior to final acceptance at no cost to the Owner.
11. All backbone cables shall be installed in the following manner:
    a. Backbone cables shall be installed separately from horizontal distribution cables.
    b. Where cables are housed in conduits, the backbone and horizontal cables shall be installed in separate conduits or in separate innerducts within conduits.
    c. Where cables are installed in an air return plenum, the cable shall be installed in conduit, or plenum cable shall be installed in a plenum innerduct to provide protection to the cable
    d. Where backbone cables and distribution cables are installed in a cable tray or wireway, backbone cables shall be installed first and bundled separately from the horizontal distribution cables.

B. Fiber Optic Cabling:
1. Prepare for pulling by cutting outer jacket for 10 inches from end, leaving strength members exposed. Twist strength members together and attach to pulling eye.
2. Support vertical cable at intervals as recommended by manufacturer.
3. Cable shall be installed in minimum 1 inch corrugated style innerduct enclosing the fiber optic cable in its entirety from termination to termination.
4. All strands are to be connected and tested. No strands are to be left 'dark'. Manufacturer's specifications for bend radii are to be strictly observed. Any instance where the bend radius of the optical cable must exceed that which is manufacturer specified or recommended shall immediately be brought to the attention of the Architect.
5. All fiber optic cable (and encasing innerduct) is not to be bound, wrapped, or otherwise secured to the copper twisted pair cable at any point, except as where the copper cable and innerduct may be commonly attached to a wall, and hence commonly supported by a wire hanger, or other approved mechanism.
6. Fiber slack shall be neatly coiled within the fiber termination panel. No slack loops shall be allowed external to the fiber panel(s).
7. Each cable shall be individually attached to the respective termination panel by mechanical means. The cables strength member(s) shall be securely attached the cable strain relief bracket in the panel.
8. Each fiber cable shall be stripped upon entering the termination panel and the individual fibers routed in the termination panel.
9. Each cable shall be clearly labeled at the entrance to the termination panel. Cables labeled within the bundle shall not be acceptable.
10. Dust caps shall be installed on the connectors and couplings at all times unless physically connected.

11. Fiber optic hardware and terminations shall be performed by a technician who has either successfully completed a manufacturer's training course for terminating and maintaining fiber optic cable, or has successfully completed such a training program offered by an authorized distributor of optical cable and termination products.
12. A 20-foot slack loop of fiber optic cable shall be left at the MDF and IDF prior to the cable entering any termination hardware.
13. Splicing: All fiber routed between MDF and IDF is to be one continuous length, without exception. No splices are to be performed.

C. Copper Cabling:
1. All outlets shall be installed in the following manner: Cables shall be coiled in the in-wall or surface-mount boxes if adequate space is present to house the cable coil without exceeding the manufacturer's bend radius. In hollow wall installations where box-eliminators are used, excess wire can be stored in the wall. No more than 12 inches of slack shall be stored in an in-wall box, modular furniture raceway, or insulated walls. Excess slack may be neatly coiled and stored in the ceiling above each drop location when there is not enough space present in the outlet box to store slack cable.
2. Enough slack shall be stored in ceiling space for outlet to be relocated to furthest location in the room from the feeding IDF.
3. In addition, each cable type shall be terminated as indicated below:
   a. Cables shall be dressed and terminated in accordance with the recommendations made in the ANSI/TIA/EIA-568-A document, manufacturer's recommendations, and/or best industry practices.
   b. Pair untwist at the termination shall not exceed 0.25 inch from Category 6 connecting hardware.
   c. The cable jacket shall be maintained as close as possible to the termination point.
4. Horizontal distribution cables shall be bundled in groups of not greater than 40 cables. Cable bundle quantities in excess of 40 cables may cause deformation of the bottom cables within the bundle.
5. UTP cable shall be installed so that there are no bends less than four times the outside diameter (4 x cable O.D.) at any point in the run. FTP cable shall be installed so that there are no bends less than 8 times the outside diameter (8 x cable O.D.) at any point in the run.

D. Equipment Racks and Enclosures:
1. Racks shall be placed in a manner that will allow a minimum of 3 feet of clearance from the front and rear mounting surfaces and on one side. If one mounting rail of the rack is placed against a wall, the mounting rail shall be no closer than 7 inches to the wall to allow room for vertical wire management hardware. Where more than one rack is to be installed, the racks shall be ganged with vertical wire management hardware to provide inter-bay management. Ganged rack frames will be placed in a manner that will allow a minimum of 3 feet of clearance from the front and rear mounting surfaces and on one side of the ganged assembly.
2. Racks shall be securely attached to the concrete floor using 3/8 inch hardware.

3. All racks shall be grounded to the telecommunications ground bus bar.
4. Rack mount screws (#12-24) not used for installing panels and other hardware shall be bagged and left with the rack upon completion of the installation.
5. All installed racks shall comply with regional seismic requirements and I.B.C.
6. Wall mount racks shall be mounted on plywood backboard per Section 27 1005.

E. Field-Installed Labels: Comply with TIA/EIA-606-A using encoded identifiers.
1. Contractor shall submit for approval by Owner a proposed labeling system based on the above standard.

3.3. FIELD QUALITY CONTROL

A. Visual Inspection:
1. Inspect cable jackets for certification markings.
2. Inspect cable terminations for color coded labels of proper type.
3. Inspect outlet plates and patch panels for complete labels.
4. Inspect patch cords for complete labels.
5. Inspect cable termination to validate that cables were dressed and terminated in accordance with ANSI/TIA/EIA specifications for jacket removal and pair untwist, compliance with manufacturer's minimum bend radius, and that cable ends are dressed in a neat and orderly fashion.

B. Testing - Fiber Optic Cabling:
1. Backbone: Perform optical fiber end-to-end attenuation test using an optical time domain reflectometer (OTDR) and manufacturer's recommended test procedures; perform verification acceptance tests and factory reel tests. Post-installation tests shall be per ANSI/TIA/EIA 568-B.3 Standard.
2. Multimode Backbone: Perform tests in accordance with TIA/EIA-526-14 Method B.
3. Single Mode Backbone: Perform tests in accordance with TIA-526-7 Method B.
4. Links: Perform optical fiber end-to-end attenuation tests and field reel tests.

C. Testing - Copper Cabling and Associated Equipment:
1. Testing will be completed per Industry Standard for cable type to be tested. TIA/EIA-568-B.2-1 (Category 6), ISO/IEC 11801:2002 2nd Edition (classes D, E and F).
2. Test backbone cables after termination but before cross-connection.
3. Test backbone cables for DC loop resistance, shorts, opens, intermittent faults, and polarity between connectors and between conductors and shield, if cable has overall shield.
4. Test operation of shorting bars in connection blocks.
5. Category 3 Backbone: Perform attenuation test.
6. Category 3 Links: Test each pair for short circuit continuity, short to ground, crosses, reversed polarity, operational and ring-back, and dial tone.
7. Category 6 Backbone: Perform near end cross talk (NEXT) and attenuation tests.
8. Category 6 Links: Perform tests for wire map, length, attenuation, NEXT, and propagation delay.

D. Testing - Documentation:

1. The Contractor shall compile test results into forms that contain all applicable test data. All forms shall be neatly completed and legible when submitted. Hard copy optical traces shall be neatly and securely attached to the test results where indicated. Computer disks containing trace files will be submitted at the same time.

E. Test Verification:

1. Upon receipt of the test documentation, The Owner reserves the right to perform spot testing of a representative sample of the cabling system to validate test results provided in the test document. Owner testing will use the same method employed by the Contractor, and minor variations will be allowed to account for differences in test equipment. If significant discrepancies are found, the Contractor will be notified for resolution.

F. Final Inspection:

1. Upon completion of the project, The Owner's Technical Representative will perform a final inspection of the installed cabling system with the Contractor's Project Foreman. The final inspection will be performed to validate that all horizontal and backbone cables were installed as defined in the drawing package, and that the installation meets the aesthetic expectations of the Owner.

END OF SECTION

SECURITY ACCESS SYSTEM

PART 1 GENERAL

1.1. SECTION INCLUDES
A. Security access devices.

1.2. RELATED SECTIONS
A. Section 08 71 00 - Door Hardware.

1.3. REFERENCES
A. NFPA 70 - National Electrical Code; National Fire Protection Association; 2008.

1.4. SYSTEM DESCRIPTION
A. Security Access System: Control access to building and selected areas using encoded cards:
   1. Selected Exterior Doors: Control access into building.
   2. Selected Building Areas: Control access into building areas.

1.5. SUBMITTALS
A. See Section 01 33 00 - Shop Drawings, Product Data, & Samples, for submittal procedures.
B. Shop Drawings: Provide system wiring diagram showing each device and wiring connection required.
C. Product Data: Provide electrical characteristics and connection requirements.
D. Test Reports: Indicate satisfactory completion of required tests and inspections.
E. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of product.
F. Project Record Documents: Record actual locations of access authorization equipment.
G. Operation Data: Operating instructions.
H. Maintenance Data: Maintenance and repair procedures.
I. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
   1. See Section 01 63 00 - Product Substitution Procedures Requirements, for additional provisions.
   2. Deliver fobs/cards not used in initial installation to Owner as directed.

1.6. QUALITY ASSURANCE
A. Conform to requirements of NFPA 70.
B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience and with service facilities within 100 miles of Project.
C. Installer Qualifications: Company specializing in installing the products specified in this section with minimum three years documented experience.

D. Products: Furnish products listed and classified by Underwriters Laboratories Inc. or testing firm acceptable to authority having jurisdiction as suitable for purpose specified and indicated.

PART 2 PRODUCTS

2.1. MANUFACTURERS

A. Security Access System:
   1. Brivo ACS 6000 series.

2.2. COMPONENTS

A. Security Access Control Panel, Accessories for elevator control, and control of card readers.
B. Encoded fob Controllers:
   1. Standard Door:
      a. Tri-Tech, 4" Fob read, 3 foot Onair Pass Read.
      b. Brivo B-BSPS for wall mount, Brivo B-BSPM for mullion mount.
   2. Entry Door and at Elevator Doors:
      a. Tri-Tech, 4" Fob Read, 3 foot Onair Pass read and keypad.
      b. Brivo: B-BSPK.
C. Encoded Fobs:
   1. Quantity: 200.
   2. Product: Schlage Multifunction thin Keyfob 125 kHz Prox + and MIFARE classic: 9691T..
D. Software: Access Control Software shall be furnished and installed; Brivo Onair and Brivo Stratis.
   1. Provide mobile pass for tenants and administrators.
E. System Cable: As recommended by manufacturer.

PART 3 EXECUTION

3.1. INSTALLATION

A. Install in accordance with manufacturer's instructions.
B. Use 18 AWG minimum size conductors for detection and signal circuit conductors unless otherwise recommended by manufacturer.
C. Make conduit and wiring connections to door hardware devices furnished and installed under Section 08 71 00.
D. Program card reader sequence of operation and schedule. Coordinate with owner.

3.2. FIELD QUALITY CONTROL

A. Perform field inspection and testing in accordance with Section 01 45 00.

B. Manufacturer Services: Furnish services of technician to supervise installation, adjustments, final connections, system testing, and to train Owner personnel.

3.3. CLOSEOUT ACTIVITIES

A. Demonstrate normal and abnormal modes of operation, and required response to each.
B. Provide 4 hours of instruction broken into (2) 2 hour sessions. Provide sign in sheet.

3.4. MAINTENANCE

A. See Section 01 77 00 - Contract Closeout, for additional requirements relating to maintenance service.
B. Provide a separate maintenance contract for specified maintenance service.

END OF SECTION

VIDEO SURVEILLANCE

PART 1 GENERAL

1.1. SECTION INCLUDES

A. Video surveillance system requirements.
B. Video recording and viewing equipment.
C. Cameras.
D. Accessories.

1.2. RELATED REQUIREMENTS

A. Section 26 05 26 - Grounding and Bonding for Electrical Systems.
B. Section 26 05 29 - Hangers and Supports for Electrical Systems.
C. Section 26 05 34 - Conduit.
D. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.
E. Section 27 10 05 - Low-Voltage Cabling Pathways.
F. Section 27 13 43 - Structured Cablingfor Voice and Data.

1.3. REFERENCE STANDARDS

A. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2015.
B. NECA 303 - Standard for Installing Closed-Circuit Television (CCTV) Systems; 2005.
C. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

1.4. ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Coordinate the placement of cameras with structural members, ductwork, piping, equipment, luminaires, diffusers, fire suppression system components, and other potential conflicts installed under other sections or by others.
   2. Coordinate the work with other installers to provide power for cameras and equipment at required locations.
   3. Notify Architect of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.
B. Preinstallation Meetings:
   1. Conduct meeting with facility representative to review camera and equipment locations and camera field of view objectives.
   2. Conduct meeting with facility representative and other related equipment manufacturers to discuss video surveillance system interface requirements.

1.5. SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Shop Drawings: Include plan views indicating locations of system components and proposed size, type, and routing of conduits and/or cables. Include elevations and details

of proposed equipment arrangements. Include system interconnection schematic diagrams. Include requirements for interface with other systems.

C. Product Data: Provide manufacturer's standard catalog pages and data sheets for each system component. Include ratings, configurations, standard wiring diagrams, dimensions, finishes, service condition requirements, and installed features.

D. Design Data:
   1. Video storage capacity calculations.

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

F. Manufacturer’s detailed field testing procedures.

G. Field quality control test reports.

H. Project Record Documents: Record actual locations of system components and installed wiring arrangements and routing.

I. Operation and Maintenance Data: Include detailed information on system operation, equipment programming and setup, replacement parts, and recommended maintenance procedures and intervals.

J. Software: One copy of software not resident in read-only memory.

1.6. QUALITY ASSURANCE

A. Comply with the following:
   1. NFPA 70
   2. Applicable TIA/EIA standards.

B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

C. Installer Qualifications: Company specializing in performing the work of this section with minimum three years documented experience with video surveillance systems of similar size, type, and complexity and providing contract maintenance service as a regular part of their business; authorized manufacturer's representative.

1.7. DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store products in accordance with manufacturer's instructions and NECA 303.

B. Store products in manufacturer's unopened packaging, keep dry and protect from damage until ready for installation.

1.8. FIELD CONDITIONS

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

1.9. WARRANTY

A. See Section 01 77 00 - Contract Closeout, for additional warranty requirements.

B. Provide minimum one year manufacturer warranty covering repair or replacement due to defective materials or workmanship.

PART 2 PRODUCTS

2.1. MANUFACTURERS

A. Video Recording and Viewing Equipment:
   1. exacqVision: www.exacq.com.

B. Cameras:
   1. Samsung Security: www.samsung-security.com.
   2. Arecont: www.arecontvision.com.
   3. Sony: pro.sony.com.
   4. Unifi.

C. Substitutions: Not permitted.

2.2. VIDEO SURVEILLANCE SYSTEM

A. Provide new video surveillance system consisting of all required equipment, conduit, boxes, wiring, connectors, hardware, supports, accessories, software, system programming, etc. as necessary for a complete operating system that provides the functional intent indicated.

B. System Description: IP system with connection to network (IP) cameras.
   1. Video Storage Capacity: Suitable for storing video from all cameras for 30 days. Record 24/7 with motion detection activation and size as required. Storage shall be Raid S Type.

C. Provide products listed, classified, and labeled by Underwriter's Laboratories Inc. (UL), Intertek (ETL), or testing firm acceptable to authority having jurisdiction as suitable for the purpose indicated.

D. Electromagnetic Interference/Radio Frequency Interference (EMI/RFI) Limits: Comply with FCC requirements of CFR, Title 47, Part 15, for Class B, consumer application.

2.3. VIDEO RECORDING AND VIEWING EQUIPMENT

A. Provide video recording and viewing equipment compatible with cameras to be connected.

B. NVR (NETWORK VIDEO RECORDER)
   1. Provide video server to meet exacqVision Enterprise VMS hardware recommendations for 64 bit systems, exacqVision A Series. Coordinate exact location with Owner. Provide all camera licenses required to complete this building plus 20% extra.
   2. Provide Monitor at NVR location. 21" LCD, 1280 x 1024 minimum resolution.
   3. Provide Remote Viewing Software. Install on client workstations. Coordinate with owner which workstations to install software on.
   4. Video to be recorded at 12 frames per second (FPS). Coordinate minimum resolution with Owner.

C. Computers:
   1. Unless otherwise indicated, client workstation hardware is not furnished by video surveillance system supplier. To be furnished by Owner.

D. Software:
   1. Servers: Unless otherwise indicated, provide all software and licenses required for fully operational system.
   2. Video Management System:
      a. Basis of Design: exacqVision; Enterprise VMS; www.exacq.com.
      b. Product: exacqVision Enterprise VMS

2.4. CAMERAS

A. Provide cameras and associated accessories suitable for operation under the service conditions at the installed location. Provide additional components (e.g. enclosures, heaters, blowers, etc.) as required.

B. Where not factory-installed, provide additional components (e.g. lenses, mounting accessories, etc.) as necessary for complete installation.

C. Network (IP) Cameras:
   1. 2MP Network (IP) Indoor Fixed Dome Camera:
      a. Unifi: UVC-G3-Bullet 3.
      b. Camera Type: True day/night with IR cut filter.
      c. Image Sensor: 1/2.8"PS Exmor 2.38M CMOS.
      d. Resolution: Up to 2 megapixel (1952 x 1116).
      e. Minimum Illumination: 0.1 lux color, 0.01 lux black and white.
      f. Lens: 3-8.5 mm varifocal; auto iris, motorized focus and zoom; f2.8x.
      g. Power: Power over Ethernet (IEEE 802.3af).
   2. Outdoor Fixed Dome Camera:
      a. Unifi: UVC-G3-Bullet 3.
      b. Camera Type: True day/night with IR cut filter.
      c. Image Sensor: 1/2.8"PS Exmor 2.38M CMOS.
      d. Resolution: Up to 2 megapixel (1952 x 1116).
      e. Minimum Illumination: 0.1 lux color, 0.01 lux black and white.
      f. Lens: 3-8.5 mm varifocal; auto iris, motorized focus and zoom; f2.8x.
      g. Power: Power over Ethernet (IEEE 802.3af).
   3. 5MP Network (IP) Indoor Fixed Dome Camera:
      a. Arecont; Model AV5145DN-3310-D-LG
      b. Camera Type: True day/night with IR cut filter.
      c. Image Sensor: 1/2.5" progressive scan CMOS.
      d. Resolution: Up to 5 megapixel (2592 x 1944).
      e. Minimum Illumination: 0.15 lux color, 0 lux black and white.
      f. Lens: 3.3-10 mm varifocal; auto iris, motorized focus and zoom; f1.6.
      g. Power: Power over Ethernet (IEEE 802.3af).
   4. 5MP Network (IP) Multi-Sensor Fixed Dome Camera:
      a. Arecont; Model AV20175DN.

b. Camera Type: True day/night with mechanical cut filter.
c. Image Sensor: 4x 5MP CMOS.
d. Resolution: Up to 5 megapixel (2560 x 1920) per camera.
e. Minimum Illumination: 0.3 lux color, 0 lux black and white.
f. Lens: 2.8-16mm; auto iris, motorized focus and zoom, f1.6.
g. Power: Power over Ethernet (IEEE 802.3af)

D. Camera Enclosures and Mounting Brackets:
1. Where not factory-installed, provide accessory camera enclosures suitable for operation under the service conditions at the installed location.
2. Where not factory-installed, provide accessory camera mounting brackets necessary for installation. Coordinate final mounting location and mounting type with owner.

2.5. ACCESSORIES

A. Provide components as indicated or as required for connection of video surveillance system to devices and other systems indicated.
B. Provide network switches as required for network connections to system components.
C. Where needed, provide MidSpan Power injector, and associated 120Volt power.
1. Manufacturer: Axis: www.axis.com
2. Model: T8120
D. Where needed provide Media Converter Switch, and associated power supply and 120Volt power.
1. Manufacturer: Axis: www.axis.com
2. Model: T8604
E. Where needed provide Power over Ethernet and Network Range Extender(s)
1. Manufacturer: Veracity: www.veracityglobal.com
2. Model: VOR-ORM
F. Provide cables as indicated or as required for connections between system components.
1. Data Cables for IP Network Connections: Unshielded twisted pair (UTP), minimum Category 6e, complying with Section 27 13 43.
2. Fiber Optic Cable for IP Network Connections: Complying with Section [27 13 43].
G. Provide accessory racks/cabinets as indicated or as required for equipment mounting.

PART 3 EXECUTION

3.1. INSTALLATION

A. Install video surveillance system in accordance with NECA 1 (general workmanship) and NECA 303.
B. Install products in accordance with manufacturer's instructions.
C. Provide required support and attachment in accordance with Section 26 05 29.
D. Wiring Method: Unless otherwise indicated, use cables (not in conduit).
1. Use suitable listed cables in wet locations, including underground raceways.

2. Use suitable listed cables for vertical riser applications.
3. Use listed plenum rated cables in spaces used for environmental air.
4. Install wiring in conduit for the following:
   a. Where required for rough-in.
   b. Where required by authorities having jurisdiction.
   c. Where exposed to damage.
   d. Where installed outside the building.
   e. For exposed connections from outlet boxes to cameras.
5. Conduit: Comply with Section 26 05 34.
6. Conceal all cables unless specifically indicated to be exposed.
7. Route exposed cables parallel or perpendicular to building structural members and surfaces.

E. Provide grounding and bonding in accordance with Section 26 05 26.
F. Identify system wiring and components in accordance with Section 26 05 53.

3.2. FIELD QUALITY CONTROL

A. See Section 01 45 00 - Contractor's Quality Control Program, for additional requirements.
B. Prepare and start system in accordance with manufacturer's instructions.
C. Adjust cameras to provide desired field of view and produce suitable images under all service lighting conditions.
D. Program system parameters according to requirements of Owner.
E. Test for proper interface with other systems.
F. Correct defective work, adjust for proper operation, and retest until entire system complies with contract documents.

3.3. CLEANING

A. Clean exposed surfaces to remove dirt, paint, or other foreign material and restore to match original factory finish.

3.4. CLOSEOUT ACTIVITIES

A. See Section 01 77 00 - Contract Closeout, for closeout submittals.
B. See Section 01 79 00 - Demonstration and Training, for additional requirements.
C. Demonstration: Demonstrate proper operation of system to Owner, and correct deficiencies or make adjustments as directed.
D. Training: Train Owner's personnel on operation, adjustment, and maintenance of system.
   1. Use operation and maintenance manual as training reference, supplemented with additional training materials as required.
   2. Provide minimum of four hours of training.
   3. Instructor: Manufacturer's authorized representative.
   4. Location: At project site.

3.5. MAINTENANCE

A. See Section 01 77 00 - Contract Closeout, for additional requirements relating to maintenance service.

B. Provide trouble call-back service upon notification by Owner:

1. Include allowance for call-back service during normal working hours at no extra cost to Owner.
2. Owner will pay for call-back service outside of normal working hours on an hourly basis, based on actual time spent at site and not including travel time; include hourly rate and definition of normal working hours in maintenance contract.

END OF SECTION

FIRE ALARM SYSTEM

PART 1 GENERAL

1.1. SECTION INCLUDES

A. Fire alarm system design and installation, including all components, wiring, and conduit.
B. Transmitters for communication with supervising station.
C. Maintenance of fire alarm system under contract for specified warranty period.

1.2. RELATED SECTIONS

A. Section 08 36 00 - Sectional Overhead Doors: Coiling fire doors to be released by fire alarm system.
B. Section 08 71 00 - Door Hardware: Electrically operated locks and door holder devices to be monitored and released by fire alarm system.
C. Section 21 13 00 - Fire-Suppression Sprinkler Systems: Supervisory, alarm, and actuating devices installed in sprinkler system.

1.3. REFERENCES

A. IEEE C62.41.2 - Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and Less) AC Power Circuits; 2002 (R2008).
B. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
C. NFPA 72 - National Fire Alarm Code and Signaling Code; 2010.
D. NFPA 101 - Code for Safety to Life from Fire in Buildings and Structures; 2009.

1.4. SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Proposal Documents: Submit the following with cost/time proposal:
    1. NFPA 72 "Record of Completion", filled out to the extent known at the time.
    2. Manufacturer's detailed data sheet for each control unit, initiating device, and notification appliance.
    3. Certification by Contractor that the system design will comply with the contract documents.
    4. Proposed maintenance contract.
C. Drawings must be prepared using AutoCAD Release 2005 (or later).
    1. Owner will provide floor plan drawings for Contractor's use; verify all dimensions on Owner-provided drawings.
D. Evidence of designer qualifications.
E. Design Documents: Submit all information required for plan review and permitting by authorities having jurisdiction, including but not limited to floor plans, riser diagrams, and description of operation:
    1. Copy (if any) of list of data required by authority having jurisdiction.
    2. NFPA 72 "Record of Completion", filled out to the extent known at the time.

3. Clear and concise description of operation, with input/output matrix similar to that shown in NFPA 72 Appendix A-7-5-2.2(9), and complete listing of software required.
4. System zone boundaries and interfaces to fire safety systems.
5. Location of all components, circuits, and raceways; mark components with identifiers used in control unit programming.
6. Circuit layouts; number, size, and type of raceways and conductors; spare capacity calculations; notification appliance circuit voltage drop calculations.
7. List of all devices on each signaling line circuit, with spare capacity indicated.
8. Manufacturer's detailed data sheet for each component, including wiring diagrams, installation instructions, and circuit length limitations.
9. Description of power supplies; if secondary power is by battery include calculations demonstrating adequate battery power.
10. Certification by either the manufacturer of the control unit or by the manufacturer of each other component that the components are compatible with the control unit.
11. Certification by Contractor that the system design complies with the contract documents.
12. Do not show existing components to be removed.
13. Shop drawings will need to be stamped by a NICET Level III certified fire alarm technician.

F. Evidence of installer qualifications.

G. Evidence of instructor qualifications; training lesson plan outline.

H. Evidence of maintenance contractor qualifications, if different from installer.

I. Inspection and Test Reports:
1. Submit inspection and test plan prior to closeout demonstration.
2. Submit documentation of satisfactory inspections and tests.
3. Submit NFPA 72 "Inspection and Test Form," filled out.

J. Operating and Maintenance Data: See Section 01 78 00 for additional requirements; revise and resubmit until acceptable; have one set available during closeout demonstration:
1. Complete set of specified design documents, as approved by authority having jurisdiction.
2. Additional printed set of project record documents and closeout documents, bound or filed in same manuals.
3. Contact information for firm that will be providing contract maintenance and trouble call-back service.
4. List of recommended spare parts, tools, and instruments for testing.
5. Replacement parts list with current prices, and source of supply.
6. Detailed troubleshooting guide and large scale input/output matrix.
7. Preventive maintenance, inspection, and testing schedule complying with NFPA 72; provide printed copy and computer format acceptable to Owner.
8. Detailed but easy to read explanation of procedures to be taken by non-technical administrative personnel in the event of system trouble, when routine testing is being conducted, for fire drills, and when entering into contracts for remodeling.

K. Project Record Documents: See Section 01 78 00 for additional requirements; have one set available during closeout demonstration:
   1. Complete set of floor plans showing actual installed locations of components, conduit, and zones.
   2. "As installed" wiring and schematic diagrams, with final terminal identifications.
   3. "As programmed" operating sequences, including control events by device, updated input/output chart, and voice messages by event.

L. Closeout Documents:
   1. Certification by manufacturer that the system has been installed in compliance with his installation requirements, is complete, and is in satisfactory operating condition.
   2. NFPA 72 "Record of Completion", filled out completely and signed by installer and authorized representative of authority having jurisdiction.
   3. Certificate of Occupancy.
   4. Written warranty.
   5. Report on training results.

M. Maintenance Materials, Tools, and Software: Furnish the following for Owner's use in maintenance of project.
   1. See Section 01 60 00 - Materials and Equipment, for additional provisions.
   2. Furnish spare parts of same manufacturer and model as those installed; deliver in original packaging, labeled in same manner as in operating and maintenance data and place in spare parts cabinet.
   3. In addition to the items in quantities indicated in PART 2, furnish the following:
      a. All tools, software, and documentation necessary to modify the fire alarm system using Owner's personnel; minimum modification capability to include addition and deletion of devices, circuits, and zones, and changes to system description, operation, and evacuation and instructional messages.
      b. Two copies, on CD-ROM, of all software not resident in read-only-memory.
         1. Extra Fuses: Two for each installed fuse; store inside applicable control cabinet.

1.5. QUALITY ASSURANCE

A. Copies of Design Criteria Documents: Maintain at the project site for the duration of the project, bound together, an original copy of NFPA 72, the relevant portions of applicable codes, and instructions and guidelines of authorities having jurisdiction; deliver to Owner upon completion.

B. Designer Qualifications: NICET Level III or IV (3 or 4) certified fire alarm technician or registered fire protection engineer, employed by fire alarm control panel manufacturer, Contractor, or installer, with experience designing fire alarm systems in the jurisdictional area of the authorities having jurisdiction.

C. Installer Qualifications: Firm with minimum 5 years documented experience installing fire alarm systems of the specified type and providing contract maintenance service as a regular part of their business.

1. Authorized representative of control unit manufacturer; submit manufacturer's certification that installer is authorized; include name and title of manufacturer's representative making certification.
2. Installer Personnel: At least 2 years of experience installing fire alarm systems.
3. Supervisor: NICET level III or IV (3 or 4) certified fire alarm technician; furnish name and address.
4. Contract maintenance office located within 50 miles of project site.
5. Certified in Oregon as fire alarm installer.
6. Instructor Qualifications: Experienced in technical instruction, understanding fire alarm theory, and able to provide the required training; trained by fire alarm control unit manufacturer.
7. Each and all items of the Fire Alarm System shall be listed as a product of a SINGLE fire alarm system manufacturer under the appropriate category by Underwriters' Laboratories, Inc. (UL), and shall bear the "UL" label. All control equipment shall be listed under UL category UOJZ as a single control unit. Partial listing shall NOT be acceptable.
8. All control equipment must have transient protection devices to comply with UL864 requirements.
9. In addition to the UL UOJZ requirement mentioned above, the system controls shall be UL listed for Power Limited Applications per NEC 760. All circuits must be marked in accordance with NEC article 760 23.

1.6. WARRANTY

A. See Section 01 77 00 - Contract Closeout, for additional warranty requirements.

B. Provide control panel manufacturer's warranty that system components other than wire and conduit are free from defects and will remain so for 1 year after date of Substantial Completion.

C. Provide installer's warranty that the installation is free from defects and will remain so for 1 year after date of Substantial Completion and certified test.

PART 2 PRODUCTS

2.1. MANUFACTURERS

A. Fire Alarm Control Units - Basis of Design:
   1. Honeywell Security & Fire Solutions; Fire Control Instruments, Inc: www.firecontrolinstruments.com.
   2. Honeywell Security & Fire Solutions; Notifier: www.notifier.com.
   3. SimplexGrinnell 4010 Series: www.simplexgrinnell.com.
   4. GE Security; EST Series: www.gesecurity.com.
      a. Fire Alarm Control Units - Other Acceptable Manufacturers: Provided their products meet or exceed the performance of the basis of design product, products of the following are acceptable:
         1. Firelite 98010.
         2. Provide alternate pricing for alternate manufacturer.

b. Initiating Devices, and Notification Appliances:
   1. Honeywell Security & Fire Solutions/Fire Control Instruments, Inc: www.firecontrolinstruments.com.
   2. Honeywell Security & Fire Solutions/Notifier: www.notifier.com.
   3. SimplexGrinnell: www.simplexgrinnell.com. Part numbers indicated are Simplex; equals by other manufacturers are acceptable, unless otherwise noted.
   4. GE Security: www.gesecurity.com.
   5. Same manufacturer as control units.
   6. Provide all initiating devices and notification appliances made by the same manufacturer.

c. Substitutions: See Section 01 60 00 - Materials and Equipment.
   1. For other acceptable manufacturers of control units specified, submit product data showing equivalent features and compliance with contract documents prior to bid per Section 01 60 00.
   2. For substitution of products by manufacturers not listed, submit product data showing features and certification by Contractor that the design will comply with contract documents.

2.2. FIRE ALARM SYSTEM

A. Fire Alarm System: Provide modifications and extensions to the existing automatic fire detection and alarm system:
   1. Provide all components necessary, regardless of whether shown in the contract documents or not, for a complete and operable system.
   2. Comply with the following; where requirements conflict, order of precedence of requirements is as listed:
      a. The Americans With Disabilities Act (ADA).
      b. The requirements of the State Fire Marshal.
      c. The requirements of the local authority having jurisdiction.
      d. Applicable local codes.
      e. The contract documents (drawings and specifications).
      f. NFPA 101.
      g. NFPA 72; where the word "should" is used consider that provision mandatory; where conflicts between requirements require deviation from NFPA 72, identify deviations clearly on design documents.
   3. Evacuation Alarm: Multiple smoke zones; allow for evacuation notification of any individual zone or combination of zones, in addition to general evacuation of entire premises.
   4. Provide all monitoring and interlocks between fire alarm system and fire pump.
   5. General Evacuation Zones: Each smoke zone is considered a general evacuation zone unless otherwise indicated, with alarm notification in all zones on the same floor, on the floor above, and the floor below.
   6. Program notification zones and voice messages as directed by Owner.

7. Hearing Impaired Occupants: Provide visible notification devices in all public areas and in dwelling units.
8. Fire Command Center: Location in Fire Pump Room.
9. Master Control Unit (Panel): In Fire Pump Room
10. Provide remote annunciator at main entry.
11. Supervising Stations and Fire Department Connections:
    a. Public Fire Department Notification: By remote supervising station.
    b. Remote Supervising Station: UL-listed central station under contract to facility.
    c. Means of Transmission to Remote Supervising Station: Digital alarm communicator transmitter (DACT), 2 telephone lines.
12. Circuits:
    a. Initiating Device Circuits (IDC): Class B, Style A.
    b. Signaling Line Circuits (SLC) Within Single Building: Class B, Style 4.
    c. Signaling Line Circuits (SLC) Between Buildings: Class A, Style 6.
    d. Notification Appliance Circuits (NAC) within single building: Class B, Style Y.
    e. Notification Appliance Circuits (NAC) between buildings: Class A, Style Z.
13. Spare Capacity:
    a. Initiating Device Circuits: Minimum 25 percent spare capacity.
    b. Notification Appliance Circuits: Minimum 25 percent spare capacity.
    c. Speaker Amplifiers: Minimum 25 percent spare capacity.
    d. Master Control Unit: Capable of handling all circuits utilized to capacity without requiring additional components other than plug-in control modules.
14. Power Sources:
    a. Primary: Dedicated branch circuits of the facility power distribution system.
    b. Secondary: Storage batteries.
    c. Capacity: Sufficient to operate entire system for period specified by NFPA 72.
    d. Each Computer System: Provide uninterruptible power supply (UPS).

2.3. EXISTING COMPONENTS

A. Existing Fire Alarm System: Remove existing system completely after new system is fully operational and tested.
B. Clearly label components that are "Not In Service."
C. Remove unused existing components and materials from site and dispose of properly.

2.4. FIRE SAFETY SYSTEMS INTERFACES

A. Supervision: Provide supervisory signals in accordance with NFPA 72 for the following:
    1. Sprinkler water control valves.

2. Dry-pipe sprinkler system pressure.
3. Dry-pipe sprinkler valve room low temperature.
4. Sprinkler water storage tank low level.
5. Sprinkler water storage tank low temperature.
6. Fire pump(s).

B. Alarm: Provide alarm initiation in accordance with NFPA 72 for the following:
1. Sprinkler water flow.
2. Total flooding suppression system activation.
3. Pump room heat detector.
4. Duct smoke detectors.

C. HVAC:
1. Duct Smoke Detectors: Close dampers indicated; shut down air handlers indicated.

D. Doors:
1. Smoke Barrier Door Magnetic Holders: Release upon activation of smoke detectors in smoke zone on either side of door, upon alarm from manual pull station on same floor, and upon sprinkler activation on same floor.
2. Electromagnetic Door Locks on Egress Doors: Unlock upon activation of any alarm initiating device or suppression system in smoke zone that doors serve as egress from.
3. Overhead Coiling Fire Doors: Release upon activation of smoke detectors in smoke zone on either side of door, upon alarm from manual pull station on same floor, and upon sprinkler activation on same floor.

2.5. COMPONENTS

A. General:
1. Provide flush mounted units where installed in finish areas; in unfinished areas, surface mounted unit are acceptable.
2. Provide legible, permanent labels for each control device, using identification used in operation and maintenance data.

B. Fire Alarm Control Units, Initiating Devices, and Notification Appliances: Analog, addressable type; listed by Underwriters Laboratories as suitable for the purpose intended.

C. Master Control Unit: As specified for Basis of Design above, or equivalent.
1. Construction shall be modular with solid state, microprocessor based electronics. An 80 character LCD display shall indicate alarms, supervisory service conditions, and any troubles. Panel shall have 250 addressable points with internal dialer.
2. Expansion Power Supplies: Provide as required for notification appliance circuits. Power supply to provide 8 Amps of power, four signal circuits, and battery standby.

D. Remote Annunciators: Shall be 80 character LCD display and include four programmable control switches, as well as alarm silence, acknowledgment, and system reset switches.

E. Initiating Devices:
1. Manual Pull Stations: Shall be addressable, single action, and constructed of high impact, red lexan with raised white lettering and a smooth high gloss finish. Stations which utilize screwdrivers, allen wrenches, or other commonly available

tools shall not be accepted. Stations shall be keyed alike with the fire alarm control panel. When the station is operated, the handle shall lock in a protruding manner to facilitate quick visual identification of the activated station.

a. Provide 1 extra.

b. Provide 50 extra break rods.

2. Smoke Detectors: Photo electric smoke detectors with 4098 Series base. Each smoke detector shall have its own unique address, analog, and with selectable sensitivity. Detectors shall be listed to UL standard 268 and shall be documented compatible with the control equipment to which it is connected. Detectors shall be listed for this purpose by Underwriters Laboratories Inc. The detectors shall obtain their operating power from the fire alarm panel supervised detection loop. The operating voltage shall be 24VDC (nominal). Removal of the detector head shall interrupt the supervisory circuit of the fire alarm detection loop and cause a trouble signal to be generated at the control panel. Each detector shall have a flashing status indicating LED for visual supervision. When the detector is actuated, the flashing LED will latch on steady and at full brilliance. The detector may be reset by actuating the control panel reset switch. Remote LED alarm indicators shall be installed where indicated.

a. Provide 5 extra.

3. Duct Smoke Detectors: Shall be addressable and of the solid state photoelectric type. The detectors shall operate on the light scattering photodiode principle. Detector design shall provide full solid state construction and compatibility with being separately monitored via a unique address via the twisted shielded pair data loop.

a. Provide 1 extra.

4. Heat Detectors: Automatic heat detectors shall be combination rate-of-rise and fixed-temperature type. Each heat detector shall have its own unique address.

a. Provide 1 extra.

5. Addressable Interface Devices: .

a. Provide 3 extra.

F. Notification Appliances:

1. Audible/visible units shall provide a common enclosure for fire alarm audible and visual alarm devices. Models shall be available which provide for horizontal or vertical mounting and with high humidity and strobe synchronization options. The audio/visual combination unit shall provide 4 Wire connection to ensure properly supervised in/out system connection and shall be UL listed for its intended purpose. Device candela shall be rated per current NFPA and ADA requirements.

a. Simplex 4906 Series or approved.

G. Circuit Conductors: Copper; color code and label.

H. Surge Protection: In accordance with IEEE C62.41.2 category B combination waveform and NFPA 70; except for optical fiber conductors.

1. Equipment Connected to Alternating Current Circuits: Maximum let through voltage of 350 V(ac), line-to-neutral, and 350 V(ac), line-to-line; do not use fuses.

2. Initiating Device Circuits, Notification Appliance Circuits, and Communications Circuits: Provide surge protection at each point where circuit exits or enters a

building; rated to protect applicable equipment; for 24 V(dc) maximum dc clamping voltage of 36 V(dc), line-to-ground, and 72 V(dc), line-to-line.

3. Signaling Line Circuits: Provide surge protection at each point where circuit exits or enters a building, rated to protect applicable equipment.

I. Locks and Keys: Deliver keys to Owner.
   1. Provide the same standard lock and key for each key operated switch and lockable panel and cabinet; provide 5 keys of each type.

J. Instruction Charts: Printed instruction chart for operators, showing steps to be taken when a signal is received (normal, alarm, supervisory, and trouble); easily readable from normal operator's station.
   1. Frame: Stainless steel or aluminum with polycarbonate or glass cover.
   2. Provide one for each control unit where operations are to be performed.
   3. Obtain approval of Owner prior to mounting; mount in location acceptable to Owner.
   4. Provide extra copy with operation and maintenance data submittal.

K. Storage Cabinet for Spare Parts and Tools: Steel with baked enamel finish, size appropriate to quantity of parts and tools.
   1. Padlock eye and hasp for lock furnished by Owner.
   2. Locate as directed by Owner.

PART 3 EXECUTION

3.1. INSTALLATION

A. Install the system in accordance with the plans and specifications, all applicable codes, and the manufacturer's recommendations. All wiring shall be installed in strict compliance with all the provisions of NEC - Article 760 A and C, Power-Limited Fire

B. Protective Signaling Circuits or if required may be reclassified as non-power limited and wired in accordance with NEC-Article 760 A and B. Upon completion, the contractor shall so certify in writing to the owner and general contractor. All junction boxes shall be sprayed red and labeled "Fire Alarm". Wiring color code shall be maintained throughout the installation.

C. Conceal all wiring, conduit, boxes, and supports where installed in finished areas.

D. Obtain Owner's approval of locations of devices, before installation.

E. Install instruction cards and labels.

F. Installation of equipment and devices that pertain to other work in the contract shall be closely coordinated with the appropriate subcontractors.

G. The contractor shall clean all dirt and debris from the inside and the outside of the fire alarm equipment after completion of the installation.

H. The manufacturer's authorized representative shall provide on site supervision of installation.

3.2. INSPECTION AND TESTING FOR COMPLETION

A. Notify Owner 7 days prior to beginning completion inspections and tests.

B. Owner will provide the services of an independent fire alarm engineer or technician to observe all tests.
C. Notify authorities having jurisdiction and comply with their requirements for scheduling inspections and tests and for observation by their personnel.
D. Provide the services of the installer's supervisor or person with equivalent qualifications to supervise inspection and testing, correction, and adjustments.
E. Prepare for testing by ensuring that all work is complete and correct; perform preliminary tests as required.
F. Provide all tools, software, and supplies required to accomplish inspection and testing.
G. Perform inspection and testing in accordance with NFPA 72 and requirements of local authorities; document each inspection and test.
H. Correct defective work, adjust for proper operation, and retest until entire system complies with contract documents.
I. Diagnostic Period: After successful completion of inspections and tests, Operate system in normal mode for at least 14 days without any system or equipment malfunctions.
    1. Record all system operations and malfunctions.
    2. If a malfunction occurs, start diagnostic period over after correction of malfunction.
    3. Owner will provide attendant operator personnel during diagnostic period; schedule training to allow Owner personnel to perform normal duties.
    4. At end of successful diagnostic period, fill out and submit NFPA 72 "Inspection and Testing Form."

3.3. OWNER PERSONNEL INSTRUCTION

A. Provide the following instruction to designated Owner personnel:
    1. Hands-On Instruction: On-site, using operational system.
    2. Classroom Instruction: Owner furnished classroom, on-site or at other local facility.
    3. Factory Instruction: At control unit manufacturer's training facility, as required.
    4. Provide a total of 16 hours of initial/refresher training to designated Owner personnel covering issues for the topics below. Duration of individual training sessions as determined by Owner, not to exceed total number of required hours.
        a. Administrative: Issues necessary for non-technical administrative staff.
        b. Basic/Detailed Operation: Issues necessary for attendant personnel, security officers, and engineering staff.
        c. Maintenance Technicians: Issues necessary for electrical technicians on programming, maintaining, repairing, and modifying.
    5. Furnish the services of instructors and teaching aids; have copies of operation and maintenance data available during instruction.
    6. Provide means of evaluation of trainees suitable to type of training given; report results to Owner.

3.4. CLOSEOUT

A. Closeout Demonstration: Demonstrate proper operation of all functions to Owner.

1. Be prepared to conduct any of the required tests.
2. Have at least one copy of operation and maintenance data, preliminary copy of project record drawings, input/output matrix, and operator instruction chart(s) available during demonstration.
3. Have authorized technical representative of control unit manufacturer present during demonstration.
4. Demonstration may be combined with inspection and testing required by authority having jurisdiction; notify authority having jurisdiction in time to schedule demonstration.
5. Repeat demonstration until successful.
6. Occupancy of the project will not occur prior to Substantial Completion.
7. Substantial Completion of the project cannot be achieved until inspection and testing is successful and:
    a. Specified diagnostic period without malfunction has been completed.
    b. Approved operating and maintenance data has been delivered.
    c. Spare parts, extra materials, and tools have been delivered.
    d. All aspects of operation have been demonstrated to Owner.
    e. Final acceptance of the fire alarm system has been given by authorities having jurisdiction.
    f. Occupancy permit has been granted.
    g. Specified pre-closeout instruction is complete.
8. Perform post-occupancy instruction within 3 months after Substantial Completion.

3.5. MAINTENANCE

A. See Section 01 77 00 - Contract Closeout, for additional requirements relating to maintenance service.

B. Provide to Owner, at no extra cost, a written maintenance contract for entire manufacturer's warranty period, to include the work described below.

C. Perform routine inspection, testing, and preventive maintenance required by NFPA 72, including:
1. Maintenance of fire safety interface and supervisory devices connected to fire alarm system.
2. Repairs required, unless due to improper use, accidents, or negligence beyond the control of the maintenance contractor.
3. Record keeping required by NFPA 72 and authorities having jurisdiction.
4. Provide trouble call-back service upon notification by Owner:
    a. Provide on-site response within 2 hours of notification.
    b. Include allowance for call-back service during normal working hours at no extra cost to Owner.
    c. Owner will pay for call-back service outside of normal working hours on an hourly basis, based on actual time spent at site and not including travel time; include hourly rate and definition of normal working hours in maintenance contract.

5. Provide a complete description of preventive maintenance, systematic examination, adjustment, cleaning, inspection, and testing, with a detailed schedule.
6. Maintain a log at each fire alarm control unit, listing the date and time of each inspection and call-back visit, the condition of the system, nature of the trouble, correction performed, and parts replaced. Submit duplicate of each log entry to Owner's representative upon completion of site visit.
7. Comply with Owner's requirements for access to facility and security.

END OF SECTION

EARTHWORK

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Removing surface debris, designated paving, curbs, topsoil, etc.
2. Removing designated trees, shrubs, and other plant life.
3. Removing abandoned utilities.
4. Excavation and rough grading, cutting, grading, filling, contouring and, compacting for building foundations, site structures, roads, parking areas, slabs-on-grade and landscaping.
5. Excavating trenches for utilities from 5 feet outside building to connection with public utility service. Compacting backfilling and compacting from top of utility bedding to subgrade elevations.
6. Removing identified and discovered rock during excavation.
7. Backfilling site structures perimeter to subgrade elevations, fill under slabs-on-grade, fill under paving, fill for over-excavation.

B. Related Sections:
1. Section 01 33 00 – Shop Drawings, Product Data, & Samples
2. Section 01 45 30 –Testing Laboratory Services
3. Section 01 60 00 – Materials and Equipment
4. Section 01 77 00 – Contract Closeout
5. Section 01 82 00 – Project Record Documents
6. Section 32 91 19 – Landscape Grading, Topsoil, and Soil Preparation
7. Section 33 11 16 – Site Water Utility Distribution Piping
8. Section 31 25 13 – Erosion Control
9. Section 33 31 00 – Sanitary Utility Sewerage Piping
10. Section 33 41 00 – Storm Utility Drainage Piping
11. Contract Documents - Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division I Specification Sections.
12. Document [1200C]: Oregon DEQ Construction Stormwater General Permit.
13. Document: Geotechnical report.

1.2 REFERENCES

A. ASTM International:
1. ASTM C117 - Standard Test Method for Materials Finer than 75-μm (No. 200) Sieve in Mineral Aggregates by Washing
2. ASTM C136 - Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
3. ASTM D1557 - Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort 56,000 ft-lbf/ft^3.
4. ASTM D2922 - Standard Test Method for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).
5. ASTM D3017 - Standard Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth).

B. National Fire Protection Association: NFPA 495 - Explosive Materials Code.

C. OSSC refers to the current edition of the State of Oregon/ APWA, Standard Specifications for Construction.

D. Regulatory Requirements: All materials and construction work within the public rights of way or for public facilities within easements shall be provided and constructed in accordance with the requirements and specifications of the Governing Authority having Jurisdiction.

1.3 DEFINITIONS

A. Utility: Any buried pipe, duct, conduit, or cable.

B. Rock: Solid mineral material of size that cannot be removed as defined in the geotechnical report.

1.4 SUBMITTALS

A. Section 01 33 00 – Shop Drawings, Product Data, & Samples: Requirements for submittals.

B. Samples: Submit, in air-tight containers, 10 lb sample of each type of fill to testing laboratory.

C. Materials Source: for materials used as imported fill material and pipe bedding and backfill. Submit name and location of imported fill materials source.

D. For information, submit description of vibratory compactors proposed for use when requesting placement of backfill and fill materials greater than requirement established herein.

E. Manufacturer's Certificate: Certify Products meet or exceed specified requirements.

F. Product Data: Submit data for herbicide. Indicate compliance with applicable codes for environmental protection. Submit data for geotextile fabric indicating fabric and construction.

G. Excavation Protection Plan: Describe sheeting, shoring, and bracing materials and installation required to protect excavations and adjacent structures and property; include structural calculations to support plan.

H. Shop Drawings: Rock Removal: Indicate proposed method of blasting, delay pattern, explosive types, type of blasting mat or cover, and intended rock removal method. Survey Report: Submit survey report on conditions of buildings near locations of rock removal.

1.5 QUALITY ASSURANCE

A. Codes and Standards: Perform Work in accordance with applicable requirements of governing authorities having jurisdiction and the recommendations of the geotechnical report.

B. Conform to all applicable codes for environmental requirements, disposal of debris, use of herbicides, and installation of protection and erosion control devices.

C. Soil Testing Service:
   1. The OWNER will engage a soil testing service, to include testing soil materials proposed for use in the work and for quality control testing during excavation and fill operations.
   2. Samples of materials shall be furnished to the testing service by the CONTRACTOR.
   3. Under this Contract, the CONTRACTOR shall smooth out areas for density tests and otherwise facilitate testing work as directed.

D. Rock Removal: Seismic Survey Firm: Licensed company specializing in seismic surveys with a minimum of five years documented experience. Explosives Firm: Company specializing in explosives for disintegration of rock, with a minimum of five years documented experience.

E. Maintain one copy of each document on site.

F. Furnish each imported soil and aggregate material from single source throughout the Work.

1.6 CLOSEOUT SUBMITTALS

A. Project Record Documents: Accurately record actual locations of utilities remaining by horizontal dimensions, elevations or inverts, and slope gradients.

1.7 QUALIFICATIONS

A. Prepare excavation protection plan under direct supervision of Professional Engineer experienced in design of this Work and licensed in State of work being performed.

1.8 FIELD MEASUREMENTS

A. Verify field measurements prior to fabrication.

1.9 COORDINATION

A. Verify Work associated with lower elevation utilities is complete before placing higher elevation utilities.

B. ROCK REMOVAL: Schedule Work to avoid working hours of and disruption to occupied buildings nearby. Conduct blasting operations between hours as required by Jurisdiction having authority only.

1.10 PROJECT CONDITIONS

A. Site information: Subsurface conditions were investigated by Intertek PSO per report dated 01/10/2020. Samples, logs and other data may be inspected by contacting them.
   1. The data on subsurface conditions are not intended as representations or warranties or accuracy or continuity of such conditions between soil borings. It is expressly understood the Owner will not be responsible for interpretations or conclusions drawn there from by the CONTRACTOR. The data is made available for the convenience of the CONTRACTOR
   2. Additional test borings and other exploratory operations may be made by the CONTRACTOR at no additional cost to the Owner.

B. Disposal of Waste Material:
   1. Disposal sites for earth waste materials are not available on Owner's property. Materials that are not suitable for use as topsoil or cannot be used in embankments or construction shall be disposed off-site.
   2. CONTRACTOR shall restrict temporary storage of waste materials and materials to be reused to the designated work areas.
   3. CONTRACTOR shall arrange and pay for removal and disposal of all waste materials encountered in the work.

C. Existing Utilities:
   1. Locate existing underground utilities in the areas of work. If utilities are to remain in place, provide adequate means of protection during excavation operations.
   2. Should uncharted or incorrectly charted piping or other utilities be encountered during excavation, consult utility owner immediately for directions. Cooperate with the Owner and public and private utility companies in keeping their respective services and facilities in operation. Repair damaged utilities to the satisfaction of the utility owner.
   3. Do not interrupt existing utilities serving facilities occupied and used by the Owner or others, except when permitted in writing by Engineer and then only after acceptable temporary utility services have been provided.
   4. Demolish and completely remove from the site existing underground utilities which are not to remain in service and are located within an excavation area. Coordinate with local utility companies for shut-off services in lines that are active.

D. Rock Removal:
   1. Conduct survey and document conditions of buildings near locations of rock removal, prior to blasting, photograph existing conditions identifying existing irregularities. Advise owners of adjacent buildings or structures in writing, prior to executing seismographic survey. Explain planned blasting and seismic operations. Obtain seismic survey prior to rock excavation to determine maximum charges that can be used at different locations in area of excavation without damaging adjacent properties or other work.

PART 2 - PRODUCTS

2.1 HERBICIDE

A. Type, approved by authority having jurisdiction.

2.2 SUBSOIL MATERIALS

A. Subsoil Type:
   1. Excavated and re-used material or imported clean structural borrow as approved by the project Geotechnical Engineer.
   2. Any on-site materials free of organic matter, non-plastic (dried), containing no particles larger than recommended, capable of compaction as specified, and approved by the Geotechnical Engineer and Governing Authorities having jurisdiction prior to use in the Work.
   3. Imported Fine-Grained Structural Fill Material: Material approved by the Geotechnical Engineer and Governing Authorities having jurisdiction for use as embankment material from an off-site source other than imported granular material. The source shall be approved by the Geotechnical Engineer and Governing Authorities having jurisdiction prior to use in the Work.

2.3 TOPSOIL MATERIALS

A. Stripping:
   1. Grass, sod, roots and other types of vegetation as well as concrete, wood and other deleterious materials to be removed.

B. Topsoil:
   1. Unclassified excavated and reused or imported material, free of roots, rocks larger than ½ inch, subsoil, debris, large weeds and foreign matter meeting the requirements of the Geotechnical Report or landscape specifications for topsoil characteristics.

2.4 CRUSHED AGGREGATE MATERIALS

A. Pipe Bedding and Backfill Material: Crushed rock with a maximum particle size of ¾”-0”. The aggregate shall be well-graded capable of compaction meeting OSSC as specified in trench zone. Material shall be approved by the Geotechnical Engineer and Governing Authorities having jurisdiction prior to use in the Work.

B. Trench Stabilization Material: Trench stabilization material shall consist of quarry run rock, crushed rock, or crushed gravel and sand and shall meet the requirements set forth by ODOT SS 00330.14 and 00330.15, with a minimum particle size of 6 inches and less than 5 percent passing the U.S. Standard No. 4 Sieve. The material shall be free of organic matter and other deleterious material. Trench stabilization material shall be placed in lifts between 12 -18 inches and compacted to a firm condition. Material shall be approved by

the Geotechnical Engineer and Governing Authorities having jurisdiction prior to use in the Work.

C. Coarse Aggregate: Angular crushed aggregate, Pit run as approved by the Geotechnical Engineer, the Governing Authorities having jurisdiction or OSSC standards prior to use in the Work.

D. Floor Slab Base Rock: The aggregate shall be well-graded capable of compaction meeting OSSC as specified, with not more than 2% passing the #200 sieve. Material shall be approved by the Geotechnical Engineer and Governing Authorities having jurisdiction prior to use in the Work.

E. Free Draining Fill: Free-draining material for blanket or wall drains for the subdrainage system shall be crushed rock with a maximum size of 2" with not more than 2% passing the #200 sieve (washed analysis) meeting OSSC 00430-11.

2.5 ACCESSORIES

A. Geotextile Fabric: As recommended in the geotechnical report.

2.6 SOURCE QUALITY CONTROL

A. Section 01 45 00 – Contractor's Quality Control Program: Testing, inspection and analysis requirements.

B. Section 01 45 30 - Testing Laboratory Services: Testing and Inspection Services, Testing and analysis of soil material.

C. Testing and Analysis of Material: Perform in accordance with ASTM D1557, ASTM D4318 and/or ASTM C136 as recommended in the geotechnical report.

D. When tests indicate materials do not meet specified requirements, change material and retest.

E. Furnish materials of each type from same source throughout the Work.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify site conditions and note subsurface irregularities affecting Work of this section.

B. Verify existing plant life designated to remain is tagged or identified.

C. Identify temporary waste area for placing removed materials until materials can be reused on site or hauled offsite and disposed of properly.

D. Verify locations of survey benchmarks, property corners and intended elevations for the Work and protect from damage.

3.2 PREPARATION

A. "Call Before You Dig" - Call Utility Notification Center at (800) 424-5555 or 811 not less than two nor more than 10 business days before performing Work.
   1. Request underground utilities to be located and marked within and surrounding construction areas.
   2. Cost(s) for locating utilities will be the responsibility of the CONTRACTOR.

B. Identify required lines, levels, contours, and datum.

C. Notify utility company(ies) to remove and/or relocate utilities as required.

D. Locate, identify, and protect utilities to remain, from damage. If utilities are to remain in place, provide adequate means of protection during Site Clearing operations.
   1. Should uncharted or incorrectly charted piping or other utilities be encountered during Work in this section, immediately consult utility owner for directions and notify Owner's representative. Cooperate with the Owner's representative and public and private utility companies in keeping their respective services and facilities in operation. Repair damaged utilities to the satisfaction of the utility owner.
   2. Do not interrupt existing utilities serving facilities occupied and used by the Owner or others, except when permitted in writing by Owner's representative and then only after acceptable temporary utility services have been provided.

E. Establish approved temporary traffic control and detours when trenching is performed in public rights-of-way. Relocate controls and reroute traffic as required during progress of Work.

3.3 PROTECTION

A. Locate, identify, and protect utilities indicated to remain, protect from damage.

B. Protect trees, other vegetation, and features remaining as a portion of the final landscaping, as indicated on the drawings and or as directed by the Owner's representative.

C. Protect benchmarks, survey control points, and existing structures from damage or displacement.

D. Prevent displacement or loose soil from falling into excavation; maintain soil stability.

E. Cold Weather Protection: Protect excavation bottoms against freezing when atmospheric temperature is less than 35 degrees F.

F. Reshape and re-compact fills subjected to vehicular traffic during construction.

G. Barricade: Open excavations in compliance with code requirements. Protect structures, utilities, sidewalks, pavement, and other facilities immediately adjacent to excavations, from damages caused by settlement, lateral movement, undermining, washout, and other hazards. Do not leave more than 15 feet of trench open at end of working day.

H. Excavation Safety: The CONTRACTOR shall be solely responsible for making all excavations in a safe manner. Provide appropriate measures to retain excavation side slopes and prevent rock falls to ensure that persons working in or near the excavation are protected. CONTRACTOR shall follow all OHSA rules and regulations.

I. Protect excavation cuts or open trenches to prevent danger to the public.

J. Protect sidewalks, paving and curbs from equipment, vehicular traffic and general construction activities.

K. Protect newly graded areas from traffic and erosion. Keep free of trash and debris.

L. Repair and re-establish grades in settled, eroded, and rutted areas to specified tolerances.

M. Reconditioning Compacted Areas: Where completed compacted areas are disturbed by subsequent construction operations or adverse weather, scarify surface, reshape, compact to required density and provide other corrective work as specified, prior to further construction.

N. Protection of Subgrade: Do not allow equipment to disturb subgrade, stripped areas, or other areas prepared for project. Prevent water from collecting on surface. Repair disturbed subgrade as specified below for unauthorized excavation.

O. Excavation Safety: The CONTRACTOR shall be solely responsible for making all excavations in a safe manner. Provide appropriate measures to retain excavation side slopes and prevent rock falls to ensure that persons working in or near the excavation are protected.

P. Notify Engineer of unexpected subsurface conditions and discontinue affected work in the area until notified to resume operations.

3.4 CLEARING

A. Clear areas required for access to site and execution of Work to minimum depth are recommended and approved by the project Geotechnical Engineer.

B. **CONTRACTOR shall stake construction / clearing limit for approval by Owner's representative prior to Work. Identify special considerations for protecting existing Trees and vegetation and other natural resources or improvements to remain. Protection measure must be in place prior to commencing Work and must be maintained throughout the construction period. No Work shall be performed beyond designated**

construction limit. CONTRACTOR is responsible for damage to significant resources and buffers as a result of careless Work, including all costs required to remedy the damage.

C. Remove vegetation, pavement, curbs, other materials and miscellaneous debris, or obstructions interfering with installation of new construction unless otherwise indicated on drawings or by the Owner's representative as protected. Remove such items off-site unless indicated differently by the Owner's representative. Removal includes stumps and roots.

D. Strip all organic matter under areas to receive pavement, sidewalks, building pads and other structural features. Remove off-site unless being used as topsoil or as directed by the Owner's representative.

E. Clear undergrowth and deadwood, without disturbing subsoil.

F. Strip grass and weeds from planting areas to be planted (seed and plants) to a depth approved by the Geotechnical Engineer and the landscape specifications. Leave remaining topsoil in place unless as directed by Owner's representative.

1. Strip only areas that are accessible to equipment without causing damage to existing trees and vegetation to be preserved. Manual stripping by method of grubbing and hand removal, per these specifications, will be approved in sensitive areas. CONTRACTOR shall identify and review sensitive areas with Owner's representative prior to Work.

G. Apply herbicide to remaining stumps to inhibit growth.

3.5 CLEARING REMOVAL

A. Demolish and completely remove from the site existing underground utilities which are not to remain in service and are located within the Work area. Coordinate with local utility companies for shut-off services in lines that are active.

1. Remove abandoned utilities as indicated on the drawings. Indicate removal termination point for underground utilities on Record Documents.

B. Remove debris, rock, and extracted plant life from site.

C. Remove demolished paving, curbs, sidewalks and other incidental materials for a complete project. Neatly saw cut edges at right angle to surface.

D. Remove abandoned utilities. Indicated removal termination point for underground utilities on Record Documents.

E. Continuously clean-up and remove waste materials from site. Do not allow materials to accumulate on site. CONTRACTOR shall restrict temporary storage of waste materials and materials to be reused to approved, designated areas.

F. Do not burn or bury materials on site. Fill excavations and pits created by Work to adjacent grades. Leave site in clean condition.

3.6 TOPSOIL EXCAVATION

A. Excavate topsoil from areas to be further excavated, re-landscaped or regraded without mixing with foreign materials for reuse in finish grading.

B. Stockpile material to be reused in area designated on site to depth not exceeding 8 feet and protect from erosion.

C. Remove excess topsoil not intended for reuse, from site.

3.7 EXCAVATION

A. Excavation consists of removal and disposal of all material encountered when establishing required grade elevations. All excavation is unclassified. The contours or spot elevations indicated on the drawings indicate finish grade unless otherwise indicated.

B. Unauthorized excavation consists of removal of materials beyond indicated subgrade elevations or dimensions without specific direction of the OWNER'S REPRESENTATIVE. Unauthorized excavation, as well as remedial work directed by the OWNER'S REPRESENTATIVE, shall be at no change in Contract amount.

C. Additional Excavation: When excavation has reached required subgrade or trench invert elevations, notify the Geotechnical Engineer who will observe conditions.
   1. Proof roll ground surface. Proof rolling will be observed by the Geotechnical Engineer. Remove soft areas detected by the proof rolling and replace with compacted structural fill material as directed.
   2. If unsuitable bearing materials are encountered at the required subgrade elevations, carry excavations deeper and replace the excavated material as directed by the Geotechnical Engineer.

D. Stability of Excavations: The stability of excavation slopes will be the responsibility of the CONTRACTOR in conformance with the recommendations of the geotechnical investigation.

E. Shoring and Bracing: Provide shoring and bracing to comply with local codes and authorities having jurisdiction. Provide materials for shoring and bracing, such as sheet piling, uprights, stringers and cross braces, in good serviceable condition. Maintain shoring and bracing in excavations regardless of the time period excavations will be open. Carry down shoring and bracing as the excavation progresses.

F. Underpin adjacent structures which may be damaged by excavation work.

G. Dewatering: Prevent surface water and subsurface or ground water from flowing into excavations and from flooding the project site and surrounding area.
   1. Do not allow water to accumulate in excavations. Remove water to prevent detrimental soil changes to stability of subgrades and foundations. Provide and maintain pumps, well points, sumps, suction and discharge lines and other dewatering system components necessary to convey water away from excavations.

2. Convey water removed from excavations and rainwater to collection or run-off areas. Establish and maintain temporary drainage ditches and other diversions outside excavation limits for each structure. Do not use trench excavations or public utility lines as temporary drainage facilities.

H. Excavation for Building Pads:
1. Conform to elevations and dimensions shown within a tolerance of plus or minus 0.10' and extend a sufficient distance from footings and foundations to permit placing and removal of concrete form work, installation of services, other construction and for inspection (5 feet minimum).
2. In excavating for footings and foundations, take care not to disturb bottom of excavation. Excavate by hand to final grade just before concrete reinforcement is to be placed. Trim bottoms to required lines and grades to leave solid base to receive concrete.

I. Excavation for Pavements: Cut surface under pavements to comply with cross-sections, elevations and grades as shown.

J. Excavate subsoil to accommodate building foundations, slabs-on-grade, paving sections, site structures and construction operations.

K. Compact disturbed load bearing soil in direct contact with foundations to original bearing capacity or greater as required by the Geotechnical Engineer.

L. Slope banks with machine to angle of repose or less until shored. Do not interfere with 45 degree bearing splay of foundations.

M. Grade top perimeter of excavation to prevent surface water from draining into excavation. Trim excavation. Remove loose matter. Remove lumped subsoil, boulders, and rock.

N. Notify Architect/Engineer of unexpected subsurface conditions. Correct areas over excavated with structural fill as directed by the Geotechnical Engineer. Repair or replace items indicated to remain damaged by excavation.

O. Excavate and process wet material to obtain optimum moisture content.

P. When excavating through roots on trees to remain, perform Work in accordance with the Arborist's recommendations.

Q. Remove excess subsoil not intended for reuse, from site.

R. Benching Slopes: Horizontally bench existing slopes as recommended by the Geotechnical Engineer to provide firm bearing.

S. Stability: Replace damaged or displaced subsoil as specified for fill.

T. Remove excavated materials not meeting requirements for subsoil materials or structural fill from site.

U. Dust: CONTRACTOR shall assume full responsibility for all alleviation or prevention of dust nuisance on or about the site in compliance with regulatory requirements.

3.8 TRENCHING

A. Excavations for Trenches: Performed as part of work installed.
   1. Dig trenches to the uniform width required for the particular item to be installed, sufficient minimum width as shown on the Drawings and to provide ample working room.
   2. Excavate trenches to the depth indicated or required. Carry the depth of trenches for piping to establish the indicated flow lines and invert elevations. Beyond the building perimeter, keep bottoms of trenches sufficiently below grade to avoid freeze-up and outside of the 1:1 slope beyond the bottom of the footings.
   3. When unstable pipe foundation is encountered, place a minimum of 12 inches of imported granular trench stabilization material under the pipe bedding material to stabilize the trench or as directed by the Geotechnical Engineer.
   4. Grade bottoms of trenches as indicated, notching under pipe bells to provide solid bearing for the entire body of the pipe.
   5. Backfill trenches prior to tests and inspections. Use care in backfilling to avoid damage or displacement of pipe systems.

B. Trench for pipes to lines and grades indicated on Drawings.
   1. Engineer reserves right to make changes in lines, grades, and depths of utilities when changes are required for Project conditions.
   2. Use laser-beam instrument with qualified operator to establish lines and grades.

C. Excavate subsoil required for utilities to utility service point of connection.

D. Perform excavation of existing utility service in accordance with utility’s requirements.

E. Do not advance open trench more than 100 feet ahead of installed pipe.

F. Cut trenches to width indicated on Drawings or sufficiently wide to enable installation and allow inspection. Remove water or materials that interfere with Work.

G. Excavate bottom of trenches maximum 2 feet wider than outside diameter of pipe.

H. Excavate trenches to depth indicated on Drawings. Provide uniform and continuous bearing and support for bedding material and pipe utilities.

I. Do not interfere with 45 degree bearing splay of foundations.

J. When Project conditions permit, slope side walls of excavation starting 2 feet above top of pipe. When side walls cannot be sloped, provide sheeting and shoring to protect excavation as specified in this section.

K. When subsurface materials at bottom of trench are loose or soft, excavate to greater depth as directed by Geotechnical Engineer until suitable material is encountered. Notify Geotechnical Engineer, and request instructions.

L. Trim excavation. Hand trim for bell and spigot pipe joints and remove loose matter.

M. Sheet, shore, and brace excavations to prevent danger to persons, structures and adjacent properties and to prevent caving, erosion, and loss of surrounding subsoil.

3.9 ROCK REMOVAL BY MECHANICAL METHOD

A. Excavate and remove rock by mechanical method.
   1. Drill holes and use expansive tools, wedges or mechanical means to fracture rock.

B. Cut away rock at bottom of excavation to form level bearing.

C. Remove shaled layers to provide sound and unshattered base for footings and foundations.

D. In utility trenches, excavate to 6 inches below invert elevation of pipe and 24 inches wider than pipe diameter.

E. Remove excavated materials from site or crush and reuse as fill if needed.

3.10 ROCK REMOVAL BY EXPLOSIVE METHODS

A. When rock is uncovered requiring explosives method for rock disintegration, notify Engineer.

B. Provide seismographic monitoring during progress of blasting operations.

C. Prepare a drilling and blasting plan and submit to Jurisdiction having authority for review and approval.

D. Disintegrate rock and remove from excavation.

E. Remove rock at excavation bottom to form level bearing.

F. Remove shaled layers to provide sound and unshattered base for footings and foundations.

G. In utility trenches, excavate to 6 inches below invert elevation of pipe and 24 inches wider than pipe diameter.

H. Remove excavated materials from site or crush and reuse as fill if needed.

3.11 BACKFILL, FILLING AND GRADING

A. In all excavations, unless otherwise specified, use satisfactory excavated or imported material for backfill which has been sampled and tested by the Geotechnical Engineer. On-

site fine-grained soils may be used in structural fills only during dry conditions when optimum moisture content can be maintained. Use optimum moisture conditioned imported fill material as structural fill during wet conditions, when onsite soils cannot be utilized.

B. Compact subgrade to density requirements for subsequent backfill materials.

C. Proof roll to identify soft spots. Cut out soft areas of subgrade not capable of compaction in place. Backfill with structural fill and compact to density equal to or greater than requirements for subsequent fill material.

D. Scarify subgrade surface to depth as recommended by the Geotechnical Engineer.

E. Proof roll to identify subsequent soft spots, fill and compact to density equal to or greater than requirements for subsequent fill material.

F. Fill areas to contours and elevations with unfrozen materials.

G. Place fill material in continuous layers and compact in accordance with the recommendations of the Geotechnical engineer.

H. Backfill simultaneously on each side of unsupported foundation walls until supports are in place. Do not backfill against unsupported foundation walls.

I. Backfill excavations as promptly as work permits, but not until completion of the following:
   1. Acceptance by OWNER'S REPRESENTATIVE of construction below finish grade including, where applicable, waterproofing, damp proofing, drainage pipe and perimeter insulation.
   2. Inspection, testing, approval and recording of locations of underground utilities.
   3. Removal of shoring and bracing and backfilling of voids with satisfactory materials.
   4. Removal of trash and debris.

J. Slope grade away from building minimum 2 percent slope for minimum distance of 5 ft, unless noted otherwise.

K. Backfill trenches to contours and elevations with unfrozen fill materials.

L. Systematically backfill trenches to allow maximum time for natural settlement. Do not backfill over porous, wet, frozen, or spongy subgrade surfaces.

M. General: Uniformly grade areas of work including adjacent transition areas. Smooth finished surface within specified tolerances, compact with uniform levels or slopes between points where elevations are shown, or between such points and existing grades.

N. Grading Outside Building Lines: Grade areas adjacent to building lines to drain away from structures and to prevent ponding. Finish surfaces free from irregular surface changes.

Grading CONTRACTOR to provide for placement of topsoil, as required, to the finish grades indicated on the drawings.

O. Make grade changes gradual. Blend slope into level areas by rounding so as to avoid sharp grade changes.

P. Repair or replace items indicated to remain damaged by excavation or filling.

Q. Placement and Compaction: Place native onsite and imported fine grained backfill and fill materials in layers not more than 8 inches in loose depth and imported granular material in layers not more than 12 inches in loose depth or as recommended by the Geotechnical Engineer for the specific application.
   1. Before compaction, moisten or aerate each layer as necessary to provide the optimum moisture content.
   2. Compact each layer to required percentage of maximum dry density or relative dry density for each area classification.
   3. Do not place backfill or fill material on surfaces muddy, frozen, or containing frost or ice.
   4. Place backfill and fill materials evenly adjacent to structures, to required elevations. Take care to prevent wedging action of backfill against structures by carrying the material uniformly around structure to approximately same elevation in each lift. Contractor shall follow the Geotechnical Engineer's recommendations when backfilling immediately adjacent to walls.

3.12 COMPACTION

A. General: Control soil compaction during construction providing minimum percentage of density specified for each area.

B. Prior to fill placement or aggregate base course placement, the subgrade shall be proofrolled with a fully loaded 10 to 12 yard dump truck. Any areas that pump, heave or appear soft shall be over excavated and backfilled a minimum of 12 inches (or as recommended by the Geotechnical Engineer) with approved fine grained structural or select imported granular fill material.

C. Percentage of Maximum Density Requirements: Compact soil, fill and backfill to not less than that recommended in the Geotechnical Report. In the absence of a Geotechnical Report, compact to the following percentages of maximum dry density for soils which exhibit a well-defined moisture density relationship determined in accordance with ASTM D1557.
   1. On site Native Fine-Grained Structural Fill: Compact exposed subgrade where disturbed, and each layer of backfill or fill material to 95 percent of maximum dry density (MDD).
   2. Base Course (Pavements and Floor Slabs): compact top 12 inches of the subgrade below the pavement and the granular base course material to 95 percent of maximum dry density MDD.
   3. Non-Structural Landscape Fill: Compact each layer of fill material to 95 percent of MDD.

4. Trench Backfill: Compact the pipe base and pipe zone as recommended by the geotechnical report and per manufacturer recommendations. Contractor shall take precautions so as to not over compact the pipe zone causing damage to the utility pipe.

D. Moisture Control: Where subgrade or layer of soil material must be moisture conditioned before compaction, uniformly apply water to surface of subgrade, or layer of soil material. Prevent free water appearing on surface during or subsequent to compaction operations.
   1. Remove and replace, or scarify and air dry, soil material too wet to permit compaction to specified density.
   2. Soil material removed because it is too wet to permit compaction may be stockpiled or spread and allowed to dry. Assist drying by discing, harrowing or pulverizing until moisture content is reduced to satisfactory value.

3.13 STOCKPILING

A. Stockpile materials on site at locations designated by OWNER.

B. Stockpile in sufficient quantities to meet Project schedule and requirements.

C. Separate differing materials with dividers or stockpile apart to prevent mixing.

D. Stockpile to 10 feet high maximum.

E. Prevent intermixing of soil types or contamination.

F. Direct surface water away from stockpile site to prevent erosion or deterioration of materials.

3.14 STOCKPILE CLEANUP

A. Remove stockpile, leave area in clean and neat condition. Grade site surface to prevent free standing surface water.

B. Leave unused materials in neat, compact stockpile.

C. When borrow area is indicated, leave area in clean and neat condition. Grade site surface to prevent free standing surface water.

3.15 QUALITY CONTROL/TOLERANCES

A. General: The CONTRACTOR is responsible for preparing and scheduling all required testing activities.

B. Quality Control Testing During Construction: Allow Geotechnical Engineer and soil testing service retained by the OWNER to observe, test and approve subgrades and fill layers before further construction work is performed.

C. If in the opinion of the OWNER'S REPRESENTATIVE, based on Geotechnical Engineer reports and observations of subgrades and fills which have been placed are below specified density, provide corrective work as required to reach specified density at no additional expense.

D. Grading Surface of Fill Under Building Slabs and Pavement: Grading smooth and even, free from voids, compacted as specified, and to required elevation. Provide final grades within a tolerance of 1/4 inch from design elevation and variations to within 1/4 inch when tested with a 10-foot straight edge.

E. Top Surface of Subgrade: Plus or minus 1 inch from required elevation.

F. Top Surface of General Backfilling: Plus or minus 1 inch from required elevations.

G. Perform laboratory material tests in accordance with ASTM D1557.

H. Perform in place compaction tests in accordance with the following:
   1. Density Tests: ASTM D1557, and ASTM D2922.
   2. Moisture Tests: ASTM D3017.

I. When tests indicate Work does not meet specified requirements, remove Work, replace and retest.

J. Frequency of Tests:
   1. Trench Backfill – As required by the geotechnical engineer or 1 test every 50 feet and every 3 feet of vertical backfill at a minimum.
   2. Structural Fill – as required by the geotechnical engineer or 1 test every 2 vertical feet or 500 yd^3 which ever requires more testing.

K. Proof roll compacted fill surfaces under slabs-on-grade, paving, and overall site grading. Request visual inspection of bearing surfaces by Geotechnical Engineer before installing subsequent work.

END OF SECTION

EROSION CONTROL

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: Furnishing, placing and maintaining all erosion control and protective materials including but not limited to the following:
   1. Construction Entrance.
   2. Filter Fabric.
   3. Sediment Fencing.
   4. Bio-Bags.
   5. Straw Wattles
   6. Inlet Protection.
   7. Mulch.
   8. Plant Materials.
   9. Maintenance

B. Related Sections:
   1. Section 01 33 00 – Shop Drawings, Product Data, & Samples
   2. Section 01 45 00 – Contractor's Quality Control Program
   3. Section 01 77 00 – Contract Closeout
   4. Section 31 05 13 – Earthwork.
   5. Section 32 91 19 – Landscape Grading, Topsoil, and Soil Preparation
   6. Section 32 93 00 – Planting
   7. Section 33 41 00 – Storm Utility Drainage Piping.
   8. Contract Documents - Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division I Specification Sections.
   9. Document: 1200C Oregon DEQ Construction Stormwater General Permit.
   10. Document: Geotechnical report.

1.2 REFERENCES

A. ASTM International:
   1. ASTM C127 - Standard Test Method for Specific Gravity and Absorption of Coarse Aggregate.
   2. ASTM D1557 - Standard Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort 56,000 ft-lbf/ft^3.
   3. ASTM D2922 - Standard Test Method for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).
   4. ASTM D3017 - Standard Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth).

B. 1200-C Oregon DEQ Best Management Practice Manual.

C. “OSSC” Refers to the State of Oregon/APWA Standard specifications for Construction.

1.3 SUBMITTALS

A. Section 01 33 00 – Shop Drawings, Product Data, & Samples: Requirements for submittals.

B. Samples:
   1. Submit two samples or rock, minimum 5 tons each or one-half total project quantity, whichever is smaller. Provide one sample in place at construction site and provide another sample at quarry. Construction site sample may be incorporated into the Work. Samples will be used as reference for judging size, and graduation of rock supplied and placed.

C. Product Data: Submit manufacturer data for materials used in Work:
   1. Sediment Fencing
   2. Biobags
   3. Inlet Protection
   4. Straw Wattles

D. Section 01 33 00 - Shop Drawings, Product Data, & Samples: Requirements for submittals.

1.4 QUALITY ASSURANCE

A. Section 01 45 00 - Contractor's Quality Control Program: Quality Requirements.

B. Perform Work in accordance with these specifications and the Oregon DEQ 1200C Permit requirements.

C. Perform Work in accordance with OSSC.

D. Maintain one copy of each document on site.

1.5 PRE-INSTALLATION MEETINGS

A. Contractor shall coordinate pre-installation meeting.

B. Convene minimum one week prior to commencing work of this section. Minimum attendees shall be the Contractor’s site superintendents and the project’s certified erosion control inspector.

1.6 REGULATORY REQUIREMENTS

A. Conform to the City of Scappose requirements.

B. Contractor shall adhere to the requirement of the Oregon DEQ 1200C permit requirements and shall supplement the erosion control plan requirements to meet the specific site demands to prevent sediment laden water from leaving the site.

1.7 PROJECT CONDITIONS

A. Erosion control is required for this Project and is the responsibility of the Contractor to provide, install and maintain erosion control measures under this Contract. Effective erosion control measures must be installed and maintained to meet jurisdictional requirements. The governing authority having jurisdiction may, at any time, order corrective action and stoppage of work to accomplish effective erosion control. Erosion control measures must be installed prior to commencing Work in this section, and shall be protected and maintained in effective, functioning condition during the construction period and through final acceptance.

PART 2 - PRODUCTS

2.8 MATERIALS

A. Gravel Construction Access: All material furnished for "Gravel Construction Entrances" shall be clean pit run with size as indicated on the drawings.

B. Sediment Fences: Woven construction fabric specifically designed to control sediment runoff. Acceptable material is Amoco 1380 Silt Stop, or equal.

C. Posts/Stakes:
   1. 2"x2" standard or better wood posts (sediment fences & straw bales).
   2. Steel fence posts (sediment fences).

D. Inlet Filter Sack: Woven construction fabric specifically designed to control sediment runoff. Acceptable material is ACF Environmental Siltsack® or approved equal.

E. Bio-Bags: Clean 100% recycled wood product waste. Size of bag to be 18x8x30-inches and weigh approximately 45 pounds and made of ½-inch plastic mesh.

F. Straw Wattles: Wheat straw, rye grass straw, coconut, or excelsior wattles as approved by the Governing Authority having Jurisdiction.

G. Hydro-Seeding: Seed, fertilizer and mulch acceptable to the landscape architect.

H. Straw Mulch: Clean, sterile dry oat or wheat straw free from weeds and other foreign matter detrimental to plant life. Hay or chopped cornstalks are not acceptable. Ensure that the mulch does not contain noxious weed seeds of any species.

I. Planting Materials:
   1. Seeding: As indicated in the landscape drawings and specifications.
   2. Trees, Shrubs and Groundcover: As indicated in the landscape drawings and specifications.

2.9 SOURCE QUALITY CONTROL (AND TESTS)

A. Section 01 45 00 - Contractor's Quality Control Program: Testing, inspection and analysis requirements.

B. Perform tests on cement, aggregates, and mixes to ensure conformance with specified requirements.

C. Make rock available for inspection at producer’s quarry prior to shipment. Notify Engineer at least seven days before inspection is allowed.

D. Allow witnessing of inspections and test at manufacturer’s test facility. Notify Engineer at least seven days before inspections and tests are scheduled.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Contractor shall coordinate verification of existing conditions before starting work.

B. Verify compacted subgrade is acceptable and ready to support devices and imposed loads.

C. Verify gradients and elevations of base or foundation for other work are correct.

D. Verify that all areas to receive erosion control measures are prepared and ready for Work in this section.

E. The contractor shall comply with all regulatory requirements.

F. Prior to performing any site clearing or earthwork operations, install all sediment and erosion control devices as early as practical and as shown on the Drawings.

G. Do not place riprap over frozen or spongy subgrade surfaces.

3.2 CONSTRUCTION ACCESS (ENTRANCE)

A. Install as indicated on the drawing details.

3.3 SEDIMENT FENCING

A. The CONTRACTOR shall place an adequate sediment barrier around the site perimeter as shown on the Drawings.

B. Place sediment barriers at toes of slopes. Embed sediment fences 6 inches below ground. Embed straw bales 4 to 6 inches.

C. Provide posts at 6-foot maximum spacing for sediment fences.

D. Provide (2) stakes per straw bale driven a minimum of 12-inches into the ground.

E. Provide filter fabric inlet barrier around the on-site catch basins and area drains per drawing details.

3.4 BIO-BAGS/STRAW WATTLES

A. Install as indicated on drawing details.

3.5 INLET PROTECTION

A. Install as indicated on drawing details.

3.6 MULCH

A. Install mulch to accomplish the following:
   1. Seeded and Planted Areas: Install as indicated in landscape specifications for seeded and planted areas.
   2. Temporary Erosion Control: Install minimum 2-inch thickness over areas requiring temporary erosion control. Install additional devices as soon as reasonably possible.
   3. Additional Protection: Install in conjunction with other approved erosion control measures, as specified, to provide additional protection per project conditions.

3.7 SITE STABILIZATION

A. Incorporate erosion control devices indicated on the Drawings into the Project at the earliest practicable time.

B. Construct, stabilize and activate erosion controls before site disturbance within tributary areas of those controls.

C. Stockpile and waste pile heights shall not exceed 20 feet. Slope stockpile sides at 2:1 or flatter.

D. Stabilize any disturbed area of affected erosion control devices on which activity has ceased and which will remain exposed for more than 20 days.
   1. During non-germinating periods, apply mulch at recommended rates.
   2. Stabilize disturbed areas which are not at finished grade and which will be disturbed within one year in accordance with Section 32 91 19 or per erosion control permit requirements.
   3. Stabilize disturbed areas which are either at finished grade or will not be disturbed within one year in accordance with Section 32 91 19 permanent seeding specifications.

E. Stabilize diversion channels, sediment traps, and stockpiles immediately.

3.8 FIELD QUALITY CONTROL

A. Section 01 45 00 - Contractor's Quality Control Program and 01 77 00 – Contract Closeout: Field inspecting, testing, adjusting, and balancing.

B. Inspect erosion control devices on a weekly basis and after each runoff event or as required by the Construction Stormwater Erosion Control Permit. Make necessary repairs to ensure erosion and sediment controls are in good working order.

C. If tracking of soil off site continually occurs, construct temporary wheel wash or hose applied tire washing station.

D. If the proposed erosion control measures are proving to be ineffective, contact the projects erosion control inspector for direction and remedial action.

3.9 CLEANING

A. Section 01 77 00 – Contract Closeout: Requirements for cleaning.

B. When sediment accumulation in sedimentation structures has reached a point one-third depth of sediment structure or device, remove and dispose of sediment.

C. Do not damage structure or device during cleaning operations.

D. Do not permit sediment to erode into construction or site areas or natural waterways.

E. Clean channels when depth of sediment reaches approximately one-half channel depth.

3.10 PROTECTION

A. **Protect at all times adjacent properties, areas and significant resources, including waterways and drainage courses, from erosion / sedimentation caused by Work in other sections.**

B. Protect soil stockpiles from erosion by plastic sheeting (with sand bags) or other approved measures.

C. When sediment accumulation in sedimentation structures has reached a point one-third depth of sediment structure or device or as required by the Construction Stormwater Erosion Control Permit, remove and dispose of sediment.

D. Do not damage structure or device during cleaning / maintenance operations.

E. Repair and/or reestablish barriers that are damaged or temporarily removed immediately after such instance occurs.

F. Remove and replace contaminated gravel with clean gravel as necessary to mitigate mud and dirt transported to public streets. Prior to construction of the asphalt pavement parking area, remove and replace contaminated gravel.

G. Provide slope protection, seeding, and all other erosion control measures as specified and shown on the Drawings.

END OF SECTION

AGGREGATE BASE COURSES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Aggregate base course.

B. Related Sections:
   1. Section 01 33 00 – Shop drawings, Product Data, & Samples
   2. Section 01 45 00 – Contractor's Quality Control Program
   3. Section 01 45 30 – Testing Laboratory Services
   4. Section 01 60 00 – Materials and Equipment
   5. Section 31 05 13 – Earthwork.
   6. Section 32 12 16 – Asphalt Paving
   7. Section 32 13 13 – Rigid Pavement, Concrete Curbs & Walks
   8. Section 33 05 13 – Manholes and Structures
   9. Section 33 11 16 – Site Water Utility Distribution Piping
   10. Section 33 31 00 – Sanitary Utility Sewerage Piping
   11. Section 33 41 00 – Storm Utility Drainage Piping
   12. Contract Documents – Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division I Specification Sections.
   13. Document: Geotechnical report.

1.2 REFERENCES

A. ASTM International:
   1. ASTM D1557 - Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort 56,000 ft-lbf/ft^3.
   2. ASTM D2922 - Standard Test Method for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).
   3. ASTM D3017 - Standard Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth).

B. OSSC refers to the current edition of the State of Oregon/ APWA, Standard Specifications for Construction.

C. Regulatory Requirements: All materials and construction work within the public rights of way or for public facilities within easements shall be provided and constructed in accordance with the requirements and specifications of the Governing Authority having Jurisdiction.

1.3 SUBMITTALS

A. Section 01 33 00 – Shop Drawings, Product Data, & Samples: Requirements for submittals.

B. Samples: Submit, in air-tight containers, 10 lb sample of each type of aggregate base rock to testing laboratory.

C. Materials Source: Submit name of imported materials suppliers.

D. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

1.4 QUALITY ASSURANCE

A. Furnish each aggregate material from single source throughout the Work.

B. Perform Work in accordance with OSSC standards.

C. Maintain one copy of each document on site.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Provide aggregate for the various gradations indicated on the drawings meeting "OSSC" standards.

B. Minimum requirements for rock: OSSC Section 02630. Rock for aggregate base course shall meet the State qualifications and meet the graduation designations indicated on the drawings.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Contractor shall coordinate verification of existing conditions before starting work.

B. Verify substrate has been inspected, gradients and elevations are correct, and is dry.

3.2 PREPARATION

A. Correct irregularities in substrate gradient and elevation by scarifying, reshaping, and re-compacting.

B. Do not place fill on soft, muddy, or frozen surfaces.

3.3 AGGREGATE PLACEMENT

A. Spread aggregate over prepared substrate to a total compacted thickness indicated on the drawings.

B. Place aggregate in maximum 6-inch layers and roller compact to specified density.

C. Level and contour surfaces to elevations and gradients indicated.

D. Add small quantities of fine aggregate to coarse aggregate as appropriate to assist compaction.

E. Maintain optimum moisture content of fill materials to attain required compaction density.

F. Use mechanical tamping equipment in areas inaccessible to roller compaction equipment.

G. Grade all areas to drain to collection points.

H. Grade all ADA parking areas to no more than 2% cross-slope in any direction and access ways to no more than 2% cross-slope and no more than 5% running slope.

3.4 TOLERANCES

A. Section 01 45 00 - Contractor's Quality Control Program: Tolerances.

B. Maximum Variation from Surface Planarity: ¼ inch measured with 10-foot straight edge.

C. Maximum Variation from Thickness: ¼ inch.

D. Maximum Variation from Elevation: Plus, or minus ¼ inch.

3.5 STOCKPILING

A. Stockpile materials on site at locations designated by OWNER REPRESENTATIVE.

B. Stockpile in sufficient quantities to meet Project schedule and requirements.

C. Separate different aggregate materials with dividers or stockpile individually to prevent mixing.

D. Direct surface water away from stockpile site to prevent erosion or deterioration of materials.

3.6 STOCKPILE CLEANUP

A. Remove stockpile, leave area in clean and neat condition. Grade site surface to prevent free standing of surface water.

3.7 FIELD QUALITY CONTROL

A. Section 01 45 00 - Contractor's Quality Control Program and 01 45 30 Testing Laboratory Services: Field inspecting, testing, adjusting, and balancing.

B. Compaction testing will be performed in accordance with ASTM D1557, ASTM D2922 and ASTM D3017 in accordance with the Geotechnical Engineering recommendations.

C. When tests indicate Work does not meet specified requirements, remove Work, replace and retest.

D. Frequency of Tests: One test every 500 SY.

END OF SECTION

ASPHALT PAVING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Asphaltic concrete paving - wearing and base course.
2. Surface sealer.
3. Aggregate subbase course.
4. Precast concrete parking bumpers.

B. Related Sections:
1. Section 01 33 00 – Shop Drawings, Product Data, & Samples
2. Section 01 45 00 – Contractor's Quality Control Program
3. Section 01 45 30 – Testing Laboratory Services
4. Section 01 60 00 – Material & Equipment
5. Section 01 77 00 – Contract Closeout
6. Section 31 05 13 – Earthwork
7. Section 32 11 23 – Aggregate Base Courses
8. Section 32 13 13 – Rigid Pavement, Concrete Curbs & Walks
9. Section 33 05 13 – Manholes and Structures

1.2 REFERENCES

A. Asphalt Institute:
1. TAI – (The Asphalt Institute) – MS-2 - Mix Design Methods for Asphalt Concrete and Other Hot- Mix Types
2. TAI – (The Asphalt Institute) – MS-3 Asphalt Plant Manual.
3. TAI – (The Asphalt Institute) – MS-8 Asphalt Paving Manual
4. TAI – (The Asphalt Institute) – MS-19 - Basic Asphalt Emulsion Manual.

B. ASTM International:
1. ASTM D946 - Standard Specification for Penetration-Graded Asphalt Cement for Use in Pavement Construction.
2. ASTM D2041- Standard test method for theoretical maximum specific gravity and density of Biumious paving mixtures.
3. ASTM D3381 - Standard Specification for Viscosity-Graded Asphalt Cement for Use in Pavement Construction.

C. Oregon Department of Transportation/American Public Works Association
1. OSSC refers to the current edition of the State of Oregon/ APWA, Standard Specifications for Construction.

1.3 PERFORMANCE REQUIREMENTS

A. Paving: Standard duty pavement per OSSC for the type shown on the drawings.

1.4 SUBMITTALS

A. Section 01 33 00 – Shop Drawings, Product Data, & Samples: Requirements for submittals.

B. Product Data: Submit product information and mix design.

C. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

1.5 QUALITY ASSURANCE

A. **All Work in the public rights of way or easements dedicated to the public shall be in accordance with the local Governing Authority having Jurisdiction.**

B. All Work outside public rights of way shall be in accordance with OSSC Specifications.

C. Obtain materials from same source throughout.

D. Maintain one copy of each document on site.

1.6 QUALIFICATIONS

A. **Installer:** Company specializing in performing work of this section with minimum 5 years documented experience.

1.7 ENVIRONMENTAL REQUIREMENTS

A. Section 01 60 00 – Material & Equipment: Environmental conditions affecting products on site.

B. Do not place asphalt when ambient air or base surface temperature is less than 40, 50 or 60 degrees Fahrenheit based on the compacted thickness of pavement being placed, or if surface is wet or frozen as required per OSSC.

C. Place bitumen mixture when temperature is not more than 15 degrees Fahrenheit below temperature at when initially mixed and not more than maximum specified temperature.

PART 2 - PRODUCTS

2.1 ASPHALT PAVING MATERIALS

A. Asphalt Cement: PG-64-22 per OSSC Specification Section 00744

B. Aggregate: OSSC Specification Section 00744.10

C. Aggregate Quality: OSSC Specification Section 00745.10

D. Tack Coat: Use CSS-1 or CSS-1H

E. Reclaimed Asphalt Pavement (RAP): Processed material obtained by milling or full depth removal of existing asphalt concrete pavements. No more than 30% RAP shall be allowed per OSSC Specification Section 00745.03.

2.2 ASPHALT PAVING MIX

A. Use dry material to avoid foaming. Mix uniformly.

2.3 ASPHALT PAVING SOURCE QUALITY CONTROL AND TESTS

A. Section 01 45 30 – Testing Laboratory Services: Testing, inspection, and analysis requirements.

B. Submit proposed mix design of each class of mix for review prior to beginning of Work.

C. Job Mix Formula: Contractor to supply a current year mix design for the Level of pavement shown in the drawings per OSSC 00744.13.

2.4 PARKING BUMPERS MANUFACTURERS

A. Old Castle Precast Concrete Bumper Curb or approved equal.
   1. Size as shown on drawings.
   2. Dowels: Cut reinforcing steel ½ inch diameter inch long, pointed tip
   3. Adhesive: Epoxy

PART 3 - EXECUTION

3.1 EXAMINATION

A. Contractor shall coordinate verification of existing conditions before starting work.

B. Verify compacted aggregate base is dry and ready to support paving and imposed loads.

C. Verify gradients and elevations of base are correct.

D. Verify gutter drainage grilles and frames, cleanout and manhole frames and lids are installed in correct position and elevation.

E. Prior to pavement placement, the aggregate base shall be proof-rolled with a fully-loaded dump truck. Any areas that pump, heave or appear soft shall be over excavated and backfilled a minimum of 12 inches as well as placing a geotextile fabric such as Mirafi 600nx with imported fill material or as directed by the Geotechnical Engineer.

3.2 SUBBASE

A. Aggregate Subbase: Install as specified in Section 32 11 23

3.3 PREPARATION - TACK COAT

A. Apply tack coat on asphalt or concrete surfaces at uniform rate of 0.05-0.20 gal/sq.yd per OSSC Specification Section 00730.

B. Apply tack coat to contact surfaces of curbs & gutters.

C. Coat surfaces of manholes, catch basins, and cleanout frames with oil to prevent bond with asphalt pavement. Do not tack coat these surfaces.

3.4 PLACING ASPHALT PAVEMENT - SINGLE COURSE

A. Prior to placement, Contractor shall review and check aggregate base rock to ensure that all areas are sloped adequately to drain to catchment points.

B. Prior to placement, Contractor shall review and check aggregate base rock to ensure that all ADA parking areas do not slope more than 2% cross-slope in any direction.

C. Install Work in accordance with OSSC standards for the level of pavement indicated on the drawings.

D. Place asphalt within 24 hours of applying tack coat.

E. Place to thickness as shown on the typical sections.

F. Compact pavement by rolling to specified density. Do not displace or extrude pavement from position. Hand compact in areas inaccessible to rolling equipment.

G. Perform rolling with consecutive passes to achieve even and smooth finish without roller marks.

H. Compact pavement by rolling to not less than 91% of ASTM D2041 (rice maximum density). Do not displace or extrude pavement from position. Hand compact in areas inaccessible to rolling equipment.

I. Minimum and maximum thickness of single courses shall be in accordance with OSSC standards.

3.5 PLACING ASPHALT PAVEMENT - DOUBLE COURSE

A. Prior to placement, Contractor shall review and check aggregate base rock to ensure that all areas are sloped adequately to drain to catchment points.

B. Prior to placement, Contractor shall review and check aggregate base rock to ensure that all ADA parking areas do not slope more than 2% cross-slope in any direction.

C. Place asphalt base course within 24 hours of applying tack coat.

D. Place base course to compacted thickness as shown on the typical sections.

E. Place wearing course within 24 hours of placing and compacting binder course. When binder course is placed more than 24 hours before placing wearing course, clean surface and apply tack coat before placing wearing course.

F. Place base course to compacted thickness as shown on the typical sections.

G. Compact each course by rolling to specified density. Do not displace or extrude pavement from position. Hand compact in areas inaccessible to rolling equipment.

H. Perform rolling with consecutive passes to achieve even and smooth finish, without roller marks.

I. Compact pavement by rolling to not less than 91% of ASTM D2041 (rice maximum density). Do not displace or extrude pavement from position. Hand compact in areas inaccessible to rolling equipment.

3.6 BUMPER INSTALLATION

A. Install bumper units without damage to shape or finish. Replace or repair damaged units.

B. Install bumper units in alignment with adjacent work.

C. Fasten bumper units in place with 2 dowels for each unit bumper along with adhesive placed at contact points.

3.7 TOLERANCES

A. Section 01 45 00 – Contractor's Quality Control Program: Tolerances.

B. Flatness: Maximum variation of ¼ inch measured with 10-foot straight edge.

C. Scheduled Compacted Thickness: Within ¼ inch.

D. Variation from Indicated Elevation: Within ¼ inch

3.8 FIELD QUALITY CONTROL

A. Section 01 45 30 – Testing Laboratory Services: Field inspecting, testing, adjusting, and balancing.

B. Coordinate the Work with pavement placement and parking striping.

C. The contractor shall have a field technician on site to establish the rolling pattern and determine the number of passes of each roller to provide the optimum compaction for the mixture. Once the rolling pattern has been established, the contractor shall maintain the pattern throughout.

D. Test compaction and composition per OSSC Specifications. Minimum one set of compaction tests per 500 ton of asphalt and one composition test per 2000 square yards of material placed.

E. Record asphalt temperature during placement and adhere to the breakdown and intermediate rolling temperature requirements.

3.9 PROTECTION OF FINISHED WORK

A. Section 01 77 00 – Contract Closeout: Protecting finished work.

B. Immediately after placement, protect pavement from damage for until surface temperature is less than 140 degrees F. Permission from the OWNER'S REPRESENTATIVE is required to allow construction traffic on finished asphaltic pavements.

END OF SECTION

RIGID PAVEMENT, CONCRETE CURBS & WALKS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Concrete sidewalks.
2. Concrete stair steps.
3. Concrete integral curbs and gutters.
4. Concrete Pavement.

B. Related Sections:
1. Section 01 33 00 - Shop Drawings, Product Data, & Samples
2. Section 01 45 00 - Contractor's Quality Control Program
3. Section 01 45 30 - Testing Laboratory Services
4. Section 01 60 00 - Materials & Equipment
5. Section 01 77 00 - Contract Closeout
6. Section 31 05 13 - Earthwork
7. Section 32 11 23 - Aggregate Base Courses
8. Section 32 12 16 - Asphalt Paving
9. Section 33 05 13 - Manholes and Structures.

1.2 REFERENCES

A. American Concrete Institute:
1. ACI 301 - Specifications for Structural Concrete.
2. ACI 304 - Guide for Measuring, Mixing, Transporting, and Placing Concrete.

B. ASTM International:
1. ASTM A185 - Standard Specification for Steel Welded Wire Fabric, Plain, for Concrete Reinforcement.
2. ASTM A497 - Standard Specification for Steel Welded Wire Fabric, Deformed, for Concrete Reinforcement.
3. ASTM A615/A615M - Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement.
4. ASTM C33 - Standard Specification for Concrete Aggregates.
5. ASTM C94/C94M - Standard Specification for Ready-Mixed Concrete.
6. ASTM C150 - Standard Specification for Portland Cement.
7. ASTM C260 - Standard Specification for Air-Entraining Admixtures for Concrete.
8. ASTM C309 - Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete.
9. ASTM C494/C494M - Standard Specification for Chemical Admixtures for Concrete.
10. ASTM C1315 - Standard Specification for Liquid Membrane-Forming Compounds Having Special Properties for Curing and Sealing Concrete.
11. ASTM D1751 - Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types).

12. ASTM D1752 - Standard Specification for Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction.

1.3 PERFORMANCE REQUIREMENTS

A. Paving: Designed for parking, light duty commercial vehicles and movement of trucks up to 75,000 lbs.

1.4 SUBMITTALS

A. Section 01 33 00 – Shop Drawings, Product Data, Samples: Requirements for submittals.

B. Provide samples, manufacturer's product data, test reports, and materials' certifications as required in referenced sections for concrete and joint fillers, sealers and tactile warning textures & truncated dome product.

C. Furnish certified reports of each proposed mix for each type of concrete at least thirty days prior to start of installation of the work of this section.

1.5 QUALITY ASSURANCE

A. **All Work in the public rights of way or easements dedicated to the public shall be in accordance with the local Governing Authority having Jurisdiction.**

B. Perform Work in accordance with ACI 301.

C. All codes referenced herein, shall include but not be limited to the following.
   1. American Society for Testing and Materials, ASTM
   2. American Concrete Institute
      a. ACI 214 Recommended Practice for Evaluation of Strength Tests results; of Concrete
      b. ACI 301 Details and Detailing of Concrete Reinforcement
      c. ACI 305 Recommended Practices for Cold Weather Concreting
      d. ACI 306 Recommended Practices for Hot Weather Concreting
      e. ACI 308 Standard Practice for Curing Concrete
      f. ACI 347 Recommended Practice for Concrete Formwork

D. Maintain one copy of each document on site.

E. NRMCA National Ready Mix Concrete Association, latest revision: Certificate of Conformance for Concrete Production Facilities.

F. Obtain cementitious materials from same source throughout.

1.6 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing Products specified in this section with minimum 3 years documented experience.

B. Installer: Company specializing in performing work of this section with minimum 5 years documented experience.

1.7 MOCKUP

A. Section 01 33 00 - Shop Drawings, Product Data, & Samples: Requirements for mockup.

B. Construct mockup, 5 x 5 feet, including showing specified paving, joints, surface texture, exposed aggregate, etc as shown in the drawings.

C. Incorporate accepted mockup as part of Work.

1.8 PRE-INSTALLATION MEETINGS

A. Contractor shall coordinate pre-installation meeting.

B. Convene minimum one week prior to commencing work of this section.

1.9 ENVIRONMENTAL REQUIREMENTS

A. Section 01 60 00 - Materials & Equipment: Environmental conditions affecting products on site.

B. Do not place concrete when base surface temperature is less than 40 degrees Fahrenheit, or surface is wet or frozen.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Form Materials: Conform to ACI 301. Steel, wood or other suitable material of size and strength to resist movement during concrete placement and to retain horizontal and vertical alignment until removal. Use straight forms, free of distortion and defects.
   1. Use flexible spring steel forms or laminated boards to form radius bends as required.
   2. Coat forms with a non-staining form release agent that will not discolor or deface surface of concrete.

B. Reinforcing Materials:
   1. Reinforcing Bars: Deformed steel bars, ASTM A 615, Grade 60.
   2. Fabricated Bar Mats: Welded or clip-assembled steel bar or rod mats, ASTM A 184. Use ASTM A 615, Grade 60 steel bars, unless otherwise indicated.
   3. Joint Dowel Bars: Plain steel bars, ASTM A 615, Grade 60. Cut bars true to length with ends square and free of burrs. Provide slip pin dowels as a product commercially manufactured for this use.

4. Supports for Reinforcement: Chairs, spacers, dowel bar supports and other devices for spacing, supporting, and fastening reinforcing bars, welded wire fabric, and dowels in place. Use wire bar-type supports complying with CRSI specifications.

C. Concrete Materials:
   1. Portland Cement: ASTM C150, Type IA or IIA.
      a. Use one brand of cement throughout Project unless otherwise acceptable to OWNER'S REPRESENTATIVE.
   2. Fly Ash: ASTM C 618; Type F.
   3. Normal-Weight Aggregates: ASTM C 33, Class 4, and as follows. Provide aggregates from a single source.
      a. Maximum Aggregate Size: 1½ inches.
      b. Do not use fine or coarse aggregates that contain substances that cause spalling.
      c. Local aggregates not complying with ASTM C 33 that have been shown to produce concrete of adequate strength and durability by special tests or actual service may be used when acceptable to OWNER'S REPRESENTATIVE.
   4. Water: Potable.
   5. Air Entrainment: ASTM C 260.
   6. Chemical Admixture: ASTM C 494

D. Isolation Joint Materials:
   1. ASTM D 994, preformed asphalt impregnated, ½ inch thick

E. Joint Sealer Material:
   1. A polymer, designed for gun application, containing no free Toluene Diisocyanate (TDI), complying with ASTM C 920, Standard Specification for Elastomeric Joint Sealants. MasterSeal SL 2, or Sikaflex 1C-SL, Spal-Pro RS88 by Metzger/McGuire, color grey, or approved equal.

F. Liquid-Membrane Forming and Sealing Curing Compound: 1. Comply with ASTM C 309, Type I, Class A unless other type acceptable to Owner's Representative. Moisture loss no more than 0.055 gr./sq.cm. when applied at 150 sq. ft./gal. W.R. Meadows Seal-Tight 1300-Clear or approved equal.

G. Bonding Compound:
   1. Acrylic or styrene batadiene base, re-wetable type.

H. Epoxy Adhesive:
   1. ASTM C 881, 2-component material suitable for use on dry or damp surfaces. Provide material "Type", "Grade" and "Class" to suit project requirements

I. Detectable Warning Texture: Provided as shown on Plans.
   1. Texture: Diamond texture or Truncated dome style where shown on drawings.
   2. Pattern: Diamond or Domes to be arranged in an in-line pattern only.
   3. Application: Cast in Place or approved equal.

4. Color: As shown on the drawings.

2.2 CONCRETE MIX DESIGN

A. Prepare design mixes for each type and strength of normal-weight concrete by either laboratory trial batch or field experience methods as specified in ACI 301. For the trial batch method, use a qualified independent testing agency for preparing and reporting proposed mix designs.
   1. Do not use the Owner's field quality-control testing agency as the independent testing agency.
   2. Limit use of fly ash to 25 percent of cement content by weight.

B. Proportion mixes according to ACI 211.1 and ACI 301 to provide normal-weight concrete with the following properties:
   1. Compressive Strength (28-Day):
      a. Sidewalks and Curbs: 3300 psi.
      b. Crosswalks in drive aisles: 4000 psi
      c. Thrust blocks: 2,500 psi
   2. Slump Limit at Point of Placement: 4 inches ± 1inch
      a. Slump limit for concrete containing high-range water-reducing admixture (superplasticizer): Not more than 8 inches.
   3. Air Entrained: 5 percent +/- 1%.

C. Adjustment to Concrete Mixes: Mix design adjustments may be requested by Contractor when characteristics of materials, project conditions, weather, test results or other circumstances warrant.

D. Use accelerating admixtures in cold weather only when approved by the Engineer in writing. Use of admixtures will not relax cold weather placement requirements.

E. Ready-Mixed Concrete: Comply with requirements and with ASTM C 94

2.3 SOURCE QUALITY CONTROL AND TESTS

A. Section 01 45 30 - Testing Laboratory Services: Testing and Inspection Services:

B. Submit proposed mix design of each class of concrete to appointed firm for review prior to commencement of Work.

C. Tests on cement, aggregates, and mixes will be performed to ensure conformance with specified requirements.

D. Test samples in accordance with ACI 301.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Contractor shall coordinate verification of existing conditions before starting work.

B. Verify compacted granular base is acceptable and ready to support paving and imposed loads.

C. Verify gradients and elevations of base are correct.

D. Remove loose material from compacted base immediately before placing concrete.

E. Proof-roll prepared base surface to check for unstable areas and need for additional compaction. Do not begin paving work until such conditions have been corrected and are ready to receive paving.

3.2 PREPARATION

A. Moisten base to minimize absorption of water from fresh concrete.

B. Coat surfaces of manholes, catch basin, and clean out frames with oil to prevent bonding with concrete pavement.

C. Notify Architect/Engineer minimum 24 hours prior to commencement of concreting operations.

3.3 FORMING

A. Place and secure forms to correct location, dimension, profile, and gradient.

B. Assemble formwork to permit easy stripping and dismantling without damaging concrete.

C. Place joint filler vertical in position, in straight lines. Secure to formwork during concrete placement.

D. Set forms to required grades and lines, braced and secured. Concrete flatwork thickness is noted on plans and details. Install forms to allow continuous progress of work and so that forms can remain in place at least 24 hours after concrete placement.

E. Check completed formwork for grade and alignment to following tolerances:
   1. Top of forms not more than ¼ inch in 10 feet.
   2. Vertical face on longitudinal axis, not more than ¼ inch in 10 feet

F. 48 hours prior to concrete placement, contractor shall call for form inspections to confirm grades are meeting ADA for the various components.

G. Clean forms after each use and coat with form release agent as required ensuring separation from concrete without damage.

3.4 REINFORCEMENT

A. General: Comply with Concrete Reinforcing Steel Institute's recommended practice for "Placing Reinforcing Bars" for placing and supporting reinforcement.

B. Place reinforcement as indicated.

C. Interrupt reinforcement at contraction/expansion joints.

D. Place dowels and reinforcement to achieve pavement and curb alignment as detailed.

E. Provide doweled joints 24 inches o.c. at transverse joints and interruptions of concrete with one end of dowel set in capped sleeve to allow longitudinal movement.

3.5 PLACING CONCRETE

A. Comply with requirements and with ACI 304R for measuring, mixing, transporting, and placing concrete.

B. Do not place concrete until subbase and forms have been checked for line and grade. Moisten subbase if required to provide a uniform dampened condition at time concrete is placed. Do not place concrete around manholes or other structures until they are at required finish elevation and alignment.

C. Place concrete by methods that prevent segregation of mix. Consolidate concrete along face of forms and adjacent to transverse joints with internal vibrator. Keep vibrator away from joint assemblies, reinforcement, or side forms. Use only square-faced shovels for hand-spreading and consolidation. Consolidate with care to prevent dislocation of reinforcing, dowels and joint devices.

D. Use bonding agent at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.

E. Deposit and spread concrete in a continuous operation between transverse joints as far as possible. If interrupted for more than ½ hour, place a construction joint.

F. Screed paved surfaces with a straightedge and strike off. Use bull floats or darbies to form a smooth surface plane before excess moisture or bleed water appears on the surface. Do not further disturb concrete surfaces prior to beginning finishing operations.

G. Place concrete in two operations; strike off initial pour for entire width of placement and to the required depth below finish surface. Lay fabricated bar mats immediately in final position. Place top layer of concrete, strike off, and screed.
   1. Remove and replace portions of bottom layer of concrete that have been placed more than 15 minutes without being covered by top layer or use bonding agent if acceptable to OWNER'S REPRESENTATIVE.

H. Curbs: When automatic machine placement is used for curb placement, submit revised mix design and laboratory test results that meet or exceed requirements. Produce curbs to required cross section, lines, grades, finish, and jointing as specified for formed concrete. If results are not acceptable, remove and replace with formed concrete.

I. Slip-Form Pavers: When automatic machine placement is used for paving, submit revised mix design and laboratory test results that meet or exceed requirements. Produce paving to required thickness, lines, grades, finish and jointing as required for formed paving.
   1. Compact base and prepare subgrade of sufficient width to prevent displacement of paver machine during operations.

J. When adjoining pavement lanes are placed in separate pours, do not operate equipment on concrete until pavement has attained 85 percent of its 28-day compressive strength.

K. Cold-Weather Placement: Comply with provisions of ACI 306R and as follows. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions or low temperatures.
   1. When air temperature has fallen to or is expected to fall below 40 degrees F (4 degree C), uniformly heat water and aggregates before mixing to obtain a concrete mixture temperature of not less than 50 degrees F (10 degrees C) and not more than 80 degrees F (27 degrees C) at point of placement.
   2. Do not use frozen materials or materials containing ice or snow.
   3. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise accepted in mix design.

L. Hot-Weather Placement: Place concrete complying with ACI 305R and as specified when hot weather conditions exist.
      1. Cool ingredients before mixing to maintain concrete temperature at time of placement to below 90 degrees F (32 degrees C). Mixing water may be chilled or chopped ice may be used to control temperature, provided water equivalent of ice is calculated to total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.
      2. Cover reinforcing steel with water-soaked burlap if it becomes too hot, so that steel temperature will not exceed the ambient air temperature immediately before embedding in concrete.
      3. Fog spray forms, reinforcing steel, and subgrade just before placing concrete. Keep subgrade moisture uniform without standing water, soft spots, or dry areas.

M. Ensure reinforcement, inserts, embedded parts and formed joints are not disturbed during concrete placement.

N. Place concrete continuously over the full width of the panel and between predetermined construction joints. Do not break or interrupt successive pours such that cold joints occur.

O. Place concrete to pattern indicated.

3.6 JOINTS

A. General: Construct isolation, weakened-plane (contraction), and construction joints true to line with face perpendicular to surface of concrete. Construct transverse joints at right angles to the centerline, unless otherwise indicated.

B. When joining existing structures, place transverse joints to align with previously placed joints, unless otherwise indicated.

C. Weakened-Plane (Contraction) Joints: Provide weakened-plane (contraction) joints, sectioning concrete into areas as shown on Drawings or at approximate 10' intervals if not shown. Align curb, gutter, and sidewalk joints. Construct weakened-plane for a depth equal to ¼ concrete thickness, as follows:

1. Tooled Joints: Form weakened-plane joints in fresh concrete by grooving top portion with a recommended cutting tool and finishing edges with a jointer.

2. Inserts: Use embedded strips of metal or sealed wood to form weakened-plane joints. Set strips into plastic concrete and carefully remove strips after concrete has hardened.

D. Construction Joints: Place construction joints at end of placements and at locations where placement operations are stopped for more than 2 hour, except where such placements terminate at isolation joints.

1. Construction joints as shown or, if not shown, use standard metal keyway-section forms.
2. Where load transfer-slip dowel devices are used, install so that one end of each dowel bar is free to move.

E. Isolation Joints: Provide pre-formed asphalt impregnated joint material.

1. Locate expansion joints abutting catch basins, manholes, inlets, structures, foundations, footings, and other fixed objects, unless otherwise indicated, and as shown on Drawings.
2. Locate expansion joints at a maximum of 45' o.c. for continuous sidewalks and within 8 - 16 feet from ends of walks which abut curbs or as shown on drawings.

F. Extend joint fillers full width and depth of joint, not less than 1-inch or more than 2-inches below finished surface for placement of backer rod and joint sealer. Place joint filler between paving components and building or other appurtenances. Recess top of filler as shown in drawings for sealant placement.

G. Finish joint fillers in one-piece lengths for full width being placed wherever possible. Where more than one length is required, lace or clip joint filler sections together.

H. Protect top edge of joint filler during concrete placement with a metal cap or other temporary material. Remove protection after concrete has been placed on both sides of joint.

I. Fillers and Sealants: Apply joint sealant to all joints in pedestrian or vehicular traffic areas, in accordance with the Scofield Tech-Data Bulletin S-404-3G, or equal if a different sealer is approved for use.

J. Provide keyed joints as indicated.

3.7 FINISHING

A. After striking-off and consolidating concrete, smooth surface by screeding and floating. Use hand methods only where mechanical floating is not possible. Adjust floating to compact surface and produce uniform texture.

B. After floating, test surface for trueness with a 10-foot straightedge. Distribute concrete as required to remove surface irregularities, or abrupt angles and refloat repaired areas to provide a continuous smooth finish, true to within ¼ inch in 10 feet.

C. Work edges of gutters, back top edge of curb, and formed joints with an edging tool, and round to 2-inch radius, unless otherwise indicated. Eliminate tool marks on concrete surface.

D. After completion of floating and when excess moisture or surface sheen has disappeared, complete troweling and finish surface as follows:
   1. Broom Finish: Broom finish by drawing a fine-hair broom across concrete surface perpendicular to line of traffic. Repeat operation if required to provide a fine line texture acceptable to OWNER'S REPRESENTATIVE.
   2. Exposed Aggregate: Apply surface retarder where exposed aggregate finish is required. Wash exposed aggregate surface with clean water and scrub with stiff bristle brush, acid etch solution exposing aggregate to match sample panel.

E. Sidewalk Paving: Light broom or Exposed aggregate where shown on drawings.

F. Curbs and Gutters: Light broom.

G. Inclined Vehicular Ramps: Broomed perpendicular to slope.

H. Place curing compound/sealer on exposed concrete surfaces immediately after finishing.

I. Do not remove forms for 24 hours after concrete has been placed, except where required for finishing. After form removal, clean ends of joints and point-up any minor honeycombed areas. Remove and replace areas or sections with major defects, as directed by OWNER'S REPRESENTATIVE.

J. Place detectable warning texture/truncated domes per manufacture's recommendations.

3.8 CURING

A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. Comply with the recommendations of ACI 306R for cold weather protection and ACI 305R for hot weather protection during curing.

B. Evaporation Control: In hot, dry, and windy weather, protect concrete from rapid moisture loss before and during finishing operations with an evaporation-control material. Apply

according to manufacturer's instructions after screeding and bull floating, but before floating.

C. Begin curing after finishing concrete but not before free water has disappeared from concrete surface.

D. Curing Methods: Cure concrete by moisture curing, moisture-retaining-cover curing, curing compound, or a combination of these.

E. Curing/Sealer Compound: Apply uniformly in continuous operation according to manufacturer’s instructions.

3.9 JOINT SEALING

A. Separate pavement from vertical surfaces with ¼ inch thick joint filler.

B. Place joint filler in pavement pattern placement sequence. Set top to required elevations. Secure to resist movement by wet concrete.

C. Extend joint filler from bottom of pavement to within ¼ inch of finished surface.

3.10 TOLERANCES

A. Section 01 45 00 - Contractor's Quality Control Program: Tolerances.

B. Maximum Variation of Surface Flatness: ¼ inch in 10 ft.

C. Maximum Variation from True Position: ¼ inch.

3.11 FIELD QUALITY CONTROL

A. Section 01 45 00 - Contractor's Quality Control Program and 01 77 00 - Contract Closeout: Field inspecting, testing, adjusting, and balancing.

B. Three concrete test cylinders will be taken for every 100 or less cu yds of each class of concrete placed each day or as directed by OWNER’S REPRESENTATIVE.

C. One additional test cylinder will be taken during cold weather and cured on site under same conditions as concrete it represents.

D. One slump and entrained air test will be taken for each set of test cylinders taken in accordance with ACI 301.

3.12 REPAIR AND PROTECTION

A. Immediately after placement, protect pavement from premature drying, excessive hot or cold temperatures, and mechanical injury.

B. Repair or replace broken or defective concrete, as directed by OWNER'S REPRESENTATIVE.

C. Drill test cores where directed by OWNER'S REPRESENTATIVE when necessary to determine magnitude of cracks or defective areas. Fill drilled core holes in satisfactory pavement with Portland cement concrete bonded to pavement with epoxy adhesive.

D. Sweep concrete pavement and wash free of stains, discolorations, dirt, and other foreign material just before final inspection.

E. Do not permit pedestrian traffic over sidewalks for 7 days and vehicular traffic over pavement until 85 percent of design strength of concrete has been achieved. When construction traffic is permitted, maintain pavement as clean as possible by removing surface stains and spillage of materials as they occur.

END OF SECTION

SECTION 32 84 00 - IRRIGATION SYSTEMS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Irrigation system shall be installed by a contractor licensed and bonded to perform such work in the State of Oregon.

B. Furnish all labor, tools, equipment, material, transportation and perform all operations necessary and incidental to proper execution and completion of the irrigation system installation in accordance with the Drawings and Specifications.

C. The irrigation system shall be a complete and operable landscape irrigation system, constructed to grades, and comply in all respects with these Specifications and Drawings and recognized good practice industry standards. **Phase 2 irrigation system shall be tied into phase 1 irrigation system and controller. Any extra zones necessary shall be added to existing phase 1 irrigation controller. Prior to beginning any irrigation work, Contractor shall coordinate a pre-installation meeting with the Owner and General Contractor to test the existing system for functionality and to determine area of service. Contractor shall also test and verify available pressure and flow rates. Adjustments and/or repairs to the irrigation systems may be required based on the findings of these tests. After completion of irrigation work, contractor shall again test existing and new irrigation systems to ensure functionality to the satisfaction of the Owner.**

D. Contractor shall test to confirm the static water pressure as per design. If the static water pressure is not within five (5) PSI of the design specified pressure the irrigation contractor will communicate this reading to the general contractor, the irrigation designer and Owner’s Representative.

E. Protect equipment, buildings, utilities, sidewalks, trees, landscaping monuments, markers, adjacent property, and work by others.

1.2 RELATED REQUIREMENTS

A. Section 01 33 00 - Submittal Procedures

B. Section 31 05 13 - Earthwork

C. Section 32 93 00 – Planting

1.3 RELATED WORK

A. Irrigation Contractor to install connections to new central controller system as per manufacturer’s instructions. Coordinate final location with Owner’s Representative.

B. Sleeving – Install sleeving prior to paving. Coordinate sleeve installation with General Contractor.

C. Confirm existing double check valve for existing systems meets current jurisdictional code requirements prior to irrigation system revisions/installation. Verify location with Owner’s Representative.

1.4 REFERENCES

A. ASTM International:

1. ASTM B32 - Standard Specification for Solder Metal
2. ASTM B42 - Standard Specification for Seamless Copper Pipe, Standard Sizes
3. ASTM D2235 - Standard Specification for Solvent Cement for Acrylonitrile-Butadiene-Styrene (ABS) Plastic Pipe and Fittings
4. ASTM D2241 - Standard Specification for Poly Vinyl Chloride (PVC) Pressure-Rated Pipe (SDR Series)
5. ASTM D1785 - Standard Specification for Poly Vinyl Chloride (PVC) Plastic Pipe, Schedules 40, 80, and 120
6. ASTM D2466 - Standard Specification for Poly Vinyl Chloride (PVC) Plastic Pipe Fittings, Schedule 40
7. ASTM D2564 - Standard Specification for Solvent Cements for Poly Vinyl Chloride (PVC) Plastic Piping Systems
8. ASTM F876 Standard Specification for Cross-linked Polyethylene (PEX) Tubing
9. ASTM F1960 Standard Specification for Cold Expansion Fittings with PEX Reinforcing Rings for Use with Cross-linked Polyethylene (PEX) Tubing
10. Uponor Professional Plumbing Installation Guide, current edition
11. Uponor Plumbing Design Assistance Manual, current edition.

B. National Electrical Manufacturers Association:

1. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).

1.5 REGULATORY REQUIREMENTS

A. All work specified and detailed will conform to the U*niform Plumbing Code* and the *National Electric Code* as modified by the State of Oregon unless more stringent requirements are specified.

B. **The contractor will be responsible for obtaining all necessary electrical and plumbing permits and including those costs into the bid price.**

1.6 SUBMITTALS

A. The contractor will provide to the Owner's Representative a record of all equipment and supplies within 30-days after the award of the contract, and before any construction begins. Submit catalog performance data with product name and model number.

B. Any change in materials, equipment, or the design, will be submitted in writing to the Owner Representative's for approval.

C. After completion of construction, submit neat and legible As-Built drawings as 'Record Drawings' to the Owner's Representative. Dimension and note all underground work vertically and horizontally. Measure from a permanent structure for location after burial.

D. Submit two copies of maintenance & operation manuals, parts list, warranty information, specification sheets, winterization instructions, precipitation rates and programming schedule.

1.7 PRE-INSTALLATION MEETINGS

A. Contractor shall coordinate pre-installation meeting. At a minimum this meeting shall test the existing irrigation system for functionality, condition, and service area; determine final locations for the new irrigation system connection, double check valve, and controller to the vacated domestic water line from the well house; and verify system water pressure and flow rates.

B. Convene minimum one week prior to commencing work of this section. Minimum attendees shall be the Contractor's site superintendents, General Contractor, the owner, and the project's irrigation installer.

1.8 SYSTEM DESCRIPTION

A. Central controller. Existing phase 1 controller shall be used for phase 2.

B. Source Power: 110-volt, single phase or per manufacturer's recommendations.

C. Double-check valve assembly, flow sensor, master valve, weather sensor, grounding, and surge equipment.

D. Sleeving

E. Quick Coupler Valves

F. Underground irrigation system, PVC piping, sprinklers and rotators, and low-flow heads as indicated on the Drawings.

1.9 QUALIFICATIONS

A. Installer: The Contractor installing work covered by this Specification must be a state licensed and bonded Contractor. Contractor must be experienced in work of best-accepted trade practices and have equipment and personnel adequate to perform the work specified. Contractor must be familiar and comply with applicable governing regulations.

B. The firm shall be Oregon Landscape Contractor Association (OLCA) certified with a Certified Landscape Technician in irrigation installation and has at least four years of experience in irrigation system installation.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Delivery: Deliver materials in manufacturer's original, unopened, undamaged packaging with identification labels intact, or alternative, secure packaging provided by distributor.

B. Storage and Protection: Store materials protected from exposure to harmful environmental conditions and at temperature and humidity conditions recommended by the manufacturer.

C. The Owner or their Representative reserves the right to inspect and reject or order repair of irrigation system at any time until final review and acceptance.

1.11 WARRANTY

A. Contractor shall guarantee workmanship, materials, and performance of installation for at least 2-years from date of Final Acceptance. Comply with terms of manufacturer's warranty to ensure product performance.

B. The Contractor will be responsible for maintaining the irrigation system and protecting it from damage (at no cost to the Owner Representative) until the date of final acceptance. This includes damage caused by vandalism or adverse weather conditions.

C. Piping system warranty shall apply to potable water distribution and water service systems constructed of pipe and fitting products sourced from the same manufacturer.

D. The Contractor will be responsible for the programming of the controller, the proper watering of all plants and any damage from over or under watering until the date of final acceptance.

E. Repair any settling of backfilled trenches, restore damaged turf, plants, and paving (caused by settling), during the warranty period at no cost to the Owner's Representative.

1.12 EXISTING UTILITIES

A. The Contractor will, at their expense, have all existing utilities located at job sites prior to commencement of work.

B. The Contractor will protect any utilities that remain in place. Any located utilities damaged during construction will be repaired at the cost of the Contractor.

C. If utilities not located are damaged during construction, the Contractor will cooperate with utility company during the utility company repairs.

1.13 EXTRA MATERIALS

A. The Contractor will provide the Owner Representative (at no extra cost) with two controller keys, two quick coupler keys with hose swivels, two adjustment / removal tools for each different type of sprinkler head and two gate valve keys.

PART 2 - PRODUCTS

2.1 GENERAL

B. All products will be new and of types and models shown on the plans or as specified herein.

C. All products will be obtained from in state, local suppliers.

D. Substitutions must be approved by the Owner's Representative and be of equal function, quality, and compatible with other irrigation system components.

2.2 PIPE

A. Plastic pipe for main line 4" and smaller will be PVC (polyvinyl chloride) Schedule 40, bell end, continuously bearing the seal of NSF International and complying with the requirements of ASTM D -1785.

B. Depth of mainlines will be 18" min. to 24" max. (Top of pipe).

C. Plastic pipe for lateral lines will be PVC (polyvinyl chloride) Class 200, SDR 21, bell end, continuously bearing the seal of NSF International and complying with the requirements of ASTM D -1784, D-2241.

D. Depth of lateral lines will be 12" min. to 18" max. Lateral lines should be installed to conform to the depth of the head being installed.

E. In all pipe installations, the manufacturer's printed seal will be visible.

F. In all cases, installation of two or more pipes in the same trench is not permitted.

G. Plastic pipe for sleeves under paved areas, will be PVC (polyvinyl chloride) Schedule 40, bell end, continuously bearing the seal of NSF International and complying with the requirements of ASTM, D -1785. Sleeves will be a minimum of 6" in diameter or twice the diameter of the mainline or lateral line, whichever is larger.

H. Plastic nipples will be PVC (polyvinyl chloride) Schedule 80, NSF International-approved pipe, threaded both ends (TBE) or threaded one end (TOE) and complying with the requirements of ASTM D-1785.

I. Metal pipe will be copper tube type K.

J. Metal nipples will be brass.

K. NOTE: No galvanized pipe will be allowed underground.

2.3 FITTINGS

A. Plastic fittings will be solvent weld PVC (polyvinyl chloride) Schedule 40, Type 1, I.P.S., NSF International- approved meeting requirements of ASTM D- 2466.

B. Metal fittings will be 125-PSI bronze.

C. NOTE: No galvanized fittings will be allowed underground.

2.4 CEMENT AND PRIMER

A. PVC solvent cement will be used on all solvent weld fittings. Weld-On 711 or approved cement equal meeting NSF International Standards for Type I and II PVC through 6-inch pipe and meeting requirements of ASTM D- 2564.

B. PVC solvent primer will be used on all solvent weld fittings. Weld-On P-70 or approved primer equal meeting the requirements of ASTM F-656, with purple color.

2.5 THREAD SEALANT

A. All PVC threads will be sealed with a Teflon sealant.

B. On main line threads (under continuous pressure) Rectorseal T+2 or approved equal for PVC.

C. On lateral lines (at heads) all threads will be sealed with three wraps of Teflon tape, meeting requirements of MIL-T-27730A.

D. Only Teflon tape will be used at plastic valves and heads per manufacturer's specifications.

2.6 BACKFLOW PREVENTOR

A. Double-check valve assembly per water purveyor and/or jurisdictional authority requirements. Confirm suitability of existing double-check valve for existing irrigation systems on site and supply new double-check valve assembly for new irrigation systems.

B. Install PVC or brass unions or cast-iron flanges on both sides of the device to match pipe size.

C. It is the responsibility of the contractor to obtain permits and allow inspection by the water purveyor and the plumbing inspector.

D. The Contractor will, at their cost, have the initial Backflow Assembly Test Report performed by a State certified tester immediately after installation. Copies of the Test Report will then be immediately submitted to the water purveyor and Owner Representative.

E. If the device fails its initial test, the contractor will have the device repaired and retested at the contractor's expense.

F. Valve box sizes for double-check valve assemblies:

1. 2"- Brooks green plastic 1730VB-18. A 1730 E8 extension will be used if needed to set to grade. Two valve boxes will be used and set base to base to create a void for double check and to allow a technician to stand in and around device.

G. Depth of devices: On 3/4" to 2" sizes the depth of the devices will be 24". The final determination will be with the water purveyor and/or the jurisdictional authority.

2.7 VALVES

A. Isolation Valves:

1. 2" and smaller will be heavy duty brass globe or manual angle valves. 125-PSI min. with standard seat, threaded ports, and a cross handle on the stem.
2. 3" and larger valves will be 125 PSI min. cast iron, flanged and have square top nut on the stem.

B. Valve Boxes:

1. A Highline (Armor) or Rain Bird 12" standard box with extensions is to be installed on 3" and smaller valves.
2. A Highline (Armor) or Rain Bird jumbo box with extensions is to be installed on 4" and larger valves.

C. Manual drains will be installed on the low points of the mainline with two (2) cubic feet of 3/4" drain rock. Champion 3/4" brass angle valve with rising swivel (200RS-075) will be used. A 3/4" X 4" PVC nipple will be installed into the drain rock from the bottom of the valve. A Highline (Armor) or Rain Bird 10" round box will be used over this valve.

D. Automatic control valves as indicated on the Drawings. Accu sync pressure regulator shall be installed where pressure regulation is required. Valve size is noted in valve schedule on Drawings. A Highline (Armor) or Rain Bird 12" standard box will be installed on 1" automatic valves. A Highline (Armor) or Rain Bird jumbo box will be installed on 1½", 2" and 3" automatic valves.

E. Quick coupler valves as indicated on the Drawings, installed in a Highline (Armor) or Rain Bird 10" round box with one (1) cubic foot of 3/4" drain rock. Quick couplers will be installed with PVC swing joint fittings and nipples of the same size as the threading of the quick coupler. Quick couplers will be secured to a 1” or 1½” aluminum angle iron 30” long with #32 or #36 stainless steel clamps.

F. Pressure Regulator (as needed) shall be Wilkens, Watts, or Conbraco top entry with double unions, as approved.

2.8 VALVE BOXES

A. All valves, wire splices and ground rods will have valve boxes with covers installed over them.

B. All valve boxes will be from:

1. Highline Products, 131 Hartwell Ave., Lexington, MA 02421 USA or
2. Rain Bird Corporation 970 West Sierra Madre Ave. Azusa, CA 91702.

C. The valves will have complete access for maintenance.

D. The bottom of the box will be below the bottom of the valve to prevent soil from covering valve body.

E. All valve boxes will have a base of 3/4" drain rock. Each size of box will have a corresponding amount of rock.

1.	10" round box:	one	(1) cubic foot
2.	12" standard box:	two	(2) cubic feet
3.	Jumbo box:	three	(3) cubic feet
4.	Brooks 1730:	four	(4) cubic feet

F. Protect rock from contamination with filter fabric.

G. Install box with a 2" space over the pipe.

H. All boxes in turf areas will be installed flush to grade and use extensions if needed.

I. All boxes in shrub areas will be installed 2" above grade and use extensions if needed, to accommodate the application of bark mulch.

2.9 SPRINKLER HEADS

A. All popup spray body sprinkler heads will be by manufacturer as indicated on the Drawings or as otherwise approved. See schedule on Drawings for proper nozzle sizes. All heads will have a sealing check device installed to prevent low head drainage. Locate heads no closer than three inches (3") from any adjacent walk, drive or road (paved or gravel).

B. All rotor heads will have swing joints of the same thread size installed or as recommended by manufacturer.

C. Six-inch pop-up heads will be installed in turf areas and planting beds.

D. All heads in shrub beds will be installed 2" above grade to accommodate the application of bark mulch.

E. All heads in turf areas will be installed to grade per manufacture's specifications. Refer also to irrigation details on Drawings.

2.10 CONTROLLERS

A. Phase 2 irrigation system shall tie into the existing phase 1 irrigation controller in well house.

2.11 ELECTRICAL

A. Confirm and coordinate power source for irrigation system with Owner and General Contractor.

B. All wiring shall follow the "National Electric Code" as modified by the State of Oregon unless more stringent requirements are specified.

C. All primary power connections and disconnects shall be performed by a state-certified electrician at the contractors' expense and inspected by the proper jurisdictional authority.

D. All automatic remote-control valves, including master valves, shall be wired with single strand copper, UL approved for direct burial, AWG (UL) Type UF, 600 V, sized per manufacturer's recommendations -14 Gauge minimum.

E. All valve wire connections shall be 3M DBY / DBR.

F. At each valve, a three (3) foot length of wire shall be provided neatly coiled.

G. The wire run shall be installed along the side of the mainline at the bottom of the trench

H. All valve field wire splices made will be installed in valve boxes, with no splices between valve boxes and valve boxes and controllers.

2.12 CONCRETE THRUST BLOCKS

A. Install concrete thrust blocks where the mainline changes direction at ells and tees and where the irrigation main ends.

B. Install thrust blocks on all mainline 2 1/2" and larger. Pour thrust blocks against pipe and firm undisturbed soil with at least one cubic foot of concrete.

C. Thrust blocks must cure for five (5) days before mainline pressure test.

PART 3 - EXECUTION

3.1 IRRIGATION SYSTEM – INSPECTION PROCEDURE

D. Owners Representative may request inspection at any time during installation of irrigation system including the following milestones:

1. Pre-construction Static Pressure Test
2. Layout
3. Excavation
4. Mainline and Wire Installation
5. Mainline Flushing
6. Automatic Valve Installation

7. Mainline Pressure Test
8. Lateral and Swing Joint Installation
9. Lateral Flushing and Head Installation
10. Controller, Primary Power Installed, and Grounded
11. Valve and Controller Wiring
12. Controller Stations Wired as per Design
13. Backfilling of Trenches
14. Finish Work
15. Heads, Valves and Controller Match Specifications
16. Head and Valve Box Grade
17. Head Adjustment
18. Submit Copy of Back Flow Assembly Test Report
19. Submit “As Built” Drawings

3.2 INSTALLATION PROCEDURE

A. No work shall be covered or enclosed until it has been inspected, tested, approved, and signed off on the checklist. A 24-hour notice for approval shall be given. The Owner’s Representative will maintain the inspection checklist.

B. Before construction begins contractor will confirm design static pressure. A change in more than five (5) PSI may require a redesign. Contractor will notify Owners Representative of this difference.

C. Layout: Stake, flag and/or paint the location of all heads, valves and piping according to the schematic design shown on the drawings. The layout is then to be approved.

D. Excavation shall proceed after layout approval. If during excavation, a large amount of unknown material (asphalt, concrete, wire, steel, etc.) is uncovered, the debris shall be removed from site, at Contractor expense. Bottom of trench shall be free of rocks, asphalt, concrete, wire, steel, and any other debris. Trenching is the preferred method for pipe installation. Pipe pulling is only allowed when the soils are known to be clean and free of debris. Hand trench around existing tree roots of 2" and larger when encountered. Pipe shall have firm and uniform bearing on all pipe runs to prevent uneven settlement. Wedging or blocking of pipe is not permitted.

E. Mainline, thrust blocks and isolation valves shall be installed according to the specifications. Valve wiring will be installed as per specifications and details. The mainline installation is then to be approved.

F. The mainline is to be flushed before the installation of the automatic remote-control valves. Soil may be placed in trenches between fittings to insure the stability of the line under pressure. Thoroughly flush all mainline pipe. The flushing is then to be approved.

G. The mainline is to be pressure tested, after valve installation, with the pipe filled with water and all air expelled. Minimum pressure test shall be 100 PSI without losing three (3) PSI over a two-hour period. Pressure can be achieved with a pump but shall not be maintained with a pump. Supply certified pressure gauge during testing. Detect and repair all leaks and retest until approval is granted.

H. The lateral lines, swing joints and flexible pipe joints shall then be installed and then approved.

I. The lateral lines shall be thoroughly flushed to remove all debris and expel all air from the piping. The flushing is then to be approved.

J. Delay complete backfilling until pressure tests have been accepted. Backfill, settle with water, and compact trenches in 6" lifts with material free of rocks and debris. Backfilling will then be approved.

K. The installation of valve boxes and heads shall be inspected and approved.

L. The installation of all wiring at valves and controller shall be inspected and approved.

M. Valve pressures will be adjusted. The contractor will then adjust all heads. The head adjustment shall be inspected and approved.

N. During a walk through with the Contractor and the Owners Representative a system test will be performed to establish a final punch list. All items on the punch list will be corrected by the Contractor to the Owner Representative's satisfaction.

O. Signing of the warranty will begin at date of final acceptance.

3.3 PIPE AND FITTINGS

A. All solvent weld cement joints are to be clean, dry and follow all manufacture's specifications. All cuts are to be square and debarred.

B. No solvent welding of PVC pipe will be permitted in freezing weather. In rainy weather, solvent weld PVC pipe only under cover.

C. All solvent weld joints are to be given at least 24-hours cure time before testing.

D. No fittings are to be closer than 12" apart.

E. All mainline threaded fittings will be applied with approved paste, hand tightened, and tool tightened with no more than two (2) turns.

F. All sleeving is to be marked and taped over during and after construction to keep soil out of sleeves.

G. All swing joints will be assembled and installed per manufacturer's specifications.

3.4 VALVES

A. All systems will have a brass angle valve with union installed before the automatic valve. On the downstream side of the valve, a MPT X SOC union will be installed. All fittings, unions, angle valve and nipples will match valve size.

B. Do not use Teflon paste on automatic plastic valves. Teflon tape will be used on valve threads.

C. Only one (1) valve per valve box unless otherwise indicated.

3.5 HEADS

A. All heads are to be installed per Specifications and manufacturer's instructions after lateral flushing.

B. Contractor will use Teflon tape only on all head threads.

C. Install heads called for in the Irrigation Schedule at locations shown on Drawings. Some field adjustments may be necessary to achieve desired coverage. Written notification and approval are required before making any significant changes.

D. Heads are to be adjusted not to water walks, streets or other pavement.

3.6 CONTROLLERS

A. Existing phase 1 controller in existing well house shall be used for new phase 2 irrigation system.

B. All valve and communication wire shall be installed in a clean and neat manner into all equipment.

C. The Contractor will note valve number, location, run time and program on the label affixed to the controller door.

D. The Contractor will have a Megger test performed on the installed specified ground rod to verify proper installation.

E. Installation of irrigation related equipment shall not damage, interfere, or restrict access to other systems located within the existing well house.

3.7 CLEAN UP

A. Remove all debris, boxes, wrappings, excess material, and equipment before final walk through and leave area in a clean and neat condition as good or better than before construction.

B. The Contractor will complete site restoration, including reestablishment of trenches and all disturbed areas, with seed mix as specified on the Drawings. If the season of the year does not permit viable seed establishment, then restoration will be completed with sod as approved.

C. Clean up and restoration will be done at Contractor’s expense.

END SECTION

SECTION 32 91 19 - LANDSCAPE GRADING, TOPSOIL, AND SOIL PREPARATION

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. This section covers all work necessary to furnish and place topsoil mixes, and general preparation of planting areas as denoted on the Drawings, including:

1. Soil preparation and testing
2. Fertilizing
3. Clean up.

B. All disturbed areas to receive soil preparation and specified landscape treatment (trees, shrubs, groundcover, grass seed mix, etc.) for establishment of permanent erosion control on all areas of the project site. Installation shall comply in all respects with these Specifications and the site Drawings. Site restoration of disturbed areas will be completed by the Contractor with specified seeding or as otherwise approved by the Owner, whether explicitly shown on the Drawings or not.

C. Furnish all labor, tools, equipment, material, transportation, and perform all operations necessary and incidental to proper execution and completion of all landscape installation work in accordance with the Drawings and Specifications.

D. Observe the conditions under which Work is to be performed and notify the Owner's Representative of unsatisfactory conditions. When conditions detrimental to plant growth are encountered, such as rubble, rock fill, utility conflicts, or adverse drainage conditions, notify the Owner's Representative before planting, adding soil amendments, and other soil work. Do not proceed with the work until unsatisfactory conditions have been corrected in a manner acceptable to the Owner.

E. Comply with governing regulations applicable to landscape materials.

1.2 RELATED REQUIREMENTS

A. Section 01 33 00 – Shop Drawings, Product Data, & Samples

B. Section 31 05 13 – Earthwork

C. Section 31 25 13 – Erosion Controls

D. Section 32 93 00 – Planting

1.3 SUBMITTALS

A. Provide certification that the following materials meet the specified requirements:

1. Compost amendment.
2. Soil fertility test results for imported topsoil with recommended soil additives (if any).

B. Quantity Certification: Provide certification of quantities of fertilizer, topsoil, and compost delivered to the site.

C. Submit any change in materials, equipment, or the design in writing to the Owner's representative for review and final approval.

D. Samples:

1. Submit duplicate samples and manufacturer's guaranteed analysis of the following items and submit other materials as may be required by the Owner's representative and obtain written approval thereof before beginning installation or delivery of materials to the project site. Finished work shall match approved samples.
   a. Soil additive conditioners (if required): 1/2 pound
   b. Imported topsoil: 1/2 pound
   c. Compost amendment with analysis report: 1/2 pound

1.4 QUALIFICATIONS

A. Installer: The Contractor installing work covered by this Specification section must be a state licensed and bonded Landscape Contractor. Contractor must be experienced in landscape work of best-accepted trade practices and have equipment and personnel adequate to perform the work specified.

1.5 QUALITY ASSURANCE

A. Comply with all governing regulations applicable to grading and soil work.

B. Protection:

1. Protect buildings, utilities, subgrade, site improvements, existing vegetation, fences, lighting, and underground irrigation systems during tiling and related soil work.
2. Protection of Work: Contractor is responsible for protecting all work during site construction.
3. Repair any item detailed above, not part of any demolition detail, damaged during construction to the approval of, and at no additional cost to, the Owner.

C. Field Superintendent – provide one person who shall:

1. Be present at all times during execution of work in this section;
2. Be familiar with the materials and best methods for installation; and
3. Direct work performed under this section.

D. Topsoil placement and soil preparation shall not take place during periods where saturated soil or surface water is present in work areas. Soil shall be in friable (workable) condition when placed. Work shall not take place when temperature is less than 32-degrees Fahrenheit or when frozen soil exists on site.

1.6 COORDINATION

A. Coordinate work with other trades.

B. Installation of irrigation system, if used, and other utilities.

C. It is the Landscape Contractor's responsibility to coordinate the performance of work in this Specification. Damage to existing systems, utilities, facilities, landscaping, or properties resulting from lack of coordination will be the Contractor's responsibility.

D. Protection of subgrade: Do not allow vehicles or equipment to pump or rut subgrade, stripped areas, footing excavations, or other areas prepared for the project. Protect subgrades, fills, and excavation areas from surface waters flowing into the work areas.

E. Coordinate the removal of grass and weeds for planting areas prior to Work in this Section.

1.7 PRE-INSTALLATION MEETINGS

A. Contractor shall coordinate pre-installation meeting.

B. Convene minimum one week prior to commencing work of this section. Minimum attendees shall be the Contractor's site superintendents, General Contractor's site superintendents, and the project's certified erosion control inspector. Pre-installation meeting may be coordinated with other work.

1.8 EXISTING UTILITIES

A. The Contractor will, at their expense, have all existing utilities located at job sites. Call Utilities Notification Center, (503) 232-1987.

B. The Contractor will protect any utilities that remain in place. Any located utilities damaged during construction will be repaired at the cost of the Contractor.

C. Locate and identify, with visible marking, existing underground utilities in the areas of work. If utilities are to remain in place, provide adequate means of protection during excavation operations.

D. If utilities not located are damaged during construction, the Contractor will comply and work with the utility company during the utility company's repairs.

E. Do not interrupt existing utilities or service facilities occupied and used by the Owner or others.

PART 2 - PRODUCTS

2.1 GENERAL

A. Native topsoil: Native (existing/stockpiled) topsoil shall be a natural friable soil and shall be reasonably free from subsoil, clay lumps, stone, or similar objects larger than 3/4-inch in greatest diameter, brush, stumps, roots, objectionable weeds or litter, growth or a hindrance to subsequent smooth grading and maintenance operations.

B. Imported topsoil: Imported topsoil shall be naturally friable; dark brown in color; pH range of 5.5 to 7.0, a minimum of 10%-30% organic material content (may include composted yard waste consisting of 100% recycled plant waste); free draining and free of stones or debris 3/4-inch or larger in any dimension and other extraneous materials harmful to plant growth. Sodium absorption ratio maximum 4.0.

C. Compost: Compost shall be a commercially manufactured material, medium grind, made from dead plant material such as grass clipping, green and dead dry leaves, garden and vegetable material, and ground branches of trees and shrubs. Furnish a product that is composted under controlled aerobic decomposition, with the internal temperature reaching 135-degrees Fahrenheit for 15 days, without exceeding 155-degrees Fahrenheit.

Ensure that it contains less than 10% bacteria and less than 10% fungus, is a mature compost, and does not contain detrimental components. If it contains more than 10% bacteria and/or fungus, it is not mature compost and will not be acceptable. Certification by testing will be required.

1. Compost Analysis: Have a Compost Foodweb Analysis test performed on a sample of the compost at a soil food web lab and submit a copy of the test results to the Owner for approval. The compost must meet the criteria of this section. The test must give resuls in the following categories:
   a. Active Bacterial Biomass
   b. Total Bacterial Biomass
   c. Active Fungal Biomass
   d. Total Fungal Biomass
   e. Hyphal Diameter
   f. Protozoa Numbers
   g. Total Nematode Numbers
2. An approved Soil Food Web Lab is:
   Soil Foodweb Inc.
   728 SW Wake Robin Ave
   Corvallis, OR 97332
   (541) 752-5066
3. Approved Material: City of Portland Leaf Compost Available through Sunderland Recycling Facility or approved equal.

D. Substitutions will only be allowed with written approval.

E. Provide fertilizer that meets the recommendations of the “Soil Fertility Test” as required by these Specifications.

2.2 SOIL ADDITIVES

A. Soil additives for correction of pH and trace elements deficiencies shall be in factory labeled containers and approved prior to application.

2.3 COMMERCIAL FERTILIZER

A. Provide fertilizer that meets the recommendations of the “Soil Fertility Test” as required in these Specifications.

2.4 EXAMINATION

A. Obtain a “Soil Fertility Test” for imported topsoil for areas to receive the Work of this Section. Test results will include recommendations for soil amendments and other particulars needed to sustain plant growth.

B. Verify prepared soil base is ready to receive the Work of this Section, including the removal of existing grass, weeds/ vegetation, gravels, etc. per these Specifications and as shown on the Drawings.

C. Saturate soil with water to test drainage.

D. Verify required underground utilities are available, in proper location, and ready for use.

2.5 SOIL FERTILITY TEST AND RECOMMENDATION

A. Obtain and submit soil samples to a qualified testing laboratory for a soil fertility test and recommendation report.

B. Imported Topsoil: Test and analyze imported topsoil to ascertain percentage of nitrogen, phosphorus, potash, soluble salt and organic matter, and pH Value. Provide recommendation for fertilizer and soil amendment application rates for specified planting as result of testing.

C. Testing is not required for imported topsoil when recent tests are available. Submit these test results to testing laboratory. Indicate, by test results, information necessary to determine suitability.

D. Submit the soil fertility test report(s) and laboratory recommendations for appropriate plant growth to the Owner's Representative for approval before beginning soil preparation work.

E. The cost for testing and the fertilizer and soil additives recommended by the tests is to be borne by the Contractor and is incidental to the soil preparation work.

PART 3 - EXECUTION

3.1 PREPARATION OF PLANTING AREAS

A. All areas shall be finish graded and approved by the Owner's Representative before commencement of planting. All areas shall allow for removal of gravels and undesirable/contaminated soils and placing planting soil amendments added to planting areas as specified. Sufficient topsoil (native soil, soil stockpiled and reused on site, and/or imported where necessary) shall be required for healthy plant growth in all new planting areas (refer also to Section 32 93 00 Planting and Drawings). All grades shall flow smoothly into one another and produce positive drainage. The Contractor is responsible for any adverse drainage conditions that may affect plant growth and architectural features unless the Contractor contacts the Owner's Representative immediately, indicating any possible problems.

B. Finish grading: Finish grade all planting areas by floating and hand raking to an acceptable smooth, even grade. Remove high points and fill low pockets to eliminate the possibility of standing water. Ensure all areas have positive drainage.

1. Slope all areas to prevent puddling and drain surface water toward catch basins, drains, curbs, or as shown on the Drawings.
2. Bring finished grade even with adjacent curbs, walks, and level with existing grades. Remove all rocks greater than 3/4-inch diameter from the top 4-inches of soil.
3. Soil in all areas shall be thoroughly settled, with a smooth surface free of humps and hollows, and shall be firm enough to resist undesirable impressions when stepped upon.

C. Lightly irrigate soil prior to seeding. Plants shall be watered after installation.

3.2 CLEAN UP

A. Pressure washing of concrete, masonry, and asphaltic paving: Any paved area or surfaces stained or soiled from landscaping materials having been hauled, carried, or spilled over or around it shall be cleaned with a power sweeper using water under pressure. Building surfaces shall be washed with proper equipment and materials as approved by the Owner.

B. At completion of work, remove all debris, equipment, and surplus materials from project site.

C. Leave project site in a neat and orderly condition.

D. Clean up and restoration will be done at Contractor's expense.

END SECTION

SECTION 32 93 00 - PLANTING

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Furnish all labor, tools, equipment, material, transportation, and perform all operations necessary and incidental to proper execution and completion of all planting work and landscape installation work in accordance with the Drawings and Specifications.

B. All planting work shall include lawn/seeded areas, shrubs, trees, groundcovers, and as shown in the Drawings and incidental to restoration of disturbed existing landscaping within the project area.

C. All disturbed existing lawn/turf areas, including irrigation trenches and areas disturbed by construction activity, to receive soil preparation and specified grass seed mix for complete restoration to pre-construction condition, whether expressly shown on the Drawings or not.

D. Comply with all governing regulations applicable to landscape materials.

1.2 RELATED REQUIREMENTS

A. Section 01 33 33 – Shop Drawings, Product Data, & Samples

B. Section 31 05 13 – Earthwork

C. Section 32 91 19 – Landscape Grading, Topsoil, and Soil Preparation

1.3 SUBMITTALS

A. Certified Confirmed Orders: Certify in writing to the Owner’s Representative within thirty (30) days of the award of the contract, confirmed orders for plants and provide the quantity, location, phone number and address of the grower who has agreed to provide any plant material. Should the Contractor neglect to provide this documentation within the allocated time, contractor may forfeit any substitution benefits.

B. Submit all substitution requests, including suggested equivalent plant material and reason for substitution request, to Owner’s Representative for approval.

C. Certificates: Certificates required by law shall accompany shipments. Upon completion of the installation, submit certificates to the Owner’s Representative.

D. Quantity Certification: Provide certification of quantities of mulch, fertilizer, herbicide, and planting accessories delivered to the site.

E. Topsoil soil test results with recommended soil additives per Section 32 91 19

F. Samples:

1. Submit duplicate samples and manufacturer’s guaranteed analysis of the following items and submit other materials as may be required by the Owner’s Representative and obtain written approval thereof before beginning installation or delivery of materials to the project site. Finished work shall match approved samples.

a. Soil additive conditioners (if required): 1/2 pound
b. Bark Mulch: 1/2 pound
c. Imported topsoil: 1/2 pound
d. Compost (soil amendment): 1/2 pound

G. Project Record Documents: Upon completion of work, submit neat and legible As-Built drawings as 'Record Drawings' indicating any changes from approved design.

1.4 QUALIFICATIONS

A. Installer: The Contractor installing work covered by this Specification section must be a state licensed and bonded Landscape Contractor. Contractor must be experienced in landscape work of best-accepted trade practices and have equipment and personnel adequate to perform the work specified. Contractor must be familiar and comply with the *American Standard for Nursery Stock* (ANSI Z60.1-2014 (or current edition) published by the American Horticulture Industry Association (AmericanHort) and other governing regulations applicable to landscape materials and their installation.

1.5 QUALITY ASSURANCE

A. Comply with all governing regulations applicable to landscape materials.

B. Tree pruning, if required, shall comply with ANSI A300 *Tree, Shrub, and other Woody Plant Management – Standard Practices (Pruning),* current edition.

C. Field Superintendent – provide one person who shall:

1. Be present at all times during execution of work in this section;
2. Be familiar with the materials and best methods for installation; and
3. Direct work performed under this section.

D. Government Inspection: All plants and planting material shall meet or exceed the specifications of federal, state, and local laws requiring inspection for plant disease and control.

E. Industry Standards: Quality definitions, size tolerances, root ball sizes, and caliper-to-height ratios shall be no less than minimums specified in *American Standard for Nursery Stock* published by the American Horticulture Industry Association ANSI Z60.1-2014 (or current edition). All plant materials shall be fully rooted, well-branched, evenly formed, and typical for their species, free from disease, pests, damage, or mechanical injury.

F. Acceptance: The Owner or their Representative reserves the right to reject any or all plant material at any time until final review and acceptance. Remove rejected plants immediately from site.

G. Certification: Produce upon request, sales receipts for all nursery stock and certificates of inspection from federal, state, and other authorities.

1.6 GUARANTEE

A. All plant materials shall be guaranteed to take root and grow and thrive for a period of 365-days after final acceptance of work. Contractor shall replace at no additional expense to the Owner, any plant material that fails to thrive during that period except in cases of gross neglect and vandalism.

1.7 CHANGE ORDERS AND SUBSTITUTIONS

A. The Contractor shall provide all plants of the size, species, variety, and quality noted and specified. If unavailable, the Contractor shall notify the Owner's Representative in writing immediately and provide the names and telephone numbers of five (5) nursery suppliers that they have contacted. If substitutions should be permitted, it can be made only with the prior written approval of the Owner.

1.8 PRE-INSTALLATION MEETINGS

A. Contractor shall coordinate pre-installation meeting.

B. Convene minimum one week prior to commencing work of this section. Minimum attendees shall be the Contractor's site superintendents, General Contractor's site superintendents, and the project's certified erosion control inspector. Pre-installation meeting may be coordinated with other work.

PART 2 - PRODUCTS

2.1 PLANT MATERIALS

A. Quantities: Plant materials shall be furnished in quantities required to complete work as indicated on the Drawings and shall be of species, kinds, sizes, etc. specified. If discrepancies occur, design intent of the Drawings prevails over quantities listed. Contractor shall be responsible for verifying plant and material quantities prior to bidding and construction.

B. Nomenclature: Plant names listed on the Drawings conform to those established by custom in the nursery trade.

2.2 QUALITY

A. Plants shall conform to current *American Standard for Nursery Stock*, in accordance with ANSI Z60.1 current edition, in all ways.

B. Plants shall be symmetrical and typical for variety and species.

C. Plants shall be nursery-grown under climatic conditions similar to those in the project area.

D. Plants shall be sound, healthy, vigorous, and free from plant disease, insect pests, or their eggs.

E. Container stock shall be grown in the containers in which delivered for at least eight (8) months but shall not be root bound.

F. Root balls of "balled and burlapped" (B&B) trees shall be grown under favorable growing conditions in the nursery, having received the proper cultural treatment to develop a well-branched root system and harvested with the ball of earth in which they are growing remaining intact. Root ball size shall be of a depth and diameter to encompass enough of the root system as necessary for the full recovery of the plant and the trunk of the tree shall be centered in the root ball. Refer to *American Standard for Nursery Stock* ANSI Z60.1.

G. Plants shall not be pruned prior to delivery, except as authorized by the Owner's Representative.

H. Protect plants in transit and after delivery to the project site. Plants in broken containers and plants with broken branches or injured trunks will be rejected. Remove rejected material from the site immediately.

2.3 INSPECTION

A. Right of inspection for approval or rejection is reserved at the place of growth and/or the project at any time upon delivery or during works. Plants may be inspected for size, variety, condition, and defects or injury.

B. Any additional required inspections caused by failure to assemble the required materials or rejection of plant material shall be paid for by the Contractor.

C. Certifications or inspections shall be furnished as may be required by city, county, or state authorities.

2.4 DIMENSIONS

A. Height and spread of screening materials are specified in the Drawings.

B. Container plants shall meet minimum size and soil volume standards per *American Standard for Nursery Stock* ANSI Z60.1.

2.5 GROUNDCOVER PLANTS

A. Groundcover plants, unless otherwise indicated on the Drawings, shall be rooted plants grown in containers.

2.6 FERTILIZERS AND SOIL CONDITIONERS

A. Materials delivery and storage: Manufactured materials shall be delivered in original container with brand and makers name marked thereon. Materials in broken containers or showing evidence of damage will be rejected and must be immediately removed from the site. Odorous material shall not be brought to the site until they are to be used.

B. Bark Mulch:

1. Planting Beds and Mulched Areas: Well-aged medium grind or shredded dark fir or hemlock mulch as specified on the Drawings.
2. Mulch shall not be placed in frequently inundated areas or in direct flow patterns to minimize migration of the mulch.

C. Peat: A natural residue formed by decomposition of reeds, sedges, or mosses from freshwater site, free from lumps, roots, and stone, absorbing at least four times its dry weight of water, organic matter not less than 90% on a dry weight basis. The maximum moisture content at time of delivery 65% by weight.

D. Rotted Sawdust: Minimum two (2) years old, color chocolate brown.

E. Sand: Clean, coarse, ungraded, meeting the following requirements:

Sieve Size in mm	Tyler Standard Sieve US Series Equiv No.	Percent Passing by Weight
4.5	4	100
2.0	10	95-100
1.0	16	85-100
0.5	30	50-70
0.25	60	0-30
0.10	140	0-10
0.07	200	0-5
0.01	270	0

F. Manure: Shredded, well-rotted, unleached stable or cattle manure, free from weed seed and refuse, containing no chemicals or materials harmful to plant life, not less than four (4) months nor more than two (2) years old. Sawdust or shavings shall not exceed 50% content of the manure.

G. Backfill Soil Mix for planting holes: 1 cubic yard organics; 1 cubic yard sand; 1 cubic yard sandy loam topsoil; controlled release fertilizer at manufacturers recommended application rate.

H. Fertilizer:

1. All fertilizers and soil conditioners shall be first quality, standard brand, agricultural products.
2. Trees and Shrubs: Controlled release fertilizer; 18-10-10-7 (N-P-K) with iron (resin coated). 18% nitrogen, 10% phosphoric acid, 10% potash, 7% sulfur or similar.
3. Lawns: Granular, pelleted, or liquid/flowable fertilizer; composition 20% nitrogen, 20% phosphorous, 10% potassium, and 3% iron, by weight or as recommended by turfgrass sod supplier.

I. Herbicides:

1. Initial Herbicides: Devrinol and manufactured by Stauffer Chemical Co., Romstar as manufactured by Chip Star or approved equals.
2. Herbicides that can be used after 6-months: Simazine “Princep” as manufactured by Geigy CO., “Round-Up” as manufactured by Monsanto Chemical Co. or approved equals.

2.7 TOPSOIL

A. Contractor shall remove existing gravels and contaminated and/or unsuitable soils in new planting areas within project work area.

B. Import new topsoil or use existing topsoil stockpiled on site where available to make up required amounts for installation.

C. Topsoil required; pH range of 5.5 to 7.0, a minimum of 10%-30% organic material content (may include composted yard waste consisting of 100% recycled plant waste), be dark brown in color, friable, free draining, free of stones or debris 3/4-inch or larger in any dimension and other extraneous materials harmful to plant growth. Sodium absorption ratio maximum 4.0.

D. Topsoil source: On-site topsoil or imported or manufactured soil void of roots, plants, sod, stones, clay lumps, alkali salts, and other extraneous material harmful to plant growth.

2.8 MISCELLANEOUS MATERIALS

A. Tree Stakes: 2" x 2" square or 2" diameter round S4S Douglas fir pressure treated tree stakes stained with Olympic Semi-transparent #916.

B. Tree support: 1" plastic chain or rigid guy with hose loop or approved equal.

C. All material incidental to the completing installation of plant material part of this scope of work.

PART 3 - EXECUTION

3.1 DELIVERY, STORAGE, AND HANDLING

A. Delivery: Notify the Owner's Representative of delivery schedule so plant materials may be inspected upon job site delivery. Remove unacceptable products immediately from job site.

B. Plant material damaged as a result of delivery, storage, or handling will be rejected.

C. Deliver fertilizer in waterproof bags showing weight, chemical analysis, and name of manufacturer.

D. Storage and Handling: Protect products against damage and dehydration. Store plants and materials in area dedicated for such purpose by the Owner's Representative. Do not impeded normal use of the site. Cover plant roots and root balls with soil or other accepted material upon job site delivery if not to be planted within 4-hours. Store plant material in light shade and protect against harmful weather until planted. Maintain plant materials not to be planted within 4-hours.

E. Turfgrass sod may be used in place of seeding depending on weather conditions with approval by the Owner's Representative. Sod, if used, shall be harvested, delivered, and installed/transplanted within a period of 24-hours, unless a suitable preservation method is approved prior to delivery. Turfgrass sod not transplanted within this period, or preserved by approved methods, shall be inspected, and approved by the Owner's Representative prior to its installation.

F. Bulk Materials:

1. Do not dump or store bulk materials near structures, utilities, walkways, and pavements, or on existing turf areas or plants.
2. Provide erosion-control measures to prevent erosion or displacement of bulk materials; discharge of soil-bearing water runoff; and airborne dust reaching adjacent properties, water conveyance systems, or walkways.
3. Accompany each delivery of bulk materials with appropriate certificates.

3.2 EXAMINATION

A. Examine areas to be planted for compliance with requirements and other conditions affecting installation and performance of the Work.

1. Verify that no foreign or deleterious material or liquid such as paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, rock fill, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, or acid has been deposited in soil within a planting area.
2. When conditions detrimental to plant growth are encountered, notify the Owner's Representative before planting or adding soil amendments. Do not proceed with the work until satisfactory conditions have been corrected in a manner acceptable to the Owner.
3. If contamination by foreign or deleterious material or liquid is present in the soil within a planting area, remove the soil and contaminations as directed by the Owner's Representative and replace with new planting soil. Contaminated soil shall be disposed of in accordance with applicable federal, state, and local jurisdictional requirements.

3.3 ENVIRONMENTAL REQUIREMENTS

A. Do not install plant material when ambient temperatures may drop below 35-degrees F or rise above 90-degrees F.

B. Do not install plant material when wind velocity exceeds 30-mph.

C. Do not install plant material in adverse drainage conditions.

D. Turfgrass sod, if used, shall not be installed if sod is dormant or if ground is frozen or muddy.

3.4 COORDINATION

A. Install plants after, and coordinate with, installation of any underground irrigation system piping and sprinkler heads, pavement, retaining walls, fencing materials, earthwork, and other site work.

3.5 PROTECTION

A. Verify location of underground utilities and facilities prior to doing work.

B. Protect structures, utilities, sidewalks, pavements, and other facilities, trees, shrubs, and plantings from damage caused by planting operations. Repair and make good any damage to services lines or improvements caused by planting operations at no additional cost to the Owner.

1. Protect grade stakes set by others until directed to remove them.
2. Install erosion-control measures to prevent erosion or displacement of soils and discharge of soil-bearing runoff or airborne dust to adjacent properties, and walkways.

3. If encountered, repair and/or replace existing irrigation components necessary to maintain full operation of the irrigation system to areas inside and outside of the project work area where it is affected by work completed as part of this scope. Coordinate with the Owner's Representative to test any existing irrigation system after repair work to ensure it is completed to the satisfaction of the Owner.

C. Protect all planted areas and plants against trespassing and damage at all times until date of final acceptance. If any plants are damaged, treat or replace as directed by the Owner's Representative, without additional cost to the Owner.

D. Contractor shall make, at the Contractor's expense, whatever arrangements are necessary to ensure an adequate supply of water to meet the needs of this contract. If an irrigation system is used, Contractor shall also furnish necessary hose, equipment, attachments, and accessories for the adequate irrigation of planting areas during planting and until irrigation system is fully operational, as may be required to protect plants in good condition. All costs of water incurred during the contract period shall be borne by the Contractor unless other arrangements are made with the Owner or utility purveyor. Water must be clean, fresh, and free of substances or matter capable of inhibiting vigorous plant growth.

3.6 PREPARATION

A. Do not install plant materials until all construction work has been completed and any irrigation systems have been installed and tested.

B. Grades: Meet the desired elevations next to all paving and curbs.

C. Soil shall be at an optimum moisture content for planting and be in friable (workable) condition. Soil shall not be worked when moisture content is so great that excessive compaction will occur, nor when it is so dry that dust will form in the air or that clots will not break readily. Water shall be applied, if necessary, to bring soil to an optimum moisture content for tilling and planting.

D. Soil loosening: Subgrade in all new planting areas shall be cultivated to 6" depth. Do not disturb root zones of existing trees to remain.

E. After topsoil has been completed and the soil water-settled, high, and low spots regraded, add soil amendments where required.

F. Turf Area Preparation:

1. Reduce elevation of planting soil bed as required to allow for soil thickness of sod (if used) or seed application (1/2" below adjacent pavement or as shown in the Drawings).
2. Moisten prepared planting bed area before planting if soil is dry. Water thoroughly and allow surface to dry before planting. Do not create muddy soil.
3. Before laying sod or applying seed, obtain Owner's Representative acceptance of finish grading. Restore planting areas if eroded or otherwise disturbed after finish grading.

G. All areas to be planted shall be cleaned of all weeds and debris prior to any soil preparation or grading work. Noxious weeds and grasses shall be removed by the roots wherever they are found at any stage of the work and disposed of offsite. Initially apply Devrinol or equal

as necessary to assure weed eradication and control in all new planting areas in accordance with manufacturer's printed instructions.

H. Tree Planting Holes:

1. Locate tree planting holes per Drawings, bringing any conflict with underground utilities and facilities to the attention of the Owner's Representative. Locations for holes shall be staked on the site and the Owner's Representative's approval thereof obtained prior to excavating planting holes.
2. Excavate holes to the sizes and depths indicated on the Drawings or as necessary to maintain soil level of plants as grown in the Nursery. Top of finished soil level shall not cover root crown/trunk flair of trees.
3. Clean topsoil may be used in backfill.
4. Scarify the sides and bottom of the planting holes.

3.7 INSTALLATION OF TOPSOIL

A. Areas to receive topsoil: all planting beds and lawn areas as described in the Drawings. New planting areas shall be excavated to a depth to reach free-draining subsoil free of contaminates, deleterious material, or other material harmful to plant growth.

B. Add soil conditioners as recommended by soil test to meet minimum soil requirements as indicated on the Drawings and Specifications.

C. Installation: In all new planting bed areas, loosen prepared subgrade 2" and place topsoil the minimum depth indicated on the Drawings. Spread in not more than 6" lifts, making sure soil is thoroughly integrated. Add 2" compost amendment and till to a depth of 8". Bring to a smooth even grade. Soil shall be thoroughly water-settled and high and low areas regraded to provide positive drainage and as indicated on the Drawings.

3.8 SOIL CONDITIONS

A. Finished grading: When weeding, soil preparation, and soil conditioning have been completed and soil has been thoroughly water-settled, all planting areas shall be smooth graded, ready for placement of plant materials.

B. Finished Grades shown on the Drawings: Slope uniformly between given spot elevations.

1. Mulch areas: Finished grades shall be 2" below top of adjacent pavement, curbs or walls unless otherwise indicated on the Drawings to allow for mulch application.
2. Lawn areas: Finished grades shall be 1/2" below top of adjacent pavement curbs or walls unless otherwise indicated on the Drawings.

3.9 WEED CONTROL

A. Apply initial pre-emergence herbicide to all mulch areas in accordance with the manufacturer's recommended rates.

3.10 MULCHING

A. Install a 3" deep mulch layer over all planting beds and mulch areas, except where lawn areas occur or in frequently inundated areas or in direct flow patterns to minimize migration of the mulch.

3.11 TREE STAKING

A. Set stakes plumb and in such a way as to limit obstruction to vehicular or pedestrian movement. Securely tie trunks to stakes as detailed or as recommended by tie manufacturer.

3.12 GENERAL CLEAN UP

A. Construction site shall be kept free of debris, excess dirt, etc. during construction to the maximum extent practicable.

B. Remove all cans, surplus materials, and other construction debris from site. Neatly dress and finish all planting areas. Flush walks, paved areas, and the like clean to the satisfaction of the Owner’s representative.

C. Rinse foliage of all plant materials within the construction area as often as necessary to keep the foliage free of dust from work of this contract. Remove tags and nursery labels from plant material.

END SECTION

MANHOLES AND STRUCTURES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Modular precast concrete manhole and structures with tongue-and-groove joints, frame, covers, anchorage, and accessories.
   2. Bedding and cover materials.
   3. Raising manhole frames and covers.
   4. Replacing manhole frames and covers.

B. Related Sections:
   1. Section 01 33 00 – Shop Drawings, Product Data, & Samples
   2. Section 01 45 00 – Contractor's Quality Control Program
   3. Section 01 60 00 – Materials & Equipment
   4. Section 01 77 00 – Contract Closeout
   5. Section 01 82 00 – Project Record Documents
   6. Section 31 05 13 – Earthwork
   7. Section 32 12 16 – Asphalt Paving.
   8. Section 33 31 00 – Sanitary Utility Sewerage Piping
   9. Section 33 41 00 – Storm Utility Drainage Piping.

1.2 REFERENCES

A. American Concrete Institute:
   1. ACI 318 - Building Code Requirements for Structural Concrete.

B. ASTM International:
   1. ASTM A48/A48M - Standard Specification for Gray Iron Castings.
   2. ASTM C478 - Standard Specification for Precast Reinforced Concrete Manhole Sections.
   3. ASTM C497 - Standard Test Methods for Concrete Pipe, Manhole Sections, or Tile.
   4. ASTM C923 - Standard Specification for Resilient Connectors between Reinforced Concrete Manhole Structures, Pipes and Laterals.
   5. ASTM C990 - Standard Specification for Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants.
   6. ASTM F593 - Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.
   7. ASTM F1554 - Standard Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength.

1.3 DESIGN REQUIREMENTS

A. Equivalent strength: Based on structural design of reinforced concrete as outlined in ACI 318.

B. Design of Lifting Devices for Precast Components: In accordance with ASTM C913.

C. Design of Joints for Precast Components: In accordance with ASTM C913; maximum leakage of 0.025 gallons per hour per foot of joint at 3 feet of head.

1.4 SUBMITTALS

A. Section 01 33 00 – Shop Drawings, Product Data, & Samples: Requirements for submittals.

B. Shop Drawings: Indicate manhole and structure locations, rim elevations, piping sizes, angles of entry/exit, and invert elevations of penetrations.

C. Product Data: Submit cover and frame construction, features, configuration, dimensions.

D. Manufacturer's Certificate: Certify Products meet or exceed specified requirements.

1.5 CLOSEOUT SUBMITTALS

A. Section 01 77 00 - Contract Closeout: Requirements for submittals.

B. Section 01 82 00 - Project Record Documents: Record actual grade adjustment elevation of manhole.

C. Provide manufacturer warranty information.

1.6 QUALITY ASSURANCE

A. **All Work in the public rights of way or easements dedicated to the public shall be in accordance with the local Governing Authority having Jurisdiction**

B. Maintain one copy of each document on site.

1.7 DELIVERY, STORAGE AND HANDLING

A. Section 01 60 00 - Materials & Equipment: Requirements for transporting, handling, storing, and protecting products.

B. Accept materials on site in undamaged, unopened container, bearing manufacturer’s original labels. Inspect for damage.

C. Comply with precast concrete manufacturer’s instructions for unloading, storing and moving precast manholes and structures.

D. Store precast concrete manholes and structures to prevent damage to Owner’s property or other public or private property. Repair property damaged from materials storage.

E. Mark each precast structure by indentation or waterproof paint showing date of manufacture, manufacturer, and identifying symbols and numbers shown on Drawings to indicate its intended use.

1.8 FIELD MEASUREMENTS

A. Verify field measurements prior to fabrication.

PART 2 - PRODUCTS

2.1 MANHOLES AND STRUCTURES

A. Manhole Sections: Reinforced precast concrete manhole sections and integral steps in accordance with ASTM C478, with gaskets in accordance with ASTM C923. Minimum wall thickness four inches. Provide eccentric cones or flat top sections where necessary. All materials to be H20 rated.

B. Mortar: Standard pre-mix mortar conforming to ASTM C387, Type N.

2.2 FRAMES AND COVERS

A. Product Description: ASTM A48/A48M, Class 30B Cast iron construction, machined flat bearing surface, removable or lockable or boltable lid, of the size and shape detailed on the drawings with load rating of H20.

2.3 COMPONENTS

A. Manhole and Structure Steps: As indicated on Drawings.

B. Base Pad: As indicated on Drawings.

C. Manhole Steps: Copolymer polypropylene encapsulated steel bars.

2.4 CONFIGURATION

A. Shaft Construction: Concentric with eccentric cone top section; lipped male/female joints; sleeved to receive pipe.

B. Shape: Cylindrical

C. Clear Inside Dimensions: As indicated on Drawings.

D. Design Depth: As indicated on Drawings.

E. Clear Cover Opening: As indicated on Drawings.

F. Pipe and Conduit Entry: Furnish openings as indicated on Drawings.

G. Steps: As indicated on Drawings. Positioned so as not to interfere with pipe penetrations

2.5 BEDDING AND COVER MATERIALS

A. Bedding: Fill Type as specified in Section 31 05 13.

B. Cover: Fill Type, as specified in Section 31 05 13.

C. Soil Backfill from Above Pipe to Finish Grade: Soil Type as specified in Section 31 05 13

PART 3 - EXECUTION

3.1 EXAMINATION

A. Contractor shall coordinate verification of existing conditions before starting work.

B. Verify items provided by other sections of Work are properly sized and located.

C. Verify built-in items are in proper location, and ready for roughing into Work.

D. Verify correct size of manhole and structure excavation.

E. Verify and locate manholes requiring grade adjustment.

3.2 PREPARATION

A. Coordinate placement of inlet and outlet pipe or duct sleeves required by other sections.

B. Do not install structures where site conditions induce loads exceeding structural capacity of structures.

C. Inspect precast concrete structures immediately prior to placement in excavation to verify structures are internally clean and free from damage. Remove and replace damaged units.

3.3 INSTALLATION

A. Excavation and Backfill:

1. Excavate for manholes [and structures] in accordance with Section 31 05 13 in location and to depth shown. Provide clearance around sidewalls of structure for construction operations.
2. When groundwater is encountered, prevent accumulation of water in excavations. Place manholes and structures in dry trench.
3. Where possibility exists of watertight structure becoming buoyant in flooded excavation, anchor structure to avoid flotation.

B. Place base pad, smooth top surface level.

C. Install manholes and structures plumb and level, supported at proper grade and alignment on crushed stone bedding as shown on Drawings.

D. Backfill excavations for manholes and structures in accordance with Section 31 05 13.

E. Cut and fit for pipe.

F. Grout base of shaft sections to achieve slope to exit piping. Trowel smooth. Contour to form continuous drainage channel as indicated on Drawings.

G. Set cover frames and covers level without tipping, to correct elevations.

H. Coordinate with other sections of Work to provide correct size, shape, and location.

3.4 PRECAST CONCRETE MANHOLE AND STRUCTURE INSTALLATION

A. Lift precast components at lifting points designated by manufacturer.

B. When lowering manholes and structures into excavations and joining pipe to units, take precautions to ensure interior of pipeline and structure remains clean.

C. Set precast structures bearing firmly and fully on crushed stone bedding, compacted in accordance with provisions of Section 31 05 13 or on other support system shown on Drawings.

D. Assemble multi-section structures by lowering each section into excavation. Lower, set level, and firmly position base section before placing additional sections.

E. Remove foreign materials from joint surfaces and verify sealing materials are placed properly. Maintain alignment between sections by using guide devices affixed to lower section.
F. Joint sealing materials may be installed on site or at manufacturer's plant.
G. Verify manholes and structures installed satisfy required alignment and grade.
H. Remove knockouts or cut structure to receive piping without creating openings larger than required to receive pipe. Fill annular space with mortar.
I. Cut pipe to finish flush with interior of structure.
J. Shape inverts through manhole and structures as shown on Drawings.

3.5 FRAME AND COVER INSTALLATION

A. Set frames without tipping using non-shrink and grout. Set frame and cover 2 inches above finished grade for manholes and structures with covers located within unpaved areas to allow area to be graded away from cover beginning 1 inch below top surface of frame. Set frames flush with finished grades when located in pavement or other hard surface areas.

3.6 RAISING MANHOLE FRAMES AND COVERS

A. Locate and raise manholes to grade as indicated on Drawings.
B. Seal joints between manhole top and frame with sealant.
C. Reinstall removed manhole frame and cover.

3.7 RESTORATION

A. Restore bituminous paving areas in accordance with Section 32 12 16. Restore grassed areas in accordance with Section 32 93 00.

3.8 FIELD QUALITY CONTROL

A. Section 01 45 00 - Contractor's Quality Control Program, 01 77 00 - Contract Closeout: Field inspecting, testing, adjusting, and balancing.
B. Vertical Adjustment of Existing Manholes and Structures:
    1. Where required, adjust top elevation of existing manholes and structures to finished grades shown on Drawings.
    2. Reset existing frames, grates and covers, carefully removed, cleaned of mortar fragments, to required elevation in accordance with requirements specified for installation of castings.

END OF SECTION

SITE WATER UTILITY DISTRIBUTION PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Pipe and fittings for site water line including domestic water line and fire water line.
2. Pipe and fittings for domestic water service connections to buildings.
3. Valves & Valve Boxes.
4. Fire Hydrants.
5. Backflow preventers.
6. Underground pipe markers.
7. Precast concrete vault.
8. Bedding and cover materials.
9. Disinfection of potable water distribution system; and testing and reporting results.

B. Related Sections:
1. Section 01 33 00 – Shop Drawings, Product Data, & Samples.
2. Section 01 45 00 – Contractor's Quality Control Program.
3. Section 01 60 00 –Materials & Equipment.
4. Section 01 82 00 – Project Record Documents
5. Section 01 77 00 – Contract Closeout.
6. Section 31 05 13 – Earthwork.
7. Section 33 05 13 – Manholes and Structures.
8. Section 32 84 00 – Irrigation System.

1.2 REFERENCES

A. American Society of Mechanical Engineers:
1. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings.
2. ASME B16.22 - Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.

B. American Society of Sanitary Engineering:
1. ASSE 1012 - Backflow Preventer with Intermediate Atmospheric Vent.
2. ASSE 1013 - Reduced Pressure Principle Backflow Preventers.

C. ASTM International:
1. ASTM B88 - Standard Specification for Seamless Copper Water Tube.
2. ASTM C858 - Standard Specification for Underground Precast Concrete Utility Structures.
3. ASTM D1557 - Standard Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3).
4. ASTM D1785 - Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120.
5. ASTM D2241 - Standard Specification for Poly (Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series).

6. ASTM D2466 - Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40.
7. ASTM D2855 - Standard Practice for Making Solvent-Cemented Joints with Poly (Vinyl Chloride) (PVC) Pipe and Fittings.
8. ASTM D2922 - Standard Test Method for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).
9. ASTM D3017 - Standard Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth).
10. ASTM D3035 - Standard Specification for Polyethylene (PE) Plastic Pipe (DR-PR) Based on Controlled Outside Diameter.
11. ASTM D3139 - Standard Specification for Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals.

D. American Water Works Association:
1. AWWA C104 - American National Standard for Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water.
2. AWWA C111 - American National Standard for Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
3. AWWA C151 - American National Standard for Ductile-Iron Pipe, Centrifugally Cast, for Water.
4. AWWA C500 - Metal-Seated Gate Valves for Water Supply Service.
5. AWWA C502 - Dry-Barrel Fire Hydrants.
6. AWWA C504 - Rubber-Sealed Butterfly Valves.
7. AWWA C508 - Swing-Check Valves for Waterworks Service, 2 in. (50 mm) Through 24 in. (600 mm) NPS.
8. AWWA C509 - Resilient-Seated Gate Valves for Water-Supply Service.
9. AWWA C550 - Protecting Epoxy Interior Coating for Valves and Hydrants.
10. AWWA C600 - Installation of Ductile-Iron Water Mains and Their Appurtenances.
11. AWWA C651 - Disinfecting Water Mains.
12. AWWA C706 - Direct-Reading, Remote-Registration Systems for Cold-Water Meters.
13. AWWA C900 - Polyvinyl Chloride (PVC) Pressure Pipe, 4 in. through 12 in., for Water Distribution.
14. AWWA C901 - Polyethylene (PE) Pressure Pipe and Tubing, 1/2 in. through 3 in., for Water Service.

E. Underwriters Laboratories Inc.:
1. UL 246 - Hydrants for Fire - Protection Service.

F. National Fire Protection Association:
1. NFPA 281 - Recommended Practice for Fire Flow Testing and Marking of Hydrants

1.3 SUBMITTALS

A. Section 01 33 00 – Shop Drawings, Product Data, & Samples: Requirements for submittals.

B. Product Data: Submit data on pipe materials, pipe fittings, valves and accessories. Submit procedures, proposed chemicals, and treatment levels for disinfection for review.

C. Test Reports: Indicate results comparative to specified requirements.

D. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

E. Certificate: Certify cleanliness of water distribution system meets or exceeds Governing Authority having Jurisdiction.

1.4 CLOSEOUT SUBMITTALS

A. Section 01 77 00 - Contract Closeout: Requirements for submittals.

B. Section 01 82 00 - Project Record Documents: Record actual locations of piping mains, valves, connections, thrust restraints, and invert elevations.

C. Identify and describe unexpected variations to subsoil conditions or discovery of uncharted utilities.

D. Disinfection Report:
1. Type and form of disinfectant used.
2. Date and time of disinfectant injection start and time of completion.
3. Test locations.
4. Name of person collecting samples.
5. Initial and 24-hour disinfectant residuals in treated water in ppm for each outlet tested.
6. Date and time of flushing start and completion.
7. Disinfectant residual after flushing in ppm for each outlet tested.

E. Bacteriological Report:
1. Date issued, project name, and testing laboratory name, address, and telephone number.
2. Time and date of water sample collection.
3. Name of person collecting samples.
4. Test locations.
5. Initial and 24-hour disinfectant residuals in ppm for each outlet tested.
6. Coliform bacteria test results for each outlet tested.
7. Certify water conforms, or fails to conform, to bacterial standards of Governing Authority having Jurisdiction.

F. Water Quality Certificate: Certify water conforms to quality standards of Governing Authority having Jurisdiction, suitable for human consumption.

G. Provide manufacturer warranty information.

1.5 QUALITY ASSURANCE

A. **All Work in the public rights of way or easements dedicated to the public shall be in accordance with the local Governing Authority having Jurisdiction.**

B. Perform Work in accordance with AWWA C651, Governing Authority having Jurisdiction, the Oregon Plumbing Specialty Code and Uniform Fire Code.

C. Maintain one copy of each document on site.

D. Valves: Manufacturer's name and pressure rating marked on valve body.

1.6 QUALIFICATIONS

A. Water Treatment Firm: Company specializing in disinfecting potable water systems specified in this section with minimum three years documented experience.

B. Testing Firm: Company specializing in testing potable water systems, certified approved by State of Oregon.

C. Submit bacteriologist's signature and authority associated with testing.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Section 01 60 00 - Materials & Equipment: Requirements for transporting, handling, storing, and protecting products.

B. Deliver and store valves in shipping containers with labeling in place.

PART 2 - PRODUCTS

2.1 GENERAL

A. All water pipe in the public right of way or easement prior to backflow device, shall be in accordance with the Governing Authority having Jurisdiction.

B. All water pipe on private property after the backflow device, shall be in accordance with the Oregon Plumbing Specialty Code and the Uniform Fire Code.

2.2 WATER PIPING

A. Ductile Iron Pipe: AWWA C151, C104 CL 51
   1. Fittings: Ductile iron, CL 51.
   2. Joints: AWWA C111, rubber gasket with rods.

B. PVC Pipe: (Private domestic service) ASTM D1785, Schedule 40, Schedule 80:

1. Fittings: ASTM D2466, PVC.
2. Joints: ASTM D2855, solvent weld.

C. PVC Pipe: (Private lines 4" and larger) AWWA C900 DR 18:
1. Fittings: AWWA C111, cast iron.
2. Joints: ASTM D3139 compression gasket ring.

D. Restrained Joint Pipe: Restrained joint pipe and fittings, use a mechanical joint with a MEGALUG follower gland as manufactured by EBAA Iron Corporation, or equal. Other acceptable restrained joints are "Loc-Tyte" joint as manufactured by the Pacific States Cast Iron Pipe Company and the United States and Foundry Company, the "Locked Fastite" joint as manufactured by the American Cast Iron Company, the "TR Flex" joint as manufactured by the United States Pipe and Foundary Company, the "Snap-Lok" joint as manufactured by the Griffin Pipe Products Co., the "Field-Lok", joint as manufactured by the United States Pipe and Foundry Company. Set screw-type retainer gland and joint harness systems will not be allowed.

2.3 GATE VALVES

A. 2-1/2 inches and Smaller: Brass or Bronze body, non-rising stem, inside screw, single wedge or disc, compression ends, with control rod, extension box and valve key.

B. 3 inches and Larger: AWWA C500, Iron body, bronze trim, non-rising stem with square nut, single wedge, flanged or mechanical joint ends, control rod, extension box and valve key.

2.4 SWING CHECK VALVES

A. 2 inches to 24 inches: AWWA C508, iron body, bronze trim, 45-degree swing disc, renewable disc and seat, flanged ends.

2.5 BUTTERFLY VALVES

A. 2 inches to 24 inches: AWWA C504, iron body, bronze disc, resilient replaceable seat, water or lug ends, infinite position lever handle.

2.6 HYDRANT

A. Hydrant: In accordance with local fire department and/or Governing Authority having Jurisdiction requirements.
1. Meet AWWA C502 specifications.
2. Have 6-inch flanged joint inlet.
3. Have one 4½-inch pumper connection and two 2½-inch connections with ANSI B26 standard threads.
4. Have "O" ring seals on operating stem.
5. Operating stem nut dimensions conforming to the Governing Authority having Jurisdiction and/or Tualatin Valley Fire & Rescue.
6. Have break-off joint located approximately 2-inches above ground surface.

7. Have drain hole in base.
8. Open counterclockwise

B. Hydrant Extensions: Fabricate in multiples of 6 inches with rod and coupling to increase barrel length.

C. Hose and Streamer Connection: Match sizes and type of thread with local fire department two hose nozzles one pumper nozzle.

D. Finish: Primer and two coats of enamel color in accordance with Governing Authority having Jurisdiction and/or fire department requirements.

2.7 WATER METERS

A. Coordinate with Governing Authority having Jurisdiction.

2.8 BACKFLOW PREVENTERS

A. Double Check Valves (DCV): Comply with ASSE 1015; Bronze body with corrosion resistant internal parts and stainless-steel springs; two independently operating check valves with intermediate atmospheric vent, Watts, Conbraco, Febco, or approved equal:

B. Furnish materials in accordance with Oregon Plumbing Specialty Code.

2.9 UNDERGROUND PIPE MARKERS

A. Trace Wire: Magnetic detectable conductor, clear, brightly colored, plastic covering, imprinted with "Water Service" in large letters Brimar or approved.

2.10 PRECAST CONCRETE VAULT

A. Utility Vault or approved equal.

B. Furnish materials in accordance with Governing Authority having Jurisdiction standards.

C. Product Description: Precast vault designed in accordance with ASTM C858, comprising modular, interlocking sections complete with accessories.

D. Shape & size: As indicated on Drawings.

E. Frames and Covers: As indicated on Drawings

F. Pipe Entry Locations: As indicated on Drawings.

G. Steps: As indicated on Drawings.

2.11 BEDDING AND COVER MATERIALS

A. Bedding: Fill Type as specified in Section 31 05 13

B. Cover: Fill Type as specified in Section 31 05 13

2.12 ACCESSORIES

A. Valve Boxes: 2 piece sliding cast iron, cover to be cast with “W” in lid.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Contractor shall coordinate verification of existing conditions before starting work.

B. Verify building service connection and municipal utility water main size, location, and invert are as indicated on Drawings.

C. Verify piping system has been cleaned, inspected, and pressure tested.

D. Perform scheduling and disinfecting activity with start-up, water pressure testing, adjusting and balancing, demonstration procedures, including coordination with related systems.

3.2 PREPARATION

A. Cut pipe ends square, ream pipe and tube ends to full pipe diameter, remove burrs.

B. Remove scale and dirt on inside and outside before assembly.

C. Prepare pipe connections to equipment with flanges or unions.

3.3 BEDDING

A. Excavate pipe trench in accordance with Section 31 05 13 for Work of this Section.

B. Form and place concrete for pipe thrust restraints at change of pipe direction. Place concrete to permit full access to pipe and pipe accessories. Provide sq ft area thrust restraint bearing on subsoil as indicated on the drawings.

C. Place bedding material at trench bottom, level fill materials in one continuous layer not exceeding 8 inches compacted depth; compact to in accordance with Section 31 05 13.

D. Backfill around sides and to top of pipe in accordance with Section 31 05 13.

E. Maintain optimum moisture content of fill material to attain required compaction density.

3.4 INSTALLATION - PIPE

A. Maintain separation of water main from sewer in accordance with Governing Authority having Jurisdiction.

B. Group piping with other site piping work whenever practical.

C. Install pipe to indicated elevation to within tolerance of 5/8 inches.

D. Install ductile iron piping and fittings to AWWA C600.

E. Route pipe in straight line.

F. Install pipe to allow for expansion and contraction without stressing pipe or joints. Excavate for pipe bells to provide uniform support along its full length.

G. Form and place concrete for thrust restraints at each elbow or change of direction of pipe main.

H. Establish elevations of buried piping with not less than 3 ft of cover or as shown on drawings.

I. Install access fittings to permit disinfection of water system.

J. Install trace wire continuous over top of pipe buried above pipe line; coordinate with Section 31 05 13.

K. Backfill trench in accordance with Section 31 05 13.

3.5 INSTALLATION - VALVES AND HYDRANTS

A. Set valves on solid bearing soil.

B. Center and plumb valve box over valve. Set box cover flush with finished grade.

C. Set hydrants plumb; locate pumper nozzle perpendicular to and facing roadway.

D. Set hydrants to grade, with nozzles above ground as shown on drawings.

E. Locate control valve away from hydrant as shown on drawings.

3.6 INSTALLATION - METERS

A. Coordinate with Governing Authority having Jurisdiction.

3.7 SERVICE CONNECTIONS

A. Install water service to 5 feet of building. Coordinate with building plumbing and fire sprinkler contractors.

3.8 DISINFECTION OF DOMESTIC WATER PIPING SYSTEM

A. Provide and attach required equipment to perform the Work of this section.

B. Inject treatment disinfectant into piping system.

C. Maintain disinfectant in system for time period as required.

D. Flush, circulate, and clean until required cleanliness is achieved, use municipal domestic water.

E. Replace permanent system devices removed for disinfection.

3.9 FIELD QUALITY CONTROL

A. Section 01 45 00 - Contractor's Quality Control Program and 01 77 00 - Contract Closeout: Field inspecting, testing, adjusting, and balancing.

B. Perform pressure test on domestic site water distribution system in accordance with AWWA C600 and Governing Authority having Jurisdiction

OR

C. Perform pressure test on domestic site water distribution system in accordance with Oregon Plumbing Specialty Code, AWWA 600, AWWA 605 and/or the Governing Authority having Jurisdiction whichever is more stringent. Repair leaks and retest. In general pressure testing shall be as follows:

1. After completion of pipeline installation, including backfill, but prior to final connection to existing system, conduct, in presence of Architect/Engineer, concurrent hydrostatic pressure and leakage tests in accordance with AWWA C600.
2. Provide equipment required to perform leakage and hydrostatic pressure tests.
3. Test Pressure: Not less than 200 psi or 50 psi in excess of maximum static pressure, whichever is greater.
4. Conduct hydrostatic test for at least two-hour duration.
5. No pipeline installation will be approved when pressure varies by more than 5 psi at completion of hydrostatic pressure test.
6. Before applying test pressure, completely expel air from section of piping under test. Provide corporation cocks so air can be expelled as pipeline is filled with water. After air has been expelled, close corporation cocks and apply test pressure. At conclusion of tests, remove corporation cocks and plug resulting piping openings.
7. Slowly bring piping to test pressure and allow system to stabilize prior to conducting leakage test. Do not open or close valves at differential pressures above rated pressure.
8. Examine exposed piping, fittings, valves, hydrants, and joints carefully during hydrostatic pressure test. Repair or replace damage or defective pipe, fittings, valves, hydrants, or joints discovered, following pressure test.
9. No pipeline installation will be approved when leakage is greater than that determined by the following formula:

$L = (SD\sqrt{P})/133{,}200$
L = allowable, in gallons per hour

S = length of pipe tested, in inches
D = nominal diameter of pipe, in inches
p = average test pressure during leakage test, in pounds per square inch (gauge)

10. When leakage exceeds specified acceptable rate, locate source and make repairs. Repeat test until specified leakage requirements are met.

D. Compaction Testing for Bedding: In accordance with ASTM D1557, ASTM D2922, and ASTM D3017.

E. When tests indicate Work does not meet specified requirements, remove Work, replace and retest.

F. Disinfection, Flushing, and Sampling:
1. Disinfect pipeline installation in accordance with AWWA C651. Use of liquid chlorine is not permitted
2. Upon completion of retention period required for disinfection, flush pipeline until chlorine concentration in water leaving pipeline is no higher than that generally prevailing in existing system or is acceptable for domestic use.
3. Legally dispose of chlorinated water. When chlorinated discharge may cause damage to environment, apply neutralizing chemical to chlorinated water to neutralize chlorine residual remaining in water.
4. After final flushing and before pipeline is connected to existing system, or placed in service, employ an approved independent testing laboratory to sample, test and certify water quality suitable for human consumption.

END OF SECTION

SANITARY UTILTY SEWERAGE PIPING

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
1. Sanitary sewage pipe.
2. Underground pipe markers.
3. Manholes and cleanouts.
4. Bedding and cover materials.
5. Pipeline flushing and cleaning.
6. TV inspection of sewer pipelines.
7. Audio-video taping of pipeline interior.

B. Related Sections:
1. Section 31 05 13 - Soils for Earthwork: Soils for backfill in trenches. Aggregates for Earthwork: Aggregate for backfill in trenches. Excavation: Product and execution requirements for excavation and backfill required by this section. Excavation: Product and execution requirements for excavation and backfill required by this section. Trenching: Execution requirements for trenching required by this section. Fill: Requirements for backfill to be placed by this section.
2. Section 01 33 00 – Shop Drawings, Product Data, & Samples.
3. Section 01 45 00 – Contractor's Quality Control Program.
4. Section 01 60 00 – Materials and Equipment
5. Section 01 82 00 – Project Record Documents
6. Section 01 78 00 – Contract Closeout.

1.2 REFERENCES

A. ASTM International:
1. ASTM A746 - Standard Specification for Ductile Iron Gravity Sewer Pipe.
2. ASTM D1557 - Standard Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3).
3. ASTM D2321 - Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications.
4. ASTM D2729 - Standard Specification for Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings.
5. ASTM D2751 - Standard Specification for Acrylonitrile-Butadiene-Styrene (ABS) Sewer Pipe and Fittings.
6. ASTM D2922 - Standard Test Method for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).
7. ASTM D3017 - Standard Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth).
8. ASTM D3034 - Standard Specification for Type PSM Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings.
9. ASTM F477 - Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe.

1.3 DEFINITIONS

A. Bedding: Fill placed under, beside and directly over pipe, prior to subsequent backfill operations.

1.4 SUBMITTALS

A. Section 01 33 00 – Shop Drawings, Product Data, & Samples: Requirements for submittals.

B. Product Data: Submit data indicating pipe material used and pipe accessories

C. Where required by the Administrative Authority having jurisdiction, submit completed tape cassettes, cd, dvd or digital files, identified by number, project name, street name, right-of-way property name, and manhole numbers. Video files become the property of Owner.

D. Submit cleaning and television inspection logs for each section of sewer line to be rehabilitated and three copies of color videotapes, cd, dvd or digital files for work performed. Include the following as minimum information: stationing and location of lateral services, wyes or tees, clock references, pipe joints, infiltration/inflow defects, cracks, leaks, offset joints, and other information required to assess condition of sewer.

E. Submit a specific detailed description of proposed bypass pumping system to include written description of plan and addressing quantity, capacity, and location of pumping equipment. Submit spill plan to address any spills that might occur.

F. Manufacturer's Installation Instructions: Indicate special procedures required to install Products specified.

G. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

1.5 CLOSEOUT SUBMITTALS

A. Section 01 78 00 – Closeout Submittals: Requirements for submittals.

B. Section 01 82 00 - Project Record Documents: Record location of pipe runs, bends, connections, manholes, cleanouts, and invert elevations.

C. Identify and describe unexpected variations to subsoil conditions or discovery of uncharted utilities.

D. Provide manufacturer warranty information.

1.6 QUALITY ASSURANCE

A. **All Work in the public rights of way or easements dedicated to the public shall be in accordance with the local Governing Authority having Jurisdiction.**

B. All Work outside public rights of way shall conform to Oregon Plumbing Specialty Code for materials and installation of the Work of this section.

C. Use cameras with video output capable of producing minimum of 600 lines of horizontal resolution at center; optimum imagery with minimum illumination; and meet requirements of EIA Standard Video Signal.

D. Maintain one copy of each document on site.

1.7 FIELD MEASUREMENTS

A. Verify field measurements and elevations are as indicated.

1.8 COORDINATION

A. Contractor shall coordinate project conditions.

B. Coordinate work with Owner and Administrative Authority having jurisdiction and other contractor's work.

C. Coordinate the Work with termination of sanitary sewer connection outside building, connection to municipal sewer utility service and trenching.

PART 2 - PRODUCTS

2.1 SANITARY SEWAGE PIPE

A. Ductile Iron Pipe: ASTM A746, Extra Heavy Service type, inside nominal diameter as indicated on the drawings, bell and spigot ends.
1. Fittings: Ductile iron.
2. Joints: AWWA C111, rubber gasket joint devices.

B. Plastic Pipe: ASTM D3034, Type PSM, Poly (Vinyl Chloride) (PVC) material; inside nominal diameter as indicated on the drawings, bell and spigot style rubber ring sealed gasket joint.
1. Fittings: PVC.
2. Joints: ASTM F477, elastomeric gaskets.

2.2 ACCESSORIES:

A. Fittings: Same material as pipe molded or formed to suit pipe size and end design, in required tee, bends, elbows, clean-outs, reducers, traps and other configurations required.

B. Trace Wire: Magnetic detectable conductor, clear, brightly colored plastic covering, imprinted with "Sewer Service" in large letters. Brimar or approved equal.

2.3 MANHOLES

A. Shaft Construction: Reinforced precast concrete sections as shown in the drawings

B. Manhole Lid and Frame:
   1. Cast iron construction, as shown on the drawings.

C. Construction and Concentric/Eccentric Cone Top Section: Reinforced precast concrete sections, lipped male/female dry joints, ladder rungs into shaft sections at 12 inches; nominal manhole diameter of 48 inches or as shown on the drawings.

D. Base Pad: Cast-In-Place concrete for connection to existing sewer mains, precast sleeved to receive sewer pipe sections for connection to new sewer mains.

2.4 CLEANOUTS

A. Cleanout Lid and Frame: Cast iron construction, as indicated on drawings.
   1. Lid Design: As indicated.

B. Shaft Construction: Of the same material as the pipe, nominal shaft diameter of eight inches.

C. Concrete: 3000 psi concrete.

2.5 BEDDING AND COVER MATERIALS

A. Bedding: Fill Type as specified in Section 31 05 13.

B. Cover: Fill Type as specified in Section 31 05 13.

C. Soil Backfill from Above Pipe to Finish Grade: as specified in Section 31 05 13.

2.6 SEWER VIDEO INSPECTION

A. VHS, DVD or acceptable digital format.

B. Audio track containing simultaneously recorded narrative commentary and evaluations of electrographer describing in detail condition of pipeline interior.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Contractor shall coordinate verification of existing conditions before starting work.

B. Verify trench cut excavation base is ready to receive work and excavations, dimensions, and elevations are as indicated on drawings.

3.2 PREPARATION

A. Correct over excavation with fine or coarse aggregate.

B. Remove large stones or other hard matter which could damage pipe or impede consistent backfilling or compaction.

C. Flush and clean pipeline interiors to remove sludge, dirt, sand, stone, grease, and other materials from pipe to ensure clear view of interior conditions. Do not flush materials into sewer system.

D. Furnish materials, labor, equipment, power, maintenance, to implement a temporary by-pass pumping system around work area for time required to complete connections to or reroutes of existing sewer mains.

3.3 BEDDING

A. Excavate pipe trench in accordance with Section 31 05 13.

B. Place bedding material at trench bottom, level materials in continuous layer not exceeding that shown in the drawings.

C. Maintain optimum moisture content of bedding material to attain required compaction density.

3.4 INSTALLATION - PIPE

A. Install pipe, fittings, and accessories in accordance with ASTM D2321 Seal joints watertight.

B. Lay pipe to slope gradients noted on drawings with maximum variation from indicated slope of 1/8 inch in 10 feet.

C. Install bedding at sides and over top of pipe to minimum compacted thickness of 12 inches.

D. Refer to Section 31 05 13 for backfilling and compacting requirements. Do not displace or damage pipe when compacting.

E. Refer to Section 33 05 13 for manhole requirements.

F. Install trace wire and colored marker tape continuous over top of pipe; coordinate with Section 31 05 13.

G. Install site sanitary sewage system piping to 5 feet of building. Connect to building sanitary waste system and municipal sewer system.

3.5 INSTALLATION – CLEANOUTS

A. Form and place cast-in-place concrete pad with provision for sanitary sewer pipe ends.

B. Establish elevations and inverts for inlets and outlets as indicated.

C. Mount lid and frame level to elevation indicated.

3.6 FIELD QUALITY CONTROL

A. Section 01 45 00 - Contractor's Quality Control Program, 01 78 00 – Contract Closeout: Field inspecting, testing, adjusting, and balancing.

B. Perform test on site sanitary sewage system in accordance with Oregon Plumbing Specialty Code and Oregon Health Division.

C. Request inspection as required by Governing Authority having Jurisdiction.

D. Compaction Testing: In accordance with ASTM D1557, ASTM D2922, ASTM D3017.

E. When tests indicate Work does not meet specified requirements, remove work, replace and retest.

F. Frequency of Compaction Tests per section 31 05 13.

G. When required by Governing Authority having jurisdiction, closed-circuit TV Camera System:
   1. Utilize cameras specifically designed and constructed for closed-circuit sewer line inspection. Utilize camera equipment with pan and tilt capability to view each lateral connection at multiple angles.
   2. Utilize camera capable of moving both upstream and downstream; minimum 1,000 feet horizontal distance with one setup, direct reading cable position meter.

H. Pipeline Inspection:
   1. Audio-video tape sections of sewer pipeline between manholes designated.
   2. Identify and record locations of flat grades, dips, deflected joints, open joints, broken pipe, protrusions into pipeline, and points of infiltration.
   3. Locate and record service connections.
   4. Record locations of pipeline defects and connection horizontal distance, in feet, and direction from manholes.
   5. Video with pipe section plugged as to view 100 percent of inside pipe diameter, use flow control methods as specified for bypass pumping system, to eliminate surcharging and reduce flow.

3.7 PROTECTION OF FINISHED WORK

A. Section 01 78 00 – Contract Closeout: Requirements for protecting finished Work.

B. Protect pipe and aggregate cover from damage or displacement until backfilling operation is in progress.

END OF SECTION

STORM UTILITY DRAINAGE PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Storm drainage piping.
2. Accessories.
3. Underground pipe markers.
4. Catch basins, trench drains & landscape area drains.
5. Cleanouts.
6. Bedding and cover materials.
7. Slope protection at culvert pipe end.
8. Building perimeter drainage system.
9. Retaining wall drainage system.
10. Riprap placed loose.

B. Related Sections:
1. Section 01 33 00 – Shop Drawings, Product Data, & Samples.
2. Section 01 45 00 - Contractor's Quality Control Program.
3. Section 01 77 00 - Contract Closeout.
4. Section 01 60 00 – Materials and Equipment
5. Section 01 82 00 – Project Record Documents
6. Section 31 05 13 - Earthwork
7. Section 32 91 19 - Landscape Grading, Topsoil, and Soil Preparation
8. Section 33 05 13 - Manholes and Structures.
9. Section 33 31 00 - Sanitary Utility Sewerage Piping:

1.2 REFERENCES

A. ASTM International:
1. AASHTO M252 - Specification for Corrugated Polyethylene Pipe, 3 - to 10-In. Diameter.
2. AASHTO M288 – Specification for Geotextiles Specification for Highway Applications
3. AASHTO M294 - Specification for Corrugated Polyethylene Pipe, 12- to 36-In. Diameter.
4. ASTM D1557 - Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3).
5. ASTM D2321 - Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications.
6. ASTM D2729 - Standard Specification for Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings.
7. ASTM D2922 - Standard Test Method for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).
8. ASTM D3017 - Standard Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth).

9. ASTM D3034 - Standard Specification for Type PSM Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings.
10. ASTM F477 - Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe.
11. ASTM F2418 - Standard Specification for Polypropylene (PP) Corrugated Wall Stormwater Collection Chambers.
12. ASTM F2787 - Standard Practice for Structural Design of Thermoplastic Corrugated Wall Stormwater Collection Chambers
13. ASTM F2922 - Specification for Polyethylene (PE) Corrugated Wall Stormwater Collection Chambers.
14. AWWA C900

B. Oregon Department of Transportation/American Public Works Association
   1. OSSC refers to the current edition of the State of Oregon/ APWA, Standard Specifications for Construction.

1.3 DEFINITIONS

A. Bedding: Fill placed under, beside and directly over pipe, prior to subsequent backfill operations.

1.4 SUBMITTALS

A. Section 01 33 00 – Shop Drawings, Product Data, & Samples: Requirements for submittals.

B. Product Data: Submit data indicating pipe, pipe accessories, and material to be used in the work.

C. Manufacturer's Installation Instructions: Submit special procedures required to install Products specified.

D. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

1.5 CLOSEOUT SUBMITTALS

A. Section 01 77 00 - Contract Closeout: Requirements for submittals.

B. Section 01 82 00 - Project Record Documents:
   1. Accurately record actual locations of pipe runs, connections, basins, cleanouts, and invert elevations.
   2. Identify and describe unexpected variations to subsoil conditions or discovery of uncharted utilities.

C. Provide manufacturer warranty information.

STORM UTILITY DRAINAGE PIPING

1.6 QUALITY ASSURANCE

A. **All Work in the public rights of way or easements dedicated to the public shall be in accordance with the local Governing Authority having Jurisdiction.**

B. All Work outside public rights of way shall conform to Oregon Plumbing Specialty Code for materials and installation of the Work of this section.

C. Furnish each riprap & aggregate material from single source throughout the Work.

D. Maintain one copy of each document on site.

1.7 COORDINATION

A. Contractor shall coordinate project conditions.

B. Coordinate the Work with termination of storm sewer connection outside building, trenching, connection to foundation drainage system and municipal sewer utility service.

PART 2 - PRODUCTS

2.1 PIPE MATERIALS

A. Plastic Pipe: ASTM D3034, Type PSM, Poly (Vinyl Chloride) (PVC) material; inside nominal diameter as shown on the drawings inches, bell and spigot style rubber ring sealed gasket joint.
   1. Fittings: PVC.
   2. Joints: ASTM F477, elastomeric gaskets.

B. Corrugated Polyethylene Pipe (CPE): AASHTO M252 or M294 type S smooth interior, bell and spigot style, ADS, Hancor Sure-Loc or approved equal.
   1. Fittings: CPE.
   2. Joints: Water Tight.

C. Perforated Corrugated Polyethylene Pipe (SCH40): AASHTO M252 or M294 type S smooth interior, bell and spigot style, ADS, Hancor Sure-Loc or approved equal.

D. Corrugated Plastic Tubing: Flexible type; inside diameter as shown on drawings, with required fittings.

2.2 BEDDING AND COVER MATERIALS

A. Bedding: Fill Type as specified in Section 31 05 13.

B. Cover: Fill Type as specified in Section 31 05 13.

C. Subdrainage pervious Fill Materials: 1 ½" – ¼" clean drain rock.

2.3 ACCESSORIES

A. Geotextile Fabric: Non-biodegradable, woven & non-woven.
   1. AMOCO
   2. Mirafi
   3. Tensar Earth Technologies, Inc.
   4. Substitutions: Section 01 60 00 - Product Requirements

B. Fittings: Same material as pipe molded or formed to suit pipe size and end design, in required tee, bends, elbows, clean-outs, reducers, traps and other configurations required.

C. Trace Wire: Magnetic detectable conductor, clear, brightly colored plastic covering, imprinted with " Storm Sewer Service " in large letters. Brimar or approved equal.

2.4 CATCH BASINS, TRENCH DRAINS, AREA DRAINS AND OVERFLOW STRUCTURES

A. Trapped Inlets: Square, Lynch style catch basin. Gibson Steel or approved equal
   1. H20 Load rated, 10 guage asphalt dipped steel.
   2. Lid design: Square, bike proof linear grill .
   3. Nominal lid and frame size: as shown on drawings.

B. Area Drain: Square 10 ga. asphalt dipped as indicated on the Drawings. Gibson Steel or approved equal.

C. Trench Drain: ACO Drain Klassik Drain or approved equal.
   a. Grate: ACO 661Q, meeting ADA requirements, ACO Drain – Iron slotted grate or approved equal.
   b. Catch Basin: ACO Drain K200 or approved equal.

D. Overflow Structure: Size, material, and product as indication on drawings.

2.5 CLEANOUTS

A. Cleanout Lid and Frame: Cast iron construction, as indicated on drawings.
   1. Lid Design: Standard cast iron frame and cover.

B. Shaft Construction: Of the same material as the pipe, nominal shaft diameter of eight inches.

C. Base Pad: Cast-in-place concrete: 3000 psi.

2.6 BEDDING AND COVER MATERIALS

A. Bedding: Fill Type as specified in Section 31 05 13.

B. Cover: Fill Type as specified in Section 31 05 13.

STORM UTILITY DRAINAGE PIPING

PART 3 - EXECUTION

3.1 EXAMINATION

A. Contractor shall coordinate verification of existing conditions before starting work.

B. Do not place riprap bags over frozen or spongy subgrade surfaces.

C. Verify trench cut or excavation base is ready to receive work and excavations, dimensions, and elevations are as indicated on drawings.

3.2 PREPARATION

A. Hand trim excavations to required elevations. Correct over excavation with fine or coarse aggregate.

B. Remove large stones or other hard matter which could damage piping or impede consistent backfilling or compaction.

3.3 BEDDING

A. Excavate pipe & culvert trench in accordance with Section 31 05 13 for work of this Section. Hand trim excavation for accurate placement of pipe to elevations indicated.

B. Place bedding material at trench bottom, level materials in continuous layer not exceeding 8 inches compacted depth.

C. Maintain optimum moisture content of bedding material to attain required compaction density.

3.4 INSTALLATION – STORM UTILITY PIPE

A. Install pipe, fittings, and accessories in accordance with ASTM D2321. Seal joints watertight.

B. Lay pipe to slope gradients noted on drawings with maximum variation from indicated slope of 1/8 inch in 10 feet.

C. Install aggregate at sides and over top of pipe. Install top cover to minimum compacted thickness of 12 inches.

D. Refer to Section 31 05 13 for backfilling and compacting requirements. Do not displace or damage pipe when compacting.

E. Refer to Section 33 05 13 for manhole requirements.

F. Connect to building drain outlet and municipal storm sewer system.

G. Install trace wire and colored marker tape continuous over top of pipe; coordinate with Section 31 05 13.

H. Connect to subdrainage tile system piping.

I. Install perforated pipe with perforations facing down. Mechanically join pipe ends.

J. Place pervious fill over perforated drainage pipe aggregate cover and compact.

K. Install storm detention chambers system per manufacturer’s recommendations.

3.5 INSTALLATION - CATCH BASINS, TRENCH DRAINS AND CLEANOUTS

A. Form bottom of excavation clean and smooth to correct elevation.

B. Level top surface of base pad; sleeve concrete shaft sections to receive storm sewer pipe sections.

C. Establish elevations and pipe inverts for inlets and outlets as indicated on Drawings.

D. Mount lid and frame level in grout/concrete to elevation indicated

E. Install trench drains as shown on the drawings and per manufacturer’s recommendations.

3.6 RIPRAP PLACEMENT

A. Place geotextile fabric over substrate, overlap edges and ends.

B. Place riprap at culvert pipe ends and at embankment slopes as indicated on Drawings.

C. Installed Thickness: As shown on the drawings.

3.7 STORM UTILITY INSTALLATION TOLERANCES

A. Section 01 45 00 - Contractor's Quality Control Program: Tolerances.

B. Lay pipe to alignment and slope gradients noted on Drawings; with maximum variation from indicated slope of 1/8 inch in 10 feet.

C. Maximum Variation From Intended Elevations: ¼ inch.

D. Maximum Offset From Indicated Alignment: 1 inch.

3.8 FIELD QUALITY CONTROL

A. Section 01 45 00 - Contractor's Quality Control Program and 01 77 00 - Contract Closeout: Field inspecting, testing, adjusting, and balancing.

B. Install Work in accordance with Oregon Plumbing Specialty Code

C. Request inspection as required by the Governing Authority having jurisdiction.

D. Compaction Testing: In accordance with ASTM D1557, ASTM D2922, ASTM D3017.

E. When tests indicate work does not meet specified requirements, remove work, replace and retest.

F. Frequency of Compaction Tests: per section 31 05 13.

G. Deflection and Pressure Test: Test in accordance with Uniform Plumbing Code requirements.

3.9 PROTECTION OF FINISHED WORK

A. Section 01 77 00 - Contract Closeout: Protecting finished Work.

B. Protect pipe and aggregate cover from damage or displacement until backfilling operation is in progress.
   1. Take care not to damage or displace installed pipe and joints during construction of pipe supports, backfilling, testing, and other operations.
   2. Repair or replace pipe that is damaged or displaced from construction operations.

END OF SECTION