PROJECT MANUAL
FOR
Sisters School District
Phase III-A
Transportation Center

1700 McKinney Butte Road
Sisters, Oregon

September 26, 2017

Book 2

ARCHITECTS

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Phase III-A – Transportation Center
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This Project Manual has been organized under the format of the Construction Specifications Institute (CSI). Section numbers are listed merely for identification, and they may not be consecutive. The Contractor shall check the contents of this Manual against the Table of Contents to assure that this volume is complete.

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PART 1 - GENERAL

1.01 SECTION INCLUDES

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

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

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

1.02 RELATED SECTIONS

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

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

1.03 REFERENCES AND STANDARDS

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

B. Codes to include latest adopted editions, including current amendments, supplements and local jurisdiction requirements in effect as of the date of the Contract Documents, of/from:
1. State of Oregon:
   a. OAR - Oregon Administrative Rules
   b. OESC - Oregon Electrical Specialty Code
   c. OFC - Oregon Fire Code
   d. OMSC - Oregon Mechanical Specialty Code
   e. OPSC - Oregon Plumbing Specialty Code
   f. OSSC - Oregon Structural Specialty Code
   g. OEESC - Oregon Energy Efficiency Specialty Code
   h. Oregon Elevator Specialty Code
C. Reference standards and guidelines include but are not limited to the latest adopted editions from:
   1. ABA - Architectural Barriers Act
   2. ADA - Americans with Disabilities Act
   3. AHRI - Air-Conditioning Heating & Refrigeration Institute
   4. ANSI - American National Standards Institute
   5. ASCE - American Society of Civil Engineers
   6. ASHRAE - American Society of Heating, Refrigerating and Air-Conditioning Engineers
   7. ASHRAE Guideline 0, the Commissioning Process
   8. ASME - American Society of Mechanical Engineers
   9. ASPE - American Society of Plumbing Engineers
  10. ASSE - American Society of Sanitary Engineering
  11. ASTM - ASTM International
  12. AWWA - American Water Works Association
  13. CFR - Code of Federal Regulations
  14. CISPI - Cast Iron Soil Pipe Institute
  15. ETL - Electrical Testing Laboratories
  16. EPA - Environmental Protection Agency
  17. FM - FM Global
  18. IAPMO - International Association of Plumbing and Mechanical Officials
  19. GAMA - Gas Appliance Manufacturers Association
  20. HI - Hydraulic Institute Standards
  21. ISO - International Organization for Standardization
  22. MSS - Manufacturers Standardization Society
  23. NEC - National Electric Code
  24. NEMA - National Electrical Manufacturers Association
  25. NFGC - National Fuel Gas Code
  26. NFPA - National Fire Protection Association
  27. NRCA - National Roofing Contractors Association
  28. NSF - National Sanitation Foundation
  29. OSHA - Occupational Safety and Health Administration
  30. SMACNA - Sheet Metal and Air Conditioning Contractors’ National Association, Inc.
  31. TEMA - Tubular Exchanger Manufacturers Association
  32. TIMA - Thermal Insulation Manufacturers Association
  33. UL - Underwriters Laboratories Inc.

D. See Division 22, Plumbing individual Sections for additional references.

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

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

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

H. All potable water system components, devices, material, or equipment containing a weighted average of greater than 0.25 percent lead are prohibited, and shall be certified in accordance with current editions of the Safe Drinking Water Act (SDWA), NSF 61 & NSF 372. Endpoint devices used to dispense water for drinking shall meet the requirements of NSF 61.
1.04 SUBMITTALS

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

B. Provide drawings in format and software release equal to the design documents. Drawings to be the same sheet size and scale as the Contract Documents.

C. In addition:
   1. "No Exception Taken" constitutes that review is for general conformance with the design concept expressed in the Contract Documents for the limited purpose of checking for conformance with information given. Any action is subject to the requirements of the Contract Documents. Contractor is responsible for the dimensions and quantity and will confirm and correlate at the job site, fabrication processes and techniques of construction, coordination of the work with that of all other trades, and the satisfactory performance of the work.
   2. Provide product submittals and shop drawings in electronic format only. Electronic format must be submitted via zip file via e-mail or posted to ftp site. For electronic format, provide one zip file per specification division containing a separate file for each Specification Section. Individual submittals sent piecemeal in a per Specification Section method will be returned without review or comment. All transmissions/submissions to be submitted to Architect. Deviations will be returned without review.
   3. Product Data: Provide Manufacturer's descriptive literature for products specified in Division 22, Plumbing Sections.
   4. Identify/mark each submittal in detail. Note what differences, if any, exist between the submitted item and the specified item. Failure to identify the differences will be considered cause for disapproval. If differences are not identified and/or not discovered during the submittal review process, Contractor remains responsible for providing equipment and materials that meet the Specifications and Drawings.
      a. Label submittal to match numbering/references as shown in Contract Documents and schedules. Highlight and label applicable information to individual equipment or cross out/remove extraneous data not applicable to submitted model. Clearly note options and accessories to be provided, including field installed items. Highlight connections by/to other trades.
      b. Include technical data, installation instructions and dimensioned drawings for products, fixtures, equipment and devices installed, furnished or provided. Reference Division 22, Plumbing Sections for specific items required in product data submittal outside of these requirements.
      c. Provide pump curves, operation characteristics, capacities, ambient noise criteria, etc. for equipment.
      d. For vibration isolation of equipment, list make and model selected with operating load and deflection. Indicate frame type where required. Submit manufacturer's product data.
      e. See Division 22, Plumbing Sections for additional submittal requirements outside of these requirements.
   5. Maximum of two reviews of complete submittal package. Arrange for additional reviews and/or early review of long-lead items; Bear costs of additional reviews at Engineer's hourly rates. Incomplete submittal packages/submittals will be returned to contractor without review.
   6. Resubmission Requirements: Make corrections or changes in submittals as required, and in consideration of Engineer's comments. Identify Engineer's comments and provide an individual response to each of the Engineer's comments. Cloud changes in the submittals and further identify changes which are in response to Engineer's comments.
   7. Structural/Seismic: Provide weights, dimensions, mounting requirements and like information required for mounting, seismic bracing, and support. Indicate manufacturer's installation and support requirements to meet ASCE 7-10 requirements for non-structural
components. Provide engineered seismic drawings and equipment seismic certification. Equipment Importance Factor as specified in Division 01 and in Structural documents.

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

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

10. Substitutions and Variation from Basis of Design:
   a. The Basis of Design designated product establishes the qualities and characteristics for the evaluation of any comparable products by other listed acceptable manufacturers if included in this Specification or included in an approved Substitution Request as judged by the Design Professional.
   b. If substitutions and/or equivalent equipment/products are being proposed, it is the responsibility of parties concerned, involved in, and furnishing the substitute and/or equivalent equipment to verify and compare the characteristics and requirements of that furnished to that specified and/or shown. If greater capacity and/or more materials and/or more labor is required for the rough-in, circuitry or connections than for the item specified and provided for, then provide compensation for additional charges required for the proper rough-in, circuitry and connections for the equipment being furnished. No additional charges above the Base Bid, including resulting charges for work performed under other Divisions, will be allowed for such revisions. Coordinate with the requirements of "Submittals". For any product marked "or approved equivalent", a substitution request must be submitted to Engineer for approval prior to purchase, delivery or installation.

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

12. Samples: Provide samples when requested by individual Sections.

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

14. Operation and Maintenance Manuals, Owners Instructions:
   a. Submit, at one time, electronic files (PDF format) on CD/DVD of manufacturer's operation and maintenance instruction manuals and parts lists for equipment or items requiring servicing. Include valve charts. Submit data when work is substantially complete and in same order format as submittals. Include name and location of source parts and service for each piece of equipment.
      1) Include copy of approved submittal data along with submittal review letters received from Engineer. Data to clearly indicate installed equipment model numbers. Delete or cross out data pertaining to other equipment not specific to this project.
2) Include copy of manufacturer's standard Operations and Maintenance for equipment. At front of each tab, provide routine maintenance documentation for scheduled equipment. Include manufacturer's recommended maintenance schedule and highlight maintenance required to maintain warranty. Furnish list of routine maintenance parts, including part numbers, sizes, quantities, relevant to each piece of equipment: belts, motors, lubricants, and filters.

3) Include copy of complete parts list for equipment. Include available exploded views of assemblies and sub assemblies.

4) Include copy of startup and test reports specific to each piece of equipment.

5) Include copy of final water systems balancing log along with pump operating data.

6) Include commissioning reports.

7) Include copy of valve charts/schedules.

8) Include Warranty per Division 00, Procurement and Contracting Requirements and Division 01, General Requirements, Section 22 00 00, Plumbing Basic Requirements and individual Division 22, Plumbing Sections.

9) Include product certificates of warranties and guarantees.

10) Engineer will return incomplete documentation without review. Engineer will provide one set of review comments in Submittal Review format. Contractor must arrange for additional reviews; Contractor to bear costs for additional reviews at Engineer's hourly rates.

b. Thoroughly instruct Owner in proper operation of equipment and systems. Where noted in individual Sections, training will include classroom instruction with applicable training aids and systems demonstrations. Field instruction per Section 22 00 00, Plumbing Basic Requirements article titled "Demonstration".

c. Copies of certificates of code authority inspections, acceptance, code required acceptance tests, letter of conformance and other special guarantees, certificates of warranties, specified elsewhere or indicated on Drawings.

15. Record Drawings:

a. Maintain at site at least one set of drawings for recording "As-constructed" conditions. Indicate on Drawings changes to original documents by referencing revision document, and include buried elements, location of cleanouts, and location of concealed mechanical items. Include items changed by field orders, supplemental instructions, and constructed conditions.

b. Record Drawings are to include equipment and fixture/connection schedules that accurately reflect "as constructed or installed" for project.

c. At completion of project, input changes to original project on Revit Model and make one set of black-line drawings created from Revit Model in version/release equal to contract drawings. Submit Revit disk and drawings upon substantial completion.

d. Provide Invert elevations and dimensioned locations for water services, building waste, and storm drainage piping below grade extending to 5-feet outside building line.

e. See Division 22, Plumbing individual Sections for additional items to include in record drawings.

1.05 QUALITY ASSURANCE

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

B. Drawings are intended to be diagrammatic and reflect the Basis of Design manufacturers equipment. They are not intended to show every item in its exact dimensions, or details of equipment or proposed systems layout. Verify actual dimensions of systems (i.e., piping) and equipment proposed to assure that systems and equipment will fit in available space. Contractor is responsible for design and construction costs incurred for equipment other than Basis of Design, including, but not limited to, architectural, structural, electrical, HVAC, fire sprinkler, and plumbing systems.
C. Manufacturer's Instructions: Follow manufacturer's written instructions. If in conflict with Contract Documents, obtain clarification. Notify Engineer/Architect, in writing, before starting work.

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

E. Provide products that are UL listed.

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

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

1.06 WARRANTY
A. Provide written warranty covering the work for a period of one year from date of Substantial Completion in accordance with Division 00, Contracting and Procurement Requirements, Division 01, General Requirements, Section 22 00 00, Plumbing Basic Requirements and individual Division 22, Plumbing Sections.

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

1.07 COORDINATION DOCUMENTS
A. Prior to construction, coordinate installation and location of HVAC equipment, ductwork, grilles, diffusers, piping, plumbing equipment/fixtures, fire sprinklers, plumbing, cable trays, lights, and electrical services with architectural and structural requirements, and other trades (including ceiling suspension, and tile systems), and provide maintenance access requirements. Coordinate with submitted architectural systems (i.e. roofing, ceiling, finishes) and structural systems as submitted, including footings and foundation. Identify zone of influence from footings and ensure systems are not routed within the zone of influence.

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

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

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

1.08 WORK INCLUDED
A. Furnish and install sleeves, inserts and anchorage required for the installation, which are embedded in work of other trades. Sleeve, wrap and seal piping in concrete.

B. Electrical: For plumbing trim/devices/equipment, provide, from the line voltage connection by Division 26, the low voltage electrical connections and wiring as required for complete and operable system. Includes, but is not limited to: Low voltage electrical raceway, wiring and accessories, such as step-down transformers as necessary for function of sensors and automatic valve and faucet controls. Supply step-down transformers and size wiring as recommended by manufacturer of plumbing trim/faucets requiring electrical low voltage connection.

PART 2 - PRODUCTS
2.01 MANUFACTURERS
A. Provide like items from one manufacturer, including but not limited to fixtures, pumps, drains and equipment.
2.02 MATERIALS
A. Base contract upon furnishing materials as specified. Materials, equipment, and fixtures used for construction are to be new, latest products as listed in manufacturer's printed catalog data and are to be UL or ETL approved or have adequate approval or be acceptable by State, County, and City authorities.
B. Articles, fixtures, and equipment of a kind to be standard product of one manufacturer.
C. Names and manufacturer's names denote character and quality of equipment desired and are not to be construed as limiting competition.
D. Hazardous Materials:
   2. Comply with Division 00, Procurement and Contracting Requirements and Division 01, General Requirements for this project relating to hazardous materials.
   3. Do not use any materials containing a hazardous substance. If hazardous materials are encountered, do not disturb; immediately notify Owner and Architect. Hazardous materials will be removed by Owner under separate contract.

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

PART 3 - EXECUTION
3.01 ACCESSIBILITY AND INSTALLATION
A. Confirm Accessibility and Installation requirements in Division 00, Procurement and Contracting Requirements, Division 01, General Requirements, Section 22 00 00, Plumbing Basic Requirements and individual Division 22, Plumbing Sections.
B. Install equipment requiring access (i.e., drain pans, drains, control operators, valves, motors, cleanouts and water heaters) so that they may be serviced, reset, replaced or recalibrated by service people with normal service tools and equipment. Do not install equipment in obvious passageways, doorways, scuttles or crawlspaces which would impede or block intended usage.
C. Install equipment and products complete as directed by manufacturer's installation instructions. Obtain installation instructions from manufacturer prior to rough-in of equipment and examine instructions thoroughly. When requirements of installation instructions conflict with Contract Documents, request clarification from Architect prior to proceeding with installation. This includes proper installation methods, sequencing, and coordination with other trades and disciplines.
D. Earthwork:
1. Confirm Earthwork requirements in Contract Documents. In absence of specific requirements, comply with individual Division 22, Plumbing Sections and the following:
   a. Perform excavation, dewatering, shoring, bedding, and backfill required for installation of work in this Division in accordance with the provisions of related earthwork Sections/divisions. Contact utilities and locate existing utilities prior to excavation. Repair any work damaged during excavation or backfilling.
   b. Excavation: Do not excavate under footings, foundation bases, or retaining walls.
   c. Provide protection of underground systems. Review the project Geotechnical Report for references to corrosive or deleterious soils which will reduce the performance or service life of underground systems materials.

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

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

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

3.02 SEISMIC CONTROL
A. Confirm Seismic Control requirements in Division 01, General Requirements, Structural documents, and individual Division 22 Plumbing Sections.
B. General:
   1. Earthquake resistant designs for Plumbing (Division 22) equipment and distribution, i.e. motors, plumbing systems, piping, equipment, water heaters, boilers, etc. to conform to regulations of jurisdiction having authority.
   2. Restraints which are used to prevent disruption of function of piece of equipment because of application of horizontal force to be such that forces are carried to frame of structure in such a way that frame will not be deflected when apparatus is attached to a mounting base and equipment pad, or to structure in normal way, utilizing attachments provided. Secure equipment and distribution systems to withstand a force in direction equal to value defined by jurisdiction having authority.
   3. Provide stamped Shop Drawings from licensed Structural Engineer of seismic bracing and seismic movement assemblies for piping equipment and water heaters. Submit Shop Drawings along with equipment submittals.
   4. Provide stamped Shop Drawings from licensed Structural Engineer of seismic flexible joints for piping and crossing building expansion or seismic joints. Submit Shop Drawings along with seismic bracing details. Coordinate exact design requirements with project Structural Engineer.
C. Piping:

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

3.03 REVIEW AND OBSERVATION

A. Confirm Review and Observation requirements in Division 00, Procurement and Contracting Requirements, Division 01, General Requirements, Section 22 00 00, Plumbing Basic Requirements and individual Division 22, Plumbing Sections.

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

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

D. Final Punch:
   1. Prior to requesting a final punch visit from the Engineer, request from Engineer the Plumbing Precloseout Checklist, complete the checklist confirming completion of systems' installation, and return to Engineer. Request a final punch visit from the Engineer, upon Engineer's acceptance that the plumbing systems are ready for final punch.
   2. Costs incurred by additional trips required due to incomplete systems will be the responsibility of the Contractor.

3.04 CONTINUITY OF SERVICE

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

3.05 CUTTING AND PATCHING

A. Confirm Cutting and Patching requirements in Division 01, General Requirements. In absence of specific requirements, comply with individual Division 22, Plumbing Sections and the following:
   1. Proposed floor cutting/core drilling/sleeve locations to be approved by Project Structural Engineer. Submit proposed locations to Architect/Project Structural Engineer. Where slabs are of post tension construction, perform x-ray scan of proposed penetration locations and submit scan results including proposed penetration locations to Project Structural Engineer/Architect for approval. Where slabs are of waffle type construction, show column cap extent and cell locations relative to proposed penetration(s).
   2. Cutting, patching and repairing for work specified in this Division including plastering, masonry work, concrete work, carpentry work, and painting included under this Section will be performed by skilled craftsmen of each respective trade in conformance with appropriate Division of Work.
3. Additional openings required in building construction to be made by drilling or cutting. Use of jack hammer is specifically prohibited. Patch openings in and through concrete and masonry with grout.

4. Restore new or existing work that is cut and/or damaged to original condition. Patch and repair specifically where existing items have been removed. This includes repairing and painting walls, ceilings, etc. where existing piping and devices are removed as part of this project. Where alterations disturb lawns, paving, and walks, surfaces to be repaired, refinished and left in condition matching existing prior to commencement of work.

5. Additional work required by lack of proper coordination will be provided at no additional cost to the Owner.

3.06 EQUIPMENT SELECTION AND SERVICEABILITY

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

3.07 DELIVERY, STORAGE AND HANDLING

A. Confirm requirements in Division 00, Procurement and Contracting Requirements and Division 01, General Requirements. In absence of specific requirements, comply with individual Division 22, Plumbing Sections and the following:

1. Handle materials delivered to project site with care to avoid damage. Store materials on site inside building or protected from weather, dirt and construction dust. Insulation and lining that becomes wet from improper storage and handling to be replaced before installation. Products and/or materials that become damaged due to water, dirt and/or dust as a result of improper storage to be replaced before installation.

2. Protect equipment and pipe to avoid damage. Close pipe openings with caps or plugs. Keep motors and bearings in watertight and dustproof covers during entire course of installation.

3. Protect bright finished shafts, bearing housings and similar items until in service.

3.08 DEMONSTRATION

A. Confirm Demonstration requirements in Division 00, Procurement and Contracting Requirements, Division 01, General Requirements, Section 22 00 00, Plumbing Basic Requirements and individual Division 22, Plumbing Sections.

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

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

3.09 CLEANING

A. Confirm cleaning requirements in Division 00, Procurement and Contracting Requirements, Division 01, General Requirements, Section 22 00 00, Plumbing Basic Requirements and individual Division 22, Plumbing Sections.

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

3.10 INSTALLATION

A. Confirm installation requirements in Division 00, Procurement and Contracting Requirements, Division 01, General Requirements, Section 22 00 00, Plumbing Basic Requirements and individual Division 22, Plumbing Sections.
B. Install equipment and fixtures in accordance with manufacturer's installation instructions, plumb and level and firmly anchored to vibration isolators. Maintain manufacturer's recommended clearances.

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

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

3.11 PAINTING

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

3.12 ACCESS PANELS

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

3.13 DEMOLITION

A. Confirm Demolition requirements in Division 01, General Requirements and Division 02, Existing Conditions. In absence of specific requirements, comply with individual Sections in Division 22, Plumbing and the following:
   1. Scope:
      a. It is the intent of these documents to provide necessary information and adjustments to plumbing system required to meet code, and accommodate installation of new work.
      b. Coordinate with Owner so that work can be scheduled not to interrupt operations, normal activities, building access or access to different areas.
      c. Existing Conditions: Determine exact location of existing utilities and equipment before commencing work, compensate Owner for damages caused by failure to exactly locate and preserve underground utilities. Replace damaged items with new material to match existing. Promptly notify Owner if utilities are found which are not shown on Drawings.
2. Equipment: Unless otherwise directed, equipment, fixtures, or fittings being removed as part of demolition process are Owner's property. Remove other items not scheduled to be reused or relocated from job site as directed by Owner.

3. Unless specifically indicated on Drawings, remove exposed, unused piping to behind finished surfaces (floor, walls, ceilings, etc.). Cap piping and patch surfaces to match surrounding finish.

4. Unless specifically indicated on Drawings, remove unused equipment, fixtures, fittings, rough-ins, and connectors. Removal is to be to a point behind finished surfaces (floors, walls, and ceilings).

3.14 ACCEPTANCE

A. Confirm requirements in Division 00, Procurement and Contracting Requirements and Division 01, General Requirements. In absence of specific requirements, comply with individual Sections in Division 22, Plumbing and the following:

1. System cannot be considered for acceptance until work is completed and demonstrated to Architect that installation is in strict compliance with Specifications, Drawings and manufacturer’s installation instructions, particularly in reference to following:
   a. Testing and Balancing Reports
   b. Cleaning
   c. Operation and Maintenance Manuals
   d. Training of Operating Personnel
   e. Record Drawings
   f. Warranty and Guaranty Certificates
   g. Start-up/Test Document and Commissioning Reports

3.15 FIELD QUALITY CONTROL

A. Confirm Field Quality Control requirements in Division 00, Procurement and Contracting Requirements, Division 01, General Requirements, Section 22 00 00, Plumbing Basic Requirements and individual Division 22, Plumbing Sections.

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

3.16 LETTER OF CONFORMANCE

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

3.17 ELECTRICAL INTERLOCKS

A. Where equipment motors are to be electrically interlocked with other equipment for simultaneous operation, utilize plumbing equipment wiring diagrams to coordinate with electrical systems so that proper wiring of equipment involved is affected.
SECTION 22 0513 - COMMON MOTOR REQUIREMENTS FOR PLUMBING EQUIPMENT

PART 1 - GENERAL

1.01 SUMMARY
   A. Work Included:
      1. General Motor Construction and Requirements
      2. Starters
      3. Disconnects

1.02 RELATED SECTIONS
   A. Contents of Division 22, Plumbing and Division 01, General Requirements apply to this Section.

1.03 REFERENCES AND STANDARDS
   A. References and Standards as required by Section 22 00 00, Plumbing Basic Requirements and Division 01, General Requirements.
   B. In addition, meet the following:
      1. NEMA Premium Efficiency.
      2. Energy Policy Act (EPACT), latest applicable version(s) for minimum motor efficiencies.

1.04 SUBMITTALS
   A. Submittals as required by Section 22 00 00, Plumbing Basic Requirements and Division 01, General Requirements.

1.05 QUALITY ASSURANCE
   A. Quality assurance as required by Section 22 00 00, Plumbing Basic Requirements and Division 01, General Requirements apply to this Section.
   B. In addition, meet the following:
      1. Field Installed Motors: Installed motors to be of single type, from one source and from a single manufacturer.
      2. Electrical components and materials to be UL and ETL listed/labeled as suitable for location and use.
      3. Variable Frequency Drives: Materials and installation for a complete adjustable frequency motor drive consisting of a pulse width modulated (PWM) inverter for use on a standard NEMA Design B induction motor. Design drive specifically for variable torque applications. Variable Frequency Drive (VFD) provided by equipment manufacturer.
         a. A firm engaged in the production of this type of equipment for a minimum of 10 years.
         b. Testing: Test printed circuit boards and burned in before being assembled into the completed VFD. Subject VFD to a preliminary functional test, minimum 8-hour burn-in, and computerized final test at 104 degrees F at full rated load.
         c. Qualifications:
            1) UL Listed.
            2) C-UL listed or CSA approved.
            3) Warranty: 12 months from the date of certified start-up. Include parts, labor, travel time, and expenses.

1.06 WARRANTY
   A. Warranty of materials and workmanship as required by Section 22 00 00, Plumbing Basic Requirements and Division 01, General Requirements.
   B. In addition, provide:
      1. For motors 50 HP and Larger: Provide five year manufacturer's limited warranty from date of substantial completion.
PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. General Motor Construction and Requirements:
   1. Lincoln Motors
   2. Century Electric Motors (formerly A.O. Smith Electrical Products)
   3. Baldor Electric (Reliance Electric)
   4. General Electric
   5. Toshiba
   6. Exceptions: Motors integral to equipment efficiency listing (EER, COP, etc.) per listing agency.
   7. Or approved equivalent.

B. Starters:
   1. Cerus
   2. Eaton Electrical
   3. General Electric
   4. Siemens
   5. Schneider Electric/Square D
   6. Or approved equivalent.

C. Disconnects:
   1. Provided and installed by Division 26.

2.02 GENERAL MOTOR CONSTRUCTION AND REQUIREMENTS

A. Electrical components and materials to be UL to ETL listed/labeled as suitable for location and use.

B. Wiring installed in conduit.

C. Electrical Service: Power wiring from source to motor termination under Division 26, Electrical. Coordinate location of disconnect and starter or motor controller. Combination starter/disconnects may be used in lieu of separate items.

D. Electrical Service - Unless otherwise noted in the Contract Documents, the following voltage and phase characteristics apply to motors:
   1. Motors 1/2 HP and Under: 120 volt, 1 phase.
   3. Motors 3/4 HP and Over: 480 volt, 3 phase

E. Construction:
   1. Open drip-proof type except where specifically noted otherwise.
   2. Design for continuous operation in 104 Degrees F environment.
   3. Design for temperature rise in accordance with NEMA MG 1 limits for insulation class, service factor, and motor enclosure type.
   4. Built-in thermal overload protection or externally protected with separate over-load with low-voltage release or lock-out. Quick trip device on hermetically sealed motors.
   5. Service Factor: 1.15 for poly-phase motors. 1.25 for motors associated with shaft pressurization system fans. 1.35 for single phase motors.
   8. Motors used in Conjunction with Variable Speed Drives: Variable torque type matched for the full operating range of the variable frequency drive. As a minimum, motors to have Class F insulation, winding insulation rated for 1000 volts and insulated bearings to prevent high frequency ground path. Loads not-to-exceed 80 percent of nameplate rating.

F. Explosion-Proof Motors: UL approved and labelled for hazard classification with over temperature protection.
G. Visible Nameplate: Indicating motor horsepower, voltage, phase, cycles, RPM, full load amps, locked rotor amps, frame size, manufacturer's name and model number, service factor, power factor, efficiency.

H. Wiring Terminations:
   1. Provide terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated. Coordinate conductor sizes with Division 26, Electrical. Enclose terminal lugs in terminal box sized to NFPA 70, threaded for conduit.
   2. For fractional horsepower motors where connection is made directly, provide conduit connection in end frame.

I. Provide inverter ready motors per NEMA MG1-30 for variable speed drive or soft-start starter use. Provide shaft grounding for motors over 2 HP serving variable speed drives. Provide shaft grounding and insulated bearings on motors 25 HP and larger serving variable speed drives. Shielded cable required for power wiring from variable speed drive to motor connection.

J. Unless otherwise indicated, motors 1-HP and larger to meet/exceed NEMA Premium Efficiency and latest EPACT.

K. Vertical in-line pump motors per NEMA MG1, Motors and Generators.

2.03 STARTERS
A. Single-Phase Motors:
   1. Manual across-the-line starting switch having toggle-operated switch pilot running light and built-in thermal overload device with heating element rated not more than 115 percent motor full load current indicated on name plate of motor to be protected. Surface mount starters. Provide NEMA-1 enclosure.
   2. Overload relays to be melting alloy type with a replaceable control circuit module. Thermal units to be interchangeable. Starter to be non operative if thermal unit is removed.

B. Starters up to Size 8 to be suitable for the addition of a minimum of three external auxiliary contacts (normally open or normally closed). Contactor, coils and relays to perform the control functions of the associated equipment and control sequence.

C. 3-Phase Motors up to and Including 15 HP:
   1. Provide enclosed type magnetic across-the-line starter with thermal overload and undervoltage protection.
   2. Operator: "Start-Stop" pushbutton, except where automatic control is indicated on Drawings or specified. Then provide "Hand-Off-Auto" selector switch.
   3. Starters for 3-phase motors to have overload protection in each of the three legs, with external manual reset.

2.04 DISCONNECTS
A. Provided by Division 26, Electrical unless specified otherwise.

PART 3 - EXECUTION
3.01 GENERAL
A. Electrical Requirements:
   1. Contractor to Provide the Following:
      a. Motors.
      b. Starters and disconnects that are integral parts of plumbing equipment as shown on the equipment schedules. Reference Drawings and subsequent Sections. Provide a working system. Coordinate with Division 26, Electrical.
      c. Low Voltage and Electronic Control Devices.
      d. Low Voltage Transformers.
      e. Low Voltage Conduit and Wire and Connecting Devices.
f. Conduit and wire for electronic devices, except for line voltage wiring.

2. Electrical work listed above performed by a licensed electrical contractor or by the control manufacturer, but provided for and coordinated under Division 22, Plumbing work. In addition, controls work supervised and subsequently approved in writing by the control manufacturer.

3. Contractor to furnish the following to the Electrical Contractor where applicable: Line voltage control equipment, including switches (except disconnects), time switches, transformers, relays, etc. (except those part of MCC).

4. Include the Following Items under Division 26, Electrical Work:
   a. Line voltage wire and conduit system.
   b. Disconnects not provided with equipment.
   c. Installation of line voltage control equipment furnished under Paragraph 3.01.C.above.

B. Electrical Interlocks: Where equipment motors are to be electrically interlocked with other equipment for simultaneous operation, utilize mechanical equipment wiring diagrams to coordinate with the electrical systems so that proper wiring of the equipment involved is affected.

C. Coordinate location of disconnect and starter or motor controller. Combination starter/disconnects may be used in lieu of separate items.

D. Explosion-Proof Motors: UL approved and labeled for hazard classification, with over temperature protection.

E. Provide inverter ready motors per NEMA MG1-30 for variable speed drive or soft-start starter use. Provide shaft grounding for motors over 2 HP serving variable speed drives. Provide shaft grounding and insulated bearings on motors 25 HP and larger serving variable speed drives. Shielded cable required for power wiring from variable speed drive to motor connection.

F. Unless otherwise indicated, motors 1-HP and larger to meet/exceed NEMA Premium Efficiency and latest EPACT.

G. Vertical in-line pump motors per NEMA MG1 vertical motor requirements.

H. Install securely on firm foundation. Mount ball bearing motors with shaft in any position.

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

J. Verify motor rotation.

K. Field Quality Control:
   1. Prepare for Acceptance Tests as Follows:
      a. Run each motor with its controller. Demonstrate correct rotation, alignment, and speed at motor design load.
      b. Test interlocks and control features for proper operation.
      c. Verify that current in each phase is within nameplate rating.
   2. Testing: Perform the Following Field Quality-Control Testing:
      a. Perform each electrical test and visual and mechanical inspection stated in NETA ATS, Section 7.15.1. Certify compliance with test parameters.
      b. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
   3. Manufacturer's Field Service: Engage a factory-authorized service representative to perform the following:
      a. Inspect field-assembled components, equipment installation, and piping and electrical connections for compliance with requirements.
      b. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
      c. Verify bearing lubrication.
      d. Verify proper motor rotation.
e. Test Reports:
   1) Prepare a written report to record the following test procedures used:
      (a) Test results that comply with requirements.
      (b) Test results that do not comply with requirements and corrective action
           taken to achieve compliance.

L. Adjusting: Align motors, bases, shafts, pulleys and belts. Tension belts according to
manufacturer's written instructions.

M. Cleaning:
   1. After completing equipment installation, inspect unit components. Remove paint splatters
      and other spots, dirt, and debris. Repair damaged finish to match original finish.
   2. Clean motors, on completion of installation, according to manufacturer's written
      instructions.

3.02 GENERAL MOTOR CONSTRUCTION AND REQUIREMENTS

A. Motor Installation: Install in accordance with manufacturer's instructions. Coordinate with starter
   or variable speed controller with control sequence to provide necessary starter accessories.

3.03 STARTERS

A. Install starters in accordance with manufacturer's instructions.
B. Coordinate disconnect requirements and location with Division 26, Electrical if not integral to
   starter. If starter is installed out of line of sight of motor, provide additional disconnect at motor
   per code.
C. Provide NEMA housing appropriate to installation location.
D. Provide supports and install securely, in neat and workmanlike manner, as specified in NECA 1.
E. Meet mounting height and accessible location requirements per local code.
F. Provide fuses for fusible switches.
G. Select and install overload heater elements in motor starters to match installed motor
   characteristics.
H. Single phase 120 Volt starter: if not furnished as single packaged controller/disconnect, provide
   contactors, relays, wiring and devices necessary to match sequence of operation for equipment.

3.04 DISCONNECTS

A. Provided by Division 26, Electrical unless specified otherwise.
B. Provide disconnecting means within sight of each motor controller and of each motor. Motor
   controller disconnecting means equipped with lock-out/tag-out padlock provisions do not require
   a disconnect switch at the controlled motor location. Locate disconnect means in view of and
   not inside of equipment, such that tools are not needed to remove covers to access the
   disconnecting means.
C. Install in accordance with manufacturer's instructions.
D. Install fuses in fusible disconnect switches. Coordinate fuse ampere rating with installed
   equipment. Do not provide fuses of lower ampere rating than motor starter thermal units.
E. Controllers:
   1. Single Phase 120 Volt Starter: If not furnished as single packaged controller/disconnect,
      provide contactors, relays, wiring and devices necessary to match sequence of operation
      for equipment.

END OF SECTION
SECTION 22 0519 - PLUMBING DEVICES

PART 1 - GENERAL

1.01 SUMMARY
A. Work Included:
   1. Pressure Gauges
   2. Thermometers
   3. Water Hammer Arrestors (Shock Absorbers)
   4. Trap Primers

1.02 RELATED SECTIONS
A. Contents of Division 22, Plumbing and Division 01, General Requirements apply to this Section.

1.03 REFERENCES AND STANDARDS
A. References and Standards as required by Section 22 00 00, Plumbing Basic Requirements and Division 01, General Requirements.

1.04 SUBMITTALS
A. Submittals as required by Section 22 00 00, Plumbing Basic Requirements and Division 01, General Requirements.

1.05 QUALITY ASSURANCE
A. Quality assurance as required by Section 22 00 00, Plumbing Basic Requirements and Division 01, General Requirements apply to this Section.

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

PART 2 - PRODUCTS

2.01 MANUFACTURERS
A. Pressure Gauges:
   1. Dwyer Instruments, Inc.
   2. Moeller Instrument Co., Inc.
   3. Omega Engineering, Inc.
   4. Trerice
   5. Or approved equivalent.

B. Thermometers:
   1. Ashcroft
   2. Trerice
   3. Weiss
   4. Marshalltown
   5. Weksler
   6. Or approved equivalent.

C. Water Hammer Arrestors (Shock Absorbers):
   1. Bellows Type:
      a. Amtrol
      b. J.R. Smith
      c. Wade
      d. Zurn
   2. Piston Type:
      a. PPP
      b. Sioux Chief

D. Trap Primers:
   1. Wade
2. Zurn
3. J.R. Smith
4. PPP

2.02 PRESSURE GAUGES
A. Pressure Gauges: ASME B40.100, phosphor-bronze bourdon type, dry type.
   1. Case: Cast aluminum, stem-mounted, flange less.
   2. Size: 4-1/2-inch diameter.
   5. Scale: White aluminum with black graduation and markings.
   7. Mid-Scale Accuracy: One percent.
   8. Scale: PSI.
   9. Basis of Design: Trerice Model 600CB.

2.03 THERMOMETERS
A. Thermometers - Adjustable Angle: Red or blue appearing organic liquid in glass, ASTM E 1; 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: Acrylic.
   3. Scale: Aluminum, white background, black graduations and markings.
   5. Accuracy: 2 percent, per ASTM E 77.
   6. Calibration: 0-160 with 2 Degrees F graduations.

2.04 WATER HAMMER ARRESTORS (SHOCK ABSORBERS)
A. Bellows-type, stainless steel casing and bellows, pressure rated, tested and certified in accordance with PDI WH-201.
B. Piston-type, copper, brass or stainless steel with O-ring piston, pressure rated, tested and certified in accordance with PDI WH-201.

2.05 TRAP PRIMERS
A. Trap automatic primer valve with integral anti siphon protection. Code approval required.
B. Flush valve tail-piece trap primer. PPP FVP-1VB.
C. Electronic trap seal automatic primer valve with integral anti siphon protection and timer. Coordinate quantity, locations and voltage characteristics for control points.
D. Trap seal primer valve (low lead) with integral automatic anti-siphon protection. The priming valve to discharge on both pressure drop and pressure spike. PPP CPO 500.

PART 3 - EXECUTION
3.01 GENERAL INSTALLATION REQUIREMENTS
A. For plumbing devices requiring access from access panels (i.e. trap primers, water hammer arrestors and the like) submit location/size of all access panels to Architect for approval prior to purchase and installation of access panel. See Section 22 00 00, General Plumbing Requirements for additional requirements.

B. Temperature Gauges:
   1. Install in vertical upright position, tilted so as to be easily read at floor.
   2. Thermometer Wells: Install in piping in vertical upright position. Fill well with oil or graphite, secure cup.
C. Provide instruments with scale ranges selected according to service with largest appropriate scale.
D. Install per manufacturer recommendations.

3.02 PRESSURE GAUGES
A. Install pressure gauge where exposure to heat and vibration are minimal and where the dial can be easily read. It is also important to install the gauge in a location with undisturbed and continuous flow of the pressure medium.
B. Provide a needle valve or gauge cock, installed between the process and the pressure gauges.
C. General: Install pressure gauges in piping tee with pressure gauge cock, located on pipe at most readable position, visible from floor.
D. Locations: Install in the following locations, and elsewhere as indicated.
   1. At each pump inlet and outlet.
   2. At inlet and discharge of each pressure reducing valve.
   3. At make-up water service outlets.
E. Adjust gauges and thermometers to final angle, clean windows and lenses, and calibrate to zero.
F. Pressure Gauge Range/Graduations:

<table>
<thead>
<tr>
<th>System</th>
<th>Pressure (PSI)</th>
<th>Graduations (PSI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cold Water</td>
<td>0-100</td>
<td>1</td>
</tr>
<tr>
<td>Hot Water</td>
<td>0-100</td>
<td>1</td>
</tr>
<tr>
<td>Compressed Air</td>
<td>0-160</td>
<td>1</td>
</tr>
</tbody>
</table>

G. Install gauges and thermometers in locations where they are easily read from normal operating level. Install vertical to 45 degrees off vertical.
H. Install per manufacturer recommendations.

3.03 THERMOMETERS
A. 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.
B. Provide instruments with scale ranges selected according to service with largest appropriate scale.
C. Adjust gauges and thermometers to final angle, clean windows and lenses, and calibrate to zero.
D. Install gauges and thermometers in locations where they are easily read from normal operating level. Install vertical to 45 degrees off vertical.
E. Thermometer Range/Graduations:

<table>
<thead>
<tr>
<th>System</th>
<th>Temperature (Degrees F)</th>
<th>Graduations (Degrees F)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cold Water</td>
<td>25-125</td>
<td>1</td>
</tr>
<tr>
<td>Hot Water</td>
<td>30-240</td>
<td>2</td>
</tr>
</tbody>
</table>

F. Install gauges and thermometers in locations where they are easily read from normal operating level. Install vertical to 45 degrees off vertical.
G. Install per manufacturer recommendations.
3.04 WATER HAMMER ARRESTORS (SHOCK ABSORBERS)
   A. Water Hammer Arrestors: Install in upright position, in locations and of sizes in accordance with PDI WH-201, and elsewhere as indicated.
   B. Locate shock absorbers in supply pipe in accordance with recommendations of Plumbing and Drainage Institute PDI-WH201. Install ahead of solenoid operated valves. Determine size of absorber by fixture unit value of fixture supplied, using PDI symbols to designate sizes. Provide access panel for each shock absorber.
   C. Install per manufacturer recommendations.

3.05 TRAP PRIMERS
   A. Flush supply line prior to installation.
   B. Install valve plumb using caution to not over tighten. Tightening to more than 55 ft. lbs. can damage valve and void the warranty. Do not wrench on hex.
   C. Effective operating range 20 to 80 PSIG (138 to 552 kPa).
   D. Do not subject trap primer valve to pressure in excess of 125 PSI.

END OF SECTION
SECTION 22 0523 - GENERAL-DUTY VALVES FOR PLUMBING PIPING

PART 1 - GENERAL

1.01 SUMMARY

A. Work Included:
   1. Valves, General
   2. Balancing Valves
   3. Ball Valves
   4. Swing Check Valves
   5. Backflow Prevention Assemblies
   6. Pressure Regulating Valve-Domestic Water
   7. Thermostatic Master Mixing Valves (ASSE 1017 Rated)
   8. Thermostatic Point-of-Use Mixing Valves (ASSE 1070 Rated)

1.02 RELATED SECTIONS

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

1.03 REFERENCES AND STANDARDS

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

1.04 SUBMITTALS

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

1.05 QUALITY ASSURANCE

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

B. In addition, meet the following:
   1. NSF 61, Annex G and/or NSF/ANSI 372 for potable water services. Valves must be 3rd party certified.
   2. ISO 9001 Certified.
   3. IAPMO Certified for Low Lead.

C. Source Limitations for Valves: Obtain each type of valve from a single source and from a single manufacturer.

D. Model numbers indicated as Basis-of-Design indicate valve characteristics. All valves are to meet code Low Lead/Lead Free Standards.

1.06 WARRANTY

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

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Source Limitations for Valves: Obtain each type of valve from a single source and from a single manufacturer.

B. Valves, General:
   1. Apollo
   2. Armstrong
   3. ASCO
   4. Cla-Val
   5. Conbraco
   6. Crane
   7. Clow
8. Griswold
9. Hammond
10. Hays
11. Jenkins
12. Josam
13. Kennedy
14. Milwaukee
15. Mueller
16. Nibco
17. Red-White Valve
18. Smith
19. Stockham
20. Tour Anderson
21. Wade
22. Watts
23. Wilkins
24. Zurn

C. Balancing Valves:
   1. Caleffi
   2. Griswold
   3. Hays
   4. Armstrong CBV
   5. Tour Anderson

D. Ball Valves:
   1. See Valves General above.
   2. NSF Valves:
      a. Clow
      b. Kennedy
      c. Nibco

E. Swing Check Valves:
   1. See Valves General above.

F. Backflow Prevention Assemblies:
   1. Backflow Preventers:
      a. Apollo
      b. Cla-Val
      c. Conbraco
      d. Watts
   2. Backflow Prevention Assemblies - Reduced Pressure Zone Backflow Preventer (RPBP) for High Hazard Applications - 2-inches and Smaller:
      a. Febco 860 with 650A
      b. Conbraco 40-210-AGD
      c. Wilkins 375-XL-SAG
      d. Watts 919-QT-S valve with 919AGC or 919AGF
   3. Backflow Prevention Assemblies - Reduced Pressure Zone Backflow Preventer (RPBP) for High Hazard Applications - 2-1/2-inches and Larger:
      a. Febco 860 with 758A
      b. Conbraco Apollo 40-700 with 758A
      c. Watts 909-S-NFA-NRS with AGC
      d. Wilkins 375-FSC
   4. Backflow Prevention Assemblies - Double Check Valve Assembly (DCVA) for Low Hazard Applications - 2-inches and smaller:
      a. Febco 850-650A
b. Conbraco Apollo 40-110-T2  
c. Watts 007-QT-FDA-S  
d. Wilkins 350-S-XL  

5. Backflow Prevention Assemblies - Double Check Valve Assembly (DCVA) for Low Hazard Applications - 2-1/2-inches and larger:  
a. Conbraco Apollo 45-11-1  
b. Watts 709-DCDA with 77F-01-FDA-12  

6. Spill Resistant Pressure Vacuum Breaker:  
a. Febco  
b. Conbraco  
c. Watts  
d. Wilkins  

7. Atmospheric Vacuum Breakers:  
a. Febco  
b. Conbraco  
c. Watts  
d. Wilkins  

G. Pressure Regulating Valve-Domestic Water:  
1. Cash Acme  
2. Cla-Val  
3. Watts  
4. Wilkins  

H. Thermostatic Master Mixing Valves (ASSE 1017 Rated):  
1. Holby Tempering Valve  
2. Lawler Series 66  
3. Leonard Type TM  
4. Powers LFMM430 (Lead Free)  
5. Symmons Temp Control Series 5  
6. Acorn Controls  

I. Thermostatic Point-of-Use Mixing Valves (ASSE 1070 Rated):  
1. Lawler  
2. Leonard  
3. Powers Hydroguard  
4. Acorn Controls  

2.02 VALVES - GENERAL  

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

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

C. Valve-End Connections:  
1. Flanged: With flanges according to ASME B16.1 for iron valves.  
2. Solder Joint: With sockets according to ASME B16.18.  
3. Threaded: With thread according to ASME B1.20.1.
D. Valve Bypass and Drain Connections: MSS SP-45.

E. Building Service:
   1. Shutoff and Isolation Valves:
      a. Pipe Sizes 3-inches and Smaller: Ball Valve.
   2. Drain Service: Ball Valves.
   3. Strainer Blow-Off: Ball Valve.

2.03 BALANCING VALVES

A. Maximum 125 PSIG System Working Water Pressure.

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

C. Automatic Flow Control Valve:
   1. 1/2-inches and Larger: Construction and attachment style as required by piping system. Internal working parts and removable flow cartridge stainless steel. Valves to be factory set and automatically limit flow to specified capacities with 5 percent plus or minus accuracy over entire operating pressure differential.
   2. Provide shut-off valve of supply side of valve and check valve on discharge side of valve.
   3. Minimum Flow Through Valve:
      a. 1/2-inches size: 1 gpm.
      b. 3/4-inches size: 1.5 gpm.

2.04 BALL VALVES

A. All ball valves on brazed piping are to be three-piece.
B. 2-1/2-inches and Smaller: MSS SP-110, 400-600 PSI, two-piece full port ball configuration, bronze body, extended soldered ends for copper pipe and threaded ends for iron pipe, brass or stainless steel ball, Teflon seat. Apollo 77 CLF 100 Series two-piece.

C. Full Port Ball Valve: 2- to 4-inch ductile iron, ASTM A536, micro finish steel chrome plated or stainless steel ball and stem. TFE seats, 600 PSI.

2.05 SWING CHECK VALVES

A. 2-inches and Smaller: Class 125, bronze body, horizontal swing, regrinding type, Y-pattern, renewable disc. Nibco 413. MSS SP-80.

B. 2-1/2-inches and Larger: Class 125, iron body, bolted bonnet, horizontal swing, renewable seat and disc, flanged ends. Nibco F918. MMS SP-71.

C. Rubber Flapper Check Valve: Horizontal or vertical upward flow installation. Working pressure to 175 PSI. Ductile iron or cast iron body. Steel reinforced Buna-N rubber flapper epoxy coating on wetted parts. MSS SP-80.

D. Gruvlok Series 7800 Check Valve: Horizontal installation. Working pressure to 300 PSI, Type 304/302 Stainless Steel conforming to ASTM 167. Ductile body, ASTM A536, and stainless clapper, EPDM, nitrile or optional viton bumper and bonnet seals. Stainless wetted parts.

2.06 BACKFLOW PREVENTION ASSEMBLIES

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

B. Reduced Pressure Zone Backflow Preventer (RPBP) for High Hazard Applications:
   1. 2-inches and Smaller: Assembly consists of shutoff ball valves in inlet and outlet, and strainer on inlet. Assemblies include test cocks and pressure-differential relief valve located between two positive seating check valves and comply with requirements of ASSE Standard 1013 and AWWA C511. Bronze construction, threaded ends, stainless steel internal parts, FDA strainer, and air gap fitting. Route pipe from air gap fitting to approved waste receptor.
   2. 2-1/2-inches and Larger: Assembly consists of shutoff OS&Y gate valves in inlet and outlet, and strainer on inlet. Assemblies include test cocks and pressure-differential relief valve located between two positive seating check valves and comply with requirements of ASSE Standard 1015 and AWWA C511. Epoxy coated cast iron body construction, flanged ends, stainless steel internal parts, bronze seats, and FDA strainer.

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

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

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

2.07 PRESSURE REGULATING VALVE-DOMESTIC WATER

A. Water: Bronze body, diaphragm or piston type, spring actuated, with separate or integral stainless steel strainer, pressure range to suit conditions, approved for potable water use, low lead. Provide shutoff valves, pressure relief valves, unions, drain valve and bypass.
B. Water: Automatic control pressure regulating valve, stainless steel seat, stem and spring, diaphragm actuated with brass body, hydraulic control pilots with effluent operating temperature range 32 degrees F to 180 degrees F, FDA and AWWA approved.

C. Water: Bronze body construction, stainless steel strainer screen, thermal expansion bypass with renewable stainless steel seat and high temperature resisting diaphragm.

2.08 THERMOSTATIC MASTER MIXING VALVES (ASSE 1017 RATED)
A. Thermostatic type with bronze body construction, corrosion resistant materials, union end stops, check inlets with strainers, 0-200 degree F dial thermometer and discharge shut-off valve. Mixing valves to meet ASSE 1017.

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

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

2.09 THERMOSTATIC POINT-OF-USE MIXING VALVES (ASSE 1070 RATED)
A. Thermostatic type with bronze body construction, corrosion resistant materials, union end stops, check inlets with strainers, 0-200 degree F dial thermometer and discharge shut-off valve. Mixing valves to meet ASSE 1070.

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

PART 3 - EXECUTION
3.01 GENERAL INSTALLATION REQUIREMENTS
A. Prepare valves for shipping as follows:
   1. Protect internal parts against rust and corrosion.
   2. Protect threads, flange faces, and weld ends.
   4. Block check valves in either closed or open position.

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

C. Inspect the shipping container before unpacking to look for damage that could have occurred during transport, and report it to the transportation company immediately. After visual inspection, remove the valve from the shipping container. Make sure the faces are free of any scratches and that there is not any obvious damage to the actuator assembly or valve body.

D. Make sure to note the valve’s model number during the unpacking process. The model number will need to be provided when purchasing replacement parts.

E. Purge and clean all piping to be connected to valve.

F. Install per manufacturer's recommendations.

G. Determine that the valve and its plumbing piping is adequately supported when installed. If a valve is not adequately supported, this could prevent the valve from operating and sealing correctly. Be sure that all mating flanges are in line and parallel to minimize straining on joints and valve body.

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

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

J. Install valves where required for proper operation of piping and equipment, including valves in branch lines where necessary to isolate sections of piping. Locate valves so as to be accessible and so that separate support can be provided when necessary.
K. Install valves with stems pointed up, in vertical position where possible, but in no case with stems pointed downward from horizontal plane unless unavoidable. Install valve drains with hose end adapter and cap on chain for each valve that must be installed with stem below horizontal plane. Ensure installation provides full stem movement.

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

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

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

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

P. When soldering, use paste flux that are approved by the manufacturer for use with lead free alloys.

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

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

S. Valves, except wafer/butterfly types, with the following end connections:
   1. For Copper Tubing, 2-inches and Smaller. Threaded ends except where solder-joint valve-end.
   2. For Copper Tubing, 2-1/2-inches to NPS 4-inches. Flanged ends except where threaded valve-end.
   3. For Copper Tubing: 5-inches and Larger: Flanged ends.
   4. For Steel Piping, 2-inches and Smaller: Threaded ends.
   5. For Steel Piping, 2-1/2-inches to NPS 4-inches: Flanged ends except where threaded valve-end.
   6. For Steel Piping, 5-inches and Larger: Flanged ends.

T. Valve Adjusting and Cleaning:
   1. Inspect valves for leaks. Adjust or replace packing to stop leaks. Replace valve if leak persists.
   2. Valve Identification. Tag valves per Section 22 05 53, Identification for Plumbing Piping and Equipment.

3.02 BALANCING VALVES
A. See General Installation Requirements above.

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

3.03 BALL VALVES
A. See General Installation Requirements above.

3.04 SWING CHECK VALVES
A. See General Installation Requirements above.

B. Swing Check Valve Installation: Install in horizontal position with hinge pin horizontally perpendicular to centerline of pipe. Install for proper direction of flow. Only install where there are 10 pipe diameters of straight pipe upstream of valve.

C. Ejector and Sump Pump-Discharge Check Valves:
   1. 2-inches and Smaller: Bronze swing or spring-loaded lift check valves with bronze disc.
2. 2-1/2-inches and Larger: Rubber flapper swing check valves with lever and weight.

D. Domestic Water and Circulation Pump Discharge Check Valves:
1. 2-inches and Smaller: Bronze body, spring loaded, lead free, lift check.
2. 2-1/2-inches and Larger: Wafer style, silent lift check valve, lead free.

3.05 BACKFLOW PREVENTION ASSEMBLIES
A. See General Installation Requirements above.
B. Install where indicated, and where required by code. Where practical, locate in same room as equipment being protected.
C. Submit product cut sheets to local AHJ for approval prior to purchase and installation.
D. Install as close to wall as possible with clearances for access and maintenance as required by AHJ.
E. Coordinate exact location of installation and type of backflow device serving a particular piece of equipment with AHJ and Architect prior to purchase and installation.
F. Provide wall/floor brackets that are of fully welded, hot dipped galvanized construction, fabricated to meet field conditions. Mount backflow preventer to brackets using cadmium plated “U” type bolts and nuts.
G. Contact local water district/backflow specialist and request backflow installation requirements. Install backflow devices per UPC and local water district/backflow specialist requirements.
H. Route waste piping from air gap waste fitting concealed within walls to point of air gap termination at indirect waste receptor.
I. Follow local codes for installation requirements. Pipe lines should be thoroughly flushed to remove foreign material before installing the unit. Provide a strainer ahead of backflow preventer to prevent disc from unnecessary fouling. Install valve inline with arrow on valve body pointing in the direction of flow. It is important that the valve be easily accessible to facilitate testing and servicing. Do not install in a concealed location.

3.06 PRESSURE REGULATING VALVE-DOMESTIC WATER
A. See General Installation Requirements above.
B. Install valve in the line with arrow on valve body pointing in the direction of flow. This valve should be installed where it is accessible with sufficient clearance for cleaning, service or adjustment. Install the reducing valve when possible before a sill cockline if possible. Before installing the reducing valve hose bibb, flush out the line to remove loose dirt and scale which might damage valve disc and seat.
C. Horizontal installation is recommended. However, valve can be installed in a vertical position. Regulator must be installed in an accessible location to facilitate servicing the regulator.
D. To readjust reduced pressures, loosen adjusting screw nut and turn adjusting screw clockwise to raise reduced pressure and counterclockwise to lower reduced pressure.
E. When reducing valve is used, it makes a closed system; therefore, pressure relief protection must be provided on the downstream side of the reducing valve to protect equipment.
F. Provide pressure relief valve and terminate discharge to indirect waste receiver.
G. Anytime a reducing valve is adjusted, the use of a pressure gauge is recommended to verify correct pressure setting. Do not bottom out adjusting screw or spring cage.
H. Provide inlet and outlet ball valves, and globe valve bypass. Provide pressure gauge on valve outlet.
I. Provide pressure relief valve piped full size to indirect waste receiver or floor drain.
J. Provide factory startup on automatic control valves.

3.07 THERMOSTATIC MASTER MIXING VALVES (ASSE 1017 RATED)
A. See General Installation Requirements above.
B. Install mixing valve per manufacturer's instruction manual.

3.08 THERMOSTATIC POINT-OF-USE MIXING VALVES (ASSE 1070 RATED)
   A. See General Installation Requirements above.
   B. Install mixing valve per manufacturer's instruction manual.

END OF SECTION
SECTION 22 0529 - HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.01 SUMMARY
A. Work Included:
1. Pipe Hangers and Supports for Plumbing Piping and Equipment
2. Wall and Floor Sleeves
3. Building Attachments
4. Flashing
5. Miscellaneous Metal and Materials

1.02 RELATED SECTIONS
A. Contents of Division 22, Plumbing and Division 01, General Requirements apply to this Section.

1.03 REFERENCES AND STANDARDS
A. References and Standards as required by Section 22 00 00, Plumbing Basic Requirements and Division 01, General Requirements.

B. In addition, meet the following:
2. Hanger spacing installation and attachment to meet all manufacturer's requirements and MSS SP-58.
3. Terminology: As defined in MSS SP-90 "Guidelines on Terminology for Pipe Hangers and Supports”.
4. Install piping per SMACNA’s requirements.

1.04 SUBMITTALS
A. Submittals as required by Section 22 00 00, Plumbing Basic Requirements and Division 01, General Requirements.

1.05 QUALITY ASSURANCE
A. Quality assurance as required by Section 22 00 00, Plumbing Basic Requirements and Division 01, General Requirements.

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

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

1.07 PERFORMANCE REQUIREMENTS
A. General - Provide pipe and equipment hangers and supports in accordance with the following:
1. When supports, anchorages, and seismic restraints for equipment, and supports, anchorages, and seismic restraints for piping are not shown on the Drawings, the contractor is responsible for their design.

2. Connections to structural framing are not to introduce twisting, torsion, or lateral bending in the framing members. Provide supplementary steel as required.

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

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

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

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

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

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Pipe Hangers and Supports for Plumbing Piping and Equipment:
   1. Pipe Hangers/Supports:
      a. B-Line Systems, Inc.
      b. Anvil International
      c. HOLDRITE
      d. Erico Co., Inc.
      e. Snappitz Thermal Pipe Shield Manufacturing
      f. Rilco Manufacturing Co. Inc.
      g. Nelson-Olson Inc.
   2. Channel Support Systems:
      a. B-Line Systems, Inc.
      b. Anvil International, Anvit-Strut
      c. Erico Hanger Co., Inc.; O-Strut Div.
      d. Unistrut Corp.
      e. HOLDRITE EZ-Strut Systems
   3. Thermal-Hanger Shield Inserts:
      a. Erico Hanger Co., Inc.
      b. Pipe Shields, Inc.
      c. Rilco Manufacturing Co., Inc.
      d. HOLDRITE Insulation Couplings
   4. Freestanding Roof Supports:
      a. Erico Hanger Co., Inc.
      b. Nelson-Olsen Inc.
      c. B-Line
      d. M. Fab
   5. Pipe Alignment and Secondary Supports:
      a. HOLDRITE
      b. Starquick
      c. Or approved equivalent.

B. Wall and Floor Sleeves:
   1. Below Grade and High Water Table Areas:
      a. Modular Link Sealing System at Pipe Sleeves:
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1) Thunderline Corporation
2) Or approved equivalent.

2. Pre-Engineered Firestop Pipe Penetration Systems:
   a. HOLDRITE HydroFlame
   b. Proset

C. Building Attachments:
   1. Anchor-It
   2. Gunnebo Fastening Corp.
   3. ITW Ramset/Red Head

D. Flashing:
   1. Fastenal
   2. Or approved equivalent.

E. Miscellaneous Metal and Materials:
   1. See Miscellaneous Metal and Materials article below.
   2. Powder-Actuated Fastener Systems:
      a. Gunnebo Fastening Corp.
      b. Hilti, Inc.
      c. ITW Ramset/Red Head.
      d. Masterset Fastening Systems, Inc.

2.02 PIPE HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT

A. Horizontal Piping Hangers and Supports - Horizontal and Vertical Piping, and Hanger Rod Attachments:
   1. Factory fabricated horizontal piping hangers and supports to suit piping systems in accordance manufacturer's published product information.
   2. Use only one type by one manufacturer for each piping service.
   3. Select size of hangers and supports to exactly fit pipe size for bare piping and to exactly fit around piping insulation with saddle or shield for insulated piping.
   4. Provide copper-plated hangers and supports for uninsulated copper piping systems.
   5. Provide padded pipe hangers, clamps and supports for thermoplastic piping system.
   6. Install no hub cast iron pipe and fittings per CISPI 301-09 Installation Procedures for Hubless Cast Iron Pipe and Fittings for Sanitary and Storm Drain Waste and Vent Piping Applications. Brace hubless cast iron pipe and fittings 5-inch and larger with HOLDRITE No Hub Pipe Restraints or approved equivalent.

B. Pipe Hangers, Guides and Channel Systems:
   1. Hanger Rods: Hanger rods continuously threaded or threaded ends only in concealed spaces and threaded ends only in exposed spaces; finish electro-galvanized or cadmium-plated in concealed spaces and prime painted in exposed spaces; sizes per MSS.
   2. Hanger Rod Couplings: Malleable iron rod coupling with elongated center sight gap for visual inspection; to have same finish as hanger rods.
   3. Pipe Rings for Hanger Rods: Pipe sizes 2-inch and smaller, MSS SP Type 6 or Type 10, or approved equivalent. Pipe sizes 2-1/2-inches and larger, clevis type hangers with adjustable nuts on rod. MSS SP Type 1. Pipe rings to have same finish as hanger rods.
   4. Pipe Slides: Type 35 reinforced Teflon slide material (3/32-inch minimum thickness) bonded to steel; highly finished steel or stainless steel contact surfaces to resists corrosion; 60-80 PSI maximum active contact surface loading; steel parts 3/16-inch minimum thickness; attachment to pipe and framing by welding.
   5. Pipe Guides:
      a. Furnish and install pipe guides on continuous runs where pipe alignment must be maintained. Minimum two on each side of expansion joints, spaced per
manufacturer's recommendations for pipe size. Fasten guides securely to pipe and structure. Any contact with chilled water pipe is not to permit heat to be transferred in sufficient quantity to cause condensation on any surface.
b. Furnish and install guides approximately 4 pipe diameters (first guide) and 14 diameters (second guide) away from each end of expansion joints. Guides are not to be used as supports and are in addition to other pipe hangers and supports.

6. Channel Type Pipe Hanging System: Framing members No. 12 gauge formed steel channels, 1-5/8-inch square, conforming to ASTM A570 GR33; one side of channel to have a continuous slot with in-turned lips; framing nut with grooves and spring 1/2-inch size, conforming to ASTM 675 GR60; screws conforming to ASTM A307; fittings conforming to ASTM A575; parts enamel painted or electro-galvanized.

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

D. Thermal-Hanger Shield Inserts: 100-PSI (690-kPa) minimum compressive strength insulation, encased in sheet metal shield.
1. Material for Cold Piping: Water-repellent-treated, ASTM C533, Type I calcium silicate with vapor barrier.
2. Material for Hot Piping: Water-repellent-treated ASTM C533, Type 1 calcium silicate.
3. For Trapeze or Clamped System: Insert and shield cover entire circumference of pipe.
4. For Clevis or Band Hanger: Insert and shield to cover lower 180 degrees of pipe.
5. Insert Length: Extend 2-inches beyond sheet metal shield for piping operating below ambient air temperature.
6. Thermal Hanger Shield Inserts should be provided at the hanger points and guide locations on pipes requiring insulation. The Inserts should consist of Polyisocyanurate (urethane or phenolic insulation) encircling the entire circumference of the pipe with a 360 degree PVC (1.524 mm thick) with a living hinge and J lock and installed during the installation of the piping system.

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

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

G. Continuous Concrete Insert:

H. Beam Clamps:
1. MSS Type 19 and 23, wide throat, with retaining clip.
2. Universal Side Beam Clamp: MSS Type 20.

I. Below Ground:
1. Pipe Hangers: Adjustable Clevis type, Federal Specification WW-H-171 (Type 1), UL listed, stainless steel Type 316. MSS Type 1. If PVC piping to be used, provide Type 1 hanger, coated for PVC piping.
2. Rod: 5/8-inch stainless steel Type 316.
3. Eyebolt: Stainless steel Type 316.
4. Nuts and Washers: Stainless steel Type 316.

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

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

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

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

O. Freestanding Roof Pipe Supports:
   1. Polyethylene high-density U.V. resistant quick "pipe" block with foam pad.
   2. Recommended installation is for pipe blocks to be freestanding.
   3. Piping 3-inches and larger mounted on block type supports.

2.03 WALL AND FLOOR SLEEVES

A. Below Grade and High Water Table Areas:
   1. Modular Link Sealing System at Pipe Sleeves: Neoprene gasket links bolted together around an interior sleeve forming a watertight seal. Use a modular link sealing system at sleeves to continuously fill the annular space between the pipe and the wall opening. Provide Link-seal Type C unless otherwise noted. OS with S-316 stainless construction for continuous water/tank walls.
   2. Sleeves through concrete foundation walls and floors. Ductile iron pipe. Class 50 or 51 pipe conforming to ANSI/AWWA C151/A21.51, cement lined. Pipe sleeve will extend a minimum of 6-inches beyond outside perimeter of foundation. Final placement of sleeve will be confirmed with project's structural engineer. In areas with a high water table, provide AWWA C900, Class 235 plastic pipe in lieu of ductile iron pipe.

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

C. Insulating Caulking: Eagle or Pitcher Super 66 high temperature cement.

D. Fabricated Accessories:
1. Steel Pipe Sleeves: Fabricate from Schedule 40 black or galvanized steel pipe. Remove end burrs by grinding.
2. Sheet Metal Pipe Sleeves: Fabricate from G-90 galvanized sheets closed with lock-seam joints. Provide following minimum gauges for sizes indicated:
   a. Sleeve Size 4-inches in Diameter and Smaller: 18 gauge.
   b. Sleeve Sizes 5-inches to 6-inches: 16 gauge.
   c. Sleeve Sizes 7-inches and Larger: 14 gauge.
   d. Fire-Rated Safing Material:
      1) Rockwool Insulation: Complying with FS-HH-I-558, Form A, Class IV, 6 lbs./cu.ft. density with melting point of 1985 Degrees F and K value of 0.24 at 75 Degrees F.
      2) Calcium Silicate Insulation: Noncombustible, complying with FS-HH-I-523, Type II, suitable for 100 Degrees F to 1200 Degrees F service with K value of 0.40 at 150 Degrees F.

2.04 BUILDING ATTACHMENTS
   A. General: Anchor supports to existing masonry, block and tile walls per anchoring system manufacturer's recommendations or as modified by project Structural Engineer. Provide anchor bolts suitable for cracked concrete.
   B. Anchor Bolts:
      1. Anchor Bolts (Cast-In-Place): Steel bolts, ASTM A307. Nuts to conform to ASTM A194. Design values for shear and tension not more than 80 percent of the allowable listed loads.
      2. Anchor (Expansion) Bolts: Carbon steel to ASTM A307; nut to conform to ASTM A194; drilled-in type. Design values for shear and tension not more than 80 percent of the allowable listed loads.
   C. Beam Clamps:
      1. MSS Type 19 and 23, wide throat, with retaining clip.
      2. Universal Side Beam Clamp: MSS Type 20.
   D. Powder-Actuated Drive Pin Fasteners:
      1. Powder-Actuated Drive-Pin Fasteners: Powder actuated type, drive pin attachments with pull-out and shear capacities appropriate for supported loads and building materials where used.
   E. Mechanical-Anchor Fasteners: Insert-type attachments with pull-out and shear capacities appropriate for supported loads and building materials where used.
   F. Grout: ASTM C1107, Grade B, factory mixed and packaged, nonshrink and nonmetallic, dry, hydraulic-cement grout.
      1. Characteristics: Post hardening and volume adjusting; recommended for both interior and exterior applications.
      3. Design Mix: 5000-PSI (34.5-MPa), 28-day compressive strength.

2.05 FLASHING
   A. Steel Flashing: 26 gauge galvanized steel.
   B. Safes: 8 mil thick neoprene.
   C. Caps: Steel, 22 gauge minimum, 16 gauge at fire-resistant structures.
   D. Provide hot dipped galvanized components for items exposed to weather.

2.06 MISCELLANEOUS METAL AND MATERIALS
   A. Miscellaneous Metal: Provide miscellaneous metal items specified hereunder, including materials, fabrication, fastenings and accessories required for finished installation, where
indicated on Drawings or otherwise not shown on drawings, that are necessary for completion of the project. The Contractor is responsible for their design.

1. Fabricate miscellaneous units to size, shapes and profiles indicated or, if not indicated, of required dimensions to receive adjacent other work to be retained by framing. Except as otherwise shown, fabricate from structural steel shapes and plates and steel bars, of welded construction using mitered joints for field connection. Cut, drill and tap units to receive hardware and similar items.

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

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

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

E. Bolts: Low carbon steel externally and internally threaded fasteners conforming with requirements of ASTM A307; include necessary nuts and plain hardened washers. For structural steel elements supporting mechanical material or equipment from building structural members or connection thereto, use fasteners conforming to ASTM A325.

F. Miscellaneous Materials: Provide incidental accessory materials, tools, methods and equipment required for fabrication.

G. Provide hot dipped galvanized components for items exposed to weather.

H. Use straps, threshold rods and wire with sizes required by SMACNA to support piping.

I. Grout: ASTM C1107, Grade B, factory mixed and packaged, nonshrink and nonmetallic, dry, hydraulic-cement grout.
   1. Characteristics: Post hardening and volume adjusting; recommended for both interior and exterior applications.
   2. Properties: Nonstaining, noncorrosive, and non gaseous.
   3. Design Mix: 5000-PSI (34.5-MPa), 28-day compressive strength.

PART 3 - EXECUTION

3.01 GENERAL INSTALLATION REQUIREMENTS

A. Examination:
   1. Verify building materials to have hangers and attachments affixed in accordance with hangers to be used. Provide supporting calculations.

B. Preparation:
   1. Examine Drawings and coordinate for verification of exact locations of fire and smoke rated walls, partitions, floors and other assemblies. Indicate, by shading and labeling on Record Drawings such locations and label as "1-Hour Wall," "2-Hour Fire/Smoke Barrier," and the like. Determine proper locations for piping penetrations. Set sleeves in place in new floors, walls or roofs prior to concrete pour or grouting.

C. Install hangers, supports, anchors and sleeves after required building structural work has been completed in areas where the work is to be installed. Coordinate with project structural engineer proper placement of inserts, anchors and other building structural attachments.

3.02 PIPE HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT

A. Hangers and Supports:
   1. Comply with MSS SP-58. Pipe Hanger and Support Installation: Install hangers, supports, clamps, and attachments as required to properly support piping from building structure. For horizontally hung grooved-end piping, provide a minimum of 2 hangers per pipe section.
   2. Pipe Ring Diameters:
a. Uninsulated and Insulated Pipe, except where oversized pipe rings are specified: Ring inner diameter to suit pipe outer diameter.
b. Insulated Piping Where Oversized Pipe Rings are Specified and Vibration Isolating Sleeves: Ring inner diameter to suit outer diameter of insulation or sleeve.

3. Oversize Pipe Rings: Provide oversize pipe rings of 2-inch and larger size.


5. Steel Backing in Walls: Provide steel backing in walls to support fixtures and piping hung from steel stud walls.

6. Channel Support System Installation: Arrange for grouping of parallel runs of piping and support together on field-assembled channel systems.
   a. Field assemble and install according to manufacturer's written instructions.

7. Pipe Guides:
   a. Install on continuous runs where pipe alignment must be maintained. Provide a minimum of two on each side of expansion joints, spaced per manufacturer's recommendations for pipe size. Fasten guides to pipe structure. Any contact with chilled water pipe should not permit heat to be transferred in sufficient quantity to cause condensation on any surface.
   b. Install approximately 4 pipe diameters (first guide) and 14 diameters (second guide) away from each end of expansion joints. Do not use as supports. Provide in addition to other required pipe hangers and supports.

8. Heavy-Duty Steel Trapeze Installation: Arrange for grouping of parallel runs of horizontal piping and support together on field-fabricated, heavy-duty trapezes.
   a. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified above for individual pipe hangers.
   b. Field fabricate from ASTM A 36/A 36M, steel shapes selected for loads being supported. Weld steel according to AWS D-1.1

9. Group parallel runs of horizontal piping to be supported together on trapeze-type hangers.

10. Where piping of various sizes is to be supported together by trapeze hangers, space hangers for smallest pipe size or install intermediate supports for smaller diameter pipe.

11. Do not support piping from other piping.

12. Fire protection piping will be supported independently of other piping.

13. Prevent electrolysis in support of copper tubing by use of hangers and supports which are copper plated.

14. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers and other accessories.

15. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchor, and to facilitate the action of expansion joints, expansion loops, expansion bends and similar units.

16. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.

17. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and so maximum pipe deflections allowed by ASME B31.9, "Building Services Piping" is not exceeded.

18. Insulated Piping: (comply with the following)
   a. Attach clamps and spacers to piping.
      1) Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
      2) Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
      3) Do not exceed pipe stress limits according to ASME B31.9.
   b. Install MSS SP-58, Type 39 protection saddles, if insulation without a vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.
1) Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 (DN100) and larger if pipe is installed on rollers.

c. Install MSS SP-58, Type 40 protective shields on cold piping having a vapor barrier. Shields to span arc of 180 degrees.

1) Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 (DN100) and larger if pipe is installed on rollers.

d. Shield Dimensions for Pipe, not less than the following:
1) NPS 1/4 to NPS 3-1/2 (DN8 to DN 90): 12-inches long and 0.048-inch thick.
2) NPS 4 (DN100): 12-inches long and 0.06-inch thick.
3) NPS 5 and NPS 6 (DN125 and DN150): 18-inches long and 0.06-inch thick.
4) NPS 8 to NPS 14 (DN200 to DN350): 24-inches long and 0.075-inch thick.
5) NPS 16 to NPS 24 (DN400 to DN600): 24-inches long and 0.105-inch thick.

e. Pipes NPS 8 (DN200) and Larger: Include wood inserts.

f. Insert Material: Length at least as long as protective shield.

g. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

19. Equipment Clearances: Do not route equipment or piping through electrical rooms, transformer vaults, elevator equipment rooms, IT rooms, or MPOE rooms and the like. Within equipment rooms, provide minimum 3-feet lateral clearance from all sides of electric switchgear panels. Do not route piping or equipment above any electric power or lighting panel, switchgear, or similar electric device. Coordinate with Electrical and coordinate exact equipment or pipe routing to provide proper clearance with such items.

20. Pipe supports and hanger spacing (pipe supported from structure or floor-supported) to meet the requirements of References and Standards Article in Part 1 above.

B. Pipe Curb Assemblies:

1. Provide prefabricated units for roof membrane and insulation penetrations related to equipment. Coordinate with roofing system. Set supports on the structural deck. Do not set supports on insulation or roofing. Provide level supports by prefabricated pitch built into the curb.

2. Pipe Curb Assemblies: Provide for piping and electrical conduit which penetrates the structural roof deck to service equipment above the roof level (i.e., piping, electrical power and control wiring). Meet requirements of roof warranty.

3. Piping above roof to be supported with freestanding roof pipe supports unless detailed otherwise. At roofing applications, the adhesion mastic is to be specifically submitted to and approved by the roofing system manufacturer/installer to maintain the integrity of all warranties.

4. At concrete floors, install a polyurethane mastic to the support block and adhere in place.

C. Vertical Piping:

1. Support with U-clamps fastened to wall to hold piping away from wall unless otherwise approved.

2. Riser to be supported at each floor penetration.

3. Provide structural steel supports at the base of pipe risers. Size supports to carry forces exerted by piping system when in operation.

D. Adjusting and Painting:

1. Adjust hangers so as to distribute loads equally on attachments. Provide grout under supports to bring piping and equipment to proper level and elevations.

2. Prime paint ferrous nongalvanized hangers, accessories, and supplementary steel which are not factory painted.

3.03 WALL AND FLOOR SLEEVES

A. "Link-Seal" Pipe Sleeves: Install at slab on grade floor/below grade piping penetrations. Provide manufacturer's sleeve appropriate to seal type for pre-cast penetrations (except for DWV piping
at slab on grade). Provide manufacturer's sleeve appropriate to seal type for pre-cast penetrations.

B. Fabricated Pipe Sleeves:
1. Provide either steel or sheet metal pipe sleeves accurately centered around pipe routes. Size such that piping and insulation, if any, will have free movement within the sleeve, including allowance for thermal expansion. Sleeve diameter to be determined by local seismic clearance requirement, and by waterproofing requirements.
2. Length: Equal to thickness of construction penetrated, except extend floor sleeves 1-inch above floor finish.
3. Provide temporary support of sleeves during placement in concrete and other work around sleeves. Provide temporary end closures to prevent concrete and other materials from entering pipe sleeves.
4. Seal each end airtight with a resilient nonhardening sealer, UL listed and fire rated per ASTM 814.

### 3.04 BUILDING ATTACHMENTS

A. Anchor Bolts:
1. General: Install anchor bolts for mechanical equipment and piping as required. Tightly fit and clamp base-supported equipment anchor bolts at equipment support points. Provide locknuts where equipment and piping are hung.
2. Anchor bolts (Cast-In-Place): Embed anchor bolts in new cast-in-place concrete to anchor equipment. Install a pipe sleeve around the anchor bolt for adjustment of the top 1/3 of the bolt embedment; sizes and patterns to suit the installation conditions of the equipment to be anchored.

B. Pipe Anchors:
1. General: Provide anchors to fasten piping which is subject to expansion and contraction, and adjacent to equipment to prevent loading high forces onto the equipment.

C. Building Attachments:
1. Install within concrete or on structural steel or wood. Attachment to Wood Structure: Provide MSS Type 34 for attachment to wooden beam or approved attachment for a wood structure.
2. Install additional building attachments where support is required for additional concentrated loads, including valves, flanges, guides, strainers, expansion joints and at changes in direction of piping.
3. Install concrete inserts before concrete is placed; fasten insert secure to forms. Where concrete with compressive strength less than 2500 PSI is indicated, install reinforcing bars through openings at top in inserts.

D. Bolting:
1. General: Provide bored, drilled or reamed holes for bolting to miscellaneous structural metals, frames or for mounts or supports. Flame cut, punched or hand sawn holes will not be accepted.

E. Escutcheon Plates: Install around horizontal and vertical piping at visible penetrations through walls, partitions, floors, or ceilings, including penetrations through closets, through below ceiling corridor wall, and through equipment room walls and floors.

F. Installation of metallic or plastic piping penetrations through non fire-rated walls and partitions and through smoke-rated walls and partitions:
1. Install fabricated pipe sleeve.
2. After installation of sleeve and piping, tightly pack entire annular void between piping or piping insulation and sleeve identification with specified material.
3. Seal each end airtight with a resilient nonhardening UL listed fire resistant ASTM 814 sealant.

G. Piping penetrations through Fire-rated (1 to 3 hour) Assemblies:
1. Select and install pre-engineered pipe penetration system in accordance with the UL listing and manufacturer's recommendation.

2. Provide proper sizing when providing sleeves or core-drilled holes to accommodate the penetration. Firestop voids between sleeve or core-drilled hole and pipe passing through to meet the requirements of ASTM E814. Use HOLDRITE HydroFlame or approved equivalent.

H. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges guides, strainers, and expansion joints, and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.

I. Install powder-actuated drive pin fasteners in concrete after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.

J. Install mechanical-anchor fasteners in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.

K. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers and other accessories.

L. Testing:
   1. Powder-Actuated Inserts: Test powder-actuated insert attachments with a minimum load of 100 pounds.

3.05 FLASHING

A. Flash and counterflash where piping passes through weather or waterproofed walls, floors and roofs.

B. Flash vent soil pipes with flashings per Division 01, General Requirements.

C. Flash floor drains over finished areas and roof drains, 10-inches clear on sides, minimum 36-inches x 36-inches sheet size. See Division 01, General Requirements. Fasten flashing to drain with clamping device.

D. Install built up fixtures (mop sinks, shower stalls, shower floors) with water sealing systems/membranes to meet Code and as prescribed by Division 01, General Requirements and Section 22 00 00, Plumbing Basic Requirements. Meet all Code testing requirements. Provide drainage devices with appropriate flanges, clamps, etc. to meet these installation requirements and ensure a water-tight installation.

3.06 MISCELLANEOUS METAL AND MATERIALS

A. Coordinate and furnish anchorages, setting drawings, diagrams, templates, instructions and directions for installation of anchorages, such as concrete inserts, sleeves, anchor bolts and miscellaneous items having integral anchors, which are to be embedded in concrete or masonry construction. Coordinate delivery of such items to project site.

B. Fastening to In-Place Construction: Provide anchorage devices and fasteners where necessary for securing miscellaneous metal fabrications to in-place construction; including, threaded fasteners for concrete and masonry inserts, toggle bolts, through-bolts, lag bolts, wood screws and other connectors as required. Avoid cutting concrete reinforcing when drilling for inserts. Reference structural drawings and reinforcing shop drawings and determine locations of stirrups prior to drilling into concrete.

C. Cutting, Fitting and Placement: Perform cutting, drilling and fitting required for installation of miscellaneous metal fabrications. Set work accurately in location, alignment and elevation, plumb, level, true and free of rack, measured from established lines and levels. Provide temporary bracing or anchors in formwork for items which are to be built into concrete masonry or similar construction.
D. Field Welding: Comply with AWS Code for procedures of manual shielded metal-arc welding, appearance and quality of welds made, and methods used in correcting welding work.

   1. Set loose leveling and bearing plates on wedges or other adjustable devices. After the bearing members have been positioned and plumbed, tighten the anchor bolts. Do not remove wedges or shims, but if protruding, cut-off flush with edge of the bearing plate before packing with grout. Use metallic non-shrink grout in concealed locations where not exposed to moisture; use non-metallic non-shrink grout in exposed locations, unless otherwise indicated.
   2. Pack grout solidly between bearing surfaces and plates to ensure that no voids remain.

F. Fabrication:
   1. General: Verify dimensions prior to fabrication. Form metal items to accurate sizes and configurations as indicated on Drawings and otherwise required for proper installation; make with lines straight and angles sharp, clean and true; drill, countersink, tap, and otherwise prepare items for connections with work of other trades, as required. Fabricate to detail of structural shapes, plates and bars; weld joints where practicable; provide bolts and other connection devices required. Include anchorages; clip angles, sleeves, anchor plates and similar devices. Hot dip galvanize after fabrication items installed in exterior locations. Set accurately in position as required and anchor securely to building construction. Construct items with joints formed for strength and rigidity, accurately machining for proper fit; where exposed to weather, form to exclude water.
   2. Finishes:
      a. Ferrous Metal: After fabrication, but before erection, clean surfaces by mechanical or chemical methods to remove rust, scale, oil, corrosion, or other substances detrimental to bonding of subsequently applied protective coatings. For metal items exposed to weather or moisture, galvanize in manner to obtain G90 zinc coating in accordance with ASTM A123. Provide other non-galvanized ferrous metal with 1 coat of approved rust-resisting paint primer, in manner to obtain not less than 1.0 mil dry film thickness. Touch-up damaged areas with primer of same material before installation. Apply zinc coatings and paint primers uniformly and smoothly; leave ready for finish painting as specified elsewhere.
      b. Metal in contact with Concrete, Masonry and Other Dissimilar Materials:
         1) Where metal items are to be erected in contact with dissimilar materials, provide contact surfaces with coating of an approved zinc-chromate primer in manner to obtain not less than 1.0 mil dry film thickness, in addition to other coatings specified in these specifications.
      c. For Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and apply galvanizing repair paint to comply with ASTM A780.

G. Metal Fabrication:
   1. Cut, drill, and fit miscellaneous metal fabrications for heavy-duty steel trapezes and equipment supports.
   2. Fit exposed connections together to form hairline joints. Field-weld connections that cannot be shop-welded because of shipping size limitations.
   3. Field Welding: Comply with AWS D1.1 procedures for shielded metal arc welding, appearance and quality of weld and methods used in correcting welding work, and with the following:
      a. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
      b. Obtain fusion without undercut or overlap.
      c. Remove welding flux immediately.
d. Finish welds at exposed connections so no roughness shows after finishing and contours of welded surfaces match adjacent contours.
4. Provide hot dipped galvanized components for items exposed to weather.

END OF SECTION
SECTION 22 0533 - HEAT TRACING FOR PLUMBING PIPING

PART 1 - GENERAL

1.01 SUMMARY
   A. Work Included:

1.02 RELATED SECTIONS
   A. Contents of Division 22, Plumbing and Division 01, General Requirements apply to this Section.
      1. Section 22 07 00 - Plumbing Insulation
      2. Section 26 00 00 - Electrical Basic Requirements

1.03 REFERENCES AND STANDARDS
   A. References and Standards as required by Section 22 00 00, Plumbing Basic Requirements and Division 01, General Requirements.
   B. In addition, meet the following:
      1. UL 718K Pipe Heating Cable.
      2. CSA Design 3A, 3B, 3C.

1.04 SUBMITTALS
   A. Submittals as required by Section 22 00 00, Plumbing Basic Requirements and Division 01, General Requirements.
   B. In addition, provide:
      1. Project Record Documents: Record physical locations of thermostats.

1.05 QUALITY ASSURANCE
   A. Quality assurance as required by Section 22 00 00, Plumbing Basic Requirements and Division 01, General Requirements.
   B. In addition, meet the following:
      1. Provide minimum heat tracing capacities per linear foot as scheduled on Drawings.

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

PART 2 - PRODUCTS

2.01 MANUFACTURERS

PART 3 - EXECUTION

3.01 GENERAL INSTALLATION REQUIREMENTS
   A. General: Installation to be by Division 26, Electrical.

END OF SECTION
PART 1 - GENERAL

1.01 SUMMARY
A. Work Included:
   1. Plastic Nameplates
   2. Tags
   3. Plastic Pipe Markers

1.02 RELATED SECTIONS
A. Contents of Division 22, Plumbing and Division 01, General Requirements apply to this Section.

1.03 REFERENCES AND STANDARDS
A. References and Standards as required by Section 22 00 00, Plumbing Basic Requirements and Division 01, General Requirements.

1.04 SUBMITTALS
A. Submittals as required by Section 22 00 00, Plumbing Basic Requirements and Division 01. General Requirements.

B. In addition, submit Valve Schedule for each piping system, in tabular format using Microsoft Word or Excel software. Tabulate valve number, piping system, system abbreviation (as shown on tag), location of valve (room or space), and variations for identification (if any). Mark valves which are intended for emergency shutoff and similar special uses by special "flags" in margin of schedule. In addition to mounted copies, furnish extra copies for maintenance manuals. Provide schedules organized as follows:
   1. Equipment Type:
      a. Identification:
      b. Background:
         1) Size:
         2) Color:
      c. Lettering:
         1) Size:
         2) Color:

C. For renovations or expansions of existing systems, coordinate with Owner and develop valve schedule on existing schedule naming and format.

1.05 QUALITY ASSURANCE
A. Quality assurance as required by Section 22 00 00, Plumbing Basic Requirements and Division 01, General Requirements.

B. In addition, meet the following:
   1. Manufacturer's Qualifications: Firms regularly engaged in manufacture of identification devices of types and sizes required.
   2. Codes and Standards: Comply with ANSI A13.1 for lettering size, length of color field, colors, and viewing angles of identification devices unless otherwise indicated.

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

PART 2 - PRODUCTS

2.01 MANUFACTURERS
A. General: Manufacturer's standard products of categories and types required for each application as referenced in other Division 22, Plumbing Sections. Where more than a single type is specified for application, provide single selection for each product category.
B. Plastic Nameplates:
   1. Brady Corporation
   2. Or approved equivalent.

C. Tags:
   1. Brady Corporation
   2. Brimer
   3. Champion America Inc.
   4. Craftmark
   5. Seton Identification Products
   6. Or approved equivalent.

D. Plastic Pipe Markers:
   1. Brady Corporation
   2. Brimer
   3. Champion America Inc.
   4. Craftmark
   5. Seton Identification Products
   6. Or approved equivalent.

2.02 PLASTIC NAMEPLATES

A. Description: Engraving stock melamine plastic laminate 1/8-inch thick, engraved with engraver's standard letter style of the sizes and wording indicated.
   2. Letter Height: 1/2 inch (13 mm).
   4. Fasteners: Self-tapping stainless steel screws, except contact-type permanent adhesive where screws cannot or should not penetrate the substrate.
   5. Access Panel Markers: Manufacturer's standard 1/16-inch thick engraved plastic laminate access panel markers, with abbreviations and numbers corresponding to concealed valve or devices/equipment. Include center hole to allow attachment.
   6. Signage for hot water outlets on 140 degree F hot water systems not protected by ASSE 1070 mixing valves; hose bibbs, janitor sinks, and fixtures used by trained personnel.
      a. Manufacturer's standard 1/8-inch thick engraved plastic laminate signage 4 by 4-inches.
      b. Letter Color: Red.
      c. Letter Height: 1/2 inch (13 mm).
      d. Background Color: White.
      e. Fasteners: Self-tapping stainless steel screws, except contact-type permanent adhesive where screws cannot or should not penetrate the substrate.

2.03 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: Polished Brass with stamped letters; tag size minimum 1-1/2-inch diameter with smooth edges.

C. Valve designations to be coordinated with existing valve identifications to ensure no repetitive designations are utilized.

D. Chart/Schedules: Valve Schedule Frames. For each page of a valve schedule, provide glazed display frame with removable mounting as appropriate for wall construction upon which frame is to be mounted. Provide frames of finished hardwood or extruded aluminum, with SSB-grade sheet glass.

E. Valve Tag Fasteners: Solid brass chain (wire link or beaded type), or solid brass S-hooks.
F. Warning Tags: Preprinted or partially preprinted, accident-prevention tags; of plasticized card stock with matte finish suitable for writing.
   1. Size: Approximately 4 by 7-inches.
   2. Fasteners: Brass grommet and wire.
   3. Nomenclature: Large-size primary caption such as DANGER, CAUTION, or DO NOT OPERATE.

2.04 PLASTIC PIPE MARKERS
   B. Plastic Pipe Markers (for external diameters of 6-inches and larger including insulation):
      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 (for external diameters less than 6-inches including insulation):
      Flexible, vinyl film tape with pressure sensitive adhesive backing and printed markings.
      Minimum information indicating flow direction arrow and identification of fluid being conveyed.

PART 3 - EXECUTION

3.01 GENERAL INSTALLATION REQUIREMENTS
   A. Lettering and Graphics:
      1. General: Coordinate names, abbreviations and other designations used in plumbing identification work with corresponding designations shown, specified or scheduled. Provide numbers, lettering and wording as indicated or, if not otherwise indicated, as recommended by manufacturers or as required for proper identification and operation/maintenance of mechanical systems and equipment.
      2. Multiple Systems: Where multiple systems of same generic name are shown and specified, provide identification which indicates individual system number as well as service (as examples: Chiller No. 3, Air Handling Unit No. 42, Standpipe F12, and the like).
   B. Preparation: Degrease and clean surfaces to receive adhesive for identification materials.
   C. Coordination: Where identification is to be applied to surfaces which require insulation, painting or other covering or finish, including valve tags in finished mechanical spaces, install identification after completion of covering and painting. Install identification prior to installation of acoustical ceilings and similar removable concealment.
   D. Install valve schedule at each mechanical room.
   E. Access Doors: Provide stenciled signs on each access door and housings, indicating purpose of access (to what equipment) and other maintenance and operating instructions.

3.02 PLASTIC NAMEPLATES
   A. Install plastic nameplates with corrosive-resistant mechanical fasteners.

3.03 TAGS
   A. Coordinate with the facility maintenance personnel to ensure consistency with the existing taggig system.
   B. Tag balancing valves with balanced GPM or CFM indicated after balancing is completed and accepted.
   C. Install tags with corrosion resistant chain.
   D. Identify pumps, heat transfer equipment, tanks, and water treatment devices with plastic nameplates riveted to equipment body. Small devices, such as in-line pumps, may be identified with tags.
   E. Identify control panels and major control components outside panels with plastic nameplates riveted to equipment body.
F. Identify valves in main and branch piping with metal tags. Indicate valve function and the normally open or closed positions on the valve tag.

3.04 PLASTIC PIPE MARKERS

A. Install plastic pipe markers in accordance with manufacturer's instructions.

B. Install plastic tape pipe markers complete around pipe in accordance with manufacturer's instructions.

C. For exterior underground piping installations, Install underground plastic pipe markers with tracer wire 6 to 8-inches below finished grade directly above buried pipe.

D. Identify piping, concealed or exposed, with plastic tape pipe markers. Use metal tags on piping 3/4-inch diameter and smaller. Identify service, flow direction, and pressure. Install in clear view and align with axis of piping. Locate identification not to exceed 20-feet (reduced to 10-feet in congested areas and mechanical equipment rooms) 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. Locate near branches, valves, control devices, equipment connections, access doors, floor/wall penetrations.

END OF SECTION
SECTION 22 0593 - TESTING, ADJUSTING, AND BALANCING FOR PLUMBING

PART 1 - GENERAL

1.01 SUMMARY
A. Work Included:
   1. Balancing water flow within distribution systems of all Division 22, Plumbing Sections, including sub-mains, branches, and terminals, to indicated quantities according to specified tolerances.
   2. Adjusting plumbing systems to provide indicated quantities.
   3. Verifying that automatic control devices are functioning properly.
   4. Reporting results of the activities and procedures specified in this Section.

1.02 RELATED SECTIONS
A. Contents of Division 22, Plumbing and Division 01, General Requirements apply to this Section.

1.03 REFERENCES AND STANDARDS
A. References and Standards as required by Section 22 00 00, Plumbing Basic Requirements and Division 01, General Requirements.

1.04 SUBMITTALS
A. Submittals as required by Section 22 00 00, Plumbing Basic Requirements and Division 01, General Requirements.

1.05 QUALITY ASSURANCE
A. Quality assurance as required by Section 22 00 00, Plumbing Basic Requirements and Division 01, General Requirements.

B. In addition, meet the following:
   1. Acceptable Balance Firm:
      a. General:
         1) Procure services of independent Testing, Adjusting, and Balancing (TAB) agency to balance, adjust and test water circulating. Minimum Experience: 5 years.
      b. Industry Standards: Testing and Balancing will conform to NEBB, American Society of Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE), and American National Standards Institute (ANSI) as follows:
         2) ASHRAE: Comply with recommendations pertaining to measurements, instruments, and TAB.
      c. Test Observation: If requested, conduct tests in the presence of the Architect or the Architect's representative.
   2. Provide proof of testing agency having successfully completed at least five projects of similar size and scope.
   3. Code Compliance: Perform tests in the presence of the Authority Having Jurisdiction (AHJ) where required by the Authority Having Jurisdiction (AHJ).
   4. Owner Witness: Perform tests in the presence of the Owners representative.
   5. Engineer Witness: The engineer or engineer's representative reserves the right to observe tests or selected tests to assure compliance with the specifications.
   6. Simultaneous Testing: Test observations by the Authority Having Jurisdiction (AHJ), the Owner's representative and the engineer's representative need not occur simultaneously.
   7. Do not perform TAB work until plumbing equipment has been completely installed and is operating continuously as required.
   8. Conduct TAB with clean filters in place. Clean strainers prior to performing TAB.
   9. Agent Qualifications: Engage a TAB Agent certified by AABC or NEBB.
10. **TAB Conference**: Meet with the Owner's and the Architect's representatives on approval of the TAB strategies and procedures plan to develop a mutual understanding of the details. Ensure the participation of TAB team members, equipment manufacturers' authorized service representatives, controls Installer, and other support personnel. Provide 7 days advance notice of scheduled meeting time and location.
   a. **Agenda Items**: Include at least the following:
      1) Submittal distribution requirements.
      2) TAB plan.
      3) Work schedule and Project site access requirements.
      4) Coordination and cooperation of trades and subcontractors.
      5) Coordination of documentation and communication flow.

11. **Certification of TAB Reports**: Certify the TAB field data reports. This certification includes the following:
   a. Review field data reports to validate accuracy of data and to prepare certified TAB reports.
   b. Certify that the TAB team complied with the approved TAB plan and the procedures specified and referenced in this Specification.

12. **TAB Reports**: Use standard forms from AABC's "National Standards for Testing, Adjusting, and Balancing."


14. **Instrumentation Type, Quantity, and Accuracy**: As described in AABC national standards.

15. **Instrumentation Type, Quantity, and Accuracy**: As described in NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems," Section II, "Required Instrumentation for NEBB Certification."

16. **Instrumentation Calibration**: Calibrate instruments at least every 6 months or more frequently if required by the instrument manufacturer.

### 1.06 WARRANTY

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

### 1.07 DEFINITIONS

A. **Adjust**: To regulate fluid flow rate at the equipment.

B. **Balance**: To proportion flows within the distribution system, including sub mains, branches, and terminals, according to design quantities.

C. **Procedure**: An approach to and execution of a sequence of work operations to yield repeatable results.

D. **Report Forms**: Test data sheets for recording test data in logical order.

E. **Static Head**: The pressure due to the weight of the fluid above the point of measurement. In a closed system, static head is equal on both sides of the pump.

F. **Suction Head**: The height of fluid surface above the centerline of the pump on the suction side.

G. **System Effect**: A phenomenon that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.

H. **System Effect Factors**: Allowances used to calculate a reduction of the performance ratings of a fan when installed under conditions different from those presented when the fan was performance tested.

I. **TAB**: Testing, Adjusting, and Balancing.

J. **Terminal**: A point where the controlled medium, such as fluid or energy, enters or leaves the distribution system.

K. **Test**: A procedure to determine quantitative performance of a system or equipment.
L. Testing, Adjusting, and Balancing (TAB) Agent: The entity responsible for performing and reporting the TAB procedures.


O. CTI: Cooling Tower Institute.

P. NEBB: National Environmental Balancing Bureau.

Q. SMACNA: Sheet Metal and Air Conditioning Contractors' National Association.

1.08 COORDINATION

A. Coordinate the efforts of factory-authorized service representatives for systems and equipment, controls installers, and other mechanics to operate systems and equipment to support and assist TAB activities.

B. Notice: Provide 7 days advance notice for each test. Include scheduled test dates and times.

C. Perform TAB after leakage and pressure tests on piping distribution systems have been satisfactorily completed.

PART 2 - PRODUCTS - NOT USED

PART 3 - EXECUTION

3.01 PROJECT CONDITIONS

A. Full Owner Occupancy: The Owner will occupy the site and existing building during the entire TAB period. Cooperate with the Owner during TAB operations to minimize conflicts with the Owner's operations.

B. Partial Owner Occupancy: The Owner may occupy completed areas of the building before Substantial Completion. Cooperate with the Owner during TAB operations to minimize conflicts with the Owner's operations.

C. Non-Owner Occupancy: Complete balancing of building systems prior to Substantial Completion and owner occupancy.

3.02 EXAMINATION

A. Examine Contract Documents to become familiar with project requirements and existing building record documents (if available) to discover conditions in systems' designs that may preclude proper TAB of systems and equipment.

1. Contract Documents are defined in the General and Supplementary Conditions of the Contract.

2. Verify that balancing devices, such as test ports, gauge cocks, thermometer wells, flow-control devices, balancing valves and fittings are required by the Contract Documents. Verify that quantities and locations of these balancing devices are accessible and appropriate for effective balancing and for efficient system and equipment operation.

B. Examine approved submittal data of Plumbing systems and equipment.

C. Examine equipment performance data including pump curves. Relate performance data to project conditions and requirements, including system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.

D. Examine system and equipment installations to verify that they are complete and that testing, cleaning, adjusting, and commissioning specified in individual Specification Sections have been performed.

E. Examine system and equipment installations to verify that indicated balancing devices, such as test ports, gauge cocks, thermometer wells, flow-control devices, balancing valves and fittings are properly installed, and their locations are accessible and appropriate for effective balancing and for efficient system and equipment operation.
F. Examine systems for functional deficiencies that cannot be corrected by adjusting and balancing.

G. Examine open-piping-system pumps to ensure absence of entrained air in the suction piping.

H. Examine equipment for installation and for properly operating safety interlocks and controls.

I. Examine automatic temperature system components to verify the following:
   1. Valves, and other controlled devices operate by the intended controller.
   2. Valves are in the position indicated by the controller.
   3. Integrity of valves for free and full operation and for tightness of fully closed and fully open positions.
   4. Automatic modulating and shutoff valves, including 2-way valves and 3-way mixing and diverting valves, are properly connected.
   5. Sensors are located to sense only the intended conditions.
   6. Sequence of operation for control modes is according to the Contract Documents.
   7. Controller set points are set at design values. Observe and record system reactions to changes in conditions. Record default set points if different from design values.

J. Report deficiencies discovered before and during performance of TAB procedures.

K. Beginning of work means acceptance of existing conditions.

3.03 PREPARATION

A. Prepare a TAB plan that includes strategies and step-by-step procedures.

B. Complete system readiness checks and prepare system readiness reports. Verify the following:
   1. Permanent electrical power wiring is complete.
   2. Systems are filled, clean, and free of air.
   3. Automatic temperature-control systems are operational.
   4. Isolating and balancing valves are open and control valves are operational.

C. Hold a pre-balancing meeting at least one week prior to starting TAB work.
   1. Attendance is required by installers whose work will be tested, adjusted, or balanced.

D. Provide instruments required for TAB operations. Make instruments available to Architect to facilitate spot checks during testing.

3.04 GENERAL TESTING AND BALANCING PROCEDURES

A. Perform TAB procedures on each system according to the procedures contained in AABC national standards or NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems" and this Section.

B. Cut insulation for pipes, and equipment cabinets for installation of test probes to the minimum extent necessary to allow adequate performance of procedures. After testing and balancing, close probe holes and patch insulation with new materials identical to those removed. Restore vapor barrier and finish according to the insulation Specifications for this Project.

C. Mark equipment settings with paint or other suitable, permanent identification material, including control positions, valve indicators and similar controls and devices, to show final settings.

3.05 ADJUSTMENT TOLERANCES

A. Piping Systems: Adjust to within plus or minus 10 percent of design.

3.06 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.
   4. Lists of completed tests.

B. Ensure recorded data represents actual measured or observed conditions.
C. Permanently mark settings of valves and other adjustment devices allowing settings to be restored. Set and lock memory stops.
D. Mark on drawings locations where other critical measurements were taken and cross reference location in final report.

3.07 FUNDAMENTAL PROCEDURES FOR PIPING SYSTEMS
A. Prepare test reports with pertinent design data and number in sequence starting at pump to end of system. Check the sum of branch-circuit flows against approved pump flow rate. Correct variations that exceed plus or minus 10 percent.
B. Prepare schematic diagrams of systems' "as-built" piping layouts.
C. Prepare systems for TAB according to the following, in addition to the general preparation procedures specified above:
   1. Open manual valves for maximum flow.
   2. Check expansion tank liquid level, or air charge if bladder type.
   3. Check makeup-water-station pressure gauge for adequate pressure.
   4. Check flow-control valves for specified sequence of operation and set at design flow.
   5. Check pump-motor load. If motor is overloaded, throttle main flow-balancing device so motor nameplate rating is not exceeded.

3.08 FINAL REPORT
A. General: Computer printout in letter-quality font, on standard bond paper, in 3-ring binder, tabulated and divided into Sections by tested and balanced systems.
B. Include a certification sheet in front of binder signed and sealed by the certified TAB engineer.
   1. Include a list of the instruments used for procedures, along with proof of calibration.
C. Final Report Contents: In addition to the certified field report data, include the following:
   1. Pump curves.
   2. Field test reports prepared by system and equipment installers.
   3. Other information relative to equipment performance, but do not include approved Shop Drawings and Product Data.
D. General Report Data: In addition to the form titles and entries, include the following data in the final report, as applicable:
   1. Title page.
   2. Name and address of TAB Agent.
   3. Project name.
   4. Project location.
   5. Architect's name and address.
   6. Engineer's name and address.
   7. Contractor's name and address.
   9. Signature of TAB Agent who certifies the report.
   10. Summary of contents, including the following:
       a. Design versus final performance.
       b. Notable characteristics of systems.
       c. Description of system operation sequence if it varies from the Contract Documents.
   11. Nomenclature sheets for each item of equipment.
   12. Notes to explain why certain final data in the body of reports vary from design values.
E. Pump Test Reports: For pumps, include the following data. Calculate impeller size by plotting the shutoff head on pump curves.
   1. Unit Data: Include the following:
      a. Unit identification.
      b. Location.
c. Service.
d. Make and size.
e. Model and serial numbers.
f. Water flow rate in gpm (L/s).
g. Water pressure differential in feet of head or PSIG (kPa).
h. Required net positive suction head in feet of head or PSIG (kPa).
i. Pump rpm.
j. Impeller diameter in inches.
k. Motor make and frame size.
l. Motor horsepower and rpm.
m. Voltage at each connection.

END OF SECTION
PART 1 - GENERAL

1.01 SUMMARY

A. Work Included:
   1. Type 1, Glass Wool Pipe Insulation
   2. Type 2, Flexible Elastomeric Insulation
   3. Type 5, Glass Wool Equipment Insulation
   4. Type 7, ADA Accessible Lavatory/Sink Insulation Kit
   5. Accessories
   6. Pipe Fitting Insulation Covers

1.02 RELATED SECTIONS

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

1.03 REFERENCES AND STANDARDS

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

B. In addition, meet the following:
   1. Piping insulation products to contain less than 0.1 percent by weight PBDE in all insulating materials.

1.04 SUBMITTALS

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

B. In addition, provide:
   1. Installer qualifications.
   2. Product Data: Identify thermal conductivity, thickness, and jackets (both factory and field applied, if any), for each type of product indicated.
   3. Material Test Reports: From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of insulation materials, sealers, attachments, cements, and jackets with requirements indicated. Include dates of tests.
   4. Installer Certificates: Signed by the Contractor certifying that installers comply with requirements.
   5. Submit manufacturer's installation instructions.

1.05 QUALITY ASSURANCE

A. Quality assurance as required by Section 22 00 00, Plumbing Basic Requirements and Division 01, General Requirements apply to this Section.

B. In addition, meet the following:
   1. Formaldehyde Free: Should be third-party certified with UL Environment Validation.
   2. Recycled Content: A minimum of 40 percent post-consumer recycled glass content certified and UL validated.
   3. Low Emitting Materials: For all thermal and acoustical applications of Glass Mineral Wool Insulation products, provide materials complying with the testing and products requirements of UL GREENGUARD Gold Certification.
   4. Installer to have minimum 5 years' experience in the business of installing insulation.

1.06 WARRANTY

A. Warranty of materials and workmanship as required by Section 22 00 00, Plumbing Basic Requirements and Division 01, General Requirements.
1.07 FIRE HAZARD CLASSIFICATION  
   A. Maximum fire hazard classification of the composite insulation construction as installed to be not more than a Flame Spread Index (FSI) of 25 and Smoke Developed Index (SDI) of 50 as tested by current edition of ASTM E84 (NFPA 255) method.  
   B. Test pipe insulation in accordance with requirements of current edition of UL "Pipe and Equipment Coverings".  

PART 2 - PRODUCTS  

2.01 MANUFACTURERS  
   A. Type 1, Glass Wool Pipe Insulation:  
      1. Owens-Corning  
      2. Johns Manville  
      3. Or approved equivalent.  
   B. Type 2, Flexible Elastomeric Insulation:  
      1. Glue:  
         a. Armacell LLC Armaflex Low VOC Adhesive  
         b. Halstead  
         c. Or approved equivalent.  
      2. Paint:  
         a. Armacell LLC Armaflex  
         b. Halstead  
         c. Or approved equivalent.  
   C. Type 5, Glass Wool Equipment Insulation:  
      1. Knauf  
      2. Owens-Corning  
      3. Johns Manville  
      4. Or approved equivalent.  
   D. Type 7, ADA Accessible Lavatory/Sink Insulation Kit:  
      1. IPS/Truebro  
      2. McGuire/Pro-Wrap  
      3. Plumberex/Pro-Extreme  
      4. Brocar Trap Wrap  
   E. Accessories:  
      1. ITW Insulation Systems  
      2. Or approved equivalent.  
   F. Pipe Fitting Insulation Covers:  
      1. Zeston Johns Manville  
      2. ITW Insulation Systems  
      3. Or approved equivalent.  

2.02 TYPE 1, GLASS WOOL PIPE INSULATION  
   A. Glass Fiber: ASTM C547 Type I and IV; rigid molded, noncombustible.  
      1. Thermal Conductivity Value: 0.27 BTU\textsuperscript{*}in/(hr*sf*F) at 75 degrees F.  
      2. Maximum Service Temperature: 850 degrees F to 1000 degrees F.  
      3. Vapor Retarder Jacket: White Kraft paper reinforced with glass fiber and bonded to aluminum foil, with self-sealing longitudinal laps and butt strips or vapor barrier mastic.  

2.03 TYPE 2, FLEXIBLE ELASTOMERIC INSULATION  
   A. Elastomeric Foam: ASTM C534; flexible, cellular elastomeric, molded or sheet.  
      1. Thermal Conductivity Value: 0.25 BTU\textsuperscript{*}in/(hr*sf*F) at 75 degrees F.  
      2. Maximum Service Temperature of 220 degrees F.  
4. Maximum Smoke Developed: 50 (3/4-inch thick and below).
5. Connection: Waterproof vapor retarder adhesive as needed.
6. UV Protection: UV outdoor protective coating per manufacturer’s requirements.

B. Glue: Contact adhesive specifically manufactured for cementing flexible elastomeric foam.
C. Paint: Nonhardening high elasticity type, specifically manufactured as a protective covering of flexible elastomeric foam insulation for prevention of degradation due to exposure to sunlight and weather.

2.04 TYPE 5, GLASS WOOL EQUIPMENT INSULATION
A. Flexible Glass Wool Blanket: ASTM C612; flexible.
   1. Thermal Conductivity Value: 0.24 BTU*in/(hr*sf*F) at 75 degrees F.
   2. Maximum Service Temperature: 450 degrees F.

2.05 TYPE 7, ADA ACCESSIBLE LAVATORY/SINK INSULATION KIT
A. P-traps, trap arms, tail pieces, hot water and cold water insulating guards. Molded closed cell insulation with vinyl cover and nylon fasteners, paintable. Thermal conductivity; K = 1.17 (BTU*in/(hr*sf*F)) at 75 degrees F mean temperature. Provide accessories as required for complete installation covering all exposed waste piping, water piping, stops and supplies. Color white.

2.06 ACCESSORIES
A. Equipment Insulation Compounds: Provide adhesives, cement, sealers, mastics and protective finishes as recommended by insulation manufacturer for applications indicated.
B. Provide staples, bands, wire, wire netting, tape corner angles, anchors, stud pins and metal covers as recommended by insulation manufacturer for applications indicated. Accessories, i.e., adhesives, mastics, cements and tape to have same flame and smoke component ratings as insulation materials with which they are used. Shipping cartons to bear a label indicating that flame and smoke ratings do not exceed those listed above. Provide permanent treatment of jackets or facings to impart flame and smoke safety. Provide non-water soluble treatments. Provide UV protection recommended by manufacturer for outdoor installation.

2.07 PIPE FITTING INSULATION COVERS
A. PVC Plastic Fitting Covers: Schuller Zeston 2000, Knauf Proto Fitting or approved equivalent. One-piece molded type fitting covers and jacketing material, gloss white. Connections: Tacks; pressure sensitive color matching vinyl tape.

PART 3 - EXECUTION
3.01 GENERAL INSTALLATION INFORMATION
A. Verification of Conditions:
   1. Do not apply insulation until pressure testing and inspection of piping has been completed. Do not apply insulation over heat tracing temperature maintenance until system has been tested.
   2. Examine areas and conditions under which insulation will be installed. Do not proceed with work until unsatisfactory conditions have been corrected.
B. Preparation: Clean and dry surfaces to be insulated.
C. Installation:
   1. Insulation: Continuous through walls, floors and partitions except where noted otherwise.
   2. Piping and Equipment:
      a. Install insulation over clean, dry surfaces with adjoining sections firmly butted together and covering surfaces. Fill voids and holes. Seal raw edges. Install insulation in a manner such that insulation may be split, removed, and reinstalled with vapor barrier tape on strainer caps and unions. Do not install insulation until piping has been leak tested and has passed such tests. Do not insulate manholes, equipment.
manufacturer's nameplates, handholes, and ASME stamps. Provide beveled edge at such insulation interruptions. Repair voids or tears.

b. Cover insulation on pipes above ground, outside of building, with aluminum jacketing. Position lap on bottom of pipe.

D. Provide accessories as required. See Part 2 Article "Accessories" above.

E. Protection and Replacement: Protect installed insulation during construction. Replace damaged insulation which cannot be repaired satisfactorily, including units with vapor barrier damage and moisture saturated units.

F. Labeling and Marking: Provide labels, arrows and color coding on piping. Attach labels and flow direction arrows to jacketing per Section 22 05 53, Identification for Plumbing Piping and Equipment.

G. Piping Surfaces to be Insulated:

<table>
<thead>
<tr>
<th>Item to be Insulated</th>
<th>System Insulation Type</th>
<th>Pipe Size</th>
<th>Insulation Thickness</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hot Water Piping Above Grade</td>
<td>1</td>
<td>Runouts up to 1-1/2-inch</td>
<td>1-inch</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Mains =&lt;1-1/2-inch</td>
<td>1-inch</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Mains &gt;1-1/2-inch</td>
<td>1-1/2-inch</td>
</tr>
<tr>
<td>Hot Water Circulation Piping Above Grade</td>
<td>1</td>
<td>Runouts up to 1-1/2-inch</td>
<td>1-inch</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Mains =&lt;1-1/2-inch</td>
<td>1-inch</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Mains &gt;1-1/2-inch</td>
<td>1-1/2-inch</td>
</tr>
<tr>
<td>Domestic Cold Water Piping Above Grade</td>
<td>1</td>
<td>=&lt;1-1/2-inch</td>
<td>1/2-inch</td>
</tr>
<tr>
<td></td>
<td></td>
<td>&gt;1-1/2-inch</td>
<td>1-inch</td>
</tr>
<tr>
<td>Domestic Water Piping Exposed to Weather</td>
<td>1, 2, 4</td>
<td>All</td>
<td>1-1/2-inch</td>
</tr>
<tr>
<td>Piping with Heat Tracing</td>
<td>1, 2, 4</td>
<td>=&lt;1-1/2-inch</td>
<td>1-inch</td>
</tr>
<tr>
<td></td>
<td></td>
<td>&gt;1-1/2-inch</td>
<td>1-1/2-inch</td>
</tr>
<tr>
<td>Above Grade Roof Drain/Overflow Drain Piping</td>
<td>1, 2</td>
<td>All</td>
<td>1/2-inch</td>
</tr>
<tr>
<td>Roof Drain Underbodies</td>
<td>5, 6</td>
<td>N/A</td>
<td>1-inch</td>
</tr>
<tr>
<td>Overflow Roof Drain Underbodies</td>
<td>5, 6</td>
<td>N/A</td>
<td>1-inch</td>
</tr>
<tr>
<td>ADA Accessible Lavatory/Sink</td>
<td>7</td>
<td>All</td>
<td>As Listed</td>
</tr>
<tr>
<td>Condensate Drain Piping</td>
<td>1, 2</td>
<td>All</td>
<td>1/2-inch</td>
</tr>
<tr>
<td>Aboveground Refrigerated Water Systems</td>
<td>1, 2</td>
<td>All</td>
<td>1-inch</td>
</tr>
</tbody>
</table>

3.02 TYPE 1, GLASS WOOL PIPE INSULATION

A. See General Installation Requirements above.
B. Lap seal insulation with waterproof adhesive. Do not use staples or other methods of attachment which would penetrate vapor barrier. Apply fitting covers with seated tacks and vapor barrier tape.

C. Apply insulation to pipe and seal with self-sealing lap. Use self-sealing butt strips to seal butt joints. Insulate fittings, valves and unions with single or multiple layers of insulation and cover to match pipe or use preformed PVC molded insulation covers.

D. Above Grade Roof Drain/Overflow Drain Piping: Cover all roof drain piping and overflow drain piping with sectional pipe covering.

E. Insulation Shields: Provide hangers and shields (18 gauge minimum) outside of insulation for cold piping (<60 degrees F). Hot water piping hangers may penetrate insulation to contact pipe directly. Provide 18-inch long, noncompressible insulation section at insulation shields for lines 1-1/2-inches and larger (hot and cold piping).

F. Install in accordance with manufacturer's instructions for below grade installation.

3.03 TYPE 2, FLEXIBLE ELASTOMERIC INSULATION

A. See General Installation Requirements above.

B. Slip insulation on pipe prior to connection. Butt joints sealed with manufacturer's adhesive. Insulate fitting with miter-cut pieces. Cover insulation exposed to weather and undergrade with two coats of finish as recommended by manufacturer.

C. Above Grade Roof Drain/Overflow Drain Piping: Cover all roof drain piping and overflow drain piping with sectional pipe covering.

D. Flexible Elastomeric Tubing: Slip insulation over piping or if piping is already installed, it should be slit and snapped over piping. Joints and butt ends must be adhered with 520 adhesive.

E. Insulation Shields: Provide hangers and shields (18 gauge minimum) outside of insulation for cold piping (<60 degrees F). Hot water piping hangers may penetrate insulation to contact pipe directly. Provide 18-inch long, noncompressible insulation section at insulation shields for lines 1-1/2-inches and larger (hot and cold piping).

F. Install in accordance with manufacturer's instructions for below grade installation.

3.04 TYPE 5, GLASS WOOL EQUIPMENT INSULATION

A. See General Installation Requirements above.

B. Apply insulation and accessories to roof drain underbodies per manufacturer's recommendations.

C. Roof Drain/Overflow Drain Underbodies: Cover underside of drain body with glass wool insulation; attached with adhesive and supported externally with 26 gauge galvanized flat strapping anchored to structure.

D. Storage Tanks: Cover with glass wool, 2-inches thick. Finish with canvas jacket and adhesive. Overlap joints minimum of 4-inches. Apply two coats latex paint; color selected by Architect.

3.05 TYPE 7, ADA ACCESSIBLE LAVATORY/SINK INSULATION KIT

A. See General Installation Requirements above.

B. Install in accordance with manufacturer's instructions.

C. Provide lavatory/sink insulation kit. Install on waste fittings, hot and cold water stops and supplies.

3.06 ACCESSORIES

A. See General Installation Requirements above.

B. Install in accordance with manufacturer's instructions.

C. Provide and install accessories for all insulation types listed in this Section.
3.07 PIPE FITTING INSULATION COVERS
   A. See General Installation Requirements above.
   B. Install in accordance with manufacturer's instructions.

END OF SECTION
SECTION 22 1000 - PLUMBING PIPING

PART 1 - GENERAL

1.01 SUMMARY

A. Work Included:
   1. Sanitary, Drainage (Rain/Stormwater) DWV Piping, Buried Within 5-feet of Building
   2. Sanitary, Drainage (Rain/Stormwater) DWV Piping, Above Grade
   3. Pump Waste Pressure Piping (Pumped Discharge)
   4. Water Piping, Buried Within 5-feet of Building
   5. Hot and Cold Domestic Water Above Grade
   6. Condensate Piping
   7. Primer Piping
   8. Cleanouts

1.02 RELATED SECTIONS

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

1.03 REFERENCES AND STANDARDS

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

B. In addition, meet the following:
   1. NSF 61, Annex G
   2. Steel pipe to conform to ASTM and ANSI Standards as specified in this Section.
   3. Copper piping to conform to ASTM B88, B306 and B208 and the standards of Copper Development Association (CDA), and American Welding Society, (AWS).
   5. Manufacturer's Standards Society (MSS) for valving and support reference standard.
   6. American Water Works Association (AWWA) for Valving Assembly Standards.
   7. American Society of Sanitation Engineers (ASSE) for Valving Standards.
   8. American National Standards Institute (ANSI) for Piping Standards.
   10. Crosslinked polyethylene (PEX) pipe conforming to ASTM F876, F877 and CSA B1375, or DIN 16892 and 16893.

1.04 SUBMITTALS

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

1.05 QUALITY ASSURANCE

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

1.06 WARRANTY

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

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. See component manufacturers listed in individual articles below.
   B. Uponor
   C. Cerro
   D. Dodge Phelps
   E. Tyler
   F. ADS
G. Charlotte
H. Elkhart
I. Enfield
J. Fusesal
K. Gruvlok
L. Spears
M. Nibco
N. Aquatherm
O. Orion
P. American-USA
Q. Sioux Chief
R. Cleanouts:
   1. J.R. Smith
   2. Zurn
   3. Wade
   4. Watts
   5. Sioux Chief
S. Firestopping Penetrations in Fire Rated Wall Floor Assemblies:
   1. Hilti
   2. Proset
   3. Or approved equivalent.

2.02 GENERAL
A. Provide pipe, tube and fittings of the same type, fitting requirements, grade, class and the size and weight indicated or required for each service, as indicated in other Division 22, Plumbing Specifications. Where type, grade, or class is not indicated, provide proper selection as determined by installer for installation requirements, and comply with governing regulations and industry standards.
B. Manufactured materials delivered, new to the project site and stored in their original containers.
C. Product Marking: Each item to be furnished with legible markings indicating name brand and manufacturer, manufacturing process, heat number and markings as required per ASTM and UL/FM Standards.

2.03 SANITARY, DRAINAGE (RAIN/STORMWATER) DWV PIPING, BURIED WITHIN 5-FEET OF BUILDING
A. Cast Iron Pipe: ASTM A 74 service weight weight hub and spigot.
   1. Fittings: Cast iron.
   1. Fittings: Cast iron.
   2. Coupling Assembly:
C. ABS Pipe: ASTM D2751 schedule 40 solid wall piping for waste and drainage only. Use of foam core ASTM F628 is approved for vent piping only.
   1. Fittings: ABS DWV ASTM D2661.
D. PVC Pipe: ASTM D 2665 IPS Schedule 40. Solid wall for waste and drainage only. Use of foam core ASTM F891 is approved for vent piping only.
2. Joints: Solvent welded, with ASTM D2564 solvent cement, 2-step glue (primer and glue) is required.

2.04 SANITARY, DRAINAGE (RAIN/STORMWATER) DWV PIPING, ABOVE GRADE

A. Cast Iron Pipe: ASTM A 74 service weight weight hub and spigot.
   1. Fittings: Cast iron.

   1. Fittings: Cast iron.
   2. Coupling Assembly:

C. ABS Pipe: ASTM D2751 schedule 40 solid wall piping for waste and drainage only. Use of foam core ASTM F628 is approved for vent piping only.
   1. Fittings: ABS DWV ASTM D2661.

D. PVC Pipe: ASTM D 2665 IPS Schedule 40, Solid wall for waste and drainage only. Use of foam core ASTM F891 is approved for vent piping only.
   2. Joints: Solvent welded, with ASTM D2564 solvent cement, 2-step glue (clear primer and glue) is required.

2.05 WATER PIPING, BURIED WITHIN 5- FEET OF BUILDING

A. Copper Pipe: ASTM B88, hard drawn, Type K (A).
   1. Fittings: ASME B16.18, cast copper alloy or ASME B16.22 wrought copper and bronze.

   1. Fittings: Ductile or gray iron, standard thickness.

2.06 HOT AND COLD DOMESTIC WATER ABOVE GRADE

A. Copper Tube: 3-inches and above. ASTM B88 (ASTM BA88m), Type L (B), Drawn.
   1. Fittings: ASME B16.18, cast copper alloy or ASME B16.22 wrought copper and bronze.

B. Copper Tube: 2-1/2-inches and smaller. ASTM B88 (ASTM BA88M), Type L (B), Drawn.
   1. Fittings: ASME B16.18 copper.

C. Copper Tube: Water pressures up to 250 PSI gauge. ASTM B 88 (ASTM BA 88m), Type K (A), Drawn.
   1. Fittings: ASME B16.18, cast copper alloy or ASME B16.22, wrought copper and bronze.

D. Copper Tube: ASTM B88 (ASTM B88M), Type K (A), Drawn.

E. Cross-Linked Polyethylene Tubing, Fittings and Accessories (except exposed locations.)
   1. Tubing:
      a. Cross-linked polyethylene (PEX) tubing complies with requirements of ASTM F876 and F877, and cross-linking method must be Type A (hot)method.
      b. PEX tubing to have minimum working pressure of not less than 160 PSI for water at 73.4 degrees F, 100 PSI for water at 180 degrees F and 80 PSI for water at 200 degrees F determined in accordance with Plastic Pipe Institute Technical Report TR-3/92, and listed in Plastic Pipe Institute Technical Report TR-4/95.
   2. Fittings:
b. Reinforcement Rings: Manufactured using "Engel Method" to ensure that viscoelastic stress regenerative properties are sufficient to produce pressure tight seal.
c. Fitting Insert: Of such dimension in that tubing must be expanded in order to facilitate insertion of fitting into tube.
d. Accomplish expansion of tubing and ring by an expansion tool designed expressly for that purpose.
e. Fittings complies with requirements of ASTM F877.

3. Manifolds: Provide premanufactured copper manifolds of same manufacturer as piping.
4. Stubout Ells and Stubout Brackets: Provide premanufactured Type L copper stubout ells and copper stubout brackets.

2.07 CONDENSATE PIPING
A. Copper Tube: ASTM B 88 (ASTM B898M), Type K (A)
B. Piping for drainage of condensate from combustion fuel sources (such as condensing boilers and water heaters) is to be chemical resistant piping as noted in this Section for area of application.

2.08 PRIMER PIPING
A. Above Ground: Type L hard-drawn copper tubing with wrought sweat fittings and soldered joints.
B. Belowground: Cross-linked polyethylene (PEX) and engineered plastic fittings.

2.09 CLEANOUTS
A. General: Locate cleanouts as shown on Drawings and as required by local code. Cleanouts same size as pipe except that greater than 4-inches will not be required. Plastic components not allowed, except unless specifically noted.
B. Types:
   3. Concrete Floor Cleanout (General): J. R. Smith 4020 with round heavy-duty nickel bronze top, taper thread and ABS plug with vandalproof screws.
   4. Parking, Drives and Concrete Floor Cleanouts (Heavy Load): J. R. Smith 4100 with round heavy-duty nickel bronze top, taper thread and ABS plug with vandalproof screws.

PART 3 - EXECUTION
3.01 GENERAL INSTALLATION REQUIREMENTS
A. Underground Piping Systems Examination:
   1. Verify that excavations are to required grade, dry, and not over-excavated.
B. General:
   1. Perform necessary excavation and backfill required for installation of plumbing work. Repair piping or other work at no expense to Owner.
2. Water: Keep excavations free of standing water. Reexcavate and fill back excavations damaged or softened by water or frost to original level with sand, crushed rock or other approved material at no expense to Owner.

3. Tests: During progress of work for compacted fill, Owner reserves right to request compaction tests made under direction of testing laboratory.

4. Trench Excavation: Excavate trenches to necessary depth and width, removing rocks, unstable soil (muck, peat), roots and stumps. Excavation material is classified as "base fill" and "native." Base fill excavation material consisting of placed crushed rock may be used as backfill above "Pipe Zone." Remove and dispose off site native excavation material. Adequate width of trench for proper installation of piping or conduit.

5. Support Foundations:
   a. Foundations: Excavate trenches located in unstable ground areas below elevation required for installation of piping to depth which is determined by Architect as appropriate for conditions encountered. Place and compact approved foundation material in excavation up to "Bedding Zone." Dewatering, placement, compaction and disposal of excavated materials to conform to requirements contained in other Sections of Specifications or Drawings.
   b. Over-Excavations: Where trench excavation exceeds required depths, provide, place and compact suitable bedding material to proper grade or elevation at no additional cost to Owner.
   c. Foundation Material: Where native material has been removed, place and compact necessary foundation material to form base for replacement of required thickness of bedding material.

<table>
<thead>
<tr>
<th>Class A</th>
<th>Class B</th>
</tr>
</thead>
<tbody>
<tr>
<td>3/4-inch Square Opening</td>
<td>27</td>
</tr>
</tbody>
</table>

d. Bedding Material: Full bed piping on sand, pea gravel, or 3/4-inch minus crushed rock. Place minimum 4-inch deep layer of sand, pea gravel, or crushed rock on leveled trench bottom for this purpose. Remove bedding to necessary depth for piping bells and couplings to maintain contact of pipe on bedding for its entire length. Provide additional bedding in excessively wet, unstable, or solid rock trench bottom conditions as required to provide firm foundation.

6. Backfilling:
   a. Following installation and successful completion of required tests, backfill piping in lifts.
      1) In "Pipe Zone" place backfill material and compact in lifts not to exceed 6-inches in depth to height of 12-inches above top of pipe. Place backfill material to obtain contact with entire periphery of pipe, without disturbing or displacing pipe.
      2) Place and compact backfill above "Pipe Zone" in layers not to exceed 12-inches in depth.
   b. Backfill Material:
      1) Backfill Material in "Pipe Zone": 3/4-inch minus crushed rock, sand or pea gravel.
      2) Crushed rock, fill sand or other backfill material approved elsewhere in Specifications may be used above "Pipe Zone."

7. Compaction of Trench Backfill:
   a. Where compaction of trench backfill material is required, use one of following methods or combination thereof:
      1) Mechanical tamper,
      2) Vibratory compactor,
3) Other approved methods appropriate to conditions encountered.

b. Architect to have right to change methods and limits to better accommodate field conditions. Compaction sufficient to attain 95 percent of maximum density at optimum moisture content unless noted otherwise on Drawings or elsewhere in Specifications. Water “puddling” or “washing” is prohibited.

C. General Installation:

1. Work performed by experienced journeyman plumbers. No exceptions.
2. Provide access panels for concealed valves, shock arrestors, trap primers and the like.
3. Install pipes and pipe fittings in accordance with recognized industry practices and manufacturer's recommendations.
5. Locate piping runs, as indicated, vertically and horizontally (pitched to drain) and avoid diagonal runs wherever possible. Orient horizontal runs parallel with walls and column lines. Locate runs as shown or described by diagrams, details, and notations or, if not otherwise indicated, run piping in shortest route which does not obstruct space or block access for servicing building and its equipment. Hold piping close to walls, overhead construction, and other structural and permanent-enclosure elements of building. Limit clearance to 1/2-inch where furring is shown for enclosure or concealment of piping, but allow for insulation thickness, if any. Where possible, locate insulated piping for 1-inch clearance outside insulation. Whenever possible in finished and occupied spaces, conceal piping from view by locating it in column enclosures, hollow wall construction or above suspended ceilings. Do not encase horizontal runs in solid partitions, except as indicated.
   a. Do not run piping through transformer vaults, telephone, elevator, electrical or electronic equipment spaces or enclosures unless indicated on Drawings.
   b. Concealed Piping Above Suspended Ceiling: Plan and coordinate to avoid interferences; install to maintain suspended ceiling heights shown on Architectural Drawings. Allow sufficient space above removable ceiling panels for panel removal. Locate piping so that valves are visible and accessible within 24-inches horizontally and vertically from point of access to the ceiling space. Provide plenum rated materials for ceiling spaces which are being used as plenums.
   c. Exposed Work: Run pipes parallel to the closest wall unless otherwise shown on Drawings; maintain maximum headroom; avoid light fixtures.
   d. Insulation Space Allowance: In piping work, allow space for pipe insulation and jackets. If interferences occur, move the piping to accommodate insulation thickness specified.
   e. Pipe Lengths: Do not use short lengths or nipples at locations where a full length of pipe will fit.
   f. Alignment Prior to Supporting and Anchoring: Place piping in proper alignment and position prior to connection to anchors, expansion loops, and equipment. Furnish jacking devices, temporary steel structural members, and assembled structures as necessary. Remove temporary equipment and structures supplied by contractor at completion; such items to remain Contractor property.
   g. Valve and Equipment Connections: Piping not to place undue stress on flanged valves and equipment connections. Mating flange faces to be true and parallel to each other and not to require springing of piping for assembly. Pipe hangers and supports to carry the full weight of the pipe and fluid.
   h. Piping Leaks: Correct immediately; use new materials; leak-sealing compounds or peening not permitted.
   i. Pressure Ratings of Fittings, Valves, and Devices in Piping Systems: Pressure rating to be equal to or greater than the maximum working pressure of the system.
   j. Equipment Vents and Drains: Provide for coils and vessels which contain water. Provide isolation valves and outlet valves at piping high and low points to permit venting and draining of the vessel without venting and draining connected piping. Provide hose connections and caps on drain lines.
k. Escutcheon Plates: Where exposed insulated and uninsulated piping passes through walls, floors or ceilings; provide spring clip type. Provide plates on both sides of wall or floor.

D. Testing:
   1. General:
      a. Provide temporary equipment for testing, including pumps, compressors, tanks, and gauges, as required. Test piping systems before insulation (if any) is installed and remove or disengage control devices before testing. Where necessary, test sections of each piping system independently, but do not use piping valves to isolate sections where test pressures exceed local valve operating pressure rating. Fill each section with water, compressed air, or nitrogen and pressurize for the indicated pressure and time.
      b. Notify Architect and local Plumbing Inspector 2 days before tests.
      c. Drainage, Waste and Vent Piping: Test in accordance with governing plumbing code or as follows: Test drainage and venting systems, with necessary openings plugged, to permit system to be filled with water and subjected to water pressure of minimum of 5 PSI head. System to hold water without water level drop greater than 1/2 pipe diameter of largest nominal pipe size within 24-hour period. Test system in sections if minimum head cannot be maintained in each section. 5 PSI head to be minimum pressure at highest joint.
      d. Water Piping: Eliminate air from system. Fill and test at 125 PSIG or minimum 1-1/2 times static pressure at connection to serving utility main for period of two hours with no loss in pressure.
      e. Send test results to Architect for review and approval and include in Operation and Maintenance Manual.
   2. Testing of Pressurized Systems:
      a. Test each pressurized piping system at 150 percent of operating pressure indicated, but not less than 125 PSIG test pressure.
      b. Observe each test section for leakage at end of test period. Test fails if leakage is observed or if pressure drop exceeds 2 percent of test pressure.
   3. Test hot and cold domestic water piping systems upon completion of rough-in and before connection to fixtures at hydrostatic pressure of 125 PSIG.

E. Corrosive Soil Conditions:
   1. Wrap steel, iron, copper or other metal piping materials/fittings with Protecto Wrap 200, 30 mils or greater. Maintain a 1/2-inch overlap and install per manufacturer's recommendations.
   2. Provide epoxy coated cast iron pipe and fittings for drainage systems.
   3. Obtain and review project soils report for verification of requirements concerning corrosive soils.

F. Protection:
   1. Keep pipe openings closed by means of plugs or caps to prevent entrance of foreign matter. Protect piping, ductwork, fixtures, equipment and apparatus against dirty water, chemical or mechanical damage both before and after installation. Restore to its original condition or replace fixtures, equipment or apparatus damaged prior to final acceptance of work.

G. Firestopping Penetrations in Fire-Rated Wall/Floor Assemblies:
   1. Provide proper sizing when providing sleeves or core-drilled holes to accommodate penetration. Firestop voids between sleeve or core-drilled hole and pipe passing through to meet requirements of ASTM E814.

H. Piping to be cut squarely, free of rough edges and reamed to full bore. Piping to be fully inserted into fittings.

I. Provide joints of type indicated in each piping system.
J. Thread pipe in accordance with ANSI/ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded ends to remove burrs and restore full inside diameter. Remove excess cutting oil from piping prior to assembly. Apply pipe joint compound, or pipe joint tape (Teflon) where recommended by pipe/fitting manufacturer, on male threads at each joint and tighten joint to leave not more than 3 threads exposed.

K. Sleeves:
   1. Pipe Sleeves:
      a. Layout work in advance of pouring concrete, furnish, and set sleeves necessary to complete work.
      b. Floor Sleeves: Provide sleeves on pipes passing through concrete or masonry construction. Extend sleeve 1-inch above finished floor. Caulk pipes passing through floor with non-shrinking grout or approved caulking compound (Except DWV Piping penetrating a concrete Slab set on Finish Grade), provide "Link-Seal" sleeve sealing system for concrete/slab penetrations which are below grade. Caulk/seal piping passing through fire rated building assembly with UL rated assemblies. Provide fire-rated assemblies per local AHJ requirements.
      c. Wall Sleeves: Provide sleeves on pipes passing through concrete or masonry construction. Provide sleeve flush with finished face of wall. Caulk pipes passing through walls with non-shrinking caulking compound. Provide modular link sealing system for concrete penetrations which are below grade. Caulk/seal piping passing through fire-rated assemblies per local AHJ requirements.
      d. Beam Sleeves: Coordinate with trades for locations of pipe sleeves in reinforced concrete and steel beams. Indicate penetrations on structural shop drawings. See Drawings and Specifications for specific sleeve location limitations. Plumbing Drawings are diagrammatic. Offset piping as required to meet these limitations. Pipe sleeve locations must be indicated on reinforced concrete and steel beam shop drawings. Field cutting of beams not allowed without written approval of structural engineer. No extra costs allowed for failure to coordinate beam penetrations prior to reinforced concrete and steel beam shop drawing submittal.
   2. Installation of metallic or plastic piping penetrations through non fire-rated walls and partitions and through smoke-rated walls and partitions:
      a. Install fabricated pipe sleeve.
      b. After installation of sleeve and piping, tightly pack entire annular void between piping or piping insulation and sleeve identification.
      c. Seal each end airtight with a resilient nonhardening seal per code.
   3. Piping penetrations through fire-rated (1 to 3 hour) assemblies:
      a. Select and install pre-engineered pipe penetration system in accordance with UL listing and manufacturer’s recommendation.
      b. Provide proper sizing when providing sleeves or core-drilled holes to accommodate penetration. Firestop voids between sleeve or core-drilled hole and pipe passing through to meet requirements of ASTM E84.

3.02 SANITARY, DRAINAGE (RAIN/STORMWATER) DWV PIPING, BURIED WITHIN 5-FEET OF BUILDING
A. Excavation and Backfill:
   1. See 3.01B. above.
B. Drainage, Waste and Vent Piping: Test in accordance with governing plumbing code or as follows: Test drainage and venting systems, with necessary openings plugged, to permit system to be filled with water and subjected to water pressure of minimum of 5 PSI head. System to hold water without water level drop greater than 1/2 pipe diameter of largest nominal pipe size within 24-hour period. Test system in sections if minimum head cannot be maintained in each section. 5 PSI head to be minimum pressure at highest joint.
C. Corrosive Soil Conditions:
1. Wrap steel, iron, copper or other metal piping materials/fittings with Protecto Wrap 200, 30 mils or greater. Maintain a 1/2-inch overlap and install per manufacturer's requirements.
2. Provide epoxy coated cast iron pipe and fittings for drainage systems.

D. Cast-Iron Joints: Comply with coupling manufacturer's Cast Iron Soil Pipe Institute Standards and installation instructions.

E. Sanitary and Storm Drainage:
1. Piping to be graded at a uniform pitch of 2 percent unless otherwise noted on Drawings.
2. Indirect Waste or Drain Piping: Extend piping to discharge as shown on Drawings. Maintain minimum air gap. Provide traps on direct waste or drain piping exceeding 60-inches.
3. Fixture Carriers: Concealed fixture carriers for wall hung plumbing fixtures are specified in Section 22 40 00.
4. Drains:
   a. Install drains to suit finished floor or roof surface. Install drains and components per manufacturer's instructions. Arrange for flooring to be sloped to floor drain or sink a minimum of 1/2-inch below finished floor elevation.
   b. Install P-traps for hub drains, floor drains and floor sinks. P-traps to be of the same materials as soil and waste piping. Provide trap primer assembly for each drain or floor sink.
5. Wall Access Panel: Secure to wall framing and install so that flange forms a close fitting joint with the finished wall surface.
6. Heat trace and insulate P-traps exposed to freezing conditions. Provide heat trace and electronic components to Division 26 for installation.
7. Insulate horizontal branch lines from floor sinks, receptors and drains receiving cold discharge from equipment and appliances.

F. Epoxy Coated Cast Iron Pipe and Fittings: Coating of cut piping: The piping terminus of any cut piping shall be coated with an applied epoxy per manufacturer's instructions. Denso - Protal 7200 fast cure epoxy repair coating.

3.03 SANITARY, DRAINAGE (RAIN/STORMWATER) DWV PIPING, ABOVE GRADE

A. Drainage, Waste and Vent Piping: Test in accordance with governing plumbing code or as follows: Test drainage and venting systems, with necessary openings plugged, to permit system to be filled with water and subjected to water pressure of minimum of 5 PSI head. System to hold water without water level drop greater than 1/2 pipe diameter of largest nominal pipe size within 24-hour period. Test system in sections if minimum head cannot be maintained in each section. 5 PSI head to be minimum pressure at highest joint.

B. Firestopping Penetrations in Fire-Rated Wall/Floor Assemblies:
1. Provide proper sizing when providing sleeves or core-drilled holes to accommodate penetration. Firestop voids between sleeve or core-drilled hole and pipe passing through to meet requirements of ASTM E814.

C. Solder copper tube and fitting joints with lead free nickel/silver bearing solder meeting ASTM std. B-32, in accordance with IAPMO Is 3-93, ASTM B-828 and Copper Development Association recommended procedures. Joints to be cleaned by other than chemical means prior to assembly. "Shock" cooling is prohibited. Fluxes to be water soluble for copper and brass potable water applications, and meets CDA standard test method 1.0 and ASTM B813-91. Solder to be applied until a full fillet is present around the joint. Solder and flux not to be applied in such excessive quantities as to run down interior of pipe. Lead solder or corrosion flux not to be present at the jobsite.

D. Cast-Iron Joints: Comply with coupling manufacturer's Cast Iron Soil Pipe Institute Standards and installation instructions.

E. Sanitary and Storm Drainage:
1. Piping to be graded at a uniform pitch of 2 percent unless otherwise noted on Drawings.
2. Indirect Waste or Drain Piping: Extend piping to discharge as shown on Drawings. Maintain minimum air gap. Provide traps on direct waste or drain piping exceeding 60-inches.

3. Fixture Carriers: Concealed fixture carriers for wall hung plumbing fixtures are specified in Section 22 40 00.

4. Drains:
   a. Install drains to suit finished floor or roof surface. Install drains and components per manufacturer's instructions. Arrange for flooring to be sloped to floor drain or sink a minimum of 1/2-inch below finished floor elevation.
   b. Install P-traps for hub drains, floor drains and floor sinks. P-traps to be of the same materials as soil and waste piping. Provide trap primer assembly for each drain or floor sink.

5. Wall Access Panel: Secure to wall framing and install so that flange forms a close fitting joint with the finished wall surface.

6. Heat trace and insulate P-traps exposed to freezing conditions. Provide heat trace and electronic components to Division 26 for installation.

7. Insulate horizontal branch lines from floor sinks, receptors and drains receiving cold discharge from equipment and appliances.

3.04 PUMP WASTE PRESSURE PIPING (PUMPED DISCHARGE)

A. Excavation and Backfill:
   1. See 3.01 B. above.

B. Drainage, Waste and Vent Piping: Test in accordance with governing plumbing code or as follows: Test drainage and venting systems, with necessary openings plugged, to permit system to be filled with water and subjected to water pressure of minimum of 5 PSI head. System to hold water without water level drop greater than 1/2 pipe diameter of largest nominal pipe size within 24-hour period. Test system in sections if minimum head cannot be maintained in each section. 5 PSI head to be minimum pressure at highest joint.

C. Testing of Pressurized Systems:
   1. Test each pressurized piping system at 150 percent of operating pressure indicated, but not less than 125 PSIG test pressure.
   2. Observe each test section for leakage at end of test period. Test fails if leakage is observed or if pressure drop exceeds 2 percent of test pressure.

D. Firestopping Penetrations in Fire-Rated Wall/Floor Assemblies:
   1. Provide proper sizing when providing sleeves or core-drilled holes to accommodate penetration. Firestop voids between sleeve or core-drilled hole and pipe passing through to meet requirements of ASTM E814.

E. Braze copper tube and fitting socket with BCUP series filler metal without flux. Listed brazing flux to be used for joining of copper tube to brass or bronze fittings and will meet AWS FB3A or FB3C. "Shock" cooling is prohibited. a continuous fillet is to be visible around the completed joint. After cooling, flux residue to be thoroughly removed with warm water and a brush prior to testing. Do not use BCUP filler on copper alloys containing over 10 percent nickel. Piping is to be capped or plugged during construction to prevent entry of foreign material.

F. Welders performing work under this Contract to be certified and qualified in accordance with tests prescribed by the National Certified Welding Bureau (NCWB) or by other approved test procedures using methodology and procedures covered in the ASME Boiler and Pressure Vessel Code, Section IX, "Qualification Standard for Welding and Brazing Procedures, Welders, Brazers, and Welding and Brazing Operators". Installation to conform to ANSI 31.1 "Power Piping".
   1. Submit for approval the names, identification, and welder's assigned number, letter or symbol for welders assigned to this project.
   2. The assigned identification symbol to be used to identify the work of each welder and to be indelibly stamped immediately upon completion of each weld.
   3. Welders to be tested and certified for all positions.
4. Submit identifying stenciled test coupons made by each operator.
5. Welders may be required to retake welding certification tests without additional expense.
6. When so requested, a welder will not be permitted to work as a welder on this project until he has been recertified in accordance with NCWB.
7. Recertification of the welder to be made after the welder has taken and passed the required tests.

G. Weld pipe joints in accordance with recognized industry practice and as follows:
1. Weld pipe joints only when ambient temperature is above 0°F.
2. Bevel pipe ends at a 37.5 degree angle where possible, smooth rough cuts, and clean to remove slag, metal particles, and dirt.
3. Use pipe clamps or tack-weld joints with 1-inch long welds, 4 welds for pipe sizes to 10-inches, 8 welds for pipe sizes 12-inches to 20-inches.
4. Build up welds with a stringer-bead pass, followed by a hot pass, followed by a cover or filler pass. Eliminate valleys at center and at edges of each weld. Weld by procedures which will ensure elimination of unsound or unfused metal, cracks, oxidation, blow-holes, and non-metallic inclusions.
5. Do not weld out piping system imperfections by tack-welding procedures. Re-fabricate to comply with requirements.
6. At Installer's option, install forged branch-connection fittings whenever branch pipe is indicated, or install a regular T-fitting.

H. Sanitary and Storm Drainage:
1. Piping to be graded at a uniform pitch of 2 percent unless otherwise noted on Drawings.
2. Indirect Waste or Drain Piping: Extend piping to discharge as shown on Drawings. Maintain minimum air gap. Provide traps on direct waste or drain piping exceeding 60-inches.
3. Fixture Carriers: Concealed fixture carriers for wall hung plumbing fixtures are specified in Section 22 40 00.
4. Drains:
   a. Install drains to suit finished floor or roof surface. Install drains and components per manufacturer's instructions. Arrange for flooring to be sloped to floor drain or sink a minimum of 1/2-inch below finished floor elevation.
   b. Install P-traps for hub drains, floor drains and floor sinks. P-traps to be of the same materials as soil and waste piping. Provide trap primer assembly for each drain or floor sink.
5. Wall Access Panel: Secure to wall framing and install so that flange forms a close fitting joint with the finished wall surface.
6. Heat trace and insulate P-traps exposed to freezing conditions. Provide heat trace and electronic components to Division 26 for installation.
7. Insulate horizontal branch lines from floor sinks, receptors and drains receiving cold discharge from equipment and appliances.

3.05 WATER PIPING, BURIED WITHIN 5-FEET OF BUILDING

A. Excavation and Backfill:
1. See 3.01 B. above.

B. Water Piping: Eliminate air from system. Fill and test at 125 PSIG or minimum 1-1/2 times static pressure at connection to serving utility main for period of two hours with no loss in pressure.

C. Domestic Water:
1. "Piping" to include pipes, fittings, nipples, valves and accessories connected thereto.
2. Run piping generally parallel to the axis of the building, arranged to conform to the building requirements and to suit the necessities of clearance for other mechanical ducts, flues, conduits and work of other trades, and as close to ceiling or other construction as practical, free of unnecessary traps or bends.
3. Grade water supply piping for complete drainage of the system. Install hose bibbs at low points.
4. Piping connections to equipment to be made up with unions.
5. Provide sufficient elbows, swings and offsets to permit free expansion and contraction.
6. Use reducers or increasers. Use no bushings.
7. Ream or file each pipe to remove burrs. Inspect each length of pipe and each fitting for workmanship and clear passageways.
8. Cover, cap or otherwise protect open ends of piping during construction to prevent damage to threads or flanges and prevent entry of foreign matter. Disinfect and sterilize water supply piping as specified. Furnish written report on final water quality results.
9. Exposed connections to equipment to be installed with special care, showing no tool marks or threads at fittings and piping. No bowed or bent piping to be permitted.
10. Ferrous to non-ferrous connections to be made by means of dielectric fittings.
11. Use extra heavy pipe for nipples, where unthreaded portion is less than 1-1/2-inches. Use no close nipples. Use only shoulder-type nipples.
12. Through-Wall Pipes: Type 'L' copper tubing for through-wall pipes which connect to exposed stops at wall surface. Anchor the pipes in the wall; attach pipe with U-bolts to steel back-up plates or steel angles anchored in the wall. Provide wrought copper elbow which securely anchors ears in wall at through-wall pipes.
13. Provide drain valves at base of risers and at low points on the system.

D. Sterilization of Domestic Water System:
1. General: Upon completion of tests and necessary replacements, thoroughly flush and disinfect domestic water piping.
2. Method: After thoroughly flushing system with water to remove sediment, fill system with a solution containing 50 parts per million of chlorine for not less than 24 hours or 200 parts per million of chlorine for not less than 3 hours. After retention, drain, reflush and return system to service.
4. Provide water line disinfections performed by a licensed contractor with training in potable water line disinfections.

E. Buried Preinsulated Pipe Installation:
1. Installation and Testing: Install and test products in accordance with manufacturer's installation instructions.
2. Manufacturer's installation instructions shall describe the following:
   a. Storage and handling of pipes.
   b. Trench preparation.
   c. Installing pipe.
   d. Installing accessories.
   e. Installing fittings.
   f. Building penetrations.
   g. Field insulation kits.
   h. Testing.

3.06 HOT AND COLD DOMESTIC WATER ABOVE GRADE
A. Water Piping: Eliminate air from system. Fill and test at 125 PSIG or minimum 1-1/2 times static pressure at connection to serving utility main for period of two hours with no loss in pressure.
B. Testing of Pressurized Systems:
1. Test each pressurized piping system at 150 percent of operating pressure indicated, but not less than 125 PSIG test pressure.
2. Observe each test section for leakage at end of test period. Test fails if leakage is observed or if pressure drop exceeds 2 percent of test pressure.
C. Test hot and cold domestic water piping systems upon completion of rough-in and before connection to fixtures at hydrostatic pressure of 125 PSIG.
D. Firestopping Penetrations in Fire-Rated Wall/Floor Assemblies:
   1. Provide proper sizing when providing sleeves or core-drilled holes to accommodate penetration. Firestop voids between sleeve or core-drilled hole and pipe passing through to meet requirements of ASTM E814.

E. Solder copper tube and fitting joints with lead free nickel/silver bearing solder meeting ASTM std. B-32, in accordance with IAPMO Is 3-93, ASTM B-828 and Copper Development Association recommended procedures. Joints to be cleaned by other than chemical means prior to assembly. "Shock" cooling is prohibited. Fluxes to be water soluble for copper and brass potable water applications, and meets CDA standard test method 1.0 and ASTM B813-91. Solder to be applied until a full fillet is present around the joint. Solder and flux not to be present in such excessive quantities as to run down interior of pipe. Lead solder or corrosion flux not to be present at the jobsite.

F. Braze copper tube and fitting socket with BCUP series filler metal without flux. Listed brazing flux to be used for joining of copper tube to brass or bronze fittings and will meet AWS FB3A or FB3C. "Shock" cooling is prohibited. a continuous fillet is to be visible around the completed joint. After cooling, flux residue to be thoroughly removed with warm water and a brush prior to testing. Do not use BCUP filler on copper alloys containing over 10 percent nickel. Piping is to be capped or plugged during construction to prevent entry of foreign material.

G. Domestic Water:
   1. "Piping" to include pipes, fittings, nipples, valves and accessories connected thereto.
   2. Run piping generally parallel to the axis of the building, arranged to conform to the building requirements and to suit the necessities of clearance for other mechanical ducts, flues, conduits and work of other trades, and as close to ceiling or other construction as practical, free of unnecessary traps or bends.
   3. Grade water supply piping for complete drainage of the system. Install hose bibbs at low points.
   4. Piping connections to equipment to be made up with unions.
   5. Provide sufficient elbows, swings and offsets to permit free expansion and contraction.
   6. Use reducers or increasers. Use no bushings.
   7. Ream or file each pipe to remove burrs. Inspect each length of pipe and each fitting for workmanship and clear passageways.
   8. Cover, cap or otherwise protect open ends of piping during construction to prevent damage to threads or flanges and prevent entry of foreign matter. Disinfect and sterilize water supply piping as specified. Furnish written report on final water quality results.
   9. Exposed connections to equipment to be installed with special care, showing no tool marks or threads at fittings and piping. No bowed or bent piping to be permitted.
  10. Ferrous to non-ferrous connections to be made by means of dielectric fittings.
  11. Use extra heavy pipe for nipples, where unthreaded portion is less than 1-1/2-inches. Use no close nipples. Use only shoulder-type nipples.
  12. Through-Wall Pipes: Type 'L' copper tubing for through-wall pipes which connect to exposed stops at wall surface. Anchor the pipes in the wall; attach pipe with U-bolts to steel back-up plates or steel angles anchored in the wall. Provide wrought copper elbow which securely anchors ears in wall at through-wall pipes.
  13. Provide drain valves at base of risers and at low points on the system.

H. Sterilization of Domestic Water System:
   1. General: Upon completion of tests and necessary replacements, thoroughly flush and disinfect domestic water piping.
   2. Method: After thoroughly flushing system with water to remove sediment, fill system with a solution containing 50 parts per million of chlorine for not less than 24 hours or 200 parts per million of chlorine for not less than 3 hours. After retention, drain, refill and return system to service.
4. Provide water line disinfections performed by a licensed contractor with training in potable water line disinfections.

3.07 CONDENSATE PIPING
A. Firestopping Penetrations in Fire-Rated Wall/Floor Assemblies:
   1. Provide proper sizing when providing sleeves or core-drilled holes to accommodate penetration. Firestop voids between sleeve or core-drilled hole and pipe passing through to meet requirements of ASTM E814.

3.08 PRIMER PIPING
A. Excavation and Backfill:
   1. See 3.01 B. above.
B. Drainage, Waste and Vent Piping: Test in accordance with governing plumbing code or as follows: Test drainage and venting systems, with necessary openings plugged, to permit system to be filled with water and subjected to water pressure of minimum of 5 PSI head. System to hold water without water level drop greater than 1/2 pipe diameter of largest nominal pipe size within 24-hour period. Test system in sections if minimum head cannot be maintained in each section. 5 PSI head to be minimum pressure at highest joint.

3.09 CLEANOUTS
A. Install in aboveground piping and building drain piping as indicated, as required by code; at each change in direction of piping greater than 135 degrees; at minimum intervals of 100-feet; and at base of each vertical soil or waste stack. Install floor and wall cleanout covers for concealed piping. Select type to match adjacent building finish. Provide shop drawings to Architect to coordinate locations and types of cleanouts with Architect prior to installation.
B. Drainage, Waste and Vent Piping: Test in accordance with governing plumbing code or as follows: Test drainage and venting systems, with necessary openings plugged, to permit system to be filled with water and subjected to water pressure of minimum of 5 PSI head. System to hold water without water level drop greater than 1/2 pipe diameter of largest nominal pipe size within 24-hour period. Test system in sections if minimum head cannot be maintained in each section. 5 PSI head to be minimum pressure at highest joint.
C. Corrosive Soil Conditions:
   1. Wrap steel, iron, copper or other metal piping materials/fittings with Protecto Wrap 200, 30 mils or greater. Maintain a 1/2-inch overlap and install per manufacturer's requirements.
   2. Provide epoxy coated cast iron pipe and fittings for drainage systems.
D. Cast-Iron Joints: Comply with coupling manufacturer's Cast Iron Soil Pipe Institute Standards and installation instructions.

END OF SECTION
SECTION 22 1500 - GENERAL SERVICE COMPRESSED-AIR SYSTEMS

PART 1 - GENERAL

1.01 SUMMARY
   A. Work Included:
   B. Equipment and work indicated in this Section are not intended or acceptable for use in NFPA 1901 regulated breathing air systems, SCBA, or NFPA 99 medical air systems.

1.02 RELATED SECTIONS
   A. Contents of Division 22, Plumbing and Division 01, General Requirements apply to this Section.

1.03 REFERENCES AND STANDARDS
   A. References and Standards as required by Section 22 00 00, Plumbing Basic Requirements and Division 01, General Requirements.

1.04 SUBMITTALS
   A. Submittals as required by Section 22 00 00, Plumbing Basic Requirements and Division 01, General Requirements.

1.05 QUALITY ASSURANCE
   A. Quality assurance as required by Section 22 00 00, Plumbing Basic Requirements and Division 01, General Requirements.

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

PART 2 - PRODUCTS

2.01 MANUFACTURERS

PART 3 - EXECUTION

3.01 GENERAL INSTALLATION REQUIREMENTS
   A. Install per manufacturer's written instructions and guidelines.
   B. Keep open ends of tube capped or plugged at all times or otherwise sealed until final assembly.
   C. Cut piping square and accurately with a tube cutter (sawing not permitted) to measurements determined at place of installation. Ream tube to remove burrs, being careful not to expand tube, and so no chips of copper remain in the tube. Work into place without springing or forcing. Bottom tube in socket so there are no gaps between tube and fitting. Exercise care in handling equipment and tools used in cutting or reaming of tube to prevent oil or grease being introduced into tubing. Where contamination has occurred, material is no longer suitable for compressed air service.
   D. Spacing of Hangers: Current NFPA and state adopted Plumbing Code.
   E. Rigidly support valves and other equipment to prevent strain on tube or joints.
   F. While being brazed, joints to be continuously purged with oil-free dry nitrogen. The flow of purge gas to be maintained until joint is cool to touch.
   G. Do not bend tubing. Use fittings.
   H. Install pressure switches, transmitters and gauges than can be easily accessed, and provide access panel where installed above plaster ceiling. Install pressure switches and sensors for demand check valves.
   I. Apply pipe labeling during installation process and not after installation is completed. Size of legend letters in accordance with ANSI A13.1.
   J. Pipe compressor intake to a source of clean ambient air.
   K. Penetrations:
1. Fire Stopping: Where pipes pass through fire partitions, fire walls, smoke partitions, or floors, install a fire stop that provides an effective barrier against the spread of fire, smoke and gases. Completely fill and seal clearances between raceways and openings with the fire stopping material.

2. Waterproofing: At floor penetrations, completely seal clearances around the pipe and make watertight with sealant as specified.

L. Initial Tests: Blowdown, piping purge, and high and low pressure leakage tests as required by NFPA 99 for a level 3 compressed air system with documentation.

M. System Verification and Final Testing: Static pressure test, pressure relief test, cross connection test, alarm tests and test of secondary equipment for a level 3 compressed air system as required by current NFPA.

END OF SECTION
SECTION 22 3000 - PLUMBING EQUIPMENT

PART 1 - GENERAL

1.01 SUMMARY
A. Work Included:
   1. Commercial High Efficiency Storage Type Gas Water Heaters
   2. Domestic Expansion Tanks Non-ASME
   3. Domestic Circulation Pump
   4. Oil/Water Interceptors

1.02 RELATED SECTIONS
A. Contents of Division 22, Plumbing and Division 01, General Requirements apply to this Section.

1.03 REFERENCES AND STANDARDS
A. References and Standards as required by Section 22 00 00, Plumbing Basic Requirements and Division 01, General Requirements.

1.04 SUBMITTALS
A. Submittals as required by Section 22 00 00, Plumbing Basic Requirements and Division 01, General Requirements.
B. In addition, provide:
   1. Seismic anchor details and calculations signed and stamped by licensed Oregon structural engineer with equipment data.

1.05 QUALITY ASSURANCE
A. Quality assurance as required by Section 22 00 00, Plumbing Basic Requirements and Division 01, General Requirements.
B. In addition, meet the following:
   1. NSF 61, Annex G compliant.
   2. ISO 9001 Certified.
   3. IAPMO Low Lead Certification
C. Products approved for installation by state authorizing agency, no exceptions.

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

PART 2 - PRODUCTS

2.01 MANUFACTURERS
A. Commercial High Efficiency Storage Type Gas Water Heaters:
   1. Bradford White Series eF
   2. AO Smith BTH
   3. Or approved equivalent.
B. Domestic Expansion Tanks Non-ASME:
   1. Bell and Gossett Series PT
   2. American Wheatley
   3. Amtrol
   4. Armstrong
   5. Watts
   6. Or approved equivalent.
C. Domestic Circulation Pumps:
   1. Bell and Gossett Series PL
   2. Armstrong
   3. Grundfos
4. Paco
5. Taco
6. Or approved equivalent.

D. Oil/Water Interceptors:
   1. Fabricated Steel:
      a. Zurn Z1188-ST-E-HD-KC
      b. Rockford
      c. Josam
      d. Smith
      e. Wade
      f. Watts
      g. Or approved equivalent.
   2. Concrete:
      a. Utility Vault 660-CPS
      b. Old Castle
      c. Or approved equivalent.

2.02 GENERAL
   A. Reference drawings for capacities and specific model numbers.

2.03 COMMERCIAL HIGH EFFICIENCY STORAGE TYPE GAS WATER HEATERS
   A. System: Domestic Hot Water.
   B. Provide 1 gas fired storage high efficiency (98 percent) water heaters with capacities as indicated on Contract Documents. System to deliver minimum 120 degrees F hot water to tenants.
   C. Water Heaters in accordance with certified UL volume III tests and most current edition of ASHRAE 90.1. Maximum supply gas pressure to heater 13.8 inches WC (0.5 PSI).
   D. Water Heaters factory provided with an CSA (AGA) electronic intermittent gas ignition, gas pressure regulator and pilot filter, coated steel burners, draft diverter and flue damper; 120 volt, 60 Hz, single phase electrical connection.
   E. Water Heaters factory provided with 2 3/4-inches by 3 3/4-inches hand hole cleanout listed by Underwriters Laboratories. Controls include, upper and lower thermostats, combination temperature and pressure gauge, low water, CSA (AGA) and ASME rated temperature and pressure relief valve, and draft regulator. Control compartment door to be hinged for easy access. Heater(s) to be equipped with multiple anodes for cathodic protection.
   F. Water Heaters to be insulated with vermin-proof glass fiber insulation, R 16 Value minimum. Outer jacket to have a baked enamel finish over a bonderized undercoating.
   G. Internal surfaces of water heaters exposed to water to be glass-lined with alkaline borosilicate, nickelous oxide composition that has been fused to steel by firing at temperature range of 1400 degrees F to 1600 degrees F.
   H. Coordinate exact location of units and electrical characteristics with Division 26, Electrical work.
   I. Provide seismic anchor calculations for this equipment, stamped and signed by licensed Oregon structural engineer.
   J. Warranty: Three year unconditional tank replacement, one year on parts and devices.

2.04 DOMESTIC EXPANSION TANKS NON-ASME
   A. Welded steel, constructed, tested and stamped in accordance with IAPMO Standards for working pressure of 125 PSI. Support floor mounted tanks with steel legs or base. Provide single flexible diaphragm securely sealed into tank to separate air charge from system water, to maintain design expansion capacity. Provide pressure gauge and air-charging fitting, and drain fitting. Diaphragm: Removable and replaceable in line.
2.05 DOMESTIC CIRCULATION PUMPS
A. System: Domestic water.
B. Provide in-line factory tested pumps, cleaned, and painted with enamel prior to shipment. Pumps to be rated for domestic water. Provide pumps of same type by same manufacturer.
C. Type: Horizontal, oil-lubricated, designed for 150 PSI working pressure, 225 F continuous water temperature.
D. Body: Bronze or Stainless steel construction.
E. Shaft: Stainless or Carbon steel, ground and polished, integral thrust collar.
F. Bearings: Two horizontal sleeve sealed steel bearings permanently lubricated designed to circulate oil.
G. Seal: Mechanical, with carbon seal face rotating against ceramic seat.
H. Face plate: Stainless steel.
I. Motor: Nonoverloading at any point on pump curve, open, drip-proof, sleeve bearings, quiet operating, rubber mounted construction, built-in thermal overload protection.
J. Elastomers: EPDM.
K. Provide Honeywell 115 volt immersion aquastat set at 115 or 118 degrees F.
L. Option. Pump may be operated from Building Automation System. Coordinate installation of additional devices with controls contractor.

2.06 OIL/WATER INTERCEPTORS
A. Fabricated Steel:
   1. Acid resistant interior and exterior fabricated steel. Oil/water interceptor with extension; Gasketed nonskid diamond plate, traffic-duty cover. Internal air relief, visible double wall trap, removable baffles. Clamping ring and anchor flange, interior storage tank.
   2. Provide extensions to furnished floor where required by structural features or depth of piping.
   3. Interceptor to be installed flush with finish floor construction.
   4. Option: Unit may be installed in exterior concrete vault.
B. Concrete:
   1. Pre-cast concrete separator with coalescing pack, three compartment unit, inlet and outlet openings, AASHTO H-20 diamond plate spring cover, sediment weir, oil retaining baffle.
   2. Provide extensions where required by structural features or depth of piping.
   3. Interceptor to be installed on compacted or undisturbed soil.

PART 3 - EXECUTION
3.01 GENERAL
A. Examine areas and conditions under which equipment is to be installed. Do not proceed with work until unsatisfactory conditions have been corrected.
B. Install equipment in accordance with manufacturer's installation instructions. Install units plumb and level, firmly anchored in locations indicated, and maintain manufacturer's recommended clearances.
C. Oriens so controls and devices needing service and maintenance have adequate access.
D. Certificates: Submit appropriate Certificates of Shop Inspection and Data Report as required by provisions of ASME Boiler and Pressure Vessel Code.
E. Connect water piping to units with shutoff valves and unions.
F. Equipment Rigging: Heavy duty rigging eye bolts for Crosby Group swivel hoist rings installed over pump access covers for removal or maintenance.
G. Equipment Start-Up:
1. Start-up, test, and adjust equipment in accordance with manufacturer's start-up instructions. Check and calibrate controls.
2. Start-up performed by authorized manufacturer's representative or agent. Provide credentials of start-up personnel to Architect and Owner's Representative for approval.
3. Remove and replace filters when start-up testing is executed.
4. Manufacturer adjusts operating parameters of equipment to compensate to elevation of 500-feet above sea level.
5. Architect, Commissioning Agent, and Owner's Representative will be notified 10 days prior to start-up and will be present at start-ups.
6. Provide written report from manufacturer's representative on results of start-up within 48 hours.
7. Technical Training of maintenance staff includes two hours minimum per each piece of equipment.
8. Seismic Verification:
   a. Contractor will retain structural engineer who will submit stamped and signed anchoring and restraint details on plumbing equipment with submittal data in accordance with Division 22, Plumbing requirements.
   b. Contractor's Structural Engineer will test and verify in writing that seismic restraints have been installed in accordance with their details.

3.02 COMMERCIAL HIGH EFFICIENCY STORAGE TYPE GAS WATER HEATERS
A. Examine areas and conditions under which equipment is to be installed. Do not proceed with work until unsatisfactory conditions have been corrected.
B. Install equipment in accordance with manufacturer's installation instructions. Install units plumb and level, firmly anchored in locations indicated, and maintain manufacturer's recommended clearances.
C. Orient so controls and devices needing service and maintenance have adequate access.
D. Certificates: Submit appropriate Certificates of Shop Inspection and Data Report as required by provisions of ASME Boiler and Pressure Vessel Code.
E. Connect water piping to units with shutoff valves and unions.
F. Equipment Start-Up:
   1. Start-up, test, and adjust equipment in accordance with manufacturer's start-up instructions. Check and calibrate controls.
   2. Start-up performed by authorized manufacturer's representative or agent. Provide credentials of start-up personnel to Architect and Owner's Representative for approval.
   3. Remove and replace filters when start-up testing is executed.
   4. Manufacturer adjusts operating parameters of equipment to compensate to elevation of 500-feet above sea level.
   5. Architect, Commissioning Agent, and Owner's Representative will be notified 10 days prior to start-up and will be present at start-ups.
   6. Provide written report from manufacturer's representative on results of start-up within 48 hours.
   7. Technical Training of maintenance staff includes two hours minimum per each piece of equipment.
   8. Seismic Verification:
      a. Contractor will retain structural engineer who will submit stamped and signed anchoring and restraint details on plumbing equipment with submittal data in accordance with Division 22, Plumbing requirements.
      b. Contractor's Structural Engineer will test and verify in writing that seismic restraints have been installed in accordance with their details.

3.03 DOMESTIC EXPANSION TANKS NON-ASME
A. Precharge tank per manufacturers recommendation.
B. Examine areas and conditions under which equipment is to be installed. Do not proceed with work until unsatisfactory conditions have been corrected.

C. Install equipment in accordance with manufacturer's installation instructions. Install units plumb and level, firmly anchored in locations indicated, and maintain manufacturer's recommended clearances.

D. Orients so controls and devices needing service and maintenance have adequate access.

E. Certificates: Submit appropriate Certificates of Shop Inspection and Data Report as required by provisions of ASME Boiler and Pressure Vessel Code.

F. Connect water piping to units with shutoff valves and unions.

3.04 DOMESTIC CIRCULATION PUMPS

A. Install equipment in accordance with manufacturer's installation instructions. Install units plumb and level, firmly anchored in locations indicated, and maintain manufacturer's recommended clearances.

B. Orients so controls and devices needing service and maintenance have adequate access.

C. Connect water piping to units with shutoff valves and unions.

D. Provide lift check valves 5 diameters downstream of pump discharge for circulating pumps piped in a parallel configuration.

E. Equipment Start-Up:
   1. Start-up, test, and adjust equipment in accordance with manufacturer's start-up instructions. Check and calibrate controls.
   2. Architect, Commissioning Agent, and Owner's Representative will be notified 10 days prior to start-up and will be present at start-ups.
   3. Seismic Verification:
      a. Contractor will retain structural engineer who will submit stamped and signed anchoring and restraint details on plumbing equipment with submittal data in accordance with Division 22, Plumbing requirements.
      b. Contractor's Structural Engineer will test and verify in writing that seismic restraints have been installed in accordance with their details.

END OF SECTION
SECTION 22 4000 - PLUMBING FIXTURES

PART 1 - GENERAL

1.01 SUMMARY

A. Work Included:
   1. General Plumbing Fixtures:
      a. China Fixtures, White Only
      b. Enameled Steel Fixtures, White Only
      c. Faucet Fittings
      d. Fiberglass Fixtures, White Only
      e. Group Showers
      f. Group Wash Fountain
      g. Hose Reels
      h. Molded Resin or Stone Fixtures
      i. Shower Valves
      j. Stainless Steel Fixtures
      k. Thermostatic Mixing Valves
      l. Trench Drains
      m. Wash Fountains
   2. Carriers
   3. Catch Basins
   4. Downspout Boot/Nozzle/Cover
   5. Drinking Fountains
   6. Electric Water Coolers
   7. Emergency Showers/Eyewash
   8. Fixture Trim
   9. Floor Drains
   10. Floor Sinks
   11. Flushometers - Water Closet/Urinal
   12. Hose Bibbs
   13. Hub Drains
   14. Kitchen Equipment
   15. Roof/Overflow Drains
   16. Water Closet Seats
   17. Drain Boxes
   18. Water Supply Boxes

1.02 RELATED SECTIONS

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

1.03 REFERENCES AND STANDARDS

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

1.04 SUBMITTALS

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

1.05 QUALITY ASSURANCE

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

B. In addition, meet the following:
   1. Comply with lead free (less than or equal to 0.25 percent) products in drinking water systems.
4. IAPMO Low Lead Certification.
5. Provide fixtures, faucets and accessories to meet barrier free requirements of the governing code with respect to plumbing fixtures provided for the physically handicapped.

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

PART 2 - PRODUCTS

2.01 MANUFACTURERS
A. "Or approved equivalent" as defined in 22 00 00, General Plumbing Requirements. Substitution process requirements apply to approved equivalent products.
B. General Plumbing Fixtures: See Schedule on Drawings for type.
   1. China Fixtures - White Only:
      a. American Standard
      b. Briggs
      c. Crane
      d. Eljer
      e. Kohler
      f. Universal-Rundle
      g. Or approved equivalent.
   2. Enameled Steel Fixtures - White Only:
      a. American Standard
      b. Briggs
      c. Crane
      d. Eljer
      e. Kohler
      f. Universal-Rundle
      g. Or approved equivalent.
   3. Faucet Fittings:
      a. Private:
         1) Chicago
         2) Delta Commercial
         3) Moen
         4) Speakman
         5) Symmons
         6) T & S Brass
         7) Or approved equivalent.
      b. Public:
         1) American Standard
         2) Chicago
         3) Delta Commercial
         4) Moen Commercial
         5) Sloan
         6) Symmons
         7) T & S Brass
         8) Or approved equivalent.
   4. Fiberglass Fixtures - White Only:
      a. Aqua-Glass
      b. Briggs
      c. Crane
      d. Fiber-Fab
e. Hytec
f. Mustee
g. Universal-Rundle
h. Or approved equivalent.

5. Group Showers:
a. Acorn
b. Bradley
c. Metcraft
d. Or approved equivalent.

6. Group Wash Fountain:
a. Acorn
b. Bradley
c. Metcraft
d. Or approved equivalent.

7. Hose Reels:
a. Balcrank
b. Lincoln
c. Or approved equivalent.

8. Molded Resin or Stone Fixtures:
a. Fiat
b. Mustee
c. Stern Williams
d. Or approved equivalent.

9. Shower Valves:
a. Acorn
b. Chicago
c. Delta
d. Moen
e. Powers
f. Symmons
g. Or approved equivalent.

10. Stainless Steel Fixtures:
a. Elkay
b. Haws
c. Just
d. Or approved equivalent.

11. Thermostatic Mixing Valves:
a. Bradley
b. Powers
c. Symmons
d. Holby
e. Or approved equivalent.

12. Trench Drains:
a. Channel-Slope
b. JR Smith
c. PolyDrain
d. Polycast
e. Quazite
f. Zurn
g. Or approved equivalent.

13. Wash Fountains:
a. Acorn
b. Bradley
c. Or approved equivalent.

C. Carriers:
   1. JR Smith
   2. Zurn
   3. Or approved equivalent.

D. Catch Basins:
   1. Lynch
   2. Or approved equivalent.

E. Downspout Boot/Nozzle/Cover:
   1. JR Smith
   2. Mifab
   3. Sioux Chief
   4. Zurn
   5. Or approved equivalent.

F. Drinking Fountain:
   1. Elkay
   2. Halsey-Taylor
   3. Haws
   4. Oasis
   5. Sunroc
   6. Or approved equivalent.

G. Electric Water Coolers:
   1. Elkay
   2. Halsey-Taylor
   3. Haws
   4. Oasis
   5. Sunroc
   6. Or approved equivalent.

H. Emergency Showers/Eyewash:
   1. Bradley
   2. Encon
   3. Guardian
   4. Haws
   5. Speakman
   6. Or approved equivalent.

I. Fixture Trim:
   1. McGuire
   2. Dearborn Brass
   3. Oatey
   4. Or approved equivalent.

J. Floor Drains:
   1. Mifab
   2. Sioux Chief
   3. Smith
   4. Wade
   5. Watts
   6. Zurn

K. Floor Sinks:
   1. Commercial Enameling
   2. Mifab
   3. Sioux Chief
4. Smith
5. Wade
6. Watts
7. Zurn
8. Or approved equivalent.

L. Flushometers - Water Closet/Urinal:
1. Delaney
2. Sloan
3. Zurn
4. Or approved equivalent.

M. Hose Bibbs:
1. Chicago
2. JR Smith
3. Mifab
4. Wade
5. Woodford
6. Zurn
7. Or approved equivalent.

N. Hub Drains:
1. JR Smith
2. Zurn
3. Or approved equivalent.

O. Kitchen Equipment:
1. No products specified. See Part 3 "Kitchen Equipment" article below for additional information.

P. Roof/Overflow Drains:
1. JR Smith
2. Mifab
3. Sioux Chief
4. Watts
5. Zurn
6. Or approved equivalent.

Q. Water Closet Seats:
1. Bemis
2. Or approved equivalent.

R. Drain Boxes:
1. Sioux Chief
2. Or approved equivalent.

S. Water Supply Boxes:
1. Sioux Chief
2. Or approved equivalent.

2.02 GENERAL PLUMBING FIXTURES

A. Review substitution request requirements in Division 01, General Requirements and 22 00 00, Plumbing General Requirements.

B. Reference Architectural Details for mounting height and location of fixtures.

C. Provide factory fabricated fixtures of type, style and material indicated on the plumbing fixture connection schedule shown on the Drawings. For each type fixture, provide fixture manufacturer's standard trim, carrier, seats, and valves as indicated by their published product information; either as designed and constructed, or as recommended by manufacturer, or required for complete installation. Where more than one type is indicated, selection is installer's
option; but, fixtures of same type must be furnished by a single manufacturer. Where type is not otherwise indicated, provide fixtures complying with governing regulations.

D. Provide fixtures complete with fittings, supports, fastening devices, bolt caps, faucets, valves, traps, stops and appurtenances.

E. Plumbing Fixture Flow Rates:
   1. Water Closets: Single flush at 1.28 GPF.
   2. Lavatories in public core areas to be set for a maximum of 0.5 GPM flow. Other lavatories to be 1.0 GPM flow.
   3. Sinks to be set for a maximum of 1.5 GPM flow.
   4. Showers factory set at a maximum of 1.8 - 2 GPM flow.

F. Plumbing Fixture Thermostatic Mixing Valves:
   1. Lavatories provide ASSE 1070 compliant mixing valves or multiple lavatories served by a single ASSE 1070 mixing valve.
   2. Sinks serviced with a single ASSE 1070 mixing valve or multiple sinks served by a single ASSE 1070 mixing valve.
   3. Commercial kitchen handsinks provide ASSE 1070 mixing valves.
   4. Janitor sinks or process/maintenance type sinks do not require ASSE 1070 mixing valves if operated by trained personnel. Provide signage per Section 22 05 53, Identification for Plumbing Piping and Equipment.
   5. Hot water hose bibbs do not require ASSE 1070 mixing valves if operated by trained personnel. Provide signage per Section 22 05 53, Identification for Plumbing Piping and Equipment.

2.03 CARRIERS

A. Wall Hung Water Closets:

B. Wall Hung Urinal: Zurn Z-1218-WS. (JR Smith 913). Coupling type or plate type with bearing plate 300 lb. capacity.

C. Wall Hung Lavatory: Zurn Z-1231 (D). (JR Smith 700). Concealed arm or Plate type, 250 lb. capacity.


E. Wall Hung Drinking Fountain: Z-1225-BL (JR Smith 834-97-98). Plate type.

2.04 CATCH BASINS

A. See Schedule on Drawings for type.

2.05 DOWNSPOUT BOOT/NOZZLE/COVER

A. See Schedule on Drawings for type.

2.06 DRINKING FOUNTAINS

A. See Schedule on Drawings for type.

2.07 ELECTRIC WATER COOLERS

A. See Schedule on Drawings for Type.

2.08 EMERGENCY SHOWERS/EYEWASH

A. Provide emergency showers/eyewash products that are compliant with ANSI Z358.1, Standards for Emergency Eyewashes and Shower Equipment.
2.09 FIXTURE TRIM
   A. Traps: Provide heavy duty commercial grade traps on fixtures except fixtures with integral traps. Exposed traps will be chromium plated cast brass or 17 gauge chromium plated brass tubing.
      1. Sink: McGuire 8912-C-DF.
      2. Lavatory: McGuire 8902-C-DF.
   B. Supplies and Stops: Lead free heavy duty commercial grade, chrome plated with brass stems. Stops: T-handle or Loose Key type.
      1. Lavatory: McGuire LFH 2165 CK
      2. Sink: McGuire LFH 2167 LK
      3. Water Closets: McGuire
   C. Lavatory Grid Strainer: McGuire 155A.
   D. Sink Grid Strainer: McGuire 152N.
   F. Sink Basket Strainer: McGuire 151.
   G. Trim barrier-free wrap for P-traps and supplies by McGuire, Pro-Wrap, Plumberex or True-bro.
   H. Escutcheons: McGuire wrought brass deep bell.
   I. Wax Rings and Toilet Bolts: WM Harvey No Seep No. 1 053065-N.

2.10 FLOOR DRAINS
   A. See Schedule on Drawings for types.

2.11 FLOOR SINKS
   A. See Schedule on Drawings for types.
   B. Plastic components are not allowed.

2.12 FLUSHOMETERS - WATER CLOSET/URINAL
   A. See Schedule on Drawings for types.

2.13 HOSE BIBBS
   A. See Schedule on Drawings for types.

2.14 HUB DRAINS
   A. See Schedule on Drawings for type.

2.15 KITCHEN EQUIPMENT
   A. No products specified. See Part 3 "Kitchen Equipment" article below for additional information.

2.16 ROOF/OVERFLOW DRAINS
   A. See Schedule on Drawings for type.
   B. Plastic components are not allowed.

2.17 WATER CLOSET SEATS
   A. See Schedule on Drawings for type.

2.18 DRAIN BOXES
   A. See Schedule on Drawings for Type.
   B. Provide fire rated ASTM E-84 rated boxes where required by building construction.

2.19 WATER SUPPLY BOXES
   A. See Schedule on Drawings for Type.
   B. Provide fire rated ASTM E-84 rated boxes where required by building construction.
PART 3 - EXECUTION

3.01 GENERAL PLUMBING FIXTURE INSTALLATION INFORMATION

A. Verification of Conditions:
1. Examine rough-in work of water supply and waste piping systems to verify actual locations of piping connections prior to installing fixtures. Examine floors and substrates, and conditions under which fixture work is to be accomplished. Correct any incorrect locations of piping and other unsatisfactory conditions for installation of plumbing fixtures.
2. Examine walls, floors and cabinets for suitable conditions where fixtures are to be installed.
3. Install plumbing fixtures level and plumb, in accordance with fixture manufacturer’s written instructions, rough-in drawings and pertinent codes and regulations, design and referenced standards.
4. Fasten plumbing fixtures securely to supports or building structure. Secure supplies behind or within wall construction to provide rigid installation.
5. Install a stop valve in a readily accessible location in water connection to each fixture.
6. Install escutcheons at each wall, floor and ceiling penetration in exposed finished locations and within cabinets and millwork.
7. Seal fixtures to walls and floors using silicone sealant Dow Corning No. 780 or approved equivalent. Match sealant color to fixture color.
8. Test fixtures to demonstrate proper operation upon completion of installation and after units are water pressurized. Replace malfunctioning units, then retest.
9. Inspect each unit for damage prior to installation. Replace damaged fixtures.
10. Replace washers or cartridges of leaking or dripping faucets and stops.
11. Clean fixtures, trim and strainers using manufacturer’s recommended cleaning methods and materials.
12. During construction, cover installed fixtures, drains, sinks and water coolers with cardboard and wrap with sheet plastic.
13. Provide trap primers for floor drains, floor sinks, trench drains and hub drains.
14. Install roof and overflow roof drains per architectural details. Cover drains during roof construction to protect drain. Provide offsets or expansion joints at each roof/overflow drain.
15. Do not use lead flashing.

B. Owner Furnished Equipment:
1. Rough-in and make final connections to Owner furnished equipment. Provide necessary items to complete installation.
2. Comply with requirements of this Section and Drawings for installation procedures.

C. Adjusting and Cleaning: Clean plumbing fixtures, trim, and strainers of dirt and debris upon completion of installation. Adjust water pressure at drinking fountains, faucets, shower valves and flush valves to provide proper flow stream and specified GPM. Repair leaks at faucets and stops.

D. Extra Stock: Furnish special wrenches and other devices necessary for servicing plumbing fixtures and trim to Owner.

E. Field Quality Control: Upon completion of installation of plumbing fixtures, test fixtures to demonstrate capability and compliance with Specifications. Correct or replace malfunctioning units at site, then retest to demonstrate compliance.

F. Protection: Protect fixtures and equipment from damage. Cover finished fixtures with cardboard and sheet plastic. Fixtures are not to be used during construction. Replace damaged items with new.

G. Signage: For fixtures that do not have ASSE 1070 mixing valve protection for hot water temperature, provide signage per Section 22 05 53, Identification for Plumbing Piping and Equipment.
3.02 CARRIERS INSTALLATION
   A. Install components in accordance with manufacturer's instructions and approved product data submittals.
   B. Set plumb, level and rigid.
   C. Coordinate wall thickness so carrier has adequate depth to be concealed.
3.03 CATCH BASINS INSTALLATION
   A. Install components in accordance with manufacturer's instructions and approved product data submittals.
   B. Set plumb and level.
   C. Backfill with 3/4-inch crushed rock and compact.
3.04 DOWNSPOUT BOOT/NOZZLE/COVER INSTALLATION
   A. Install components in accordance with manufacturer's instructions and approved product data submittals.
   B. Set plumb, level and rigid.
3.05 DRINKING FOUNTAIN INSTALLATION
   A. Install components in accordance with manufacturer's instructions and approved product data submittals.
   B. Set plumb, level and rigid.
3.06 ELECTRIC WATER COOLER INSTALLATION
   A. Install components in accordance with manufacturer's instructions and approved product data submittals.
   B. Set plumb, level and rigid.
3.07 EMERGENCY SHOWERS/EYEWASH INSTALLATION
   A. Install components in accordance with manufacturer's instructions and approved product data submittals.
   B. Set plumb, level and rigid.
3.08 FIXTURE TRIM INSTALLATION
   A. Install components in accordance with manufacturer's instructions and approved product data submittals.
   B. Set plumb, level and rigid.
3.09 FLOOR DRAINS INSTALLATION
   A. Install components in accordance with manufacturer's instructions and approved product data submittals.
   B. Set plumb, level and rigid.
3.10 FLOOR SINK INSTALLATION
   A. Install components in accordance with manufacturer's instructions and approved product data submittals.
   B. Set plumb, level and rigid. Set fixture rim/grate flush with surrounding finish surface unless specifically noted otherwise.
3.11 FLUSHOMETERS - WATER CLOSET/URINAL INSTALLATION
   A. Install components in accordance with manufacturer's instructions and approved product data submittals.
   B. Set plumb, level and rigid. Set fixture rim/grate flush with surrounding finish surface unless specifically noted otherwise.
3.12 HOSE BIBB INSTALLATION
   A. Install components in accordance with manufacturer's instructions and approved product data submittals.
   B. Set plumb, level and rigid.

3.13 HUB DRAINS INSTALLATION
   A. Install components in accordance with manufacturer's instructions and approved product data submittals.
   B. Set plumb, level and rigid.

3.14 KITCHEN EQUIPMENT INSTALLATION
   A. Install components in accordance with manufacturer's instructions and approved product data submittals.
   B. Furnish and install shutoff valves, pressure regulators, shock arrestors, vacuum breakers, strainers, indirect waste piping, backflow preventers, and other devices or piping which are not furnished with kitchen equipment or shown on Drawings.
   C. Set plumb, level and rigid.

3.15 ROOF/OVERFLOW DRAINS INSTALLATION
   A. Install components in accordance with manufacturer's instructions and approved product data submittals.
   B. Set plumb, level and rigid.

3.16 WATER CLOSET SEAT INSTALLATION
   A. Install components in accordance with manufacturer's instructions and approved product data submittals.
   B. Set plumb, level and rigid.

3.17 DRAIN BOX INSTALLATION
   A. Install components in accordance with manufacturer's instructions and approved product data submittals.
   B. Set plumb, level and rigid.

3.18 WATER SUPPLY BOX INSTALLATION
   A. Install components in accordance with manufacturer's instructions and approved product data submittals.
   B. Set plumb, level and rigid.

END OF SECTION
PART 1 - GENERAL
1.01 SECTION INCLUDES
A. Work included in 23 00 00, HVAC Basic Requirements applies to Division 23, HVAC work to provide materials, labor, tools, permits, incidentals, and other services to provide and make ready for Owner’s use of heating, ventilating and air conditioning systems for proposed project.
B. Contract Documents include, but are not limited to, Specifications including Division 00, Procurement and Contracting Requirements and Division 01, General Requirements, Drawings, Addenda, Owner/Architect Agreement, and Owner/Contractor Agreement. Confirm requirements before commencement of work.
C. Definitions:
   1. Provide: To furnish and install, complete and ready for intended use.
   2. Furnish: Supply and deliver to project site, ready for unpacking, assembly and installation.
   3. Install: Includes unloading, unpacking, assembling, erecting, installation, applying, finishing, protecting, cleaning and similar operations at project site as required to complete items of work provided.
   4. Approved or Approved Equivalent: To possess the same performance qualities and characteristics and fulfill the utilitarian function without any decrease in quality, durability or longevity. For equipment/products defined by the Contractor as "equivalent", substitution requests must be submitted to Engineer for consideration, in accordance with Division 01, General Requirements, and approved by the Engineer prior to submitting bids for substituted items.
   5. Authority Having Jurisdiction (AHJ): Indicates reviewing authorities, including local fire marshal, Owner’s insurance underwriter, Owner’s representative, and other reviewing entity whose approval is required to obtain systems acceptance.

1.02 RELATED SECTIONS
A. Contents of Section applies to Division 23, HVAC Contract Documents.
B. Related Work:
   1. Additional conditions apply to this Division including, but not limited to:
      a. Specifications including Division 00, Procurement and Contracting Requirements and Division 01, General Requirements.
      b. Drawings
      c. Addenda
      d. Owner/Architect Agreement
      e. Owner/Contractor Agreement
      f. Codes, Standards, Public Ordinances and Permits

1.03 REFERENCES AND STANDARDS
A. References and Standards per Division 01, General Requirements, individual Division 23, HVAC Sections and those listed in this Section.
B. Codes to include latest adopted editions, including current amendments, supplements and local jurisdiction requirements in effect as of the date of the Contract Documents, off/from:
   1. State of Oregon:
      a. OAR - Oregon Administrative Rules
      b. OESC - Oregon Electrical Specialty Code
      c. OFC - Oregon Fire Code
      d. OMSC - Oregon Mechanical Specialty Code
      e. OPSC - Oregon Plumbing Specialty Code
      f. OSSC - Oregon Structural Specialty Code
      g. OEESC - Oregon Energy Efficiency Specialty Code
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h. Oregon Elevator Specialty Code

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

D. See Division 23, HVAC individual Sections for additional references.

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

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

G. Piping and duct insulation products to contain less than 0.1 percent by weight PBDE in all insulating materials.

1.04 SUBMITTALS

A. See Division 01, General Requirements for Submittal Procedures as well as specific individual Division 23, HVAC Sections.
B. Provide drawings in format and software release equal to the design documents. Drawings to be the same sheet size and scale as the Contract Documents.

C. In addition:
   1. "No Exception Taken" constitutes that review is for general conformance with the design concept expressed in the Contract Documents for the limited purpose of checking for conformance with information given. Any action is subject to the requirements of the Contract Documents. Contractor is responsible for the dimensions and quantity and will confirm and correlate at the job site, fabrication processes and techniques of construction, coordination of the work with that of all other trades, and the satisfactory performance of the work.
   2. Provide product submittals and shop drawings in electronic format only. Electronic format must be submitted via zip file via e-mail or posted to ftp site. For electronic format, provide one zip file per specification division containing a separate file for each Specification Section. Individual submittals sent piecemeal in a per Specification Section method will be returned without review or comment. All transmissions/submissions to be submitted to Architect. Deviations will be returned without review.
   3. Product Data: Provide Manufacturer's descriptive literature for products specified in Division 23, HVAC Sections.
   4. Identify/mark each submittal in detail. Note what differences, if any, exist between the submitted item and the specified item. Failure to identify the differences will be considered cause for disapproval. If differences are not identified and/or not discovered during the submittal review process, Contractor remains responsible for providing equipment and materials that meet the Specifications and Drawings.
      a. Label submittal to match numbering/references as shown in Contract Documents. Highlight and label applicable information to individual equipment or cross out/remove extraneous data not applicable to submitted model. Clearly note options and accessories to be provided, including field installed items. Highlight connections by/to other trades.
      b. Include technical data, installation instructions and dimensioned drawings for products, fixtures, equipment and devices installed, furnished or provided. Reference individual Division 23, HVAC Specification Sections for specific items required in product data submittal outside of these requirements.
      c. Provide pump curves, operation characteristics, capacities, ambient noise criteria, etc. for equipment.
      d. For vibration isolation of equipment, list make and model selected with operating load and deflection.
      e. See Division 23, HVAC individual Sections for additional submittal requirements outside of these requirements.
   5. Maximum of two reviews of submittal package. Arrange for additional reviews and/or early review of long-lead items; Bear costs of these additional reviews at Engineer's hourly rates. Incomplete submittal packages/submittals will be returned to contractor without review.
   6. Resubmission Requirements: Make corrections or changes in submittals as required, and in consideration of Engineer's comments. Identify Engineer’s comments and provide an individual response to each of the Engineer’s comments. Cloud changes in the submittals and further identify changes which are in response to Engineer's comments.
   7. Structural/Seismic: Provide weights, dimensions, mounting requirements and like information required for mounting, seismic bracing, and support. Indicate manufacturer's installation and support requirements to meet ASCE 7-10 requirements for non-structural components. Provide engineered seismic drawings and equipment seismic certification. Equipment Importance Factor as specified in Division 01 and in Structural documents.
   8. Trade Coordination: Include physical characteristics, electrical characteristics, device layout plans, wiring diagrams, and connections as required by Division 23, HVAC
Coordination Documents. For equipment with electrical connections, furnish copy of approved submittal for inclusion in Division 26, Electrical submittals.

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

10. Substitutions and Variation from Basis of Design:
   a. The Basis of Design designated product establishes the qualities and characteristics for the evaluation of any comparable products by other listed acceptable manufacturers if included in this Specification or included in an approved Substitution Request as judged by the Design Professional.
   b. If substitutions and/or equivalent equipment/products are being proposed, it is the responsibility of parties concerned, involved in, and furnishing the substitute and/or equivalent equipment to verify and compare the characteristics and requirements of that furnished to that specified and/or shown. If greater capacity and/or more materials and/or more labor is required for the rough-in, circuitry or connections than for the item specified and provided for, then provide compensation for additional charges required for the proper rough-in, circuitry and connections for the equipment being furnished. No additional charges above the Base Bid, including resulting charges for work performed under other Divisions, will be allowed for such revisions. Coordinate with the requirements of "Submittals". For any product marked "or approved equivalent", a substitution request must be submitted to Engineer for approval prior to purchase, delivery or installation.

11. Shop Drawings: Provide coordinated shop drawings which include physical characteristics of all systems, equipment, ductwork and piping layout plans, and control wiring diagrams. Reference individual Division 23, HVAC Specification Sections for additional requirements for shop drawings outside of these requirements.
   a. Provide Shop Drawings indicating access panel locations for items that require Code or maintenance access, size and elevation for approval prior to installation.

12. Samples: Provide samples when requested by individual Sections.

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

14. Operation and Maintenance Manuals, Owners Instructions:
   a. Submit, at one time, electronic files (PDF format) on CD/DVD of manufacturer's operation and maintenance instruction manuals and parts lists for equipment or items requiring servicing. Include valve charts. Submit data when work is substantially complete and in same order format as submittals. Include name and location of source parts and service for each piece of equipment.
      1) Include copy of approved submittal data along with submittal review letters received from Engineer. Data to clearly indicate installed equipment model numbers. Delete or cross out data pertaining to other equipment not specific to this project.
      2) Include copy of manufacturer's standard Operations and Maintenance for equipment. At front of each tab, provide routine maintenance documentation for scheduled equipment. Include manufacturer's recommended maintenance schedule and highlight maintenance required to maintain warranty. Furnish list of routine maintenance parts, including part numbers, sizes, quantities, relevant to each piece of equipment: belts, motors, lubricants, and filters.
3) Include Warranty per Division 00, Procurement and Contracting Requirements and Division 01, General Requirements, Section 23 00 00, HVAC Basic Requirements and individual Sections.

4) Include product certificates of warranties and guarantees.

5) Include copy of complete parts list for equipment. Include available exploded views of assemblies and sub assemblies.

6) Include copy of startup and test reports specific to each piece of equipment.

7) Include copy of final air and water systems balancing log along with pump, fan and distribution system operating data.

8) Include commissioning reports.

9) Include copy of valve charts/schedules.

10) Engineer will return incomplete documentation without review. Engineer will provide one set of review comments in Submittal Review format. Contractor must arrange for additional reviews; Contractor to bear costs for additional reviews at Engineer's hourly rates.

b. Thoroughly instruct Owner in proper operation of equipment and systems. Where noted in individual Sections, training will include classroom instruction with applicable training aids and systems demonstrations. Field instruction per Section 23 00 00, HVAC Basic Requirements Article titled "Demonstration".

c. Copies of certificates of code authority inspections, acceptance, code required acceptance tests, letter of conformance and other special guarantees, certificates of warranties, specified elsewhere or indicated on Drawings.

15. Record Drawings:

a. Maintain at site at least one set of drawings for recording "As-constructed" conditions. Indicate on drawings changes to original documents by referencing revision document, and include buried elements, location of cleanouts, and location of concealed mechanical items. Include items changed by field orders, supplemental instructions, and constructed conditions.

b. Record Drawings are to include equipment and fixture/connection schedules, control dampers, fire smoke dampers, fire dampers, valves, bottom of pipe, duct and equipment elevations and dimensioned locations for all distribution systems (hydronic and air). Invert elevations and dimensioned locations for underground systems below grade to 5-feet outside building that accurately reflect "as constructed or installed" for project.

c. At completion of project, input changes to original project Revit Model and make one set of black-line drawings created from Revit Model in version/release equal to contract drawings. Submit Revit disk and drawings upon substantial completion.

d. See Division 23, HVAC individual Sections for additional items to include in record drawings.

1.05 QUALITY ASSURANCE

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

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

C. Manufacturer's Instructions: Follow manufacturer's written instructions. If in conflict with Contract Documents, obtain clarification. Notify Engineer/Architect, in writing, before starting work.
D. Items shown on Drawings are not necessarily included in Specifications or vice versa. Confirm requirements in all Contract Documents.
E. Provide products that are UL listed.
F. ASME Compliance: ASME listed water heaters and boilers with an input of 200,000 BTUH and higher, hot water storage tanks which exceed 120 gallons, and hot water expansion tanks which are connected to ASME rated equipment or required by code or local jurisdiction.
G. Provide safety controls required by National Boiler Code (ASME CSD 1) for boilers and water heaters with an input of 400,000 BTUH and higher.

1.06 WARRANTY
A. Provide written warranty covering the work for a period of one year from date of Substantial Completion in accordance with Division 00, Contracting and Procurement Requirements, Division 01, General Requirements, Section 23 00 00, HVAC Basic Requirements and individual Division 23, HVAC Sections.
B. Sections under this Division can require additional and/or extended warranties that apply beyond basic warranty under Division 01, General Requirements and the General Conditions. Confirm requirements in all Contract Documents.

1.07 COORDINATION DOCUMENTS
A. Prior to construction, coordinate installation and location of HVAC equipment, ductwork, grilles, diffusers, piping, equipment, fire sprinklers, plumbing, cable trays, lights, and electrical services with architectural and structural requirements, and other trades (including ceiling suspension, and tile systems), and provide maintenance access requirements. Coordinate with submitted architectural systems (i.e. roofing, ceiling, finishes) and structural systems as submitted, including footings and foundation. Identify zone of influence from footings and ensure systems are not routed within the zone of influence.
B. Advise Architect in event a conflict occurs in location or connection of equipment. Bear costs resulting from failure to properly coordinate installation or failure to advise Architect of conflict.
C. Submit final Coordination Drawings with changes as Record Drawings at completion of project.

PART 2 - PRODUCTS
2.01 MANUFACTURERS
A. Provide like items from one manufacturer, including but not limited to pumps, fans, valves, control devices, air handlers, vibration isolation devices, etc.

2.02 MATERIALS
A. Base contract upon furnishing materials as specified. Materials, equipment, and fixtures used for construction are to be new, latest products as listed in manufacturer's printed catalog data and are to be UL or ETL approved or have adequate approval or be acceptable by State, County, and City authorities.
B. Articles, fixtures, and equipment of a kind to be standard product of one manufacturer.
C. Names and manufacturer's names denote character and quality of equipment desired and are not to be construed as limiting competition.
D. Hazardous Materials:
   2. Comply with Division 00, Procurement and Contracting Requirements and Division 01, General Requirements for this project relating to hazardous materials.
   3. Do not use any materials containing a hazardous substance. If hazardous materials are encountered, do not disturb; immediately notify Owner and Architect. Hazardous materials will be removed by Owner under separate contract.
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2.03 ACCESS PANELS

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

B. Confirm Access Panel requirements in Division 01, General Requirements, Division 08, Openings and individual Division 23, HVAC Sections. In absence of specific requirements in Division 01, General Requirements, comply with the following:

1. Provide flush mounting access panels for service of systems and individual components requiring maintenance or inspection. Where access panels are located in fire-rated assemblies of building, rate access panels accordingly.
   a. Ceiling access panels to be minimum 24-inch by 24-inch required and approved size.
   b. Wall access panels to be minimum of 12-inch by 12-inch required and approved size.
   c. Provide screwdriver operated catch.

2. Manufacturers and Models:
   1) Drywall: Karp KDW.
   2) Plaster: Karp DSC-214PL.
   3) Masonry: Karp DSC-214M.
   4) 2 hour rated: Karp KPF-350FR.
   5) Manufacturers: Milcor, Elmdor, Acudor or approved equivalent.

PART 3 - EXECUTION

3.01 ACCESSIBILITY AND INSTALLATION

A. Confirm Accessibility and Installation requirements in Division 00, Procurement and Contracting Requirements and Division 01, General Requirements, Section 23 00 00, HVAC Basic Requirements and individual Division 23, HVAC Sections.

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

C. Install equipment and products complete as directed by manufacturer's installation instructions including all appurtenances recommended in manufacturer's installation instructions, at no additional charge to Owner. Obtain installation instructions from manufacturer prior to rough-in of equipment and examine instructions thoroughly. When requirements of installation instructions conflict with Contract Documents, request clarification from Architect prior to proceeding with installation. This includes proper installation methods, sequencing and coordination with other trades and disciplines.

D. Earthwork:
   1. Confirm Earthwork requirements in Contract Documents. In absence of specific requirements, comply with individual Division 23, HVAC Sections and the following:
      a. Perform excavation, dewatering, shoring, bedding, and backfill required for installation of work in this Division in accordance with related earthwork Sections. Contact utilities and locate existing utilities prior to excavation. Repair any work damaged during excavation or backfilling.
      b. Excavation: Do not excavate under footings, foundation bases, or retaining walls.
      c. Provide protection of underground systems. Review the project Geotechnical Report for references to corrosive or deleterious soils which will reduce the performance or service life of underground systems materials.

E. Firestopping:
   1. Confirm Firestopping requirements in Division 07, Thermal and Moisture Protection. In absence of specific requirements, comply with individual Division 23, HVAC Sections and the following:
a. Coordinate location and protection level of fire and/or smoke rated walls, ceilings, and floors. When these assemblies are penetrated, seal around piping, ductwork and equipment with approved firestopping material. Install firestopping material complete as directed by manufacturer's installation instructions. Meet requirements of ASTM E814, Standard Test Method for Fire Tests of Through-Penetration Fire Stops.

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

G. Plenums:
1. Plenums: Materials within plenums shall be noncombustible or shall have a flame spread index of not more than 25 and a smoke-developed index of not more than 50 when tested in accordance with ASTM E 84 or UL 723. Immediately notify Architect / Engineer of any discrepancy.

3.02 SEISMIC CONTROL
A. Confirm Seismic Control requirements in Division 01, General Requirements, Structural documents, and individual Division 23 HVAC Sections.
B. General:
1. Earthquake resistant designs for HVAC (Division 23) equipment and distribution, i.e. motors, ductwork, piping, equipment, etc. to conform to regulations of jurisdiction having authority.
2. Restraints which are used to prevent disruption of function of piece of equipment because of application of horizontal force to be such that forces are carried to frame of structure in such a way that frame will not be deflected when apparatus is attached to a mounting base and equipment pad, or to structure in normal way, utilizing attachments provided. Secure equipment and distribution systems to withstand a force in direction equal to value defined by jurisdiction having authority.
3. Provide stamped Shop Drawings from licensed Structural Engineer of seismic bracing and seismic movement assemblies for piping equipment and water heaters. Submit Shop Drawings along with equipment submittals.
4. Provide stamped Shop Drawings from licensed Structural Engineer of seismic flexible joints for piping and crossing building expansion or seismic joints. Submit Shop Drawings along with seismic bracing details.
C. Piping and Ductwork:
D. Provide means to prohibit excessive motion of mechanical equipment during earthquake.

3.03 REVIEW AND OBSERVATION
A. Confirm Review and Observation requirements in Division 00, Procurement and Contracting Requirements, Division 01, General Requirements, Section 23 00 00, HVAC Basic Requirements and individual Division 23, HVAC Sections.
B. Notify Architect, in writing, at following stages of construction so that they may, at their option, visit site for review and construction observation:
1. Underground system installation prior to backfilling.
2. Prior to covering walls.
3. Prior to ceiling cover/installation.
4. After major equipment is installed.
5. When main systems, or portions of, are being tested and ready for inspection by AHJ.

C. Final Punch:
1. Prior to requesting a final punch visit from the Engineer, request from Engineer the Mechanical Precloseout Checklist, complete the checklist confirming completion of systems’ installation, and return to Engineer. Request a final punch visit from the Engineer, upon Engineer’s acceptance that the mechanical systems are ready for final punch.
2. Costs incurred by additional trips required due to incomplete systems will be the responsibility of the Contractor.

3.04 CONTINUITY OF SERVICE
A. Confirm requirements in Division 00, Procurement and Contracting Requirements and Division 01, General Requirements. In absence of specific requirements, comply with individual Division 23, HVAC Sections and the following:
1. During remodeling or addition to existing structures, while existing structure is occupied, current services to remain intact until new construction, facilities or equipment is installed.
2. Prior to changing over to new service, verify that every item is thoroughly prepared. Install new piping and ductwork, and wiring to point of connection. Where existing systems are being utilized, clean existing distribution systems (ductwork, piping, fans, air handlers) prior to connecting new ductwork or piping.
3. Coordinate transfer time to new service with Owner. If required, perform transfer during off peak hours. Once changeover is started, pursue to its completion to keep interference to a minimum.
   a. If overtime is necessary, there will be no allowance made by Owner for extra expense for such overtime or shift work.
4. Organize work to minimize duration of power interruption.

3.05 CUTTING AND PATCHING
A. Confirm Cutting and Patching requirements in Division 00, Procurement and Contracting Requirements and Division 01, General Requirements. In absence of specific requirements, comply with individual Division 23, HVAC Sections and the following:
1. Proposed floor cutting/core drilling/sleeve locations to be approved by Project Structural Engineer. Submit proposed locations to Architect/Project Structural Engineer. Where slabs are of post tension construction, perform x-ray scan of proposed penetration locations and submit scan results including proposed penetration locations to Project Structural Engineer/Architect for approval. Where slabs are of waffle type construction, show column cap extent and cell locations relative to proposed penetration(s).
2. Cutting, patching and repairing for work specified in this Division including plastering, masonry work, concrete work, carpentry work, and painting included under this Section will be performed by skilled craftsmen of each respective trade in conformance with appropriate Division of Work.
3. Additional openings required in building construction to be made by drilling or cutting. Use of jack hammer is specifically prohibited. Patch openings in and through concrete and masonry with grout.
4. Restore new or existing work that is cut and/or damaged to original condition. Patch and repair specifically where existing items have been removed. This includes repairing and painting walls, ceilings, etc. where existing conduit and devices are removed as part of this project. Where alterations disturb lawns, paving, and walks, surfaces to be repaired, refinished and left in condition matching existing prior to commencement of work.
5. Additional work required by lack of proper coordination will be provided at no additional cost to the Owner.
3.06 EQUIPMENT SELECTION AND SERVICEABILITY
   A. Replace or reposition equipment which is too large or located incorrectly to permit servicing, at no additional cost to Owner.
   B. Maintain design intent where equipment other than as shown as Basis of Design in Contract Documents is provided. Where equipment requires ductwork or piping arrangement, controls/control diagrams, or sequencing different from that indicated in Contract Documents, provide at no additional cost to Owner.

3.07 DELIVERY, STORAGE AND HANDLING
   A. Confirm requirements in Division 00, Procurement and Contracting Requirements and Division 01, General Requirements. In absence of specific requirements, comply with individual Division 23, HVAC Sections and the following:
      1. Handle materials delivered to project site with care to avoid damage. Store materials on site inside building or protected from weather, dirt and construction dust. Insulation and lining that becomes wet from improper storage and handling to be replaced before installation. Products and/or materials that become damaged due to water, dirt, and/or dust as a result of improper storage to be replaced before installation.
      2. Protect equipment and pipe to avoid damage. Close pipe openings with caps or plugs. Keep motors and bearings in watertight and dustproof covers during entire course of installation.
      3. Protect bright finished shafts, bearing housings and similar items until in service.

3.08 DEMONSTRATION
   A. Confirm Demonstration requirements in Division 00, Procurement and Contracting Requirements and Division 01, General Requirements, Section 23 00 00, HVAC Basic Requirements and individual Division 23, HVAC Sections.
   B. Upon completion of work and adjustment of equipment and test systems, demonstrate to Owner's Representative, Architect and Engineer that equipment furnished and installed or connected under provisions of these Specifications functions in manner required. Provide field instruction to Owner's Maintenance Staff as specified in Division 01, General Requirements, Section 23 00 00, HVAC Basic Requirements and individual Division 23, HVAC Sections.
   C. Manufacturer's Field Services: Furnish services of a qualified person at time approved by Owner, to instruct maintenance personnel, correct defects or deficiencies, and demonstrate to satisfaction of Owner that entire system is operating in satisfactory manner and complies with requirements of other trades that may be required to complete work. Complete instruction and demonstration prior to final job site observations.

3.09 CLEANING
   A. Confirm Cleaning requirements in Division 00, Procurement and Contracting Requirements, Division 01, General Requirements, Section 23 00 00, HVAC Basic Requirements and individual Division 23, HVAC Sections.
   B. Upon completion of installation, thoroughly clean exposed portions of equipment, removing temporary labels and traces of foreign substances. Throughout work, remove construction debris and surplus materials accumulated during work.

3.10 INSTALLATION
   A. Confirm Installation requirements in Division 00, Procurement and Contracting Requirements, Division 01, General Requirements, Section 23 00 00, HVAC Basic Requirements and individual Division 23, HVAC Sections.
   B. Install equipment and fixtures in accordance with manufacturer's installation instructions, plumb and level and firmly anchored to vibration isolators. Maintain manufacturer's recommended clearances.
C. Start up equipment, in accordance with manufacturer's start-up instructions, and in presence of manufacturer's representative. Test controls and demonstrate compliance with requirements. Replace damaged or malfunctioning controls and equipment.
   1. Do not place equipment in sustained operation prior to initial balancing of HVAC systems.

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

3.11 PAINTING

A. Confirm Painting requirements in Division 01, General Requirements and Division 09, Finishes. In absence of specific requirements, comply with individual Division 23, HVAC Sections and the following:
   1. Ferrous Metal: After completion of work, thoroughly clean and paint exposed supports constructed of ferrous metal surfaces in mechanical rooms, i.e., hangers, hanger rods, equipment stands, with one coat of black asphalt varnish for exterior or black enamel for interior, suitable for hot surfaces.
   2. After acceptance by Authority Having Jurisdiction (AHJ), in a mechanical room, on roof or other exposed areas, machinery and equipment not painted with enamel to receive two coats of primer and one coat of rustproof enamel, colors as selected by Architect.
   3. See individual equipment Specifications for other painting.
   4. Structural Steel: Repair damage to structural steel finishes or finishes of other materials damaged by cutting, welding or patching to match original.
   5. Piping and Ductwork: Clean, primer coat and paint exposed piping and ductwork on roof or at other exterior locations with two coats paint suitable for metallic surfaces and exterior exposures. Color selected by Architect.
   6. Covers: Covers such as manholes, cleanouts and the like will be furnished with finishes which resist corrosion and rust.

3.12 ACCESS PANELS

A. Confirm Access Panel requirements in Division 01, General Requirements. In absence of specific requirements, comply with individual Division 23, HVAC Sections and the following:
   1. Coordinate locations/sizes of access panels with Architect prior to work.

3.13 DEMOLITION

A. Confirm requirements in Division 01, General Requirements and Division 02, Existing Conditions. In absence of specific requirements, comply with individual Division 23, HVAC Sections and the following:
   1. Scope:
      a. It is the intent of these documents to provide necessary information and adjustments to the HVAC system required to meet code, and accommodate installation of new work.
      b. Coordinate with Owner so that work can be scheduled not to interrupt operations, normal activities, building access or access to different areas.
      c. Existing Conditions: Determine exact location of existing utilities and equipment before commencing work, compensate Owner for damages caused by failure to exactly locate and preserve utilities. Replace damaged items with new material to match existing. Promptly notify Owner if utilities are found which are not shown on Drawings.
   2. Equipment: Unless otherwise directed, equipment, fixtures, or fittings being removed as part of demolition process are Owner's property. Remove other items not scheduled to be reused or relocated from job site as directed by Owner.
   3. Unless specifically indicated on Drawings, remove exposed, unused ductwork and piping to behind finished surfaces (floor, walls, ceilings, etc.). Cap and patch surfaces to match surrounding finish.
4. Unless specifically indicated on Drawings, remove unused equipment, fixtures, fittings, rough-ins, and connectors. Removal is to be to a point behind finished surfaces (floors, walls, and ceilings).

3.14 ACCEPTANCE
A. Confirm requirements in Division 00, Procurement and Contracting Requirements and Division 01, General Requirements. In absence of specific requirements, comply with individual Division 23, HVAC Sections and the following:
1. System cannot be considered for acceptance until work is completed and demonstrated to Architect that installation is in strict compliance with Specifications, Drawings and manufacturer's installation instructions, particularly in reference to following:
   a. Testing and Balancing Reports
   b. Cleaning
   c. Operation and Maintenance Manuals
   d. Training of Operating Personnel
   e. Record Drawings
   f. Warranty and Guaranty Certificates
   g. Start-up/Test Document
   h. Commissioning Reports

3.15 FIELD QUALITY CONTROL
A. Confirm Field Quality Control requirements in Division 01, General Requirements, Section 23 00 00, HVAC Basic Requirements and individual Division 23, HVAC Sections.

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

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

3.17 ELECTRICAL INTERLOCKS
A. Where equipment motors are to be electrically interlocked with other equipment for simultaneous operation, utilize equipment wiring diagrams to coordinate with electrical systems so that proper wiring of equipment involved is affected.
3.18 TEMPORARY HEATING, COOLING AND HUMIDITY CONTROL

A. Provide temporary heating, cooling, controls, humidification and dehumidification as required to facilitate the construction of the project. Size and select temporary system based on the requirements of the various trades during construction. This includes, but is not limited to, drywall, case work, wood flooring and wood finishes that are subject to warping. Size and install system to prevent mold growth. Coordinate the location of the temporary system. The house system can be used. Develop a procedure for how the house system will be used including a sketch depicting the house system, how filtration will be used to prevent construction debris from entering the system and how often the filters will be changed, how the ductwork will be cleaned after use to ensure a clean system is turned over to the Owner and how the units are sized. Submit this procedure to the Mechanical Engineer for review. Follow National Air Duct Cleaners Association (NADCA) duct cleaning procedures and guidelines. WARRANTIES for the house system, if new, to commence when the Owner moves in if house system is used as the means to maintain the climate within the building during construction. Include this warranty requirement in the original bid or proposal amount. Coordinate and provide any temporary power, controls, ductwork, piping, plumbing anchorage, miscellaneous steel and structural supports required to support the temporary system. Installation of the system to comply with all applicable codes and be acceptable to the Authority Having Jurisdiction (AHJ).

END OF SECTION
SECTION 23 0529 - HANGERS AND SUPPORTS FOR HVAC PIPING, DUCTWORK AND EQUIPMENT

PART 1 - GENERAL

1.01 SUMMARY
A. Work Included:
   1. Hangers and Supports for HVAC Piping, Ductwork and Equipment
   2. Building Attachments
   3. Flashing
   4. Miscellaneous Metal and Materials

1.02 RELATED SECTIONS
A. Contents of Division 23, HVAC and Division 01, General Requirements apply to this Section.

1.03 REFERENCES AND STANDARDS
A. References and Standards as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.
B. In addition, meet the following:
   2. Terminology: As defined in MSS SP-90 "Guidelines on Terminology for Pipe Hangers and Supports".
   3. Install ductwork and piping per SMACNA's requirements.
   4. Hanger spacing installation and attachment to meet all manufacturer's requirements and MSS SP-58.

1.04 SUBMITTALS
A. Submittals as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

1.05 QUALITY ASSURANCE
A. Quality assurance as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.
B. In addition, meet the following:
   1. Welding:
      a. Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications".
   2. Welding for Hangers:
      a. Qualify procedures and personnel according to AWS D9.1, Sheet Metal Welding Code for duct joint and seam welding.
   3. Engineering Responsibility:
      a. Design and preparation of Shop Drawings and calculations for each multiple pipe support, trapeze, duct support equipment hangers/supports, and seismic restraint by a qualified Structural Professional Engineer.
      1) Professional Engineer Qualifications: A professional engineer who is legally qualified to practice in jurisdiction where project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of hangers and supports that are similar to those indicated for this Project in material, design, and extent.
      4. Manufacturers regularly engaged in the manufacture of bolted metal framing support systems, whose products have been in satisfactory use in similar service for not less than 10 years.
   5. Support systems to be supplied by a single manufacturer.
1.06 WARRANTY
A. Warranty of materials and workmanship as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

1.07 PERFORMANCE REQUIREMENTS
A. Provide pipe, ductwork and equipment hangers and supports in accordance with the following:
   1. When supports, anchorages, and seismic restraints for equipment, and supports, anchorages, and seismic restraints for conduit, piping, and ductwork are not shown on the Drawings, the contractor is responsible for their design.
   2. Connections to structural framing not to introduce twisting, torsion, or lateral bending in the framing members. Provide supplementary steel as required.
B. Provide seismic restraint hangers and supports for piping, ductwork and equipment. See Section 23 0548.
C. Obtain approval from AHJ for seismic restraint hanger and support system to be installed for piping and equipment. See Section 23 0548.

PART 2 - PRODUCTS
2.01 MANUFACTURERS
A. Hangers and Supports for HVAC Piping, Ductwork and Equipment:
   1. Anvil International
   2. B-Line Systems, Incorporated
   3. Erico Company, Incorporated
   4. Nelson-Olsen Incorporated
   5. Rilco Manufacturing Company, Incorporated
   6. Snappitz Thermal Pipe Shield Manufacturing
   7. Unistrut Corporation
   8. Or approved equivalent.
B. Building Attachments:
   1. Anchor-It
   2. Gunnebo Fastening Corporation
   3. Hilti Corporation
   4. ITW Ramset/Red Head
   5. Masterset Fastening Systems, Incorporated
   6. Or approved equivalent.

2.02 HANGERS AND SUPPORTS FOR HVAC PIPING, DUCTWORK AND EQUIPMENT
A. Hanger Rods: Hanger rods continuously threaded or threaded ends only in concealed spaces and threaded ends only in exposed spaces; finish electro-galvanized or cadmium-plated in concealed spaces and prime painted in exposed spaces; sizes per MSS.
B. Hanger Rod Couplings: Anvil Figure 136, B-Line Figure B3220, or approved equivalent; malleable iron rod coupling with elongated center sight gap for visual inspection; to have same finish as hanger rods.
C. Channel Hanging System:
   1. Framing members No. 12 gauge formed steel channels, 1-5/8-inch square, conforming to ASTM A570 GR33, one side of channel to have a continuous slot within turned lips; framing nut with grooves and spring 1/2-inch size, conforming to ASTM 675 GR60; screws conforming to ASTM A307; fittings conforming to ASTM A575; parts enamel painted or electro-galvanized.
   2. Concrete Inserts: Malleable iron body, hot dipped galvanized finish. Lateral adjustment. MSS Type 18.
D. Continuous Concrete Insert: Steel construction, minimum 12 gauge. Electrogalvanized finish. Pipe clamps and insert nuts to match.
E. Freestanding Roof Supports: Polyethylene high-density UV resistant quick "pipe" block with foam pad.

2.03 BUILDING ATTACHMENTS

A. Beam Clamps:
   1. MSS Type 19 and 23, wide throat, with retaining clip.
   2. Universal Side Beam Clamp: MSS Type 20.
B. Powder-Actuated Drive Pin Fasteners: Powder actuated type, drive pin attachments with pull-out and shear capacities appropriate for supported loads and building materials where used.
C. Anchor Bolts:
   1. Anchor supports to existing masonry, block and tile walls per anchoring system manufacturer's recommendations or as modified by project structural engineer. Insert-type attachments with pull-out and shear capacities appropriate for supported loads and building materials where used.
   2. Anchor Bolts (Cast-In-Place): Steel bolts, ASTM A307. Nuts to conform to ASTM A194. Design values for shear and tension not more than 80 percent of the allowable listed loads.
   3. Anchor (Expansion) Bolts: Carbon steel to ASTM A307; nut to conform to ASTM A194; drilled-in type. Design values for shear and tension not more than 80 percent of the allowable listed loads.

2.04 FLASHING

A. Steel Flashing: 26 gauge galvanized steel.
B. Safes: 8 mil thick neoprene.
C. Caps: Steel, 22 gauge minimum, 16 gauge at fire-resistant structures.

2.05 MISCELLANEOUS METAL AND MATERIALS

A. General:
   1. Provide miscellaneous metal items specified, including materials, fabrication, fastenings and accessories required for finished installation, where indicated on drawings or otherwise not shown on drawings that are necessary for completion of the project. Contractor is responsible for their design.
   2. Fabricate miscellaneous units to size shapes and profiles indicated or, if not indicated, of required dimensions to receive adjacent other work to be retained by framing. Except as otherwise shown, fabricate from structural steel shapes and plates and steel bars, of welded construction using mitered joints for field connection. Cut, drill and tap units to receive hardware and similar items.
B. Structural Shapes: Where miscellaneous metal items are needed to be fabricated from structural steel shapes and plates, provide members constructed of steel conforming with requirements of ASTM A36 or approved equivalent.
C. Steel Pipe: Provide seamless steel pipe conforming to requirements of ASTM A53, Type S, Grade A, or Grade B. Weight and size required as specified.
D. Fasteners: Provide fasteners of types as required for assembly and installation of fabricated items; surface-applied fasteners are specified elsewhere.
E. Bolts: Low carbon steel externally and internally threaded fasteners conforming with requirements of ASTM A307; include necessary nuts and plain hardened washers. For
structural steel elements supporting mechanical material or equipment from building structural members or connection thereto, use fasteners conforming to ASTM A325.

F. Miscellaneous Materials: Provide incidental accessory materials, tools, methods, and equipment required for fabrication.

G. Provide hot dipped galvanized components for items exposed to weather. Use materials compatible with system being supported (i.e. aluminum for aluminum ductwork, stainless steel for stainless steel ductwork).

H. Use straps, threshold rods and wire with sizes required by SMACNA to support ductwork.

I. Grout:
   1. ASTM C1107, Grade B, factory mixed and packaged, nonshrink and nonmetallic, dry, hydraulic-cement grout.
   2. Characteristics: Post hardening and volume adjusting; recommended for both interior and exterior applications.
   3. Properties: Nonstaining, noncorrosive, and non gaseous.
   4. Design Mix: 5000-PSI (34.5-MPa), 28-day compressive strength.

PART 3 - EXECUTION

3.01 GENERAL INSTALLATION REQUIREMENTS

A. Verify building materials to have hangers and attachments affixed in accordance with hangers to be used. Provide supporting calculations.

B. Examine Drawings and coordinate for verification of exact locations of fire and smoke rated walls, partitions, floors and other assemblies. Indicate, by shading and labeling on Record Drawings such locations and label as “1-Hour Wall”, “2-Hour Fire/Smoke Barrier”, and the like. Determine proper locations for piping penetrations. Set sleeves in place in new floors, walls or roofs prior to concrete pour or grouting.

C. Install hangers, supports, anchors and sleeves after required building structural work has been completed in areas where the work is to be installed. Coordinate proper placement of inserts, anchors and other building structural attachments.

D. Equipment Clearances: Do not route ductwork, equipment, or piping through electrical rooms or other electrical or electronic equipment spaces and enclosures and the like. Within equipment rooms, provide minimum 3-feet lateral clearance from all sides of electric switchgear panels. Do not route ductwork, equipment, or piping above any electric power or lighting panel, switchgear, or similar electric device. Coordinate with Electrical and coordinate exact ductwork, equipment or pipe routing to provide proper clearance with such items.

3.02 HANGERS AND SUPPORTS FOR HVAC PIPING, DUCTWORK AND EQUIPMENT

A. Hang rectangular sheet-metal ducts with a cross sectional area of less than 7 SF with galvanized strips of No. 16 USS gauge steel 1-inch wide, and larger ducts with steel angles and adjustable hanger rods similar to piping hangers. Support at a maximum of 8-feet on center.

B. Support horizontal ducts within 24-inches of each elbow and within 48-inches of each branch intersection.

C. Provide aluminum supports for aluminum ductwork.

D. Provide stainless steel supports for stainless steel ductwork.

E. Support vertical ducts at maximum intervals of 16-feet and at each floor.

F. Install upper attachments to structures with an allowable load not exceeding one-fourth of failure (proof-test) load.

G. Use double nuts and lock washers on threaded rod supports.

H. Floor supports in mechanical rooms to be elevated 1-inch above finish floor and void space filled with masonry grout.
I. Anchor ducts securely to building in such a manner as to prevent transmission of vibration to structure. Do not connect duct hanger straps to roof deck. Do not support ducts from other ducts, piping or equipment.

J. Attach strap hangers installed flush with end of sheet-metal duct run to duct with sheet-metal screws.

K. Channel Support System Installation:
1. Arrange for grouping of parallel runs of piping and support together on field-assembled channel systems.
2. Field assemble and install according to manufacturer's written instructions.

L. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers, and other accessories.

M. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.

N. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.

O. Adjust hangers so as to distribute loads equally on attachments. Provide grout under supports to bring piping, ductwork and equipment to proper level and elevations.

P. Prime paint ferrous nongalvanized hangers, accessories, and supplementary steel which are not factory painted.

3.03 BUILDING ATTACHMENTS

A. Factory fabricated attachments complying with MSS SP-58, selected to suit building substructure conditions and in accordance manufacturer's published product information.

B. Select size of building attachments to suit hanger rods.

C. Install concrete inserts before placing concrete.

D. Install powder-actuated concrete fasteners after concrete is placed and completely cured.

E. Do not use powder-actuated concrete fasteners for lightweight aggregate concretes or for slabs less than 4-inches thick.

F. Install within concrete or on structural steel or wood. Attachment to wood structure: Anvil side beam bracket Figure 202 for attachment to wooden beam or approved attachment for a wood structure.

G. Install additional building attachments where support is required for additional concentrated loads, including valves, flanges, guides, strainers, expansion joints, and at changes in direction of piping.

H. Install concrete inserts before concrete is placed; fasten insert secure to forms. Where concrete with compressive strength less than 2500 PSI is indicated, install reinforcing bars through openings at top in inserts.

I. Install building attachments within concrete slabs or attach to structural steel. Space attachments within maximum piping span length indicated in MSS SP-58. Install additional attachments at concentrated loads, including valves, flanges guides, strainers, and expansion joints, and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.

J. Install powder-actuated drive-pin fasteners in concrete after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.

K. Install mechanical-anchor fasteners in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.
L. Bolting: Provide bored, drilled or reamed holes for bolting to miscellaneous structural metals, frames or for mounts or supports. Flame cut, punched or hand sawn holes will not be accepted.

M. Anchor Bolts:
1. Install anchor bolts for mechanical equipment, piping and ductwork as required. Tightly fit and clamp base-supported equipment anchor bolts at equipment support points. Provide locknuts where equipment, piping and ductwork are hung.
2. Anchor bolts (Cast-In-Place): Embed anchor bolts in new cast-in-place concrete to anchor equipment. Install a pipe sleeve around the anchor bolt for adjustment of the top 1/3 of the bolt embedment; sizes and patterns to suit the installation conditions of the equipment to be anchored.

N. Testing: Test powder-actuated insert attachments with a minimum load of 100 pounds.

3.04 FLASHING
A. Flash and counterflash where piping, ductwork and equipment passes through weather or waterproofed walls, floors, and roofs.

B. Provide 12-inches minimum height curbs for roof-mounted mechanical equipment. Flash and counter flash with galvanized steel, soldered and waterproofed.

3.05 MISCELLANEOUS METAL AND MATERIALS
A. General: Verify dimensions prior to fabrication. Form metal items to accurate sizes and configurations as indicated on drawings and otherwise required for proper installation; make with lines straight and angles sharp, clean and true; drill, countersink, tap, and otherwise prepare items for connections with work of other trades, as required. Fabricate to detail of structural shapes, plates and bars; weld joints where practicable; provide bolts and other connection devices required. Include anchorages; clip angles, sleeves, anchor plates, and similar devices. Hot dipped galvanize after fabrication items installed in exterior locations. Set accurately in position as required and anchor securely to building construction. Construct items with joints formed for strength and rigidity, accurately machining for proper fit; where exposed to weather, form to exclude water.

B. Finishes:
1. Ferrous Metal: After fabrication, but before erection, clean surfaces by mechanical or chemical methods to remove rust, scale, oil, corrosion, or other substances detrimental to bonding of subsequently applied protective coatings. For metal items exposed to weather or moisture, galvanize in manner to obtain G90 zinc coating in accordance with ASTM A123. Provide other non-galvanized ferrous metal with 1 coat of approved rust-resisting paint primer, in manner to obtain not less than 1.0 mil dry film thickness. Touch-up damaged areas in primer with same material, before installation. Apply zinc coatings and paint primers uniformly and smoothly; leave ready for finish painting as specified elsewhere.
2. Metal in Contact with Concrete, Masonry and Other Dissimilar Materials: Where metal items are to be erected in contact with dissimilar materials, provide contact surfaces with coating of an approved zinc-chromate primer in manner to obtain not less than 1.0 mil dry film thickness, in addition to other coatings specified in these specifications.
3. For Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and apply galvanizing repair paint to comply with ASTM A780.

C. Coordinate and furnish anchorages, setting drawings, diagrams, templates, instructions, and directions for installation of anchorages, such as concrete inserts, sleeves, anchor bolts and miscellaneous items having integral anchors, which are to be embedded in concrete or masonry construction. Coordinate delivery of such items to project site.

D. Fastening to In-Place Construction: Provide anchorage devices and fasteners where necessary for securing miscellaneous metal fabrications to in-place construction; including, threaded fasteners for concrete and masonry inserts, toggle bolts, through-bolts, lag bolts, wood screws.
and other connectors as required. Avoid cutting concrete reinforcing when drilling for inserts. Reference structural drawings and reinforcing shop drawings and determine locations of stirrups prior to drilling into concrete.

E. Cutting, Fitting and Placement: Perform cutting, drilling and fitting required for installation of miscellaneous metal fabrications. Set work accurately in location, alignment and elevation, plumb, level, true and free of rack, measured from established lines and levels. Provide temporary bracing or anchors in formwork for items, which are to be built into concrete masonry or similar construction.

F. Field Welding: Comply with AWS Code for procedures of manual shielded metal-arc welding, appearance and quality of welds made, and methods used in correcting welding work.


H. Set loose leveling and bearing plates on wedges, or other adjustable devices. After the bearing members have been positioned and plumbed, tighten the anchor bolts. Do not remove wedges or shims, but if protruding, cut-off flush with edge of the bearing plate before packing with grout. Use metallic non-shrink grout in concealed locations where not exposed to moisture; use non-metallic non-shrink grout in exposed locations, unless otherwise indicated.

I. Pack grout solidly between bearing surfaces and plates to ensure that no voids remain.

J. Cut, drill, and fit miscellaneous metal fabrications for heavy-duty steel trapezes and equipment supports.

K. Fit exposed connections together to form hairline joints. Field-weld connections that cannot be shop-welded because of shipping size limitations.

L. Field Welding: Comply with AWS D1.1 procedures for shielded metal arc welding, appearance and quality of welds, and methods used in correcting welding work, and with the following:
   1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
   2. Obtain fusion without undercut or overlap.
   3. Remove welding flux immediately.
   4. Finish welds at exposed connections so no roughness shows after finishing and contours of welded surfaces match adjacent contours.

M. Provide galvanized components for items exposed to weather.

END OF SECTION
SECTION 23 0548 - VIBRATION AND SEISMIC CONTROLS FOR HVAC EQUIPMENT

PART 1 - GENERAL

1.01 SUMMARY
A. Work Included:
   1. Vibration Isolation
   2. Seismic Restrained Spring Vibration Isolation Roof-Curb
   3. Seismic Restraint Devices
   4. Factory Finishes
   5. Seismic-Bracing/Restraint Devices/Systems for Equipment, Piping and Ductwork
B. General:
   1. Vibration isolation for mechanical ductwork, piping and equipment.
   2. Seismic restraint for mechanical ductwork, piping and equipment.
   3. Seismic Certification for equipment, hangers and systems
   4. Special inspections for systems.

1.02 RELATED SECTIONS
A. Contents of Division 23, HVAC and Division 01, General Requirements apply to this Section.

1.03 REFERENCES AND STANDARDS
A. References and Standards as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

1.04 SUBMITTALS
A. Submittals as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.
B. In addition, provide:
   1. Vibration Isolation:
      a. Product Data: Provide catalog data indicating size, type, load and deflection of each isolator; and percent of vibration transmitted based on lowest disturbing frequency of equipment.
      b. Shop Drawings: Showing complete details of construction for steel and concrete bases including:
         1) Fabrication, including anchorages and attachments to structure and to supported equipment. Include auxiliary motor slides and rails, base weights, equipment static loads, power transmission, component misalignment and cantilever loads.
         2) Equipment mounting holes.
         3) Dimensions.
         4) Size and location of concrete and steel bases and curbs.
         5) Isolation selected for each support point.
         6) Details of mounting brackets for isolator.
         7) Weight distribution for each isolator.
         8) Details of seismic snubbers.
         9) Code number assigned to each isolator.
      c. Design calculations: Provide calculations for selecting vibration isolators and for designing vibration isolation bases.
   2. Riser Supports: Include riser diagrams and calculations showing anticipated expansion and contraction at each support point, initial and final loads on building structure, spring deflection changes and seismic loads. Include certification that riser system has been examined for excessive stress and that none will exist.
   3. Seismic Restraint:
VIBRATION AND SEISMIC CONTROLS FOR HVAC EQUIPMENT

a. Shop Drawings: Show compliance with requirements of Quality Assurance article of this Section. Shop drawings to be stamped by a professional Structural Engineer licensed in State of Oregon.
b. Calculations: Submit seismic calculations indicating restraint loadings resulting from design seismic forces. Include anchorage details and indicate quantity, diameter and depth of penetration of anchors. Calculations certified by professional Structural Engineer licensed in State of Oregon.

4. Seismic Restraint Details: Detail fabrication and attachment of seismic restraints and snubbers. Show anchorage details and indicate quantity, diameter and depth of penetration of anchors.
5. Submittals for Interlocking Snubbers: Include load deflection curves up to 1/2-inch deflection in x, y and z planes.
7. Equipment Certification: Provide seismic certification for equipment as noted in Seismic Design Summary or schedules on Drawings.

1.05 QUALITY ASSURANCE

A. Quality assurance as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.
B. In addition, meet the following:

1. Vibration Isolation:
   a. Except for packaged equipment with integral isolators, single manufacturer selects and furnishes isolation required.
   b. Deflections indicated on drawings are minimum actual static deflections for specific equipment supported.
   c. Isolator Stability:
      1) Size springs of sufficient diameter to maintain stability of equipment being supported. Spring diameters not less than 0.8 of compressed height at rated load.
      2) Springs have minimum additional travel to solid equal to 50 percent of rated deflection.
      3) Springs support 200 percent of rated load, fully compressed, without deformation or failure.
   d. Maximum Allowable Vibration Levels: Peak vibration velocities not exceed 0.08 in/sec. Correct equipment operating at vibration velocities that exceed this criteria.
2. Seismic Restraint:
   a. Code and Standard Requirements:
      1) Seismic restraint of equipment, piping and ductwork to be in accordance with latest enacted version of ASCE 7-10.
   b. Confirm Seismic Control requirements in Division 01, General Requirements and Structural documents.
   c. Certification: See Seismic Design Table or schedules on Drawings for equipment, systems and seismic-restraint devices designated to have seismic certification/qualification. Horizontal and vertical load testing and analysis performed according to ASCE 7-10. Anchorage systems to bear anchorage preapproval number from an agency acceptable to authorities having jurisdiction, showing maximum seismic-restraint ratings. Ratings based on independent testing or calculations, if preapproved ratings are not available. Calculations (including combining shear and tensile loads) to support seismic-restraint designs must be sealed by qualified licensed professional engineer in State of Oregon. Testing and calculations must include both shear and tensile loads and one test or analysis at 45 degrees to weakest mode.
d. Seismic restraint and anchorage of permanent equipment and associated systems listed below to building structure be designed to resist total design seismic force prescribed in local building code:
   1) Floor- or roof-mounted equipment weighing 400 pounds or greater.
   2) Suspended, wall-mounted or vibration isolated equipment weighing 20 pounds or greater.
   3) In-line duct devices connected to ductwork weighing 75 pounds or greater.
   4) Housekeeping slabs: provide reinforcement and anchorage to building structure.

e. Where required, seismic sway bracing of suspended duct and piping meet following:
   1) Pipe and duct runs requiring seismic bracing have minimum of two traverse braces and one longitudinal brace. Longitudinal (or traverse) brace at 90 degree change in direction may act as traverse (or longitudinal) brace if located within 2-feet of change in direction.
   2) Seismic bracing may not pass through seismic separation joint. Pipe or duct runs that pass through seismic separation joint must be restrained within 5-feet of both sides of separation.
   3) Seismic brace assembly spacing not to exceed 40-feet transverse and 80-feet longitudinal.

f. Seismic restraints may be omitted from suspended piping and duct if following conditions are satisfied:
   1) For piping or ducts supported by rod hangers 12-inches or less in length from top of duct to bottom of structural support. Top connections to structure have swivel joints, eye bolts, or vibration isolation hangers for entire length of system run.
   2) Lateral motion of system will not cause damaging impact with surrounding systems or cause loss of system vertical support.
   3) System must be welded steel pipe, brazed copper pipe, sheet metal duct or similar ductile material with ductile connections.

C. Seismic restraints, including anchors to building structure, be designed by registered professional Structural Engineer licensed in State of Oregon. Design includes:
   1. Number, size, capacity and location of anchors for floor- or roof-mounted equipment. For curb-mounted equipment, provide design of attachment of both unit to curb and curb to structure.
   2. Number, size, capacity and location of seismic restraint devices and anchors for vibration-isolation and suspended equipment. Provide calculations and test data verifying horizontal and vertical ratings of seismic restraint devices.
   3. Number, size, capacity and location of braces and anchors for suspended piping and ductwork on as-built plan drawings.
   4. Maximum seismic loads to be indicated on drawings at each brace location. Drawings bear stamp and signature of registered professional Structural Engineer who designed layout of braces.

1.06 WARRANTY
   A. Warranty of materials and workmanship as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

1.07 EXTRA MATERIALS
   A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   B. Seismic Snubber Units: Furnish replacement neoprene inserts for snubbers.

PART 2 - PRODUCTS

2.01 MANUFACTURERS
   A. Vibration Isolation:
1. The VMC Group
2. B-Line Systems, Inc.
4. Mason Industries Inc.
5. M.W. Sausse - Vibrex
6. Where Mason numbers are specified, equivalent products by listed manufacturers are acceptable.
7. Or approved equivalent.

B. Seismic Restraint Devices:
1. The VMC Group
2. B-Line Systems, Inc.
3. Hilti, Inc.
5. Mason Industries, Inc.
6. California Dynamics Corporation
7. Cooper B-Line Tolco.
8. Unistrut
9. ISAT, Inc.
10. Where Mason numbers are specified, equivalent products by listed manufacturers are acceptable.
11. Or approved equivalent.

D. Factory Finishes:
1. Kynar 500 Fluoropolymer Coating
2. Or approved equivalent.

E. Seismic-Bracing/Restraint Devices/Systems for Equipment, Piping and Ductwork:
1. The VMC Group
2. California Dynamics Corporation
3. Cooper B-Line, Inc.
4. Hilti, Inc.
5. Mason Industries, Inc.
7. Unistrut
8. ISAT, Inc.
9. Where Mason numbers are specified, equivalent products by listed manufacturers are acceptable.
10. Or approved equivalent.

2.02 VIBRATION ISOLATION

A. Type 1 - Neoprene Pad: Natural rubber waffle pads, arranged in single or multiple layers, 3/4-inch thick per layer with pattern repeating on ½-inch centers; 50 durometer hardness; maximum loading 60 PSI. 1/4-inch thick steel load distribution plate between layers and
between pad and equipment, factory cut to sizes matching requirements of supported equipment. Molded bridge with neoprene anchor bolt bushing and flat washer face to prevent metal to metal contact. Number of layers required for equipment scheduled. Mason Type: Super WMH.

B. Type 2 - Neoprene Mount: Double-deflection type, with ductile-iron housing containing two separate and opposing, oil-resistant natural rubber or bridge bearing neoprene elements, factory-drilled, encapsulated top plate for bolting to equipment and with baseplate for bolting to structure. Neoprene elements to prevent metal to metal contact during normal operation. Minimum static deflection of 0.20-inches. Mason Type: BR.

C. Type 3 - Spring: Freestanding, laterally stable, open-spring isolators.
   1. Outside Spring Diameter: Not less than 80 percent of compressed height of spring at rated load.
   2. Minimum Additional Travel: 50 percent of required deflection at rated load.
   3. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
   4. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
   5. Baseplates: Factory drilled for bolting to structure and bonded to 1/4-inch- thick, natural rubber or bridge bearing neoprene isolator pad attached to baseplate underside. Baseplates limit floor load to 100 PSIG (690 kPa).
   6. Top Plate and Adjustment Bolt: Threaded top plate with adjustment bolt and cap screw to fasten and level equipment.
   7. Brackets: Manufacturer's standard bracket, utilize height saving brackets to accommodate height restrictions.
   8. Mason Type: SLFH.

D. Type 4a - Restrained Spring Isolators: Freestanding, steel, open-spring isolators with seismic restraint.
   1. Housing: Steel with resilient vertical-limit stops (out of contact during normal operation) to prevent spring extension due to wind loads or if weight is removed; factory-drilled baseplate bonded to 1/4-inch thick, natural rubber or bridge bearing neoprene isolator pad attached to baseplate underside; and adjustable equipment mounting and leveling bolt that acts as blocking during installation. Restraining bolts have large rubber grommets to provide cushioning in vertical and horizontal directions. A minimum clearance of 3/8-inch maintained around restraining bolts so as not to interfere with spring action.
   2. Outside Spring Diameter: Not less than 80 percent of compressed height of spring at rated load.
   3. Minimum Additional Travel: 50 percent of required deflection at rated load.
   4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
   5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
   6. Brackets: Manufacturer's standard bracket, utilize height saving brackets to accommodate height restrictions.
   7. Mason Type: SLR.

E. Type 4b - Housed Spring Mounts: Housed spring isolator with integral seismic snubbers.
   1. Housing: Ductile-iron or steel housing to provide all-directional seismic restraint with neoprene acoustical cup, spring inspection ports and rebound adjustment ports.
   2. Base: Factory drilled for bolting to structure.
   3. Snubbers: Vertically adjustable to allow a maximum of 1/4-inch travel before contacting a resilient collar.
   4. Brackets: Manufacturer's standard bracket, utilize height saving brackets to accommodate height restrictions.
   5. Mason Type: SSLFH.
F. Type 5a - Restrained Elastomeric Hangers: Double-deflection type, with molded, oil-resistant natural rubber or bridge bearing neoprene isolator elements bonded to steel housings with threaded connections for hanger rods. Color-code or otherwise identify to indicate capacity range. Seismic rebound steel and bonded LDS rubber washer to limit upward seismic movement. Mason Type: RWHD.

G. Type 5b- Spring Hangers: Combination coil-spring and elastomeric-insert hanger with spring and insert in compression.
1. Frame: Steel, fabricated for connection to threaded hanger rods and to allow for a maximum of 15 degrees of angular hanger-rod misalignment from vertical without binding or reducing isolation efficiency.
2. Outside Spring Diameter: Not less than 80 percent of compressed height of spring at rated load.
3. Minimum Additional Travel: 50 percent of required deflection at rated load.
4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
6. Elastomeric Element: Molded, oil-resistant rubber or neoprene. Steel-washer-reinforced cup to support spring and bushing projecting through bottom of frame.
7. Mason Type: 30N.

H. Type FC-1, Flexible duct connectors. See Specification Section 23 33 00 Air Duct Accessories.

2.03 SEISMIC RESTRAINED SPRING VIBRATION ISOLATION ROOF-CURB
A. Type RC-1, Spring Roof Curb: Continuous steel frames above and below isolators. Isolators adjustable, freestanding and laterally stable and include 1/4-inch acoustical neoprene cup and leveling bolts. Continuous sheet metal flashing attached to upper frame and separated from lower frame by neoprene weather seal with removable cover plates for adjustment and inspection of isolators. Seismic snubbers with all directional neoprene bushing and 1/4-inch air gap incorporated into each corner. Fasten unit to top steel frame and lower sheet metal curb must be attached to roof structure. Mason Type: ISC.

2.04 SEISMIC RESTRAINT DEVICES
A. Resilient Isolation Washers and Bushings: 1-piece, molded, bridge-bearing neoprene complying with AASHTO M 251 and having a durometer of 50, plus or minus 5, with a flat washer face.
B. Seismic Snubbers: Factory fabricated using welded structural-steel shapes and plates, anchor bolts and replaceable resilient isolation washers and bushings. Snubber load rating to match equipment size. Mason Type: Z-1011 or Z-1225.
1. Anchor bolts for attaching to concrete be seismic-rated, drill-in and stud-wedge or female-wedge type.
2. Resilient Isolation Washers and Bushings: 1-piece, molded, bridge-bearing neoprene complying with AASHTO M 251 and having a durometer of 50, plus or minus 5.
C. Restraining Cables: Galvanized steel aircraft cables with end connections made of steel assemblies that swivel to final installation angle and utilize two clamping bolts for cable engagement. Mason Type: SCB.
D. Anchor Bolts: Seismic-rated, drill-in and stud-wedge or female-wedge type. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488/E 488M.

2.05 FACTORY FINISHES
A. Provide manufacturer's standard prime-coat finish ready for field painting. Units mounted outdoors exposed to weather: Epoxy powder coated, with 1000 hour salt spray rating per ASTM B-117. For high levels of corrosion protection utilize:
1. Conform to AAMA 605.2.
2. Apply coating following cleaning and pretreatment.
3. Cleaning: AA-C12C42R1X.
4. Dry system before final finish application.
5. Total Dry Film Thickness: Approximately 1.2 mils, when baked at 450 degrees F for 10 minutes.

B. Finish:
1. Manufacturer's standard paint applied to factory-assembled and factory-tested equipment before shipping.
2. Powder coating on springs and housings.
3. Hardware be electrogalvanized. Hot-dip galvanize metal components for exterior use.
4. Baked enamel for metal components on isolators for interior use.
5. Color-code or otherwise mark vibration isolation and seismic-control devices to indicate capacity range.

2.06 SEISMIC-BRACING/RESTRAINT DEVICES/SYSTEMS FOR EQUIPMENT, PIPING AND DUCTWORK
A. General Requirements for Restraint Components: Rated strengths, features and applications to be as defined in reports by agency acceptable to authorities having jurisdiction.
B. Structural Safety Factor: Allowable strength in tension, shear and pullout force of components be at least four times maximum seismic forces to which they will be subjected.
C. Anchor bolts for attaching to concrete to be seismic-rated, drill-in and stud-wedge or female-wedge type.
D. Resilient Isolation Washers and Bushings: Oil- and water-resistant neoprene.
E. Maximum 1/4-inch air gap and minimum 1/4-inch thick resilient cushion.

PART 3 - EXECUTION
3.01 GENERAL INSTALLATION REQUIREMENTS
A. Provide roof curbs, equipment supports and roof penetrations. Work to maintain roof warranty. Coordinate location, size, structural connections/requirements and flashing prior to installation.
B. Install Type 6 horizontal thrust restraints at centerline of thrust, symmetrical on either side of equipment.
C. Vibration isolators must not cause change of position of equipment or piping which would stress piping connections or misalignment shafts or bearings. Isolated equipment is to be level and in proper alignment with connecting ducts and pipes.
D. Examination:
1. Examine areas and equipment to receive vibration isolation and seismic-control devices for compliance with requirements, installation tolerances and other conditions affecting performance.
2. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation.
3. Proceed with installation only after unsatisfactory conditions have been corrected.
E. Testing: Perform following field quality-control testing:
1. Isolator seismic-restraint clearance.
2. Isolator deflection.
3. Snubber minimum clearances.
F. Adjusting:
1. Adjust snubbers according to manufacturer's written recommendations.
2. Torque anchor bolts according to equipment manufacturer's written recommendations to resist seismic forces.
G. Cleaning: After completing equipment installation, inspect vibration isolation and seismic-control devices. Remove paint splatters and other spots, dirt and debris.
H. Demonstration: Engage factory-authorized service representative to train Owner's maintenance personnel to adjust, operate and maintain air-mounting systems. Reference Division 01, General Requirements.

3.02 VIBRATION ISOLATION

A. Reference 3.01, General Installation Requirements.

B. Install per manufacturer's instructions and recommendations.

C. Vibration isolators must be installed in strict accordance with manufacturer's written instructions and certified submittal data.

D. Install isolation as indicated on drawings by type and location and where indicated below.

E. Equipment Vibration Isolation Schedule:

<table>
<thead>
<tr>
<th>Equipment</th>
<th>Size</th>
<th>Vibration Isolator Type</th>
<th>Minimum Deflection (in)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fan-coils, Unit Heaters, Fan-Powered Terminal Units</td>
<td>All</td>
<td>Type 5B, or 5C, FC-1,2</td>
<td>0.75</td>
</tr>
<tr>
<td>Rooftop Air Handlers, AC, Heat Pump Units</td>
<td>0 to 19.5 tons</td>
<td>RC-1, FC-1,2</td>
<td>0.75</td>
</tr>
<tr>
<td>Axial, Cabinet, Centrifugal Inline Fans</td>
<td>0 to 23.5-inch diameter</td>
<td>Type 3, 4A, 4B, 5B, or 5C, FC-1</td>
<td>0.75</td>
</tr>
</tbody>
</table>

F. Isolation Mounts:
1. Install minimum of four seismic snubbers on isolated equipment. Locate snubbers as close as possible to vibration isolators and bolt to equipment base and supporting structure.
2. Install resilient bolt isolation washers on equipment anchor bolts.
3. Provide flexible piping connection and flexible ductwork connection to equipment with isolation mounts or bases.

G. Isolating Hangers:
1. Support piping and ductwork connected to isolated equipment within equipment rooms on isolating hangers as scheduled on drawings. Unless otherwise noted, first three hangers from isolated equipment to have a minimum of 1/2 static deflection of equipment isolators. Other isolating hangers to have a minimum of 1/4 static deflection of equipment isolators.
2. Position isolating hanger elements as high as possible in hanger rod assembly, but not in contact with building structure. Install hangers so that hanger housing may rotate full 360 degrees about rod axis without contacting any object.
3. Unless otherwise noted, air supply units with internally isolated fans do not require isolating hangers for connecting pipes and ductwork.
4. Where parallel running pipes are hung together on an isolated trapeze, provide isolator deflections for largest determined by provisions for pipe isolation. Do not mix isolated and non-isolated pipes in same trapeze.
5. Install limit stops so they are out of contact during normal operation.

H. Adjusting:
1. Adjust isolators after piping systems have been filled and equipment is at operating weight.
2. Adjust limit stops on restrained spring isolators to mount equipment at normal operating height. After equipment installation is complete, adjust limit stops so they are out of contact during normal operation.
3. Attach thrust limits at centerline of thrust and adjust to a maximum of 1/4-inch movement during start and stop.
3.03  SEISMIC RESTRAINED SPRING VIBRATION ISOLATION ROOF-CURB
   A. Reference 3.01, General Installation Requirements.
   B. Install per manufacturer's instructions and recommendations.
   C. Adjusting:
      1. Adjust isolators after piping systems have been filled and equipment is at operating weight.
      2. Adjust limit stops on restrained spring isolators to mount equipment at normal operating
         height. After equipment installation is complete, adjust limit stops so they are out of contact
         during normal operation.
      3. Attach thrust limits at centerline of thrust and adjust to a maximum of 1/4-inch movement
         during start and stop.
      4. Adjust active height of spring isolators.

3.04  SEISMIC RESTRAINT DEVICES
   A. Reference 3.01, General Installation Requirements.
   B. Install in strict accordance with manufacturer's written instructions and certified submittal data.
   C. Install and adjust seismic restraints so equipment, piping and ductwork supports are not
      degraded by restraints.
   D. Restraints must not short circuit vibration isolation systems or transmit objectionable vibration or
      noise.
   E. Install restraining cables at each trapeze, individual pipe hanger and hanging vibration isolated
      equipment. Provide restraining cables in each of the four directions of movement. Install
      restraining cables no less than 45 Degrees from vertical. At trapeze anchor locations, shackle
      piping to trapeze. Install cables so they do not bend across sharp edges of adjacent equipment
      or building structure.
   F. Install steel angles or channel, sized to prevent buckling, clamped with ductile-iron clamps to
      hanger rods for trapeze and individual pipe hangers. At trapeze anchor locations, shackle piping
      to trapeze. Requirements apply equally to hanging equipment. Do not weld angles to rods.

3.05  FACTORY FINISHES
   A. Reference 3.01, General Installation Requirements.
   B. Install per manufacturer's instructions and recommendations.
   C. Finishes to be factory-applied. No field patching or holidays allowed.

3.06  SEISMIC-BRACING/RESTRAINT DEVICES/SYSTEMS FOR EQUIPMENT, PIPING AND
      DUCTWORK
   A. Reference 3.01, General Installation Requirements.
   B. Install per manufacturer's instructions and recommendations.
   C. Adjust seismic restraints to permit free movement of equipment within normal mode of
      operation.

END OF SECTION
SECTION 23 0553 - IDENTIFICATION FOR HVAC PIPING, DUCTWORK AND EQUIPMENT

PART 1 - GENERAL

1.01 SUMMARY
A. Work Included:
   1. Plastic Nameplates
   2. Tags
   3. Ceiling Tags

1.02 RELATED SECTIONS
A. Contents of Division 23, HVAC and Division 01, General Requirements apply to this Section.

1.03 REFERENCES AND STANDARDS
A. References and Standards as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

1.04 SUBMITTALS
A. Submittals as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.
B. In addition, provide:
   1. Schedules:
      a. Submit valve schedule for each piping system, in tabular format using Microsoft Word or Excel software. Tabulate valve number, piping system, system abbreviation (as shown on tag), location of valve (room or space), and variations for identification (if any). Mark valves which are intended for emergency shutoff and similar special uses by special “flags” in margin of schedule. In addition to mounted copies, furnish extra copies for maintenance manuals.

1.05 QUALITY ASSURANCE
A. Quality assurance as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.
B. In addition, meet the following:
   1. Manufacturer’s Qualifications: Firms regularly engaged in manufacture of identification devices of types and sizes required.
   2. Codes and Standards: Comply with ANSI A13.1 for lettering size, length of color field, colors, and viewing angles of identification devices unless otherwise indicated.

1.06 WARRANTY
A. Warranty of materials and workmanship as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

PART 2 - PRODUCTS

2.01 MANUFACTURERS
A. General: Manufacturer’s standard products of categories and types required for each application as referenced in other Division 23, HVAC Sections. Where more than a single type is specified for application, provide single selection for each product category.
B. Plastic Nameplates:
   1. Brady Corporation
   2. Brimar
   3. Champion America
   4. Craftmark
   5. Seton
   6. Or approved equivalent.
C. Tags:
SECTION 23 0553 23 0553-2
IDENTIFICATION FOR HVAC PIPING, DUCTWORK AND EQUIPMENT

1. Brady Corporation
2. Brimar
3. Champion America
4. Craftmark
5. Seton
6. Or approved equivalent.

D. Ceiling Tags:
   1. Brady Corporation
   2. Brimar
   3. Champion America
   4. Craftmark
   5. Seton
   6. Or approved equivalent.

2.02 PLASTIC NAMEPLATES

A. Description: Engraving stock melamine plastic laminate in the size and thicknesses indicated, engraved with engraver's standard letter style of the sizes and wording indicated, black with white core (letter color), punched for mechanical fastening except where adhesive mounting is necessary because of substrate. Provide 1/8-inch thick material.
   2. Letter Height: 1/2-inch.
   4. Fasteners: Self-tapping stainless steel screws, except contact-type permanent adhesive where screws cannot or should not penetrate the substrate.
   5. Access Panel Markers: Manufacturer's standard 1/16-inch thick engraved plastic laminate access panel markers, with abbreviations and numbers corresponding to concealed valve or devices/equipment. Include center hole to allow attachment.

2.03 TAGS

A. Plastic Tags: Laminated three-layer plastic with engraved black letters on light contrasting background color. Tag size minimum 2-inch diameter.
   B. Metal Tags: Polished Brass with stamped letters; tag size minimum 2-inch diameter with smooth edges.
   C. Warning Tags: Preprinted or partially preprinted, accident-prevention tags; of plasticized card stock with matte finish suitable for writing.
   1. Size: Approximately 4 by 7-inches.
   2. Fasteners: Brass grommet and wire.
   3. Nomenclature: Large-size primary caption such as DANGER, CAUTION, or DO NOT OPERATE.

2.04 CEILING TAGS

A. Description: Steel with 3/4-inch diameter color coded head.
   B. Color code as follows:
   1. Yellow - HVAC equipment.
   2. Red - Fire dampers/smoke dampers.
   4. Ceiling tile labels, machine generated, adhesive backed tape labels with black letters, clear tape.
PART 3 - EXECUTION

3.01 GENERAL - INSTALLATION

A. Identify air handling units, pumps, heat transfer equipment, tanks, and water treatment devices with plastic nameplates riveted to equipment body.

B. Coordinate names, abbreviations and other designations used in mechanical identification work with corresponding designations shown, specified or scheduled. Provide numbers, lettering and wording as indicated or, if not otherwise indicated, as recommended by manufacturers or as required for proper identification and operation/maintenance of mechanical systems and equipment.

C. Multiple Systems: Where multiple systems of same generic name are shown and specified, provide identification which indicates individual system number as well as service (as examples: Chiller No. 3, Air Handling Unit No. 42, Standpipe F12, and the like).

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

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

F. Coordinate with the facility maintenance personnel to ensure consistency with the existing tagging system.

G. Install all products in accordance with manufacturer's instructions.

H. Manual Balancing Dampers: Provide 12-inch long orange marker ribbon to end of balancing damper handle.

3.02 PLASTIC NAMEPLATES

A. Install plastic nameplates with corrosive-resistant mechanical fasteners.

B. Identify control panels and major control components outside panels with plastic nameplates riveted to equipment body.

C. Identify thermostats with nameplates.

3.03 CEILING TAGS

A. Provide ceiling tile labels to identify valves, dampers, and equipment above accessible ceilings.

B. Provide ceiling tags to locate valves, dampers, and equipment above accessible ceilings. Locate in corner of ceiling tee grid closest to equipment.

END OF SECTION
SECTION 23 0593 - TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 - GENERAL

1.01 SUMMARY

A. Work Included:
   1. General Requirements and Procedures
   2. Fundamental Air Systems Balancing Procedures
   3. Temperature Control Verification
   4. Constant Volume Air Systems Balancing Procedures
   5. Pre-Balance Reporting
   6. Final Reports:
      a. Report Requirements
      b. General Report Data
      c. System Diagrams
      d. Air Handling Units
      e. Gas-fired Heaters
      f. Fans
      g. Duct Traverses
      h. Diffusers/Registers/Grilles
      i. Instrument Calibration
   7. Additional Tests

1.02 RELATED SECTIONS

A. Contents of Division 23, HVAC and Division 01, General Requirements apply to this Section.

1.03 REFERENCES AND STANDARDS

A. References and Standards as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

1.04 SUBMITTALS

A. Submittals as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

B. In addition, provide:
   1. Quality-Assurance Submittals: Submit two copies of evidence that the Testing, Adjusting, and Balancing (TAB) Agent and this Project's TAB team members meet the qualifications specified in the "Quality Assurance" Article below.
   2. Pre-Construction Phase Report:
      a. Provide a pre-construction phase TAB Plan at least two weeks prior to the commencement of TAB work. This report is to include:
         1) A complete set of report forms intended for use on the project, with data filled in except for the field readings. Forms to be Project-specific.
         2) Marked up shop drawings identifying all HVAC equipment to be balanced, and associated outlets and terminal devices.
         3) Identification of the type, manufacturer, and model of the actual instruments to be used, and clear indication of which instrument will be used to take each type of reading. Calibration certifications are to be included.
         4) A narrative of any project specific and/or non-standard TAB procedures to be used, and the equipment or systems they apply to.
      2. Pre-Construction Phase Report:
      a. Provide a pre-construction phase TAB Plan at least two weeks prior to the commencement of TAB work. This report is to include:
         1) A complete set of report forms intended for use on the project, with data filled in except for the field readings. Forms to be Project-specific.
         2) Marked up shop drawings identifying all HVAC equipment to be balanced, and associated outlets and terminal devices.
         3) Identification of the type, manufacturer, and model of the actual instruments to be used, and clear indication of which instrument will be used to take each type of reading. Calibration certifications are to be included.
         4) A narrative of any project specific and/or non-standard TAB procedures to be used, and the equipment or systems they apply to.
   3. Contract Documents Examination Report: Within 45 days from the Contractor's Notice to Proceed, submit two copies of the Contract Documents review report as specified in Part 3 of this Section.
   5. Specify reports required because of editing procedures in Part 3 of this Section.
6. Certified TAB Reports: Submit two copies of reports prepared, as specified in this Section, on approved forms certified by the TAB Agent.
7. Sample Report Forms: Submit two sets of sample TAB report forms.
8. Test Instrument Calibration: Submit proof of calibration within the last 6 months.
10. Provide additional submittals to commissioning authority as dictated in commissioning specifications.

1.05 QUALITY ASSURANCE

A. Quality Assurance as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

B. In addition, meet the following:
1. Acceptable Balance Firm:
   a. General:
      1) Procure services of independent TAB agency to balance, adjust and test water circulating and air moving equipment and air distribution or exhaust systems. Minimum experience: 5 years.
   b. Industry Standards: Testing and Balancing will conform to NEBB, American Society of Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE), and American National Standards Institute (ANSI) as follows:
      2) ASHRAE: Comply with recommendations pertaining to measurements, instruments, and TAB.
      3) ANSI:
         (a) S1.4 Specifications for sound level meters.
         (b) S1.11 Specifications for Octave-Band and Fractional-Octave-Band analog and digital filters.
         (c) ANSI S1.13 Methods for the Measurement of Sound Pressure Levels.
   c. Test Observation: If requested, conduct tests in the presence of the Architect or the Architect's representative.
2. Allowable Vibration Tolerances for Rotating, Non-Reciprocating Equipment: Not to exceed a self-excited vibration maximum velocity of 5 mm per second (0.20 inch per second) RMS, filter in, when measured with a vibration meter on bearing caps of machine in vertical, horizontal and axial directions or measured at equipment mounting feet if bearings are concealed. Measurements for internally isolated fans and motors may be made at the mounting feet.
3. Provide proof of testing agency having successfully completed at least five projects of similar size and scope.
4. Code Compliance: Perform tests in the presence of the Authority Having Jurisdiction (AHJ) where required by the Authority Having Jurisdiction (AHJ).
5. Owner Witness: Perform tests in the presence of the Owners representative.
6. Engineer Witness: The engineer or engineer's representative reserves the right to observe tests or selected tests to assure compliance with the specifications.
7. Simultaneous Testing: Test observations by the AHJ, the Owner's representative and the engineer's representative need not occur simultaneously.
8. Do not perform TAB work until heating, ventilating, and air conditioning equipment has been completely installed and is operating continuously as required.
9. Conduct air testing and balancing with clean filters in place. Clean strainers prior to performing hydronic testing and balancing.
10. Agent Qualifications: Engage a TAB agent certified by AABC or NEBB.
11. TAB Conference: Meet with the Owner's and the Architect's representatives on approval of the TAB strategies and procedures plan to develop a mutual understanding of the details. Ensure the participation of TAB team members, equipment manufacturers' authorized
service representatives, HVAC controls Installer, and other support personnel. Provide 7 days advance notice of scheduled meeting time and location.

a. Agenda Items: Include at least the following:
   1) Submittal distribution requirements.
   2) Contract Documents examination report.
   3) TAB plan.
   4) Work schedule and Project site access requirements.
   5) Coordination and cooperation of trades and subcontractors.
   6) Coordination of documentation and communication flow.

12. Certification of TAB Reports: This certification includes the following:
   a. Review field data reports to validate accuracy of data and to prepare certified TAB reports.
   b. Certify that the TAB team complied with the approved TAB plan and the procedures specified and referenced in this Specification.


14. Instrumentation Type, Quantity, and Accuracy: As described in AABC national standards and NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems," Section II, "Required Instrumentation for NEBB Certification."

15. Instrumentation Calibration: Calibrate instruments at least every 6 months or more frequently if required by the instrument manufacturer.

1.06 WARRANTY

A. Warranty of materials and workmanship as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

B. In addition, provide:
   1. TAB Agency provides warranty for a period of 90 days following submission of completed report, during which time, Owner may request a recheck of up to 10 percent of total number of terminals, or resetting of any outlet, coil, or device listed in the final TAB report.
   2. Guarantee: Meet the requirements of the following programs:
      a. Provide a guarantee on AABC or NEBB forms stating that the agency will assist in completing the requirements of the Contract Documents if the TAB Agent fails to comply with the Contract Documents. Guarantee includes the following provisions:
         1) The certified Agent has tested, adjusted, and balanced systems according to the Contract Documents.
         2) Systems are balanced to optimum performance capabilities within design and installation limits.

1.07 DEFINITIONS

A. Adjust: To regulate fluid flow rate and air patterns at the terminal equipment, such as to reduce fan speed or adjust a damper.

B. Balance: To proportion flows within the distribution system, including submains, branches, and terminals, according to design quantities.

C. Draft: A current of air, when referring to localized effect caused by one or more factors of high air velocity, low ambient temperature, or direction of airflow, whereby more heat is withdrawn from a persons skin than is normally dissipated.

D. Procedure: An approach to and execution of a sequence of work operations to yield repeatable results.

E. Report Forms: Test data sheets for recording test data in logical order.

F. Static Head: The pressure due to the weight of the fluid above the point of measurement. In a closed system, static head is equal on both sides of the pump.

G. Suction Head: The height of fluid surface above the centerline of the pump on the suction side.
H. System Effect: A phenomenon that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.

I. System Effect Factors: Allowances used to calculate a reduction of the performance ratings of a fan when installed under conditions different from those presented when the fan was performance tested.

J. TAB: Testing, Adjusting, and Balancing.

K. Terminal: A point where the controlled medium, such as fluid or energy, enters or leaves the distribution system.

L. Test: A procedure to determine quantitative performance of a system or equipment.

M. Testing, Adjusting, and Balancing (TAB) Agent: The entity responsible for performing and reporting the TAB procedures.


P. CTI: Cooling Tower Institute.


R. SMACNA: Sheet Metal and Air Conditioning Contractors' National Association.

1.08 COORDINATION

A. Coordinate the efforts of factory-authorized service representatives for systems and equipment, HVAC controls installers, and other mechanics to operate HVAC systems and equipment to support and assist TAB activities.

B. Notice: Provide 7 days advance notice for each test. Include scheduled test dates and times.

C. Perform TAB after leakage and pressure tests on air and water distribution systems have been satisfactorily completed.

PART 2 - PRODUCTS - NOT USED

PART 3 - EXECUTION

3.01 GENERAL REQUIREMENTS AND PROCEDURES

A. Project Conditions:
   1. Full Owner Occupancy: The Owner will occupy the site and existing building during the entire TAB period. Cooperate with the Owner during TAB operations to minimize conflicts with the Owner's operations.
   2. Partial Owner Occupancy: The Owner may occupy completed areas of the building before Substantial Completion. Cooperate with the Owner during TAB operations to minimize conflicts with the Owner's operations.
   3. Non-Owner Occupancy: Complete balancing of building systems prior to Substantial Completion and owner occupancy.

B. General Requirements:
   1. Where HVAC systems and/or components interface with life safety systems, including fire and smoke detection, alarm, and controls, coordinate scheduling and testing and inspection procedures with authorities having jurisdiction.
   2. Perform TAB work with doors, closed windows, and ceilings installed etc., to obtain simulated or project operating conditions. Do not proceed until systems scheduled for TAB are clean and free from debris, dirt and discarded building materials.
   3. Where Owner occupies building during the testing period, cooperate with Owner to minimize conflicts with Owner's operations.

C. Examination:
   1. Examine Contract Documents to become familiar with project requirements and existing building record documents (if available) to discover conditions in systems' designs that may preclude proper TAB of systems and equipment.
a. Contract Documents are defined in the General and Supplementary Conditions of the Contract.
b. Verify that balancing devices, such as test ports, gauge cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers, are required by the Contract Documents. Verify that quantities and locations of these balancing devices are accessible and appropriate for effective balancing and for efficient system and equipment operation.

2. Examine approved submittal data of HVAC systems and equipment.
3. Examine project record documents described in Division 01, General Requirements.
4. Examine Architect's and Engineer's design data, including Basis of Design, HVAC system descriptions, statements of design assumptions for environmental conditions and systems' output, and statements of philosophies and assumptions about HVAC system and equipment controls.
5. Examine equipment performance data, including fan and pump curves. Relate performance data to project conditions and requirements, including system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system. Calculate system effect factors to reduce the performance ratings of HVAC equipment when installed under conditions different from those presented when the equipment was performance tested at the factory. To calculate system effects for air systems, use tables and charts found in AMCA 201, "Fans and Systems," Sections 7 through 10; or in SMACNA's "HVAC Systems--Duct Design," Sections 5 and 6. Compare this data with the design data and installed conditions.
6. Coordinate requirements in system and equipment with this Section.
7. Examine system and equipment installations to verify that they are complete and that testing, cleaning, adjusting, and commissioning specified in individual Specification Sections have been performed.
8. Examine system and equipment test reports.
9. Examine HVAC system and equipment installations to verify that indicated balancing devices, such as test ports, gauge cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers, are properly installed, and their locations are accessible and appropriate for effective balancing and for efficient system and equipment operation.
10. Examine systems for functional deficiencies that cannot be corrected by adjusting and balancing.
11. Examine equipment for installation and for properly operating safety interlocks and controls.
13. Beginning of work means acceptance of existing conditions.

D. Preparation:
1. Prepare a TAB plan that includes strategies and step-by-step procedures.
2. Complete system readiness checks and prepare system readiness reports. Verify the following:
   a. Permanent electrical power wiring is complete.
   b. Hydronic systems are filled, clean, and free of air.
   c. Automatic temperature-control systems are operational.
   d. Equipment and duct access doors are securely closed.
   e. Balance, smoke, and fire dampers are open.
   f. Isolating and balancing valves are open and control valves are operational.
   g. Ceilings are installed in critical areas where air-pattern adjustments are required and access to balancing devices is provided.
   h. Windows, doors and other portions of the building envelope can be closed so design conditions for system operations can be met.
3. Hold a pre-balancing meeting at least one week prior to starting TAB work.
   a. Attendance is required by installers whose work will be tested, adjusted, or balanced.
4. Provide instruments required for TAB operations. Make instruments available to Architect to facilitate spot checks during testing.

E. General TAB Procedures:
1. Perform TAB procedures on each system according to the procedures contained in AABC national standards or NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems" and this Section.
2. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary to allow adequate performance of procedures. After testing and balancing, close probe holes and patch insulation with new materials identical to those removed. Restore vapor barrier and finish according to the insulation Specifications for this Project.
3. Mark equipment settings with paint or other suitable, permanent identification material, including damper-control positions, valve indicators, fan-speed-control levers, and similar controls and devices, to show final settings.

F. Adjustment Tolerances:
1. Air Handling Systems: Adjust to within plus or minus 5 percent of design for supply systems and plus or minus 5 percent of design for return and exhaust systems.
2. Air Outlets and Inlets: Adjust total to within plus 10 percent and minus 5 percent of design. Adjust outlets and inlets in space to within plus or minus 10 percent of design.
3. Adjust supply, return, and exhaust air quantities to maintain pressurization in spaces indicated on Drawings. Note and document room-to-room pressurization and maintain these relationships. Adjust pressure controlled spaces to within plus or minus 0.01 in WC.

G. Recording and Adjusting:
1. Field Logs: Maintain written logs including:
   a. Running log of events and issues.
   b. Discrepancies, deficient or uncompleted work by others.
   c. Contract interpretation requests.
   d. Lists of completed tests.
2. Ensure recorded data represents actual measured or observed conditions.
3. Permanently mark settings of valves, dampers, and other adjustment devices allowing settings to be restored. Set and lock memory stops.
4. Mark on drawings locations where traverse and other critical measurements were taken and cross reference location in final report.
5. After adjustment, take measurements to verify balance has not been disrupted or that such disruption has been rectified.
6. Leave systems in proper working order, replacing belt guards, closing access doors, closing doors to electrical switch boxes, and restoring thermostats to specified settings.

3.02 FUNDAMENTAL AIR SYSTEMS BALANCING PROCEDURES
A. Examine air-handling equipment to ensure clean filters have been installed, bearings are greased, belts are aligned and tight, and equipment with functioning controls is ready for operation.
B. Examine terminal units, such as variable-air-volume boxes and mixing boxes, to verify that they are accessible and their controls are connected and functioning.
C. Prepare test reports for both fans and inlets and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Cross check the summation of required outlet volumes with required fan volumes.
D. Prepare schematic diagrams of systems' "as-built" duct layouts.
E. Determine the best locations in main and branch ducts for accurate duct airflow measurements.
F. Check the airflow patterns from the outside-air louvers and dampers and the return- and exhaust-air dampers, through the supply-fan discharge and mixing dampers.
G. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.
H. Verify that motor starters are equipped with thermal protection, sized for the connected load.
I. Check dampers for proper position to achieve desired airflow path.
J. Check for airflow blockages.
K. Check that condensate drains are installed, trapped and primed and routed to drain.
L. Check for readily observable leaks in air-handling unit components and ductwork.
M. Use sheaves and pulleys to adjust the speed of belt drive fans to achieve design flow with motors running at 60 Hertz unless noted otherwise.

3.03 TEMPERATURE CONTROL VERIFICATION
A. Examine automatic temperature system components to verify the following:
   1. Dampers, valves, and other controlled devices operate by the intended controller.
   2. Dampers and valves are in the position indicated by the controller.
   3. Integrity of valves and dampers for free and full operation and for tightness of fully closed and fully open positions. This includes dampers in multizone units, mixing boxes, and variable-air-volume terminals.
   4. Automatic modulating and shutoff valves, including 2-way valves and 3-way mixing and diverting valves, are properly connected.
   5. Thermostats and humidistats are located to avoid adverse effects of sunlight, equipment, drafts, and cold walls.
   6. Sensors are located to sense only the intended conditions.
   7. Sequence of operation for control modes is according to the Contract Documents.
   8. Controller set points are set at design values. Observe and record system reactions to changes in conditions. Record default set points if different from design values.
   9. Interlocked systems are operating.
  10. Changeover from heating to cooling mode occurs according to design values.
B. Verify that controllers are calibrated and commissioned.
C. Check transmitter and controller locations and note conditions that would adversely affect control functions.
D. Record controller settings and note variances between set points and actual measurements.
E. Verify operation of limiting controllers (i.e., high- and low-temperature controllers).
F. Verify free travel and proper operation of control devices such as damper and valve operators.
G. Verify sequence of operation of control devices. Note air pressures and device positions and correlate with airflow and water-flow measurements. Note the speed of response to input changes.
H. Confirm interaction of electrically operated switch transducers.
I. Confirm interaction of interlock and lockout systems.
J. Verify main control supply-air pressure and observe compressor and dryer operations.
K. Note operation of electric actuators using spring return for proper fail-safe operations.

3.04 CONSTANT VOLUME AIR SYSTEMS BALANCING PROCEDURES
A. Adjust fans to deliver total design airflows within the maximum allowable rpm listed by the fan manufacturer. Adjust fans to deliver design airflow at the lowest possible speed.
   1. Measure fan static pressures to determine actual static pressure as follows:
      a. Measure outlet static pressure as far downstream from the fan as practicable and upstream from restrictions in ducts such as elbows and transitions.
      b. Measure static pressure directly at the fan outlet or through the flexible connection.
      c. Measure inlet static pressure of single-inlet fans in the inlet duct as near the fan as possible, upstream from flexible connection and downstream from duct restrictions.
      d. Measure inlet static pressure of double-inlet fans through the wall of the plenum that houses the fan.
2. Measure static pressure across each air-handling unit component under final balanced condition.
3. Compare design data with installed conditions to determine variations in design static pressures versus actual static pressures. Recommend corrective action to align design and actual conditions.
4. Make required adjustments to pulley sizes, motor sizes, and electrical connections to accommodate fan-speed changes.
5. Do not make fan-speed adjustments that result in motor loading greater than full load amps. Do not increase fan speed beyond fan class rating. Modulate dampers and measure fan-motor amperage to ensure no overload will occur. Measure amperage in full cooling, full heating, and economizer modes to determine the maximum required brake horsepower.
6. Adjust volume dampers for main duct, submain ducts, and major branch ducts to design airflows within specified tolerances.
7. Calibrate airflow measuring stations.

3.05 PRE-BALANCE REPORTING

A. Pre-Construction Phase Report:
   1. Provide a pre-construction phase TAB Plan at least 2 weeks prior to the commencement of TAB work. This report is to include:
      a. A complete set of report forms intended for use on the project, with all data filled in except for the field readings. Forms to be project specific.
      b. Marked up shop drawings identifying all HVAC equipment to be balanced, and associated outlets and terminal devices.
      c. Identification of the type, manufacturer, and model of actual instruments to be used, and clear indication of which instrument will be used to take each type of reading. Calibration certifications are to be included.
      d. A narrative of any project specific and/or non-standard TAB procedures to be used, and the equipment or systems they apply to.

B. Initial Construction-Phase Report: Based on examination of the Contract Documents as specified in "Examination" Article above, prepare a report on the adequacy of design for systems' balancing devices. Recommend changes and additions to systems' balancing devices to facilitate proper performance measuring and balancing. Recommend changes and additions to HVAC systems and general construction to allow access for performance measuring and balancing devices.

C. Status Reports: As Work progresses, prepare reports to describe completed procedures, procedures in progress, and scheduled procedures. Include a list of deficiencies and problems found in systems being tested and balanced.

3.06 FINAL REPORTS

A. Report Requirements:
   1. General:
      a. Computer printout in letter-quality font, on standard bond paper, in 3-ring binder, tabulated and divided into sections by tested and balanced systems.
      b. Include a certification sheet in front of binder signed and sealed by the certified TAB engineer.
         1) Include a list of the instruments used for procedures, along with proof of calibration.
      c. Final Report Contents: In addition to the certified field report data, include the following:
         1) Pump curves.
         2) Fan Curves
         3) Manufacturers Test Data
         4) Field test reports prepared by system and equipment installers.
5) Other information relative to equipment performance, but do not include approved Shop Drawings and Product Data.

B. General Report Data:
1. In addition to the form titles and entries, include the following data in the final report, as applicable:
   a. Title Page
   b. Name and Address of TAB Agent
   c. Project Name
   d. Project Location
   e. Architect's Name and Address
   f. Engineer's Name and Address
   g. Contractor's Name and Address
   h. Report Date
   i. Signature of TAB Agent who Certifies the Report
   j. Summary of Contents, Including the Following:
      1) Design versus Final Performance
      2) Notable Characteristics of Systems
      3) Description of System Operation Sequence if it varies from the Contract Documents
   k. Nomenclature Sheets for Each Item of Equipment
   l. Data for Terminal Units, including Manufacturer, Type Size, and Fittings
   m. Notes to explain why certain final data in the body of reports vary from design values.
   n. Test Conditions for Fans and Pump Performance Forms, Including the Following:
      1) Settings for Outside-, Return-, and Exhaust-air Dampers
      2) Conditions of Filters
      3) Cooling Coil, Wet- and Dry-bulb Conditions
      4) Face and Bypass Damper Settings at Coils
      5) Fan Drive Settings, including Settings and Percentage of Maximum Pitch Diameter
      6) Settings for Supply-air, Static-pressure Controller
      7) Other System Operating Conditions that affect Performance

C. System Diagrams:
1. Include schematic layouts of air and hydronic distribution systems. Present with single-line diagrams and include the following:
   a. Quantities of Outside, Supply, Return, and Exhaust Airflows
   b. Duct, Outlet, and Inlet Sizes
   c. Balancing Stations

D. Air Handling Units:
1. For air-handling units, split systems, fan coils, pumps, and evaporator units with coils, include the following:
   a. Unit Data: Include the following:
      1) Unit Identification
      2) Location
      3) Make and Type
      4) Model Number and Unit Size
      5) Manufacturer's Serial Number
      6) Unit Arrangement and Class
      7) Discharge Arrangement
      8) Sheave Make, Size in inches, and Bore
      9) Sheave Dimensions, Center-to-center and Amount of Adjustments in Inches
      10) Number of Belts, Make, and Size
      11) Number of Filters, Type, and Size
   b. Motor Data: Include the following:
1) Make and Frame Type and Size
2) Horsepower and rpm
3) Volts, Phase, and Hertz
4) Full-load Amperage and Service Factor
5) Sheave Make, Size in Inches, and Bore
6) Sheave Dimensions, Center-to-center and Amount of Adjustments in Inches

E. Gas-fired Heaters:
   1. In addition to the manufacturer's factory startup equipment reports, include the following:
      a. Unit Data: Include the following:
         1) System Identification
         2) Location
         3) Make and Type
         4) Model Number and Unit Size
         5) Manufacturer's Serial Number
         6) Fuel Type in Input Data
         7) Output Capacity in Btuh
         8) Ignition Type
         9) Burner-control Types
         10) Motor Horsepower and rpm
         11) Motor Volts, Phase, and Hertz
         12) Motor Full-load Amperage and Service Factor
         13) Sheave Make, Size in Inches, and Bore
         14) Sheave Dimensions, Center-to-center and Amount of Adjustments in Inches
      b. Test Data: Include design and actual values for the following:
         1) Total Airflow Rate in cfm (L/s)
         2) Total System Static Pressure in Inches wg (Pa)
         3) Fan rpm
         4) Discharge Static Pressure in Inches wg (Pa)
         5) Filter Static-pressure Differential in Inches wg (Pa)
         6) Cooling Coil Static-pressure Differential in Inches wg (Pa)
         7) Heating Coil Static-pressure Differential in Inches wg (Pa)
         8) Outside Airflow in cfm (L/s)
         9) Return Airflow in cfm (L/s)
         10) Outside-air Damper Position
         11) Return-air Damper Position
         12) Low-fire Fuel Input in Btuh
         13) High-fire Fuel Input in Btuh
         14) Manifold Pressure in PSIG
         15) High-temperature-limit Setting in Degrees F
         16) Operating Set Point in Btuh
         17) Motor Voltage at Each Connection
         18) Motor Amperage for Each Phase
         19) Heating Value of Fuel in Btuh

F. Fans:
   1. Fan Test Reports: For supply, return, and exhaust fans, include the following:
a. Fan Data: Include the following:
   1) System Identification
   2) Location
   3) Make and Type
   4) Model Number and Size
   5) Manufacturer's Serial Number
   6) Arrangement and Class
   7) Sheave Make, Size in Inches, and Bore
   8) Sheave Dimensions, Center-to-center and Amount of Adjustments in Inches.

b. Motor Data: Include the following:
   1) Make and Frame Type and Size
   2) Horsepower and rpm
   3) Volts, Phase, and Hertz
   4) Full-load Amperage and Service Factor
   5) Sheave Make, Size in Inches, and Bore
   6) Sheave Dimensions, Center-to-center and Amount of Adjustments in Inches
   7) Number of Belts, Make, and Size

c. Test Data: Include design and actual values for the following:
   1) Total Airflow Rate in cfm
   2) Total System Static Pressure in Inches wg
   3) Fan rpm
   4) Discharge Static Pressure in Inches wg
   5) Suction Static Pressure in Inches wg

G. Duct Traverses:
   1. Include a diagram with a grid representing the duct cross-section and record the following:
      a. Report Data: Include the following:
         1) System and Air-handling Unit Number
         2) Location and Zone
         3) Traverse Air Temperature in Degrees F
         4) Duct Static Pressure in Inches wg
         5) Duct Size in Inches
         6) Duct Area in SF
         7) Design Airflow Rate in cfm
         8) Design Velocity in fpm
         9) Actual Airflow Rate in cfm
        10) Actual Average Velocity in fpm
        11) Barometric Pressure in PSIG

H. Diffusers/Registers/Grilles:
   1. For diffusers, registers and grilles, include the following:
      a. Unit Data: Include the following:
         1) System and Air-handling Unit Identification
         2) Location and Zone
         3) Test Apparatus Used
         4) Area Served
         5) Air-terminal-device Make
         6) Air-terminal-device Number from System Diagram
         7) Air-terminal-device Type and Model Number
         8) Air-terminal-device Size
        9) Air-terminal-device Effective Area in SF
      b. Test Data: Include design and actual values for the following:
         1) Airflow Rate in cfm
         2) Air Velocity in fpm
         3) Preliminary Airflow Rate as Needed in cfm
4) Preliminary Velocity as Needed in fpm
5) Final Airflow Rate in cfm
6) Final Velocity in fpm
7) Space Temperature in Degrees F

I. Instrument Calibration:
   1. For instrument calibration, include the following:
      a. Report Data: Include the following:
         1) Instrument Type and Make
         2) Serial Number
         3) Application.
         4) Dates of Use
      b. Dates of Calibration.

3.07 ADDITIONAL TESTS

A. Within 90 days of completing TAB, perform additional testing and balancing to verify that balanced conditions are being maintained throughout and to correct unusual conditions.

B. Seasonal Periods: If initial TAB procedures were not performed during near-peak summer and winter conditions, perform additional inspections, testing, and adjusting during near-peak summer and winter conditions.

END OF SECTION
SECTION 23 0700 - HVAC INSULATION

PART 1 - GENERAL

1.01 SUMMARY
A. Work Included:
   1. Type A, Flexible Glass Wool Blanket
   2. Type B, Duct Liner
   3. Jacketing
   4. Accessories
   5. Duct Insulation Accessories
   6. Duct Insulation Compounds

1.02 RELATED SECTIONS
A. Contents of Division 23, HVAC and Division 01, General Requirements apply to this Section.

1.03 REFERENCES AND STANDARDS
A. References and Standards as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.
B. In addition, meet the following:
   1. Piping and duct insulation products to contain less than 0.1 percent by weight PBDE in all insulating materials.

1.04 SUBMITTALS
A. Submittals as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.
B. In addition, provide:
   1. Installer qualifications.
   2. Product Data: Identify thermal conductivity, thickness, and jackets (both factory and field applied, if any) for each type of product indicated.
   3. Material Test Reports: From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of insulation materials, sealers, attachments, cements, and jackets with requirements indicated. Include dates of tests.
   4. Installer Certificates: Signed by the Contractor certifying that installers comply with requirements.
   5. Submit manufacturer's installation instructions.

1.05 QUALITY ASSURANCE
A. Quality assurance as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.
B. In addition, meet the following:
   1. Formaldehyde Free: Should be third-party certified with UL Environment Validation.
   2. Recycled Content: A minimum of 40 percent post-consumer recycled glass content certified and UL validated.
   3. Low Emitting Materials: For all thermal and acoustical applications of Glass Mineral Wool Insulation products, provide materials complying with the testing and products requirements of UL GREENGUARD Gold Certification.
   4. Installer to have minimum 5 years' experience in the business of installing insulation.

1.06 WARRANTY
A. Warranty of materials and workmanship as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.
1.07 FIRE HAZARD CLASSIFICATION
   A. Maximum fire hazard classification of the composite insulation construction as installed to be not more than a Flame Spread Index (FSI) of 25 and Smoke Developed Index (SDI) of 50 as tested by current edition of ASTM E84 (NFPA 255) method.
   B. Test pipe insulation in accordance with the requirements of current edition of UL "Pipe and Equipment Coverings R5583 400 8.15".
   C. Test duct insulation in accordance with current edition of ASTM E84, UL 723, NFPA 255, NFPA 90A and NFPA 90B.

PART 2 - PRODUCTS

2.01 MANUFACTURERS
   A. Type A, Flexible Glass Wool Blanket:
      1. Certainteed
      2. Johns Manville
      3. Knauf
      4. Owens-Corning
      5. Or approved equivalent.
   B. Type B, Duct Liner:
      1. Certainteed
      2. Johns Manville
      3. Knauf
      4. Owens-Corning
      5. Or approved equivalent.
   C. Jacketing:
      1. ITW Insulation Systems
      2. Or approved equivalent.
   D. Accessories:
      1. ITW Insulation Systems
      2. Or approved equivalent.
   E. Duct Insulation Accessories:
      1. Certainteed
      2. Johns Manville
      3. Owens-Corning
      4. Or approved equivalent.
   F. Duct Insulation Compounds:
      1. Certainteed
      2. Johns Manville
      3. Owens-Corning
      4. Or approved equivalent.

2.02 TYPE A, FLEXIBLE GLASS WOOL BLANKET
   A. ASTM C553, Type 1, Class B-2; flexible blanket.
   B. 'K' Value: 0.27 BTU*in/(hr*sf*F) at 75 degrees F installed, maximum service temperature: 250 degrees F.
   C. Density: 0.75 pounds per cubic foot.
   D. Vapor Barrier Jacket: FSK aluminum foil reinforced with glass wool yarn and laminated to fire resistant Kraft, secured with UL listed pressure sensitive tape or outward clinched expanded staples and vapor barrier mastic as needed.
   E. DBDE-free. UL/E validated to be formaldehyde-free.
2.03 TYPE B, DUCT LINER
   A. ASTM C1071; flexible blanket.
   B. 'K' Value: ASTM C518, 0.25 BTU*in/(hr*sf*F) at 75 degrees F, maximum service temperature: 250 degrees F.
   C. Noise Reduction Coefficient: 0.65 or higher based on ASTM C 423 "Type A mounting."
   D. Maximum Velocity on Mat or Coated Air Side: 5,000 FPM.
   E. Adhesive: UL listed waterproof type.
   F. Fasteners: Duct liner galvanized steel pins, welded or mechanically fastened.
   H. ASTM G21 and ASTM G22 Microbial Growth Resistance.
   I. 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”. DBDE-free. UL/E validated to be formaldehyde-free.

2.04 JACKETING
   A. Canvas Jacket: Ul listed fabric, 6 ounce/sq. yd., plain weave cotton treated with dilute fire retardant lagging adhesive.
   B. PVC preformed molded insulation covers. Zeston or approved equivalent.
   C. Aluminum Jacket: 0.016-inch-thick sheet, (smooth/embossed) finish, with longitudinal slip joints and 2-inch laps, die-shaped fitting covers with factory attached protective liner.
   D. Stainless Steel Jacket: Type 304 stainless steel, 0.010-inch, smooth finish.

2.05 ACCESSORIES
   A. Equipment Insulation Jacketing: Presized glass cloth, not less than 7.8 ounces/sq.yd., except as otherwise indicated. Coat with gypsum based cement.
   B. Equipment Insulation Compounds: Provide adhesives, cement, sealers, mastics and protective finishes as recommended by insulation manufacturer for applications indicated.
   C. General: Provide staples, bands, wire, wire netting, tape corner angles, anchors, stud pins and metal covers as recommended by insulation manufacturer for applications indicated. Accessories, i.e., adhesives, mastics, cements and tape to have the same flame and smoke component ratings as the insulation materials with which they are used. Shipping cartons to bear a label indicating that flame and smoke ratings do not exceed those listed above. Provide permanent treatment of jackets or facings to impart flame and smoke safety. Provide nonwater soluble treatments. Provide UV protection recommended by manufacturer for outdoor installation.

2.06 DUCT INSULATION ACCESSORIES
   A. Staples, bands, wires, tape, anchors, corner angles and similar accessories as recommended by insulation manufacturer for applications indicated.

2.07 DUCT INSULATION COMPOUNDS
   A. Cements, adhesives, coatings, sealers, protective finishes and similar accessories as recommended by insulation manufacturer for applications indicated.

PART 3 - EXECUTION
3.01 GENERAL INSTALLATION REQUIREMENTS
   A. Verification of Conditions:
      1. Do not apply insulation until pressure testing and inspection of ducts and piping has been completed.
2. Examine areas and conditions under which duct and pipe insulation will be installed. Do not proceed with work until unsatisfactory conditions have been corrected.

B. Preparation: Clean and dry surfaces to be insulated.

C. Installation:
   1. Insulation: Continuous through walls, floors and partitions except where noted otherwise.
   2. Piping and Equipment:
      a. Install insulation over clean, dry surfaces with adjoining sections firmly butted together and covering surfaces. Fill voids and holes. Seal raw edges. Install insulation in a manner such that insulation may be split, removed, and reinstalled with vapor barrier tape on strainer caps and unions. Do not install insulation until piping has been leak tested and has passed such tests. Do not insulate manholes, equipment manufacturer's nameplates, handholes, and ASME stamps. Provide beveled edge at such insulation interruptions. Repair voids or tears.

D. Provide accessories as required. See Part 2 Article "Accessories" above.

E. Protection and Replacement: Installed insulation during construction. Replace damaged insulation which cannot be repaired satisfactorily, including units with vapor barrier damage and moisture saturated units.

F. Glass Wool Insulation:
   1. Lap seal insulation with waterproof adhesive. Do not use staples or other methods of attachment which would penetrate the vapor barrier. Apply fitting covers with seated tacks and vapor barrier tape.
   2. Apply insulation to pipe and seal with self-sealing lap. Use self-sealing butt strips to seal butt joints. Insulate fittings, valves and unions with single or multiple layers of insulation and cover to match pipe or use performed PVC molded insulation covers.

G. Labeling and Marking: Provide labels, arrows and color on piping and ductwork. Attach labels and flow direction arrows to the jacketing per Section 23 05 53, Identification for HVAC Piping, Ductwork and Equipment.

H. Ductwork:
   1. Install insulation in conformance with manufacturer's recommendations to completely cover duct.
   2. Butt insulation joints firmly together and install jackets and tapes smoothly and securely.
   3. Apply duct insulation continuously through sleeves and prepared openings, except as otherwise specified. Apply vapor barrier materials to form complete unbroken vapor seal over insulation.
   4. Coat staples and seals with vapor barrier coating.
   5. Cover breaks in jacket materials with patches of same material as vapor barrier. Extend patches not less than 2-inches beyond break or penetration on all directions and secure with adhesive and staples. Seal staples and joints with vapor barrier coating.
   6. Fill jacket penetrations. i.e., hangers, thermometers and damper operating rods, and other voids in insulation with vapor barrier coating. Seal penetration with vapor barrier coating. Insulate Hangers and Supports for cold duct in un-conditioned spaces to extent to prevent condensation on surfaces.
   7. Seal and flash insulation terminations and pin punctures with reinforced vapor barrier coating.
   8. Continue insulation at fire dampers and fire/smoke dampers up to and including those portions of damper frame visible at outside of the rated fire barrier. Insulating terminations at fire dampers in accordance with this Section.
   9. Do not conceal duct access doors with insulation. Install insulation terminations at access door in accordance with this Section.

I. Insulated Pipe Exposed to Weather: Where piping is exposed to weather, cover insulation with aluminum jacket. Seal watertight jacket per manufacturer's recommendations. Install metal
jacket with 2-inch overlap at longitudinal and butt joints with exposed lap pointing down. Secure jacket with stainless-steel draw bands 12-inches on center and at butt joints.

J. Insulation Shields: Provide hangers and shields (18 gauge minimum) outside of insulation for cold piping (<60 degrees F). Hot water piping hangers may penetrate insulation to contact pipe directly. Provide 18-inch long, noncompressible insulation section at insulation shields for lines 2-inches and larger for steam and chilled water piping.

K. Ductwork Surfaces to be Insulated:

<table>
<thead>
<tr>
<th>Item to be Insulated</th>
<th>System Insulation Type</th>
<th>Duct Size</th>
<th>Insulation Thickness</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply ductwork where duct is not specified to be lined.</td>
<td>A</td>
<td>All</td>
<td>1-1/2-inch</td>
</tr>
<tr>
<td>Return ductwork where duct is not specified to be lined or where ductboard is not utilized.</td>
<td>--</td>
<td>All</td>
<td>None</td>
</tr>
<tr>
<td>Supply ductwork (exposed to weather, in crawl space and in unheated attics)</td>
<td>A</td>
<td>All</td>
<td>3-inch</td>
</tr>
<tr>
<td>Return ductwork (exposed to weather, in crawl space and in unheated attics)</td>
<td>A</td>
<td>All</td>
<td>3-inch</td>
</tr>
<tr>
<td>Duct Silencers</td>
<td>C</td>
<td>All</td>
<td>1-1/2-inch</td>
</tr>
<tr>
<td>Outside Air Ducts</td>
<td>A</td>
<td>All</td>
<td>3-inch</td>
</tr>
<tr>
<td>HVAC plenums and unit housings not preinsulated</td>
<td>B</td>
<td>All</td>
<td>1-1/2-inch</td>
</tr>
<tr>
<td>Exhaust ducts within 10-feet of exterior</td>
<td>A</td>
<td>All</td>
<td>3-inch</td>
</tr>
<tr>
<td>Exposed insulation in mechanical rooms or areas subject to damage</td>
<td>C,D</td>
<td>All</td>
<td>1-1/2-inch</td>
</tr>
</tbody>
</table>

1. Note: Insulation thickness shown is a minimum. If state codes require additional thickness, then provide insulation thickness per code requirements.

3.02 TYPE A, FLEXIBLE GLASS WOOL BLANKET

A. Install insulation in conformance with manufacturer's recommendations and requirements.

B. Duct Wrap: Cover air ducts per insulation table except ducts internally lined where internal duct lining is adequate to achieve adequate insulating values to meet local Energy Codes (indicate on shop drawings, locations where duct wrap is planned to be omitted and indicate internal duct lining insulating values to confirm they will meet the Energy Code.) Wrap tightly with circumferential joints butted and longitudinal joints overlapped minimum of 2-inches. On ducts over 24-inches wide, additionally secure insulation with suitable mechanical fasteners at 18-inches on center. Circumferential and longitudinal joints stapled with flare staples 6-inches on center and covered with 3-inch wide, foil reinforced tape.

3.03 TYPE B, DUCT LINER

A. Install insulation in conformance with manufacturer's recommendations and requirements.
B. Duct Liners: Mat finish surface on air stream side. Secure insulation to cleaned sheet metal duct with continuous (minimum 90) percent coat of adhesive. Secure liner with mechanical fasteners 15-inches on center or per manufacturer requirements. Accurately cut liner and thoroughly coat ends with adhesive. Butt joints tightly. Top and bottom Sections of insulation overlap sides. Factory/field coat exposed edges. Metal nosing for exposed leading or transverse edges and when velocity exceeds 3500 FPM or manufacturer rating on exposed edges. Keep duct liner clean and free from dust. At completion of project, vacuum duct liner if it is dirty or dusty. Do not use small pieces. If insulation is installed without horizontal, longitudinal, and end joints butted together, installation will be rejected and work removed and replaced with work that conforms to this Specification.

3.04 JACKETING
A. See General Installation Requirements above.
B. Install in accordance with manufacturer's instructions.

3.05 ACCESSORIES
A. Install insulation in conformance with manufacturer's instructions, recommendations and requirements.
B. See General Installation Requirements above.
C. Provide and install accessories for all insulation types listed in this Section.

3.06 DUCT INSULATION ACCESSORIES
A. Install insulation in conformance with manufacturer's recommendations and requirements.

3.07 DUCT INSULATION COMPOUNDS
A. Install insulation in conformance with manufacturer's recommendations and requirements.

END OF SECTION
PART 1 - GENERAL

1.01 SUMMARY
A. Sisters High School has an existing Automated Logic building automation system. The Automated Logic system shall be expanded to control new equipment associated with the Transportation Building.

B. Work Included:
   1. Power Supplies and Line Filtering
   2. Control Panels
   3. Auxiliary Control Devices
   4. Wiring and Raceways
   5. Smoke Detection for Projects with a Building Fire Alarm System

C. This is a performance specification and Contractor is responsible for design tasks and engineering.

1.02 RELATED SECTIONS
A. Contents of Division 23, HVAC and Division 01, General Requirements apply to this Section.

1.03 REFERENCES AND STANDARDS
A. References and Standards as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

B. In addition, meet the following:
   2. Current edition of UL 916 Underwriters Laboratories Standard for Energy Management Equipment, Canada and the US.

1.04 SUBMITTALS
A. Submittals as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

B. In addition, provide:
   1. Prepare and submit a detailed schedule of work. Schedule to identify milestones such as equipment submittals, control panel diagrams, color graphic panel displays, Interlock.
   2. Wiring diagrams, control program sequence software flow chart diagrams, conduit layout diagrams, device location diagrams, equipment and component deliveries, installation sequencing, controller startup, point to point startup, control programming, sequence testing, commissioning/acceptance testing and training.
   3. Submit design drawings, sequences of operation, program listings, software flow charts and details for each typical piece of equipment and system being controlled. No work to be initiated or fabrication of any equipment started prior to the Owner's Representatives return of REVIEWED submittals.
      a. Sequence of Operation: The sequence of operation included in the design documents is intended only to communicate the Engineers’ general control intent and is not to be used as a direct reference for programming of the EMS system. Verbatim duplication of the Engineer's Sequence of Operation on the submittals is discouraged and may result in non-approval of the submittal. Sequence of operation on submittals to accurately detail the system’s intended programming, and include details of enhancements, adjustments, or deviations from the Engineer’s sequence of operation. Submitted sequence of operation to be written with a logical and organized format and flow. Provide detailed, clear and unambiguous sequence of operation language. Point descriptors and point nomenclature referenced in the submitted
sequence of operation to match those (to be) actually programmed. As-built submittal
Sequence of Operation to include modifications to the programming made as a result
of any addendum, bulletins, RFI’s, change orders, and commissioning.

4. Format: Make each submittal in one complete and contiguous package. Partial or
unmarked submittals will be rejected without review.

5. Submit Manufacturers Data as Follows:
   a. Complete materials list of items proposed to be furnished and installed. A complete
      Bill of Materials, listing materials, components, devices, wire and equipment are
      required for this work. The Bill of Materials to be separate for each controller on its
      own page(s) and to contain the following information for each item listed:
         1) Manufacturer's Name and Model number with furnished options highlighted.
         2) Quantity of each by controller location.
         3) Description of product (generic).
         4) Specified item.
         5) Operating range or span.
         6) Operating point or setpoint.
   b. Manufacturer's specifications and other data required demonstrating compliance with
      the specified requirements, including but not limited to: Catalog cuts, technical data
      and descriptive literature on hardware, software, and system components to be
      furnished.
   c. The data to be clearly marked and noted to identify specific ranges, model numbers,
      sizes, and other pertinent data. Submit printed manufacturer's technical product data
      for each control device furnished, indicating dimensions, capacities, performance
      characteristics, electrical characteristics, finishes of materials and including printed
      installation instructions and start-up instructions.
   d. Unless specifically called for otherwise, provide bound copies of catalog cuts for
      standard products, not requiring specifically prepared Shop Drawings, for the
      following:
         1) Wire and Cable, Class II
         2) Face Plates for Devices
         3) Disconnect Switches for Power Control
   e. Where more than one item, size, rating or other variations appear on a catalog cut
      sheet, clearly identify items to be provided. These items to be properly indexed and
      referenced to identification numbers, designations and/or details on the Drawings.

6. Shop Drawings: Submit shop drawings for each controlled system, depicting the following
   information:
   a. Schematic flow diagram of system showing fans, pumps, coils, dampers, valves and
      other control/monitoring devices.
   b. Label each control device with initial setting or adjustable range of control. Label
      points in schematic diagrams with termination at corresponding controller.
   c. Electrical Wiring: Clearly differentiate between portions of wiring that are factory
      installed and portions of be field-installed.
   d. Details of control panel faces, including controls, instruments, and labeling.
   e. Interfaces to equipment furnished under other Specification Sections identifying
      numbers of wires, termination location, voltages and pertinent details. Responsibility
      for each end of the interfaces to be noted on these drawings whether or not they are a
      part of this Section.
   f. System architecture diagram showing the global connectivity of new controllers and
      any existing systems that will be connected to.

7. Equipment locations, wiring and piping schematics, details, panel configurations, sizes,
   damper motor mounting details, valve schedules, and a points list keyed to specific
   hardware submittals. Control wiring depicted as fully annotated ladder diagrams with
terminations identified, completely configured as to the exact panel, wiring, relay, switch, and component configuration.

8. Tag Number Lists: Develop instruments tag number system and submit list for approval. Coordinate methods and number block with the Owner Representative.

9. Format the Shop and Field Drawings to Include:
   a. A Title Sheet containing a drawing list, abbreviations list, symbols list, site and vicinity maps for project location and schedules.
   b. Floor Plans showing proposed device locations and device nomenclatures.
   c. A Riser Diagram illustrating conduit relationships between devices shown on the Floor Plans. Show device nomenclatures.
   d. A Single-Line Diagram for each system showing signal relationships of devices within the system. Show device nomenclatures.
   e. A Wiring Diagram for each assembly, enclosure or free standing device, showing:
      1) The Devices Within
      2) Wiring Connections
      3) Wire Identification
      4) Voltage Levels
      5) Fuse Ratings
   f. Operations and Maintenance Manuals:
      1) Following approval of Shop Drawings of control equipment and prior to acceptance of control work, prepare Operating and Maintenance manuals describing operating, servicing, and maintenance requirements of control systems and equipment installed under this Section, in accordance the General and Special Conditions of these Specifications.
      2) Information contained in the manual for the above equipment to include the following:
         (a) Manufacturer's catalog cuts and printed descriptive bulletins.
         (b) Manufacturer's installation, operating, and maintenance instruction booklets. Complete instructions regarding the operation and maintenance of equipment involved.
         (c) Instrument calibration certificates.
         (d) Parts list and costs.
         (e) Complete nomenclature of replaceable parts, list of recommended spare parts for 12 months operation, their part numbers, current cost and name and address of the nearest vendor of replacement parts.
         (f) Name, address and telephone number for closest source of spare parts.
         (g) Wiring and schematic diagrams.
         (h) Include final record copies of shop drawings.
         (i) Copy of guarantees and warranties issued for the various items of equipment, showing dates of expiration.
         (j) Reduced plans, diagrams, and control schematics.
         (k) Copies of test results.
         (l) Control System Operating Manual including: point of summary and point data base; complete printout of program listings; magnetic tape CD or DVD backup of Field Control Cabinet programs; cabinet layout; hard copy of graphic screens; hard copy of specified reports.
   g. A final Bill of Quantities including a separate schedule for portable equipment, if delivered as part of this work.
   h. Performance, Test and Adjustment Data: Comprehensive documentation of performance verification according to parameters specified in these specifications.
   i. Record Drawings: Comply with Division 01, General Requirements and Section 23 00 00, HVAC Basic Requirements. Provide complete as-built submittals including "as-programmed" sequence of operation as well as final occupancy schedules.
1.05 QUALITY ASSURANCE
   A. Quality assurance as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.
   B. In addition, meet the following:
      1. Installer Qualifications: Company specializing in performing work of the type specified in this Section with minimum five years' experience in the local area. Installers required to have successfully completed manufacturer's control system factory training.

1.06 WARRANTY
   A. Warranty of materials and workmanship as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

1.07 SYSTEM DESCRIPTION
   A. Control system referenced throughout specifications and drawings as Building Automation System (BAS), Building Management System (BMS), or Energy Management System (EMS) interchangeably consists of high-speed, peer-to-peer network of DDC controllers, control system server, and operator workstation. System to be UUKL listed if used for smoke control.
   B. System software based on server/thin-client architecture, designed around open standards of web technology. Control system server accessed using a web browser over control system network, Owner's local area network, and remotely over Internet (through Owner's LAN). Intent of thin-client architecture is to provide operators complete access to control system via web browser. No special software other than web browser required to access graphics, point displays, and trends.
   C. Local Area Network (LAN) either 10 or 100 Mpbs Ethernet network.
   D. System will consist of open architecture that is capable of:
      1. High speed Ethernet communication using TCP/IP protocol.
      2. Native BACnet communications according to ANSI / ASHRAE Standard 135, latest edition. Provide necessary BACnet-compliant hardware and software to meet the system's functional specifications. Controller devices must be BTL tested and listed by an official BACnet Testing Laboratory and have the BTL mark issued.
   E. Complete temperature control system to be DDC with electronic sensors and electronic/electric actuation valves and dampers.
   F. Prepare individual hardware layouts, interconnection drawings, building riser/architecture diagram and sequence of control from the project design data. Any architecture diagrams on design drawings have been included as schematics only and are not meant to portray quantity of devices or power/data requirements.
   G. Design, provide, and install equipment cabinets, panels, data communication network infrastructure (including cables, conduits, outlets, connections, etc.) needed, and associated hardware.
   H. Provide complete manufacturer's specifications for items that are supplied. Include vendor name and model number of every item supplied.
   I. Provide a comprehensive operator and technician training program as described in these Specifications.
   J. Provide as-built documentation, operator's terminal software, diagrams, and other associated project operational documentation (such as technical manuals) on approved media, the sum total of which accurately represents the final system.
   K. Provide 120V power, low voltage power, transformers, etc. for control panels, transformer panels, and BAS devices. Install per Division 26, Electrical Specifications. Power for devices within this Specification Section is solely the responsibility of the BAS Contractor.
   L. Conduit and raceway systems. Provide per Division 26, Electrical Specifications.
M. Devices, components, controllers, and software to be manufacturer's most current version at the time of installation.

1.08 SYSTEM PERFORMANCE

A. Performance Standards - System conforms to following minimum standards over network connections:
   1. Graphic Display: Graphic with 20 dynamic points display with current data within 10 seconds.
   2. Graphic Refresh: Graphic with 20 dynamic points update with current data within 8 seconds.
   3. Object Command: Devices react to command of binary object within 2 seconds. Devices begin reacting to command of analog object within 2 seconds.
   4. Object Scan: Data used or displayed at controller or workstation have been current within previous 6 seconds.
   5. Alarm Response Time: Object that goes into alarm is annunciated at workstation within 45 seconds.
   6. Program Execution Frequency: Custom and standard applications are capable of running as often as once every 5 seconds. Select execution times consistent with mechanical process under control.
   7. Performance: Programmable controllers are able to completely execute DDC PID control loops at frequency adjustable down to once per second. Select execution times consistent with mechanical process under control.
   8. Multiple Alarm Annunciation: Each workstation on network receive alarms within 5 seconds of other workstations.

B. Reporting Accuracy: System reports values with minimum end-to-end accuracy listed in Reporting Accuracy Table below.

   1. Reporting Accuracy Table:

<table>
<thead>
<tr>
<th>Measure Variable</th>
<th>Reported Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Space Temperature</td>
<td>Plus or Minus 1 degree F</td>
</tr>
<tr>
<td>Ducted Air</td>
<td>Plus or Minus 1 degrees F</td>
</tr>
<tr>
<td>Outside Air</td>
<td>Plus or Minus 2 degrees F</td>
</tr>
<tr>
<td>Dew Point</td>
<td>Plus or Minus 3 degrees F</td>
</tr>
<tr>
<td>Water Temperature</td>
<td>Plus or Minus 1 degree F</td>
</tr>
<tr>
<td>Delta-T</td>
<td>Plus or Minus 0.25 degree F</td>
</tr>
<tr>
<td>Relative Humidity</td>
<td>Plus or Minus 5 percent RH</td>
</tr>
<tr>
<td>Water Flow</td>
<td>Plus or Minus 2 percent of full scale</td>
</tr>
</tbody>
</table>

   2. Note 1: Accuracy applies to 10 percent-100 percent of scale
   3. Note 2: For both absolute and differential pressure
   4. Note 3: Not including utility-supplied meters

C. Control Stability and Accuracy. Control loops maintain measured variable at setpoint within tolerances listed in Control Stability and Accuracy Table below.

   1. Control Stability and Accuracy Table:

<table>
<thead>
<tr>
<th>Controlled Variable</th>
<th>Control Accuracy</th>
<th>Range of Medium</th>
</tr>
</thead>
<tbody>
<tr>
<td>Air Pressure</td>
<td>Plus or minus 0.2 inch wg</td>
<td>0-6 inch wg</td>
</tr>
<tr>
<td></td>
<td>Plus or minus 0.01 inch wg</td>
<td>-0.1 to 0.1 inch wg</td>
</tr>
<tr>
<td>Airflow</td>
<td>Plus or minus 10 percent of full scale</td>
<td></td>
</tr>
<tr>
<td>Space Temperature</td>
<td>Plus or minus 2.00 degrees F</td>
<td></td>
</tr>
</tbody>
</table>
### PART 2 - PRODUCTS

**2.01 OREGON/SW WASHINGTON MANUFACTURERS/INSTALLERS**

A. Automated Logic (ALC)/Clima-Tech

**2.02 COMMUNICATIONS**

A. Each controller to have communication port for connection to operator interface.
   1. Internetwork operator interface and value passing to be transparent to internetwork architecture.
   2. Operator interface connected to controller to allow operator to interface with each internetwork controller as if directly connected. Controller information such as data, status, reports, system software, and custom programs to be viewable and editable from each internetwork controller.

B. Inputs, outputs, and control variables used to integrate control strategies across multiple controllers to be readable by each controller on internetwork.

C. Operator Workstation to be capable of simultaneous direct connection and communication with BACnet/IP, OPC and TCP/IP networks without use of interposing devices such as PC or gateway with hard drive.

D. Workstations, Building Control Panels and Controllers with real-time clocks use time synchronization service. System automatically synchronizes system clocks daily from operator-designated device via internetwork. System automatically adjusts for daylight savings and standard time as applicable.

E. Wireless Network Communications:
   1. Wireless communications take place using modular wireless transceivers at each device, which eliminates need for communication cabling.
   2. Wireless transceiver utilizes 2.4 GHz in license free global Industrial Scientific and Medical (ISM) band.
   3. Wireless transceiver is encased in plenum-rated enclosure. If application dictates, wireless transceiver is able to be installed in metal enclosure utilizing remote mounted antenna.
   4. Wireless transceiver channel is factory set and capable of being field set to different channel if interference with IEEE 802.11 devices or other 2.4 GHz products is encountered.
   5. Wireless transceiver is 24 VAC powered.
   6. Wireless transceiver gives a visual indication that it is powered and communicating.
   7. Wireless transceiver has a field-settable network identifier that allows multiple networks to occupy same channel for maximum scalability.

**2.03 OPERATOR INTERFACE**

A. Operator Interface: PC-based workstations reside on high-speed network with building controllers. Each workstation or each standard browser connected to server is able to access system information.

B. Hardware: Each operator workstation or web server consists of the following:
   1. Computer: Hardware meets or exceeds DDC system manufacturer’s recommended specifications and meet response times specified elsewhere in this document. Following hardware requirements also apply:
      a. Hard disk have sufficient memory to store:
         1) Required operator workstation software.
2) One year of trend data based on points specified to be trended at specified trend intervals.
   b. Minimum hardware configuration includes:
      1) Intel i7 Processor
      2) 22-in LCD Monitor with at least 1024 x 768 Resolution
      3) 8 GB of RAM
      4) 48x CD-RW/DVD Optical Drive
      5) 1 TB Hard Disk Drive Providing Data at 3 GB/sec
      6) Ethernet 10/100 Network Interface Card
      7) High Performance Graphics Card
      8) Keyboard and Mouse
      9) Color Inkjet Printer
     10) UPS (uninterruptible power supply) installed at server, sized with sufficient capacity to allow full operation for 10 minutes or more.

2. Modem: Auto-dial modem and associated cables transmit over voice-grade telephone lines at nominal 56Kb between workstation or web server and remote buildings and workstations.

3. Portable Operator's Terminal: Portable Operator's Terminal capable of accessing system data. This device may be connected to any point on system network or to any controller for programming, setup, and troubleshooting. Portable Operator's Terminal is IBM-compatible notebook-style PC including software and hardware required. PC contains at minimum:
   a. Intel i5 Processor
   b. 15-in LCD Monitor with at least 1024 x 768 Resolution
   c. 8 GB of RAM
   d. 1 TB Hard Drive
   e. Touch-Pad or Other Internal Pointing Device
   f. High-Performance Graphics Adapter
   g. Ethernet 10/100 Network Interface Card
   h. Integrated Wireless 802.11 b/g/n
   i. Serial Port and CD/RW-ROM
   j. Internal Modem, 56Kb Minimum

C. System Software:
   1. Operating System: Furnish concurrent multi-tasking operating system. Operating system also supports use of and includes other common software applications such as Microsoft Excel, Word, Microsoft Access and Adobe Acrobat. Acceptable operating systems are Windows 7 and Windows 10.
   2. Dynamic Color Graphics:
      a. Real-time color graphic displays dynamic and able to update displays.
      b. Provide operator ability to change values (setpoints) and states in system controlled equipment directly from graphic display.
      d. Graphics Library. Furnish library of standard HVAC equipment graphics and include standard symbols for fans, pumps, coils, valves, piping, dampers, and ductwork.
   3. Software to be manufacturer's most current version at the time of installation.

D. System Applications: Each workstation provides operator interface and off-line storage of system information. Provide following applications at each workstation:
   1. Automatic System Database Save and Restore: Each workstation stores on hard disk copy of current database of each Building Controller. This database automatically updated whenever change is made in any system panel.
   2. Manual Database Save and Restore: System operator able to manually save or clear database and initiate download of specified database from/to any panel.
3. System Configuration: Workstation software provides method of configuring system to allow for changes or additions by users and performs following tasks:
   a. Create, delete or modify control strategies.
   b. Add/delete objects to system.
   c. Tune control loops through adjustment of control loop parameters.
   d. Enable or disable control strategies.
   e. Generate hard copy records of control strategies on printer.
   f. Select points to be alarmed and define alarm state.
   g. Select points to be trended and initiate automatic recording of values.
   h. Start/Stop binary objects and adjust analog objects.

4. Security: Operator required to log on to system with user name and password in order to view, edit, add, or delete data. System security selectable for each operator.

5. System Diagnostics: System automatically monitor operation of workstations, printers, modems, network connections, building management panels, and controllers. Failure of any device to be annunciated.

6. Alarm Indication and Handling:
   a. Workstation provides visual means of alarm indication. Alarm indication becomes highest priority regardless of application(s) running.
   b. System provides and archive log of alarm messages to hard drive. Alarm messages to include description of event-initiating object, source, location and time/date of alarm.

7. Trend Logs: Operator able to define custom trend log for any data object and include interval, start time, and stop time. Trend data sampled and stored on building controller panel, is archived on hard disk, and is retrievable for use in spreadsheets and standard database programs.
   a. System server to periodically gather historically recorded data stored in the building controllers and archive the information. Archived files to be appended with new sample data, allowing samples to be accumulated.
   b. Software to be included that is capable of graphing the trend logged object data. Software capable of creating two-axis (x,y) graphs that display object values relative to time.
   c. Operator able to change trend log setup information. This includes the information to be logged as well as the interval at which it is to be logged. Input, output, and value object types in the system may be logged. Provide operations password protected. Setup and viewing may be accessed directly from any graphics on which object is displayed.
   d. BAS Contractor to enable trending for any system points (physical or virtual) as directed by the Engineer, Owner or Commissioning Authority (Commissioning Authority). There will be no limit on the number of trended points the BAS Contractor is to set up. BAS Contractor will modify trend setup parameters as directed by the Commissioning Authority during testing. BAS Contractor to be proactive and enable trending for major system points during system startup/programming. BAS Contractor is not to wait for direction to begin trending points. Trend data for each point to be archived on the main server for a minimum of one year. Trend data archiving to be enabled immediately upon trend setup, or as soon as communication between the field panel and server is established. Trend data uploads from field panel to server set up to be automatically performed with sufficient frequency to ensure no data gaps or loss of trend data.
   e. Trend points as identified in the points list. Provide system specific trend data in two-axis (x,y) graphs that display object values relative to time to Engineer, Owner, or Commissioning Authority.

8. Standard Reports: Standard system reports provided for this project. Provide ability for Owner to readily customize these reports for this project:
   a. Objects: System (or subsystem) objects and their current values.
b. Logs:
   1) Alarm History
   2) System Messages
   3) System Events
   4) Trends

9. Electrical, Gas, and Weather Report:
   a. System server capable of periodically gathering energy log data stored in the field equipment and archive the information. Archive files appended with new data, allowing data to be accumulated.
   b. Operator able to change the energy log setup information as well. This includes the meters to be logged, meter pulse value, and the type of energy units to be logged. Meters monitored by the system may be logged.
   c. System to display archived data in tabular format form for both consumption and peak values. Data shown in hourly, daily, weekly, monthly and yearly formats. In each format the user able to select a specific period of data to view.
   d. Electrical Meter Report: Provide monthly report showing daily electrical consumption and peak electrical demand with time and date stamp for each building meter and for each electrical sub-meter on individual building panels, circuits, equipment (such as chillers), and variable frequency drives. Provide an annual (12-month) report showing monthly electrical consumption and peak electrical demand with time and date stamp for each individual meter.
   e. Gas Meter Report: Provide monthly report showing daily natural gas consumption for each meter and sub-meter. Provide annual (12-month) report that shows monthly consumption for each meter.
   f. Weather Data Report: Provide monthly report showing daily minimum, maximum, and average outdoor air temperature (dry bulb, wet bulb) and humidity. Provide annual (12-month) report showing minimum, maximum, and average outdoor air temperature for month.

E. Interfaces to Third Party Systems: BAS connects to third party systems (VFDs, chillers, emergency generators, rooftop AC units, etc.). Communication protocol specified for third party system, and BAS provides compatible protocol to assure proper two way communication. Points, alarms, and commands displayed on BAS as indicated.

F. Workstation Applications Editors: Each PC workstation supports editing of system applications, which downloaded and executed at one or more controller panels.

2.04 CONTROLLER SOFTWARE

A. Furnish following applications software for building and energy management. Software applications reside and operate in system controllers. Software to be manufacturer's most current version at the time of installation. Software and associated functions (scheduling, optimum start/stop, etc.) noted in this specification are to be configured and enabled for this project. Incorporate into sequence of operation submittals for review prior to installation.

B. System Security:
   1. User access secured using individual security passwords and user names.
   2. Restrict user passwords to objects, applications, and system functions as assigned by system manager. Provide monitoring only access to Engineer of Record and Commissioning Authority for period of one year for trouble shooting purposes.
   3. Record user Log On/Log Off attempts.
   4. Provide passwords, user names, and access assignments adjustable at the operator's terminal. Each user to have a set security level, which defines access to displays and individual objects the user may control. System to include 10 separate and distinct security levels for assignment to users.
   5. System to include an Auto Logout Feature that will automatically logout user when there has been no keyboard or mouse activity for a set period of time. Time period to be
adjustable by system administrator. Auto Logout may be enabled and disabled by system administrator. Operator terminal to display message on screen that user is logged out after Auto Logout occurs.

C. Scheduling: Provide capability to schedule each object or group of objects in system.
   Coordinate schedule with Owner and program accordingly. Each schedule consists of:
   1. Operator's workstation to show information in easy-to-read daily format. Priority for scheduling: Events, holidays and daily with events being the highest.
   2. Holiday and special event schedules to display data in calendar format. Operator able to schedule holidays and special events directly from these calendars.
   3. Operator able to change information for a given weekly or exception schedule if logged on with the appropriate security access.

D. Optimum Start/Stop: Provide software and program system to start equipment on sliding schedule based upon indoor and outdoor conditions. Determine minimum time of HVAC system operation needed to satisfy space environmental requirements and also determine earliest possible time to stop mechanical systems (i.e. shut down cooling/heating and only provide ventilation one hour prior to scheduled unoccupied period.) Optimum start/stop program operates in conjunction with scheduled start/stop and night setback programs.

E. Alarms:
   1. Operator's workstation to provide visual means of alarm indication. The alarm dialog box to always become the top dialog box regardless of the application(s), currently running.
   2. System to provide log of alarm messages. Alarm log to be archived to the hard disk of the system operator's terminal. Each entry to include a description of the event-initiating object generating the alarm. Entry to include time and date of alarm occurrence.
   3. Alarm messages in user-definable text and entered either at the operator's terminal or via remote communication.
   4. Each binary object set to alarm based on operator-specified state.
   5. Each analog object have both high and low alarm limits.
   6. Alarms must be able to be automatically and manually disabled.
   7. Alarms are routed to appropriate workstations based on time and other conditions. An alarm is able to start programs, print, be logged in event log, generate custom messages, and display graphics.
   8. System have ability to dial out in event of alarm.
   9. Alarm Levels:
      a. Provide 5 levels of alarm as follows, and program alarm levels for every required and specified alarm:
         1) Level 1: Critical/life safety.
         2) Level 2: Significant equipment failure.
         3) Level 3: Non-critical equipment failure/operation.
         4) Level 4: Energy conservation monitor.
         5) Level 5: Maintenance indication, notification.
      b. Prior to training of Owner's representative, submit the complete Points List and suggested Alarm Levels to the Owner.
      c. During training of Owner's representative(s):
         1) Discuss Alarm Levels and the alarms currently included in the BAS.
         2) Provide additional alarms without addition of new hardware points, as required by Owner's Representative.
         3) Agree with the Owner's Representative on action(s) to be taken for each alarm level and implement same for each alarm. Said action to include visual and/or audible alarm(s) at the Operator workstation including whether Operator acknowledgement is required or not, email messages, and text messages.

F. Demand Limiting:
1. System to include demand limiting program that includes two types of load shedding. One type of load shedding to shed/restore equipment in binary fashion based on energy usage when compared to shed and restore settings. The other type of shedding to adjust operator selected control setpoints in an analog fashion based on energy usage when compared to shed and restore settings. Shedding may be implemented independently on each and every zone or piece of equipment connected to system.

2. Status of each and every load shed program capable of being displayed on every operator terminal connected to system. Status of each load assigned to an individual shed program displayed along with the description of each load.

3. Demand-limiting program monitor building power consumption from signals generated by pulse generator (provided by BAS contractor) mounted at building power meter or from watt transducer or current transformer attached to building feeder lines.

4. Demand-limiting program predicts probable power demand so that when demand exceeds demand limit, action will be taken to reduce loads in predetermined manner. When demand limit will not be exceeded, action will be taken to restore loads in predetermined manner.

G. Maintenance Management: System monitors equipment status and generate maintenance messages based upon user-designated run-time, starts, and/or calendar date limits. Coordinate settings with Owner.

H. Sequencing: Provide application software based upon sequences of operation specified to properly sequence designated systems. Provide points to achieve specified sequences.

I. Staggered Start: This application prevents controlled equipment from simultaneously restarting after a power outage. Order in which equipment (or groups of equipment) is started, along with time delay between starts to be user-selectable.

J. Energy Calculations: Provide software to allow instantaneous power (e.g. kW) or flow rates (e.g. L/s (gpm)) to be accumulated and converted to energy usage data.

K. Anti-Short Cycling: Binary output objects protected from short cycling by allowing minimum on-time and off-time to be selected.

L. On/Off Control with Differential: Provide algorithm that allows binary output to be cycled based on controlled variable and setpoint. Algorithm direct-acting or reverse-acting and incorporate adjustable differential.

M. Run-Time Totalization: Provide software to totalize run-times for binary input objects.

2.05 WEB BASED ACCESS

A. General Description: BAS supplier to provide web-based access to the system as part of standard installation. Provide access to user of displays of real-time data that are part of the BAS via a standard Web browser. Web browser to tie into the network via Ethernet network connection. Provide web-page host that resides on the BAS network. Web-page software not to require a per user licensing fee or annual fees. The web-page host must be able to support at least 50 simultaneous users with the ability to expand the system to accommodate an unlimited number of users. Software to be manufacturer's most current version at time of installation.

B. Browser Technology: Browser to be standard version of Microsoft Internet Explorer (latest edition). No special vendor-supplied software needed on computers running browser. Displays viewable and the Web-page host to directly access real-time data from the BAS network. Data displayed in real time and update automatically without user interaction. User able to change data on displays if logged in with the appropriate user name and password.

C. Display of Data: Web page graphics shown on browser to be replicas of the BAS displays. User to need no additional training to understand information presented on Web pages when compared to what is shown on BAS displays. Web page displays to include animation just as BAS displays. Fans to turn, pilot lights to blink, and coils to change colors, and so on. Real-time data shown on browser Web pages. This data must be directly gathered via the BACnet.
network and automatically updated on browser Web page displays without any user action. Data on the browser to automatically refresh as changes are detected without re-drawing the complete display. User to be able to change data from browser Web page to if the user is logged on with the appropriate password. Clicking on a button or typing in a new value to change digital data. Using pull-down menus or typing in a new value to change analog data. Data displays navigated using pushbuttons on the displays that are simply clicked on with the mouse to select a new display. Alternatively, the standard back and forward buttons of the browser can be used for display navigation.

D. Web Page Generation: Web pages generated automatically from the BAS displays that reside on the BAS server. User to access Web-page host via the network and initiate a web page generation utility that automatically takes the BAS displays and turns them into Web pages. The Web pages generated are automatically installed on the Web page host for access via any computer's standard browser. Any system that requires use of an HTML editor for generation of Web pages will not be considered.

E. Password Security and Activity Log: Access via Web browser to utilize the same hierarchical security scheme as BAS system. User asked to log in once the browser makes connection to Web-page host. Once the user logs in, any changes that are made to be tracked by the BAS system. User able to change only those items that the user has authority to change. A user activity report to show any activity of the users that have logged in to the system regardless of whether those changes were made using a browser or via the BAS workstation.

F. Communication: Web-page host to communicate using the specified protocol standard to devices on the BAS network.

2.06 BAS GRAPHICS

A. Develop customized graphics showing the project building(s) and their floor plans, mechanical, and electrical equipment, flow and control diagrams, and other relevant features on Workstation graphic screens. Associated input, output, and virtual objects (e.g., temperature and pressure setpoints) listed in the Sequence of Operation, and shown on the Input/Output Objects List included in the graphic screens and bound to the database. Real-time value of objects updated on the display of each graphic automatically. For projects where existing campus and/or building controls systems exist, replicate graphics used in the existing BAS graphics screens.

B. Graphics to have links to the Print function and to display a Standard Legend in the corner of the graphic. Graphics, except pop-ups, to have the date and time displayed in the upper corner of the graphic. Each graphic titled.

C. Weather: Graphics, except pop-ups, to have the outdoor temperature and humidity in the upper corner of the graphic.

D. Alarms: System and component summary alarms located near the top of each relevant graphic screen. Provide links to the associated system/component as part of these tags to assist trouble shooting. Other alarms placed near the associated system/device as depicted in the graphic. Provide text and color of information tags that describe each object and alarm value consistent with a graphics color legend.

E. The Following Graphics Provided as a Minimum:
   1. A building graphic, typically a photograph of the building, with links to each floor plan and other links as defined below.
   2. A central plant graphic with equipment (chillers, boilers, pumps, heat exchangers, storage tanks, etc.), temperature sensors, pressure sensors, flow sensors and refrigeration leak detectors. The central plant graphic to have links to each building on the campus.
   3. Central equipment such as air handler, package rooftop equipment, supply fans, exhaust fans, and smoke control systems.
   4. Floor plans of each floor, with temperature sensors, pressure sensors, temperature control zones, heating/cooling zones, ventilation zones, and supply air zones identified. Rooms grouped on a graphic only to the extent that detailed and complete sensing information can
be comfortably viewed by an operator and the bound points updated in less than 10 seconds. Each zone to have a temperature symbol that changes color over the range from low (blue) through normal (green) to high (red) and indicate an alarm (flashing red). The zone temperature and or pressure symbol(s) to be a link to a zone control pop-up graphic. Individual floor plan graphics to provide links to related mechanical systems. The mechanical room plan graphics to show the relative location of, and provide links to, either the equipment pop-up or flow and control graphic for mechanical equipment monitored or controlled by the BAS.

5. Pop-up graphics provided for each zone control system showing a flow diagram and related monitoring and control points and system parameters. Pop-up graphics provided for each piece of equipment that is not shown on a flow and control graphic.

6. Flow and control diagrams for each system including but not limited to central plant, fan coils, generators, packaged equipment, chilled water systems, heating hot water systems, heat exchangers, pumps, storage tanks, zone terminal units, isolation room systems, smoke damper status, combination fire and smoke damper status, and ventilation systems. The flow and control graphics to have parameters grouped in the lower portion of the graphics. Standard equipment graphics used. Pumps, fans, dampers and other elements to dynamically indicate their state (i.e. pumps and fans to rotate when on and damper positions to dynamically adjust and be shown in their current position, etc.). System flow and control graphics displayed in a general left to right flow or loop arrangement. Return and exhaust air flow shown on top and return water shown on the bottom of the graphic.

7. Individual equipment/component screens showing sensing and control information available for each device provided.

F. Penetration: The graphic interface to consistently apply a convention whereby a left-click to always penetrate to more detailed information. The text windows to represent the deepest level of penetration. A right-click to always produce a menu of options that are specific to the item selected.

G. Navigation: Graphics organized to provide a "branching structure" that allows an operator to move from a "macro view" to a "micro view" and return. These links to other associated graphics, or allow a return to a previous macro view, provided and arranged horizontally along the bottom of each graphic screen. From left to right, the graphic links as follows: site/building map, building/trailer floor plans, and major mechanical systems at each building. Pop-up right click menus provided as needed on the lower button bar to allow for uncluttered navigation.

H. Clutter Minimization: Each graphic to have separate check boxes in the lower right corner that show/hide setpoints, alarms/safeties, and devices/equipment.

I. Templates: To the maximum extent possible, use standard graphics as templates to provide a consistent look throughout the interface.

J. Color Scheme: The graphics to use dynamic color changes to communicate equipment type, or object status consistent with the graphics color legend.

K. Symbols and Animations: Fans, pumps, dampers, coils, and generation equipment to be dynamic symbols indicating rotation, state, or position, movement, flow, etc.

L. Macros: When macros are used to add functionality to the graphics, detailed documentation provided.

M. Configure Mode: Access to "Configure Mode" for editing of the graphics password protected to prevent unauthorized changes to the graphics. This password supplied to the appropriate personnel.

N. Graphics Version: Graphics provided in the most current format available at time of control system programming.
O. Points and graphics checked for the proper binding and graphic programming, settings to ensure that the correct system, location, point values and dynamics are shown in the proper location and rotate in the proper directions.

P. After graphics have been accepted, provide, on a CD ROM in an agreed upon file structure. If the graphics have active-x controls or other files that must be placed outside the graphics folder structure a set-up program provided on the disk to place the files in the correct locations.

2.07 BUILDING CONTROLLERS

A. General: Provide adequate number of building controllers to achieve performance specified. Panels to meet the following requirements.
1. Building Automation System (BAS) to be composed of one or more independent, stand-alone, microprocessor-based building controllers to manage global strategies described in Controller Software article.
2. Provide sufficient memory to support operating system, database, and programming requirements.
3. Share data between networked building controllers.
4. Distributed controllers to share real and virtual object information and allow for central monitoring and alarms.
5. Controllers that perform scheduling have real-time clock.
6. Continually check status of its processor and memory circuits and if abnormal operation is detected, controller:
   a. Assume predetermined failure mode.
   b. Generate alarm notification.
7. Building Controller communicates with other devices on internetwork including BACnet communications according to specified protocol.

B. Communication:
1. Each building controller resides on network using ISO 8802-3 (Ethernet) Data Link/Physical layer protocol and performs routing to network of custom application and application specific controllers.
2. Controller provides a service communication port for connection to a portable operator's terminal.

C. Environment:
1. Controllers used outdoors and/or in wet ambient conditions mounted within NEMA waterproof enclosures and rated for operation at 0 degrees F to 150 degrees F.
2. Controllers used in conditioned space are mounted in NEMA dust-proof enclosures and rated for operation at 32 degrees F to 120 degrees F.

D. Keypad: Local keypad and display to be provided for each controller. Security password to be available to prevent unauthorized use of keypad and display.

E. Serviceability: Provide diagnostic LEDs for power, communication, and processor. Wiring connections are made to modular terminal strips or to termination card connected by ribbon cable.

F. Memory: Building controller maintains BIOS and programming information in event of power loss for at least 72 hours.

G. Immunity to power and noise. Controller able to operate at 90 percent to 110 percent of nominal voltage rating and performs an orderly shutdown below 80 percent nominal voltage. Operation protected against electrical noise of 5 to 120 Hz and from keyed radios up to 5 W at 3-feet.

H. Controller to have a battery to provide power for orderly shutdown of controller and storage of data in nonvolatile flash memory. Battery backup to maintain real-time clock functions for a minimum of 10 days.
2.08 APPLICATION SPECIFIC CONTROLLERS

A. Application specific controllers (ASCs) are microprocessor-based DDC controllers, which through hardware or firmware design are dedicated to control a specific piece of equipment. Controllers to be fully programmable using graphical programming blocks.
   1. ASC controllers communicate with other devices on internetwork.
   2. Each ASC capable of stand-alone operation without being connected to network.
   3. Each ASC will contain sufficient I/O capacity to control target system.
   4. Application controllers to include universal inputs with minimum 10-bit resolution that accept thermistors, 0-10VDC, 0-5 VDC, 4-20 mA and dry contact signals. Any input on a controller may be either analog or digital with at least 1 input that accepts pulses. Controller to also include support and modifiable programming for interface to intelligent room sensor with digital display. Controller to include binary and analog outputs on board. Provide analog outputs switch selectable as either 0-10VDC or 0-20mA. Software to include scaling features for analog outputs. Application controller to include 24VDC voltage supply for use as power supply to external sensors.
   5. Program sequences stored on board application controller in EEPROM. No batteries needed to retain logic program. Program sequences executed by controller 10 times per second and capable of multiple PI and PID loops for control of multiple devices. Calculations completed using floating-point math and system to support display of information in floating-point nomenclature at operator's terminal. Programming of application controller completely modifiable in the field over installed BAS LANs or remotely via modem interface. Operator to program logic sequences by graphically moving function blocks on screen and tying blocks together on screen.
   6. Application controller to include support for room sensor. Display on room sensor programmable at application controller and include an operating mode and a field service mode. Provide button functions and display data programmable to show specific controller data in each mode based on which button is pressed on the sensor. See sequence of operation for specific display requirements at intelligent room sensor.

B. Communication:
   1. Controller resides on network using MS/TP Data Link/Physical layer protocol.
   2. Each controller connected to building controller.
   3. Each controller capable of connection to laptop computer or portable operator's tool.

C. Environment:
   1. Controllers used outdoors and/or in wet ambient conditions mounted within NEMA waterproof enclosures and rated for operation at 0 degrees F to 150 degrees F.
   2. Controllers used in conditioned space mounted in NEMA dust-proof enclosures and rated for operation at 32 degrees F to 120 degrees F.

D. Serviceability: Provide diagnostic LEDs for power, communication, and processor.

E. Memory: ASC use nonvolatile memory and maintains BIOS and programming information in event of power loss.

2.09 INPUT/OUTPUT INTERFACE

A. Input/output points protected such that shorting of point to itself, to another point, or to ground will cause no damage to controller. Input and output points protected from voltage up to 24 V.

B. Binary inputs (BI or DI) allow monitoring of On/Off signals from remote devices. Binary inputs sense “dry contact” closure without external power (other than that provided by controller) being applied.

C. Pulse accumulation input objects accept up to 10 pulses per second for pulse accumulation.

D. Analog inputs (AI) allow monitoring of low-voltage (0 to 10 VDC), current (4 to 20 mA), or resistance signals (thermistor, RTD).
E. Binary outputs (BO or DO) provide for On/Off operation or pulsed low-voltage signal for pulse width modulation control. Binary outputs on building and custom application controllers have three-position (On/Off/Auto) override switches and status lights. Outputs selectable for either normally open or normally closed operation.

F. Analog outputs (AO) provide a modulating signal for control of end devices. Outputs provide either a 0 to 10 VDC or a 4 to 20 mA signal as required to provide proper control of the output device. Analog outputs on building controllers have status lights and two-position (AUTO/MANUAL) switch and adjustable potentiometer for manual override. Analog outputs not exhibit drift of greater than 0.4 percent of range per year.

G. Tri-State Outputs. Provide tri-state outputs (two coordinated binary outputs) for control of three-point floating type electronic actuators without feedback. Use of three-point floating devices limited to zone control and terminal unit control applications (VAV terminal units, duct-mounted heating coils, zone dampers, radiation, etc.). Control algorithms run zone actuator to one end of its stroke once every 24 hours for verification of operator tracking.

2.10 POWER SUPPLIES AND LINE FILTERING

A. Control transformers UL listed. Furnish Class 2 current-limiting type or furnish over-current protection in both primary and secondary circuits. Limit connected loads to 80 percent of rated capacity.

B. DC power supply output match output current and voltage requirements. Unit operates between 32 degrees F and 120 degrees F.

C. Line voltage units UL listed and CSA approved.

D. Power line filtering. Provide transient voltage and surge suppression for workstations and controllers.

2.11 CONTROL PANELS

A. Control Panels:
   1. Enclosures may be NEMA 1 when located in a clean, dry, indoor environment. Indoor enclosures to be NEMA 12 when installed in other than a clean environment. Outdoor enclosures must be NEMA 3R. Provide (hinged door) key-lock latch and removable subpanels. Single key common to field panels and subpanels. In existing campus or building settings, key lock to match existing keys.
   2. Interconnections between internal and face-mounted devices prewired with color-coded stranded conductors neatly installed in plastic troughs and/or tie-wrapped. Terminals for field connections UL listed for 600 volt service, individually identified per control/interlock drawings, with adequate clearance for field wiring. Control terminations for field connection individually identified per control drawings.
   3. Provide ON/OFF power switch with overcurrent protection for control power sources to each local panel.
   4. Provide laminated plastic nameplates for enclosures in any mechanical room or electrical room labeled with TCP number. Laminated plastic to be 1/8-inch thick sized appropriately to make label easy to read.

2.12 AUXILIARY CONTROL DEVICES

A. Temperature Instruments:
   1. Low-voltage or Line-voltage Thermostats: Bimetal-actuated, snap acting SPDT contact, enclosed, UL listed for electrical rating, exposed setpoint adjustment on cover with heat anticipator. Thermostat operates within 55 degrees F to 85 degrees F setpoint range, with 2 degrees F maximum differential.
   2. Room Temperature Sensors: Thermistor or platinum RTD type with accuracy of plus or minus 0.5 degrees F at 70 degrees F; operating range 30-120 degrees F; linear signal; single point sensing element in wall-mounted ventilated enclosure with insulating back plate if mounted on exterior wall; plug-in portable operators terminal port.
3. Room Temperature Sensor: Thermistor or platinum RTD type with accuracy of plus or minus 0.5 degrees F at 70 degrees F; operating range 30-120 degrees F; linear signal; single point sensing element in wall-mounted ventilated enclosure with insulating back plate if mounted on exterior wall; push button for occupancy override; digital setpoint adjustment plus or minus 2 degrees F in both directions; LCD temperature display indicating setpoint only. Setpoint adjustment to revert to building programmed standard temperature upon next building occupancy schedule change (user adjustable). Room temperature sensor may have integral space carbon dioxide sensor with minimum performance characteristics identified within this specification. Include integral occupancy sensor for public rooms but not in offices.

4. Averaging Duct Temperature Sensors: Thermistor or platinum RTD element with accuracy of plus or minus 0.5 degrees F at 32 degrees F, consisting of array of single point sensing elements, securely mounted in duct or plenum; operating range 20-120 degrees F; linear signal; 1-foot element per 2 SF of duct cross-sectional area. Use when duct is 9 SF or larger or where air is subject to temperature stratification.

5. Probe Duct Temperature Sensors: Thermistor or platinum RTD element with accuracy of plus or minus 0.5 degrees F at 32 degrees F, consisting of single point sensing elements, securely mounted in duct or plenum; operating range 20-120 degrees F; linear signal; 24-inch rigid probe. Use where duct is less than 9 SF cross-sectional area.

6. Outside Air Temperature Sensor: Thermistor or platinum RTD element with accuracy of plus or minus 0.5 degrees F at 32 degrees F; Range -58 to 120 degrees F, single element, linear, with weather and sun shield for exterior mounting.

7. Low Temperature Limit Thermostat: Minimum 20 foot capillary sensing element, triggering on low temperature as sensed by any 12-inch segment; snap acting, normally open contacts, manual reset, line voltage.

8. Liquid Immersion Temperature Sensor: Thermistor or platinum RTD element, with accuracy of plus or minus 0.5 degrees F at 32 degrees F, stainless steel well and assembly, range 30 to 250 degrees F.

9. Pneumatic Room Thermostat: Two-pipe relay type with concealed adjustment, and no thermometer, blank cover secured with Allen screws.

B. Pressure Transmitters and Transducers:

1. Transducer have linear output signal; field adjustable zero and span. Sensing elements withstand continuous operating conditions of positive or negative pressure 50 percent greater than calibrated span without damage.

2. Differential Pressure Switch: Setpoint adjustable with operating range of 0.5 to 12-inch WG for fans, and 5 to 30-feet WC for pumps. Switches UL listed; SPDT snap-acting; pilot duty rated (125 VA minimum); NEMA 1 enclosure; scale range and differential suitable for intended application.

3. Filter Differential Pressure Switch: Setpoint adjustable with operating range of 0.1 to 5-inch WG; auto reset. Contactor to close when pressure differential setting is met or exceeded. Provide mounting bracket, metallic tubing and appropriate fittings for connection to duct or air-handling unit.

4. Duct Static Differential Pressure Transducer: Operating range 0 to 5-inch WC for duct mounted transmitter; ceramic capacitive sensing element with probe securely mounted in duct; digital input terminal and push button to zero output. Accuracy plus or minus 1 percent of full scale; maximum response time 2 seconds.

5. Building Static Pressure Transducer: Operating range of -0.1 to 0.1-inch WC, linear signal. Sensing tubes located inside and outside building use shielding and/or surge tanks to minimize effects of wind. Accuracy plus or minus 1 percent of full scale.

6. Piping Pressure Transmitter: Operating range 0 to 50 PSIG, linear signal; stainless steel diaphragm; digital input terminal and push button to zero output. Accuracy plus or minus 1 percent of full scale.

C. Motorized Control Dampers:
1. Performance: Maximum leakage of 3 CFM/SF at 1-inch WG differential pressure, AMCA Class 1A, maximum pressure rating of 13-inch WG differential pressure, maximum velocity of 6,000 fpm, -72 degrees F to 275 degrees F temperature rating.

2. Multi-blade type, except where either dimension is less than 10-inch single blade may be used. Maximum blade length to be 48-inch.

3. Provide parallel blades for modulating mixing service and opposed blades for throttling service.

4. Blades to be interlocking: minimum 16 gauge galvanized steel; compression type edge seals and side seating stops. In copper, aluminum and stainless steel duct work, damper material matches duct work material.

5. Damper blades are reinforced, have continuous full length axle shafts, axle to axle linkage, and/or operating “jackshafts” as required to provide coordinated tracking of blades.


7. Dampers over 25 SF in area to be in two or more sections, with interconnected blades.

8. Provide remote damper blade position status with binary input.

9. Tested in accordance with AMCA Standard No. 500.

D. Motorized Control Valves:

1. Body pressure rating and connection type construction conforms to pipe, fitting and valve schedules.

2. Fluid valve close-off ratings and spring ranges operate at maximum flows and maximum available pump heads scheduled without leakage.

3. Screwed ends except 2-1/2-inch and larger valves with flanged ends.

4. Steam valve close-off ratings operates at 150 percent of steam pressure without leakage.

5. Motorized Control Valves (Pressure Independent Control Valves):
   a. Description: Valve consists of pressure compensating cartridge, actuated ball or Y pattern globe valve, and multiple pressure/temperature test ports in a single valve housing.
   b. Construction: Rated for no less than 125 PSI and 250 degrees F. 2-inch and Smaller: brass with threaded connections. 2-1/2-inch and larger: cast iron with flanged connections.
   c. Performance: Flow rate controlled linearly to within 5 percent of target flow rate, for any actuator position (0 to 100 percent), over an operating differential pressure range of 6 to 50 PSI across the valve. Provide valve with integral test ports to verify pressure differential.
   d. Manufacturers: Belimo, Danfoss, Flow Control Industries, Griswold, Tour and Andersson or approved equivalent.

6. Fluid three-way valves globe valves with linear plug with composition disc for tight shutoff.

7. Pressure drop equal to twice pressure drop through heat exchanger (load), 50 percent of pressure difference between supply and return mains, or 5 PSI, whichever is greater, except two-position valves to be line size.

8. Bubble-tight line size butterfly valves acceptable on 2-1/2-inch lines and above for two-position action only; cast iron body; aluminum bronze disc; EPDM seat, 200 PSI wg.

9. For modulating service that require valve sizes above 6-inch, butterfly or v-port ball valves are allowed.

10. Steam Valves: Body and trim materials in accordance with manufacturer’s recommendations for design conditions and service with linear ports for modulating service. Sizing Criteria:
    a. Two-Position Service: Pressure drop 10 percent to 20 percent of inlet PSIG.
    b. Modulating Service: 15 PSIG or less; pressure drop 80 percent of inlet PSIG.
    c. Modulating Service: 16 to 50 PSIG; pressure drop 50 percent of inlet PSIG.
    d. Modulating Service: Over 50 PSIG; pressure drop as scheduled on Drawings.

E. Electric Damper/Valve Actuators:

1. Provide mechanical or electronic stall protection for each actuator.
2. Where indicated provide internal mechanical, spring-return mechanism or provide uninterruptible power supply (UPS). Non-spring-return actuators have external manual gear release to position damper/valve when actuator is not powered.

3. Proportional actuators accepts 0 to 10 VDC or 0 to 20 mA control signal and provide 2 to 10 VDC or 4 to 20 mA operating range.

4. Actuator sized for torque required plus 25 percent; UL or CSA listed; electronic current overload protection.

5. VAV Actuators: Actuators proportional 24 VAC actuators using a 4 to 20 mA range of control signals; stops automatically at end of travel; include permanently lubricated gear train.

6. Actuators for emergency generator damper control rated for 350 degree F. maximum operating temperature and capable to drive fully open and close within 15 seconds.

F. Room Pressure Monitor: Active room pressure monitor and alarm which provides local audio alarm and analog and alarm signals to DDC system. Wall mounted panel with LED differential pressure readout; audible and visual alarm; mute button; range of -0.05 to +0.05-inch WC; accurate to 1 percent of full scale; repeatability plus or minus 1.0 percent of full scale per year, alarm delay ability between 0-30 seconds. Provide door switch to deactivate alarm when space door(s) are open. Input status from BAS to deactivate alarm in unoccupied or shutdown modes. Phoenix Controls APM100.

G. Wall Mounted Space Carbon Dioxide Sensor:
   1. Sensor to employ non-dispersive infrared technology. (N.D.I.R.)
   3. Sensor Accuracy: Less than or equal to 75 ppm over 0-1500 ppm range.
   4. Sensor Response Time: Less than 1 minute.
   5. Sensor to employ reference channel design for long-term stability.
   6. Sensor to have field selectable 0-10VDC, or 4-20mA outputs.
   7. Sensor power requirement less than 3W.
   8. Sensor Input Voltage: 20 to 30VAC/DC.
   9. Sensor Operating Temperature Range: 0 degrees C to 50 degrees C.
   10. Sensor to have models for wall mounting or duct mounting.
   11. Sensor to provide at least a 1-year factory warranty from date of purchase.
   12. Sensor to match cover in color and look to temperature sensor.
   13. Sensor to have display.
   14. Manufacturers:
       a. Telaire
       b. Vaisala
       c. Veris

H. Carbon Monoxide Detector:
   1. Microprocessor based CO sensor and controller with fan relay, pilot light indicators; comply with UL Standards 2034; self-supervision activates fan if system detects problems; calibration kit for project.
   2. Relay to activate fan at sensing 35 ppm CO after 5 minutes. Minimum fan runtime to be 2-1/2 minutes. Relay to activate alarm at sensing 100 ppm CO after 30 minutes. Vulcain Electrochemical Type (Q1).

I. Nitrogen Dioxide Detector:
   1. Microprocessor based NO2 sensor and controller with fan relay, pilot light indicators; comply with UL Standards 2034; self-supervision activates fan if system detects problems; calibration kit for project.
   2. Relay to activate fan at sensing 10 PPM NO2 after 5 minutes. Minimum fan runtime to be 2-1/2 minutes. Relay to activate alarm at sensing 15 PPM NO2 after 30 minutes. Vulcain Electrochemical Type (Q1).

J. Relays:
1. Control relays UL listed plug-in type with dust cover and LED “energized” indicator. Contact rating, configuration, and coil voltage to be suitable for application.

2. Time delay relays UL listed solid-state plug-in type with adjustable time delay. Delay adjustable plus or minus 200 percent (minimum) from setpoint or as indicated. Contact rating, configuration, and coil voltage to be suitable for application. Provide NEMA 1 enclosure when not installed in local control panel.

K. Override Timers: Override timers spring-wound line voltage, UL Listed, with contact rating and configuration as required by application. Provide 0-to-6-hour calibrated dial unless otherwise specified. Timer suitable for flush mounting on control panel face and located on local control panels or where shown.

L. Current Transmitters:
   1. AC current transmitters are self-powered, combination split-core current transformer type with built-in rectifier and high-gain servo amplifier with 4 to 20 mA two-wire output. Unit range compatible with actual applied span of current value, with internal zero and span adjustment and plus or minus 1 percent full-scale accuracy at 500 ohm maximum burden.
   2. Transmitter meets or exceeds ANSI/ISA S50.1 requirements and UL/CSA recognized.
   3. Unit split-core type for clamp-on installation on existing wiring.

M. Current Transformers: AC current transformers UL/CSA recognized and completely encased (except for terminals) in approved plastic material; plus or minus 1 percent accuracy at 5 A full-scale.

N. Voltage Transmitters: AC voltage; self-powered single-loop (two-wire) type; 4 to 20 mA output with zero and span adjustment; UL/CSA recognized at 600 VAC rating and meet or exceed ANSI/ISA S50.1. Ranges include 100 to 130 VAC, 200 to 250 VAC, 250 to 330 VAC, and 400 to 600 VAC full-scale, adjustable, plus or minus 1 percent full-scale accuracy with 500 ohm maximum burden.

O. Voltage Transformers: AC voltage transformers UL/CSA recognized, 600 VAC rated; built-in fuse protection; suitable for ambient temperatures of 40 degrees F to 130 degrees F; plus or minus 0.5 percent accuracy at 24 VAC and a 5 VA load.

P. Power Monitors: Selectable rate pulse output for kWh reading; 4-20 mA output for kW reading; N.O. alarm contact; ability to operate with 5.0 amp current inputs or 0-0.33 volt inputs; plus 1.0 percent full-scale true RMS power accuracy; plus 0.5 Hz, voltage input range 120-600 V, and auto range select; NEMA 1 enclosure. Current transformers having a 0.5 percent FS accuracy, 600 VAC isolation voltage with 0-0.33 V output. If 0-5 A current transformers are provided, a three-phase disconnect/shorting switch assembly is required.

Q. End Switches: Turret head Type SPDT. Schneider Electric/Square D Class 9007, Type C54B2, or equal.

2.13 WIRING AND RACEWAYS

A. General: Provide copper wiring, plenum cable, and raceways as specified in applicable Sections of Division 26, Electrical.

B. Insulated wire to be copper conductors, UL labeled for 90 degrees C minimum service.

C. Field panels and controllers to be supplied by building emergency power system where systems being monitored or controlled are on emergency power.

D. Run control wiring as follows:
   1. Mechanical Rooms: In conduit.
   2. Exposed in Building Spaces: In conduit.

E. Field and Subfield Panels: Voltage in panels not-to-exceed 120 volts.
F. Motor Control Centers: Responsibility for correct voltage of holding coils and starter wiring in pre-wired motor control centers interfacing with automatic controls is included hereunder.

G. Wiring for BAS systems communications buses two conductor minimum 18 gauge foil-shielded, stranded twisted pair cable rated at 300 VDC or more than 80 degrees C.

2.14 SMOKE DETECTION (FOR PROJECTS WITH A FIRE ALARM SYSTEM)
A. See Division 28 for Products.

PART 3 - EXECUTION

3.01 EXAMINATION
A. Prior to starting work, carefully inspect installed work of other trades and verify that such work is complete to the point where work of this Section may properly commence.
B. Notify the Owners' representative in writing of conditions detrimental to the proper and timely completion of the work.
C. Do not begin work until unsatisfactory conditions are resolved.

3.02 CONTROL SYSTEM CHECKOUT AND TESTING
A. Testing completed before Owner's representative is notified of system demonstration.
B. Calibrate and prepare for service of instruments, controls, and accessory equipment furnished under this specification.
C. Verify that control wiring is properly connected and free of shorts and ground faults.
D. Enable control systems and verify calibration and operation of input and output devices.
E. Verify that system operation adheres to sequences of operation.
F. Commissioning and Verification: In addition to commissioning requirements specified elsewhere, provide the following commissioning on the HVAC instrumentation and controls system:
   1. Control systems completely commissioned to ensure aspects of the system are operating as intended and at optimum tuning.
   2. Wiring connections verified and traced from field device to panel to ensure proper connections.
   3. Measured values verified by a hand held calibrated device to validate that value indicated by the control system is in fact the actual measured value.
   4. Loops properly tuned to obtain the desired control value. Each loop to be "upset" and put back in control to demonstrate its ability to stabilize quickly.
   5. Provide a final point-by-point report submitted that indicates the date of each verification, the results, and initialed on each page by the person performing the reading.

3.03 ACCEPTANCE TESTING AND TRAINING
A. Site Testing:
   1. Contractor provides personnel, equipment, instrumentation, and supplies necessary to perform testing. Owner or Owner's representative will witness and sign off on acceptance testing.
   2. Contractor demonstrates compliance of completed control system with Contract Documents. Using approved test plan, physical and functional requirements of project demonstrated.
B. Training:
   1. General: Contractor conducts training courses for up to three other designated personnel in operation and maintenance of system. Training manuals provided for each trainee, with two additional copies provided for archival at project site. Manuals include detailed description of subject matter for each lesson. Copies of audiovisuals delivered to Owner. Training day is defined as 8 hours of classroom instruction, including two 15-minute breaks.
2. Operator's Training I: First course taught at supplier's facility for period of one training day. Upon completion, each student should be able to perform elementary operations with guidance and describe general hardware architecture and functionality of system.

3. Operator's Training II: Second course taught at project site for a period of one training day after completion of contractor's field testing. Course includes instruction on specific hardware configuration of installed system and specific instructions for operating installed system. Upon completion, each student should be able to start system, operate the system, recover system after failure, and describe specific hardware architecture and operation of system.

4. Operator's Training III: Third course taught at project site for period of one training day no later than six months after completion of the acceptance test. Course will be structured to address specific topics that students need to discuss and to answer questions concerning operation of system. Upon completion, students should be fully proficient in system operation and have no unanswered questions regarding operation of installed system.

3.04 Wiring

A. Provide electrical wiring required to control systems specified in this Section. Control and interlock wiring complies with national, state and local electrical codes and Division 26, Electrical of this specification.

B. Power wiring required for building control panel(s) to be dedicated circuit(s).

C. Verify location of operator work station with Owner prior to installation.

D. NEC Class 1 (line voltage) wiring UL Listed in approved raceway according to NEC and Division 26, Electrical requirements.

E. Low-voltage wiring meets NEC Class 2 requirements. (Low-voltage power circuits subfused when required to meet Class 2 current limit.)

F. Where NEC Class 2 (current-limited) wires are in concealed and accessible locations, including ceiling return air plenums, approved cables not in raceway may be used provided that cables are UL listed for intended application.

G. Do not install Class 2 wiring in raceway containing Class 1 wiring. Boxes and panels containing high-voltage wiring and equipment may not be used for low-voltage wiring except for purpose of interfacing (e.g., relays and transformers).

H. Where Class 2 wiring is run exposed, wiring run parallel along surface or perpendicular to it and tied at 10 foot intervals.

I. Where plenum cables are used without raceway, support from structural members. Do not support cables with ductwork, electrical raceways, piping, or ceiling suspension systems.

J. Make wire-to-device connections at terminal block or terminal strip. Make wire-to-wire connections at terminal block.

K. Maximum allowable voltage for control wiring 24 V. If only higher voltages are available, provide step-down transformers.

L. Wiring installed as continuous lengths, with no splices permitted between termination points.

M. Install plenum wiring in sleeves where it passes through walls and floors. Maintain fire rating at penetrations.

N. Include one pull string in each raceway 1-inch or larger.

O. Control and status relays are to be located in designated enclosures. Enclosures include packaged equipment control panels unless they also contain Class 1 starters.
P. Install raceway to maintain a minimum clearance of 6-inches from high-temperature equipment (e.g., steam pipes or flues).

Q. Secure raceways with raceway clamps fastened to structure and spaced according to code requirements. Raceways and pull boxes may not be hung on flexible duct strap or tie rods. Raceways may not be run on or attached to ductwork.

R. Install insulated bushings on raceway ends and openings to enclosures. Seal top end of vertical raceways.

S. Flexible metal raceways and liquid-tight, flexible metal raceways not-to-exceed 3-feet in length and be supported at each end. In areas exposed to moisture, including chiller and boiler rooms, liquid-tight, flexible metal raceways to be used.

T. Raceway must be rigidly installed, adequately supported, properly reamed at both ends, and left clean and free of obstructions. Raceway sections joined with couplings. Terminations made with fittings at boxes.

U. Input and output terminations to be labeled at the controller to identify if they are AI, DI, AD, DO, and function (i.e. pump start, OM Sensor).

3.05 COMMUNICATION WIRING
A. Follow manufacturer’s installation recommendations for communication cabling.

B. Verify integrity of network following cable installation.

C. Communication wiring unspliced length when that length is commercially available; labeled to indicate origination and destination data.

D. Grounding of coaxial cable in accordance with NEC regulations article on “Communications Circuits, Cable, and Protector Grounding.”

3.06 INSTALLATION OF AUXILIARY CONTROL DEVICES
A. General:
1. Install sensors and thermostats in accordance with manufacturer's recommendations.

2. Room sensors and thermostats installed at 48-inches AFF to midline of sensor on concealed junction boxes properly supported by wall framing at the locations shown on the Drawings.

3. Low-limit sensors used in mixing plenums installed in a serpentine manner horizontally across duct.

4. Pipe-mounted temperature sensors installed in wells with heat-conducting fluid in thermal wells.

5. Install outdoor air temperature sensors on north facing wall or screen, complete with sun shield at designated location.

B. Flow Switch: Use correct paddle for pipe diameter. Adjust flow switch in accordance with manufacturer's instructions.

C. Actuators:
1. General:
   a. Mount and link control damper actuators according to manufacturer's instructions.
   b. Check operation of damper/actuator combination to confirm that actuator modulates damper smoothly throughout stroke to both open and closed positions.

2. Actuator Mounting for Damper and Valve Arrangements to Comply with the Following:
   a. Damper Actuators: Do not install in the air stream.
   b. Use a weather proof enclosure (clear and see through) if actuators are located outside.
   c. Damper or valve actuator ambient temperature not-to-exceed 122 degrees F through any combination of medium temperature or surrounding air. Provide appropriate air gaps, thermal isolation washers or spacers, standoff legs, or insulation as necessary. Mount per manufacturer’s recommendations.
d. Actuator cords or conduit to incorporate a drip leg if condensation is possible. Do not allow water to contact actuator or internal parts. Location of conduits in temperatures dropping below dew point to be avoided to prevent water from condensing in conduit and running into actuator.

e. Damper mounting arrangements to comply with the following:
   1) Furnish and install damper channel supports and sheet metal collars.
   2) Jack shafting of damper sections not allowed.
   3) Multi-section dampers arranged so that each damper section operates individually. Provide one electronic actuator direct shaft mounted per section.

f. Size damper sections based on actuator manufacturers specific recommendations for face velocity, differential pressure and damper type. In general: Damper section not-to-exceed 24 ft-sq. with face velocity 1500 FPM.

g. Multiple section dampers of two or more arranged to allow actuators to be direct shaft mounted on the outside of the duct.

h. Multiple section dampers of three or more sections wide arranged with a 3-sided vertical channel (8-inch wide by 6-inch deep) within the duct or fan housing and between adjacent damper sections. Vertical channel anchored at the top and bottom to the fan housing or building structure for support. Connect sides of each damper frame to the channels. Holes in the channel to allow damper drive blade shafts to pass through channel for direct shaft mounting of actuators. Face open side of channel downstream of the airflow, except for exhaust air dampers.

i. Multiple section dampers to be mounted flush within a wall or housing opening to receive either vertical channel supports as described above or sheet metal standout collars. Sheet metal collars (12-inch minimum) to bring each damper section out of the wall to allow direct shaft mounting of the actuator on the side of the collar.

D. Control Damper:
   1. Dampers installed in accordance with manufacturer's instructions. Unless specifically designed for vertical blade application, dampers must be mounted with blade axis horizontal.
   2. After installation of low-leakage dampers with seals, caulk between frame and duct or opening to prevent leakage around perimeter of damper.

3.07 SEQUENCES OF OPERATION AND POINTS LISTS

A. Where local energy code dictates certain sequences (such as night setback, night flush, pressure and temperature reset, terminal unit sequences, etc.), the sequences are not necessarily repeated in the documents. It is not the intent of this specification or documentation to reiterate the energy code. Provide energy code mandated sequences and document in sequence of operations submittals at no additional cost to the Owner. Provide required points to achieve the appropriate sequences.

B. See control diagrams and sequences on drawings.

C. Variable Frequency Drives: For a VFD dependent on an external input for its output setting (e.g., the VFD gets “Frequency” as an input), loss of that external input to result in the VFD holding its last value. If the VFD is running its own PID loop and the external input to the VFD is a setpoint (e.g. duct static pressure setpoint), the VFD to hold the last setpoint. If the VFD loses its process variable (e.g. duct static pressure), the VFD to go to its minimum speed setting.

D. Except as specified otherwise, throttling ranges, proportional bands, and cycle differentials to be centered on the associated setpoint. Modulating feedback control loops to include the capability of having proportional, integral, and derivative action. Unless the loop is specified “proportional only” or “P+I”, Contractor to apply appropriate elements of integral and derivative gain to each control loop to result in stable operation, minimum settling time and maintain the primary variable within the specified maximum allowable variance.

E. Provide a real time clock and schedule controller with sufficient scheduling capability to schedule required controllers and sequences. Schedule functionality may reside in a controller.
If a controller is used, document scheduling functionality including names and types on controller points list submittal. Set up initial schedules in coordination with Owner.

F. Scheduling Terminology: When air handlers are scheduled throughout the day, the following defines the terminology used:
1. Occupied Period: Period of time when the building is in use and occupied. Confirm schedule with Owner. Exclude all national holidays. Generally systems will be fully operational throughout this period and ventilation air to be continuously introduced. Space temperature setpoints will generally be in the “normal” range of 68 degrees to 78 degrees F.
2. Unoccupied period: Period of time when the building or zone is not in use and unoccupied. Ventilation air not to be introduced.
3. Preoccupancy Period: Time prior to the Occupied period when the systems are returning the space temperatures from setback to “normal” or occupied setpoints (warm-up and cool-down). Ventilation air shall not be introduced unless outside air conditions permit free-cooling or to support a pre-occupancy purge sequence. Time period to be determined by an optimum start strategy unless otherwise specified.
4. Setback Period: Setback will typically start with the end of the occupied period and end with the start of the preoccupancy period, however it shall be provided with its own schedule. Generally systems will be off except to maintain a “setback” temperature, economization may be enabled to maintain “setback” cooling setpoint when applicable.

G. Where any sequence or occupancy schedule calls for more than one motorized unit to start simultaneously, the BAS start commands to be staggered by 5 second (adj.) intervals to minimize inrush current.

H. Wherever a value is indicated as adjustable (adj.), it shall be modifiable, with the proper password level. For these points, it is unacceptable to have to modify programming statements to change the setpoint.

I. When a power failure is detected in any phase, the BAS start commands to be retracted immediately from electrically powered units served by the failed power source. If the associated controller is powered by normal or emergency power, it may monitor its own power source as an indication of power status. If the controller is powered by uninterruptible power supply (UPS), or if it is not capable of monitoring its own power for use in sequences, provide at least one voltage monitor (three phase when applicable) per building. When the BAS detects that normal or emergency power has been restored, all equipment for which the BAS start command had been retracted to be automatically restarted in an orderly manner on staggered 5 second intervals to minimize inrush current.

J. Where reset action is specified in a sequence of operation, but a reset schedule is not indicated on the drawings, employ one of the following methods:
1. Determine a fixed reset schedule to result in stable operation and maintain the primary variable within the specified maximum allowable variance.
2. Use a floating reset algorithm which increments the secondary variable setpoint (setpoint of control loop being reset) on a periodic basis to maintain primary variable setpoint. The recalculation time and reset increment to be chosen to maintain the primary variable within the specified maximum allowable variance.
3. Primary variable to control the devices directly using a PID feedback control loop without resetting the secondary variable. However, the control devices to still modulate as necessary to maintain upper and lower limits on the secondary variable. Proportional band, integral gain, and derivative term to be selected to maintain the primary variable within the specified maximum allowable tolerance while minimizing overshoot and settling time. Gain prior approval for implementing this method of reset.

K. Where “prove operation” of a device (generally controlled by a digital output) is indicated in the sequence, it shall require that the BAS, after an adjustable time delay after the device is commanded to operate (feedback delay), confirm that the device is operational via the status
input. If the status point does not confirm operation after the time delay or anytime thereafter for an adjustable time delay (debounce delay) while the device is commanded to run, an alarm to be enunciated audibly. Upon failure, run command to be removed and the device to be locked out until the alarm is manually acknowledged unless specified otherwise.

L. Wherever a value is indicated to be dependent on another value (i.e., setpoint plus 5 degrees F) BAS to use that equation to determine the value. Simply providing a virtual point that the operator must set is unacceptable. In this case three virtual points to be provided. One to store the parameter (5 degrees F), one to store the setpoint, and one to store the value which is the result of the equation.

M. Trend points as identified in the points list. Trends to be grouped system specific and setup in two-axis (x,y) graphical format that display object values relative to time. Setup trends to record data in 5 minute increments.

N. **Packaged Rooftop Unit (RTU-1, RTU -2, RTU -3, RTU -4):**
   1. General:
      a. Refer to Section 23 74 00 - Rooftop Packaged Air Conditioning Units for features of unit controller.
      b. Unit controls to operate under following modes:
         1) Occupied
            (a) Supply air temperature control with economizer, DX cooling and gas fired heat.
            (b) Relief fan building static pressure control.
            (c) Demand Control Ventilation (RTU-1, RTU-2)
         2) Shutdown
         3) Unoccupied
            (a) Night Setback
            (b) Night Setup
            (c) Night Purge
            (d) Unoccupied override
         4) Morning warmup
   2. Occupied Mode:
      a. General:
         1) Occupied mode initiated from BAS schedule.
         2) BAS signals occupied mode to unit controller.
      b. Supply Air Temperature (SAT) Control:
         1) Factory mounted supply air temperature sensor signals air handler controller which modulates in sequence mechanical heating, mechanical cooling and economizer to maintain supply air temperature setpoint.
         2) Disable economizer operation above outside air temperature of 70°F (adj).
         3) Discharge air temperature setpoint to have 5°F deadband between cooling enable and heating enable setpoints.
      c. Relief Fan Building Static Pressure Control:
         1) Unit controller modulates relief fan speed to maintain building static pressure of 0.03-inch positive (adj.) relative to outdoors at field installed building pressure sensor.
      d. Demand Control Ventilation:(RTU-1, RTU-2):
         1) If space CO2 concentration is greater than 900 PPM (adj.), unit controller modulates outside air damper between minimum and DCV maximum scheduled outdoor airflow.
   3. Shutdown Mode:
      a. BAS signals unit controller to shutdown unit.
   4. Unoccupied Mode:
      a. General:
1) Unoccupied mode initiated from BAS schedule.
2) Air handler is shutdown unless enabled in night setback, night setup, night purge
   or unoccupied override.

b. Night Setback:
   1) BAS signals unit controller to unoccupied heating (night setback) mode.
   2) Enable night setback when any space temperature drops below 60°F (adj.).
   3) Disable night setback when lowest space temperature is above 63°F.

c. Night Setup:
   1) BAS signals unit controller to unoccupied cooling (night setup) mode.
   2) Enable night setup when any space temperature rises above 85°F.
   3) Disable night setup when highest space temperature is below 82°F.

d. Night Purge:
   1) BAS signals unit controller to night purge mode.
   2) Night purge begins when:
      (a) Peak outside air temperature in previous 24 hours has exceeded 85°F.
      (b) Space is less than 5 hours from occupancy.
      (c) Space temperature is above 73°F.
      (d) Outside air temperature is above 45°F and below 65F.
   3) Terminate night purge when one of the following occurs:
      (a) Space is less than 20 minutes from occupancy.
      (b) Return air temperature is less than 68°F.

e. Unoccupied Mode Override:
   1) BAS signals unit controller to occupied mode upon receiving an override signal
      from designated space temperature sensors.
   2) BAS signals unit controller to unoccupied mode when one of the following
      occurs.
      (a) Timed override period of two hours (adjustable) has expired.
      (b) Timed override is cancelled.
      (c) Morning warmup is enabled.

5. Morning Warm-up:
   a. Morning warm-up is initiated using an “optimal” start program that uses an adaptive
      learning feature that automatically adjusts the morning warm-up start time so that the
      space temperature are at the occupied start space temperature setpoint, 70°F (adj.)
      at the scheduled occupied start time.
   b. BAS calculates optimal start time and signals unit controller to enter warm-up mode.
   c. The supply air temperature during morning warmup is 85°F (adj.).

6. Alarms / Safeties:
   a. Differential pressure switches located across filter bank generates an alarm when
      static pressure drop exceeds 1.2-inches.

7. Points List:

<table>
<thead>
<tr>
<th>Point Name</th>
<th>Hardware</th>
<th>Software</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>AI</td>
<td>AO</td>
</tr>
<tr>
<td>Unit Enable</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Occupied Mode</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Unoccupied Mode</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Shutdown</td>
<td></td>
<td>X</td>
</tr>
</tbody>
</table>
O. **Recirculating Domestic Hot Water Pump (RHWP):**
1. Pump controller receives signal from building controller, which initiates occupied or unoccupied mode. During occupied mode pump will run continuously. During unoccupied mode pump will be off.
2. Current transformer signals controller which generates alarm when pump/controller fails to operate.
3. Recirculating Domestic Hot Water Pump (RHWP) Points List:

<table>
<thead>
<tr>
<th>Points List</th>
<th>Analog In</th>
<th>Analog Out</th>
<th>Digital In</th>
<th>Digital Out</th>
<th>Alarms</th>
<th>Trend</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pump Start/Stop</td>
<td>X</td>
<td></td>
<td></td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pump Status (current transformer)</td>
<td></td>
<td></td>
<td>X</td>
<td>Fail</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

P. **General Exhaust Fan (CV):**
1. Fan controller receives signal from building controller, which initiates occupied or unoccupied mode. During occupied mode open isolation damper and run fan continuously. During unoccupied mode close isolation damper and fan off.
2. Current transformer signals controller which generates alarm when fan/controller fails to operate.
3. General Exhaust Fan (CV) Points List:
## SECTION 23 0900

### INSTRUMENTATION AND CONTROL PERFORMANCE SPECIFICATIONS

#### Points List

<table>
<thead>
<tr>
<th>Points List</th>
<th>Analog In</th>
<th>Analog Out</th>
<th>Digital In</th>
<th>Digital Out</th>
<th>Alarms</th>
<th>Trend</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exhaust Fan Start/Stop</td>
<td></td>
<td></td>
<td></td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Exhaust Fan Status (Current Transformer)</td>
<td></td>
<td></td>
<td>X</td>
<td>Fail</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Damper Open/Close</td>
<td></td>
<td></td>
<td></td>
<td>X</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Infrared Heaters:
1. Occupied Mode: temperature sensor signals controller to enable heater to maintain space temperature setpoint.
2. Unoccupied Mode: BAS signals controller to unoccupied heating mode. Heater to enable to maintain space temperature of 45 degrees F.

<table>
<thead>
<tr>
<th>Points List</th>
<th>Analog In</th>
<th>Analog Out</th>
<th>Digital In</th>
<th>Digital Out</th>
<th>Alarms</th>
<th>Trend</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heater Enable / Disable</td>
<td></td>
<td></td>
<td></td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Space Temp.</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Heater Status</td>
<td></td>
<td></td>
<td>Fail</td>
<td>X</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Vehicle Exhaust and Welding Fume Exhaust Fans:
1. Fans EF-1, -2, and -3 controlled by wall switch.
2. Current transformer signals controller which generates alarm when fan/controller fails to operate.
3. General Exhaust Fan (CV) Points List:

<table>
<thead>
<tr>
<th>Points List</th>
<th>Analog In</th>
<th>Analog Out</th>
<th>Digital In</th>
<th>Digital Out</th>
<th>Alarms</th>
<th>Trend</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exhaust Fan Status (Current Transformer)</td>
<td></td>
<td></td>
<td>X</td>
<td>Fail</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Damper Open/Close</td>
<td></td>
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<td></td>
<td>X</td>
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<td></td>
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</table>

END OF SECTION
SECTION 23 1126 - FACILITY FUEL - PROPANE GAS PIPING AND SYSTEMS

PART 1 - GENERAL

1.01 SUMMARY

A. Work Included:
   1. Pipe and Pipe Fittings - General
   2. Valves for Metallic Piping
   3. Aboveground Liquid Propane Storage Tanks (AST)
   4. High-Pressure Regulator for Distribution Piping System
   5. Primary Regulator for Distribution Piping System
   6. Secondary Regulator for Building Piping System

B. Provide Propane System to supply 1000 MBTU/HR of propane gas at 2 PSIG Pressure.

C. Provide and install major components and appurtenances, including electrical power to main disconnect, for complete Propane System to Owner. Equipment new, unless otherwise specified. Equipment of first class manufacture and meets Federal, State, and Local requirements for LPG (propane) usage. Installation in accordance with NFPA 58, and meets local and state codes.

D. Material furnished of first quality, furnished and installed in accordance with applicable codes and standards of LPG (propane) industry.

E. Supply necessary concrete work including 6-inch thick concrete pad to support above ground storage tank/tanks and equipment, electrical wiring, insulation, piping, painting, fencing and paving for equipment as specified to result in complete working system. Contractor responsible for coordination of working components with supporting facilities as described above.

F. Contractor responsible for obtaining necessary permits and payment of applicable fees. Coordinate AHJ inspections by Contractor.

1.02 RELATED SECTIONS

A. Contents of Division 23, HVAC and Division 01, General Requirements apply to this Section.

1.03 REFERENCES AND STANDARDS

A. References and Standards as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

B. In addition, meet the following:
   1. Division 26, Electrical requirements for grounding fuel piping systems.

1.04 SUBMITTALS

A. Submittals as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

B. In addition, provide:
   1. Product Data: Submit manufacturer's technical product data and installation instructions for fuel-oil system materials and products, instrumentation, and leak detection systems.
      a. Provide submittals for materials, equipment, devices and appurtenances listed in Part 1.1 of this Section.
      b. Provide submittals for piping, safety devices, storage tanks, cathodic protection products, truck transfer station, and any other products required to provide complete working system together with their listed regulatory compliance.
      c. List regulatory compliance of submitted products to applicable construction standards.
      d. Submit copies of product warranties applicable to products specified in this Section.
      e. Submit manufacturer's shop drawings for storage tanks either above or below grade applications. Include dimensions and locations of fittings and accessories, including manways, ladders, and emergency relief vents. Indicate locations for related electrical equipment, control panels, and electrical enclosures. Include corrosion protective...
product coatings and cathodic protection systems for below grade applications in compliance with NACE Standards RP0169 and RP0285.

f. Provide submittals for electrical products required to provide complete working system together with their listed regulatory compliance. Products provided will be suitable for installation in hazardous locations as defined by NFPA 70, National Electrical Code. Provide electrical enclosures with NEMA ratings appropriate for their installed use.

g. Submit shop drawings and calculations for support and seismic bracing of above grade storage tanks. Seismic support calculations to be wet-stamped and signed by licensed structural engineer specifically for project's storage tank.

h. Submit shop drawings and buoyancy calculations for support and anchoring of below grade storage tanks. Support and buoyancy calculations to be wet-stamped and signed by licensed structural engineer specifically for project's storage tank.

2. Record Drawings: At project closeout, submit Record Drawings of installed piping, fuel storage tanks, and fuel systems products. Below grade installed products include invert elevations for piping and storage tank.

3. Maintenance Data: Submit maintenance data and parts list for fuel systems materials and products. Include this data, product data, shop drawings and Record Drawings in maintenance manual.

1.05 QUALITY ASSURANCE

A. Quality assurance as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

B. In addition, meet the following:

1. Qualifications: Firms regularly engaged in manufacture and/or installation of fuel-oil burning equipment and fuel-oil system products of types, materials, and sizes required. Provide proof of previous successful installation of similar equipment in past 12 months. Employ technically qualified personnel who have installed similar LPG (propane) equipment in past 12 months. Provide such individuals to supervise installation of major components, to start up and balance control equipment, and to train personnel in operation and maintenance of final installed system.

2. Regulatory Requirements:
   a. Complete and entire LP storage tank installation and distribution piping will be in accordance with specific requirements from district Fire Marshal, latest edition of NFPA Bulletin 58, and will be in accordance with applicable state and local ordinances.
   b. Equipment, devices and wiring on equipment within 50-feet of LP storage tank and will be considered to be in a Class I, Division II location. Equipment and devices will be types approved for Group D atmospheres. Provide Class 1, Division 01 installation within 5-feet of bulk storage tank.

C. Corrosion Protection for Steel Pipe, Pipe Fittings, and Steel Storage Tanks (Below grade Installations Only)

1.06 WARRANTY

A. Warranty of materials and workmanship as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Pipe and Pipe Fittings - General:
   1. See component manufacturers listed in individual articles below.
2. Uponor
3. Cerro
4. Dodge Phelps
5. Tyler
6. ADS
7. Charlotte
8. Elkhart
9. Enfield
10. Gruvlok
11. Spears
12. Nibco
13. Aquatherm
14. Orion
15. American-USA

B. Valves for Metallic Piping:
   1. Ball Valves: Nibco T-595YSDT-UL, T590YSDT-UL

C. Aboveground Liquid Propane Storage Tanks (AST):
   1. Tank:
      a. Trinity Tank
      b. Or approved equivalent.
   2. Relief Valves:
      a. Rego
      b. Fisher
      c. Or approved equivalent.

D. High-Pressure Regulator for Distribution Piping System:
   1. Francel
   2. Or approved equivalent.

E. Primary Regulator for Distribution Piping System:
   1. Francel
   2. Or approved equivalent.

F. Secondary Regulator for Building Piping System:
   1. Actaris
   2. Equimeter
   3. Or approved equivalent.

2.02 PIPE AND PIPE FITTINGS - GENERAL

A. Steel Pipe (Above Grade Installations):
   1. Piping subject to tank pressure: ASTM A53, Electric-Resistance Welded (Type E) or Seamless (Type S), Grade B, Black, Schedule 80 pipe, manufactured for threaded or welded pipe connections.
   2. Piping not subject to tank pressure: ASTM A53, Electric-Resistance Welded (Type E) or Seamless (Type S), Grade B, Black, Schedule 40 pipe, manufactured for threaded or welded pipe connections.

B. Fittings for Steel Pipe (Above Grade Installations):
   1. Threaded pipe fittings subject to tank pressure: ASTM B16.11, 2000 PSIG, threaded steel pipe fittings.
   2. Welded pipe fittings subject to tank pressure: ASTM B16.11, 2000 PSIG, welded forged steel pipe fittings.
   3. Flanged pipe fittings subject to tank pressure: ASTM A105, 2000 PSIG.
5. Welded pipe fittings not subject to tank pressure: ASTM A234, ANSI B16.9, B16.28. Butt-welding type unless otherwise indicated to be socket welding type.
6. Flanged pipe fittings not subject to tank pressure: ASTM A105, ANSI B16.5, and factory forged in USA. Flanges which have been machined, remade, painted, or are non-domestic origin are not acceptable. Provide raised or full face ends wherever indicated or required.
7. Flange Gaskets: Gaskets to be constructed from Buna-N (Nitrile), NBR, or Viton elastomeric materials.
8. Flange Hardware: Bolting materials to be corrosion resistant carbon steel bolts and hex nuts conforming to ASTM A307. Bolting materials used in access sumps below grade applications, stainless steel bolts and hex nuts conforming to ASTM A453. Threads and dimensions to be in accordance with ANSI B1.1 and B18.2.
9. Unions: Conform to ANSI B16.39, ASTM A47 and are fabricated from malleable iron with bronze-to-iron ground joints rated at 150 percent design operating pressure. Threads to conform to ANSI B2.1.
11. Thread Lubricant: Meet or exceed AGA No. 4-90 rating and compliant with Federal Specification TT-S-1732, manufactured compatible with fuel oil.

C. Steel Pipe (Below grade Installations):
1. Piping subject to tank pressure: ASTM A53, Electric-Resistance Welded (Type E) or Seamless (Type S), Grade B, Black, Schedule 80 pipe, manufactured for threaded or welded pipe connections.
2. Piping not subject to tank pressure: ASTM A53, Electric-Resistance Welded (Type E) or Seamless (Type S), Grade B, Black, Schedule 40 pipe, manufactured for threaded or welded pipe connections.

D. Fittings for Steel Pipe (Below grade Installations):
1. Threaded pipe fittings subject to tank pressure: ASTM B16.11, 2000 PSIG, threaded steel pipe fittings.
2. Welded pipe fittings subject to tank pressure: ASTM B16.11, 2000 PSIG, welded forged steel pipe fittings.
4. Welded pipe fittings not subject to tank pressure: ASTM A234, ANSI B16.9, B16.28. Butt welding type unless otherwise indicated to be socket welding type.

E. Corrosion Protection for Steel Pipe and Fittings Installed Below grade:
1. Steel piping furnished for below grade installation will be provided with 60-mil, high-density polyethylene jacket, sealed to pipe exterior with 20-mil coal tar based mastic. Pipe connections will be coated with tape primer and wrapped, half-lapped with 10-mil polyethylene tape

F. Polyethylene Pipe (Below grade Installations at 30 PSIG and Less Only):
1. General: Polyethylene pipe, tubing and fittings furnished under this Specification conforms to applicable provisions and requirements of latest revision of US Department of Transportation Pipeline Safety Regulations (CFR) Title 49, Part 192, "Transportation of Natural or Other Gases by Pipeline: Minimum Federal Safety Standards," and, by inclusion, appropriate standards referenced in those documents.
2. Materials:
   a. Polyethylene compounds utilized in manufacture of products furnished under this Specification have grade of PE24 or PE34, and minimum cell classification of PE213363 or PE334464, as defined in ASTM D3350. In conformance with ASTM D2513, they have PPI recommended hydrostatic design basis (HDB) of 1250 PSI (PE2406) or 1600 PSI (PE3408) at temperature of 73.4F (23C). In addition,
substantiate HDB by showing that extrapolation of stress regression curve is linear to 438,000 hour intercept in accordance with ASTM D2837.

b. When plastic material is used for transportation of liquefied petroleum gas (LPG), it must qualify for use through testing with LPG as test medium, and have hydrostatic design basis category of at least 1,000 PSI (6.9 MPa) at 73.4F (23C), as determined by ASTM D2837. Materials that qualify for natural gas service and that carry recommended HDB at 140F in accordance with ASTM D2513 also qualify for LPG service without need for further testing.

c. Clean rework material of same type and grade, generated from manufacturer's own pipe and fitting production, may be used by same manufacturer as long as pipe, tubing or fitting produced meet requirements of ASTM D2513.

3. Pipe and Tubing: Manufacture pipe and tubing furnished under this Specification using compounds complying with requirements of Section 2, above, and appropriate requirements of Part 192 of Minimum Federal Safety Standards. Dimensional characteristics (including outside diameter, wall thickness, toe-in, ovality and length) and performance characteristics (including chemical resistance, sustained pressure, elevated temperature service, burst pressure/apparent tensile strength, joining, squeeze-off and outdoor storage stability) conforms to requirements of ASTM 02513 including applicable annexes. Pipe and tubing may be supplied in either coils or straight lengths.

G. Polyethylene Pipe Fittings (Below grade Installations at 30 PSIG and Less Only):

1. Fittings: Manufacture polyethylene fittings furnished under this specification using compounds complying with requirements of Paragraph B, above, and appropriate requirements of Part 192 of Minimum Federal Safety Standards. Socket type fittings comply with ASTM 02683. Butt fusion fittings comply with ASTM 03261. Electrofusion fittings complies with ASTM F1055. Plastic mechanical fittings comply with ASTM F1924. Mechanical fittings produced from metallic or materials other than plastics listed in Paragraph B approved only after submission of appropriate test data and service histories indicating their acceptability for intended service. In addition, categorize mechanical fittings for pullout resistance as stated in ASTM 02513 and identified as to appropriate category. Plastic valves meet requirements of ANSI Standard B16.40. Specifications and requirements for fittings supplied complies with appropriate Sections of Part 192 of Minimum Federal Safety Standards or NFPA 58 LP Gas Code.
   a. ASTM D2683, socket-type polyethylene fittings
   b. ASTM D3261, butt-fusion polyethylene fittings
   c. ASTM F1055, electro-fusion polyethylene fittings
   d. ASTM F1924, mechanical push-on fittings for polyethylene pipe

2. Anodeless Epoxy Coated Steel Riser Assembly: Provide an anodeless riser assembly to terminate underground polyethylene piping either above grade or inside concrete vault.
   a. Provide riser casing for corrosion protection at each riser assembly. Casing will manufactured from ASTM A53, Schedule 40 steel pipe, ASTM A513 ER steel pipe (minimum 0.073-inch pipe wall), or flexible metallic tubing with minimum crush strength of 1000 PSIG and tensile strength of 300 PSIG including transition connection as tested by manufacturer.
      1) Horizontal portion of riser assembly will be installed with minimum 12-inches of compacted cover.
      2) Factory-assembled riser assemblies will be sealed and leak tested by manufacturer.
      3) Field-assembled riser assemblies will be accepted when supplied in kit form with necessary hardware for riser installation. Field-assembled riser assemblies will be provided compliant with following requirements:
         (a) They are design certified.
         (b) They are sealed and pressure tested by installed.
         (c) They are assembled and installed in accordance with manufacturer's instructions.
   b. Manufacturer: ERS Inc., or approved equivalent.
3. Flexible Connectors: Flexible connectors used in LP and LPG piping systems will be provided compliant with following:
   a. They will be installed in accordance with manufacturer’s instructions.
   b. Flexible connectors and hose used as flexible connectors will not exceed 3-feet in length where used with liquid or vapor piping on portable or stationary tanks.
   c. Hose will be permitted to be used if flexibility is required for liquid or vapor transfer.

4. Marking:
   a. Mark pipe and tubing in accordance with ASTM 02513. Marking: legible and remain legible under normal handling and installation practices. Indent marking may be utilized provided (1) marking does not reduce wall thickness to less than minimum value for pipe or tubing, (2) it has been demonstrated that these marks have no effect on long-term strength of pipe or tubing, and (3) marking will not provide leakage channels when approved elastomeric gasket compression fittings are used to make joints.
   b. Mark fusion fittings on body or hub. Marking in accordance with ASTM 02513 or standard to which fitting is manufactured. Mark mechanical fittings in accordance with fitting standard to which it is manufactured or Part 192 of Minimum Federal Safety Standard Section 192.63.

5. Fusion Qualification: Manufacturer of pipe, tubing, or fittings supplied under this Specification establishes and certifies heat fusion procedures for joining of materials supplied in accordance with applicable Section of (CFR) Title 49, Part 192 “Transportation of Natural or Other Gases by Pipeline: Minimum Federal Safety Standards,” paragraph 192.283. Provide qualified fusion procedures, with appropriate supporting data, to purchaser upon request. Suitable generic fusion procedures are included in PPI TR-33, Generic Butt Fusion Joining Procedure for Polyethylene (PE) Gas Pipe.

2.03 VALVES FOR METALLIC PIPING
   A. General: Isolation valves provided for LP or LPG service will be UL listed for 250 PSIG LPG service per UL842. Valves will also be compliant with NFPA 58 minimum requirements.
   B. Ball Valves: MSS SP110, three cast bronze construction with corrosion resistant alloy steel bolts, Type 316L stainless steel full-port ball with PTFE seals. UL listed for LPG service at 250 PSIG maximum pressure. Nibco, T-595YSDT-UL, T-590YSDT-UL, or acceptable product meeting minimum requirements.
   C. Globe Valves, Angle or Straight Pattern: MSS SP85, heavy-duty ductile iron, threaded globe valves manufactured for LPG applications. Valve is furnished with spring-loaded PTFE chevron packing and PTFE disc seat. Disc is ball bearing mounted to minimize wear. Valve is provided with 1/4-inch FNPT port for hydrostatic relief valve or venting valve installation. UL listed for LPG service at 250 PSIG maximum pressure. Fisher, N301T, N310T, N401T, and N410T.

2.04 ABOVEGROUND LIQUID PROPANE STORAGE TANKS (AST)
   A. Construct storage tank in accordance with ASME Code for Unfired Pressure Vessels for design pressure of 250 PSIG at 65F. Storage Tank with 1000-gallon storage capacity.
   B. Provide tank with gauges, fittings, valves and accessories as required by ASME Code for Unfired Pressure Vessels and NFPA 58 and 59 or by system components being supplied.
   C. Provide the following, but not limited to, minimum fittings required for propane tank:
      1. Three 2-inch relief valve with breakaway stand-pipe adapter for tank pressure relief.
      2. Three 3-inch relief pipe with counter-balanced rain caps.
      3. One Magnatel or equal level gauge.
      4. One 3/4-inch Combination 85 percent liquid level valve and gauge.
      5. One 1/2-inch Thermometer for liquid temperature.
      6. One excess flow valve for liquid fill or withdrawal.
      7. Two excess flow valves for liquid withdrawal and vapor openings.
      8. Two 2-inch Globe shutoff valves for liquid fill and withdrawal.
D. Tank will be delivered fully painted. Touch up finish coat, using an industry standard tank paint. White color. Paint per Division 09, Finishes requirements.
E. Use multi-port Relief Valves as relief system on storage tanks. Approved valves are manufactured by either Rego or Fisher.
F. Use pneumatically operated emergency shutoff valves with built-in thermal fuse protection on three bottom openings of propane storage tank. These valves can be closed locally or remotely within seconds using an emergency stop valve, nitrogen supply, will activate these valves.
G. Seismic Bracing: Storage tank to be constructed, supported, anchored and installed to comply with requirements of AHJ. Straps, anchors, mounting devices, and to be shown on equipment submittal. Provide seismic calculations and seismic bracing installation shop drawings signed by registered structural engineer for compliance to seismic requirements.

2.05 HIGH-PRESSURE REGULATOR FOR DISTRIBUTION PIPING SYSTEM
A. Provide approved pressure regulators for distribution piping regulation to 25 PSIG at indicated flow rates and capacities with maximum inlet pressure of 250 PSIG.
B. Diaphragm and spring actuated type, with vented internal relief feature. Ductile iron construction, pressure range and venting features suitable for intended service. Regulator will be furnished with "slam-shut" option that will terminate service in distribution if regulator fails to maintain service pressure below 28 PSIG. Regulator to meet code and serving utility requirements. Pipe vented type to atmosphere in approved location. Francel, Model 627-VSX2.

2.06 PRIMARY REGULATOR FOR DISTRIBUTION PIPING SYSTEM
A. Provide approved pressure regulators for distribution piping regulation to 10 PSIG at indicated flow rates and capacities with maximum inlet pressure of 30 PSIG.
B. Diaphragm and spring actuated type, with vented internal relief feature. Ductile iron construction, pressure range and venting features suitable for intended service. Regulator will be furnished with "slam-shut" option that will terminate service in distribution if regulator fails to maintain service pressure below 12 PSIG. Regulator to meet code and serving utility requirements. Pipe vented type to atmosphere in approved location. Francel, Model 627-VSX2.

2.07 SECONDARY REGULATOR FOR BUILDING PIPING SYSTEM
A. Provide approved pressure regulators for building regulation of 11-inch WC at indicated flow rates and capacities.
B. Diaphragm and spring actuated type, with vented relief feature. Construction, pressure range and venting features suitable for intended service. Integral compensation for altitude and temperature. Regulator to meet code and serving utility requirements. Pipe vented type to atmosphere in approved location. Manufacturer: Actaris or Equimeter.

PART 3 - EXECUTION
3.01 GENERAL INSTALLATION REQUIREMENTS
A. Piping and Equipment Removal:
   1. Remove as indicated on drawings. Remove and dispose of excess piping and equipment (not identified by Contracting Officer as salvage) in safe manner.
B. Accessibility:
   1. Installation of valves, gauges and equipment conveniently and accessibly located with reference to finished building for repairs, removal and service.
C. Painting:
   1. Prime tanks where factory primer is rubbed bare. Prime paint is to be of first quality suitable for steel and for outside use. Clean metal of scale and rust and dry prior to painting.
   2. Finish Coat: Top quality white enamel to reflect heat and applied over dry undercoat and suitable for outdoor use.
   3. Painting to comply with Division 09, Finishes requirements.
4. Reference Section “Painting” for painting requirements.
5. Paint piping exposed to weather with two coats of Rustoleum.

D. Field Quality Control:
1. Upon completion of installation of equipment, test equipment to demonstrate capability and compliance with requirements. When possible, correct malfunctioning units at site, then retest to demonstrate compliance; otherwise, remove and replace with new equipment and proceed with retesting.

E. Piping System Identification:
1. Install pipe markers on each system and include arrows to show normal direction of flow.
2. Locate pipe markers and color bands wherever piping is exposed to view in exterior locations as follows:
   a. Near each valve and control device.
   b. Near each branch, excluding short take-offs for future connection.
   c. Near locations where pipes pass through vaults or enter manway enclosures.
   d. At manholes and similar access points which permit view of concealed piping.
   e. Near major equipment items and other points of origination and termination.

F. Connections to Existing:
1. Prior to connection of piping to existing as indicated on Mechanical Drawings, field verify existing conditions and exact sizes and locations of existing piping. Provide additional offsets, transitions, and joints and replace portions of existing as required to facilitate connections of new as shown on Documents.

G. Propane Storage Tank Testing:
1. Test piping and tank per UFC, NFPA and local AHJ requirements and in presence of fire marshal. Notify Contracting Officer 72 hours prior to testing.

H. Propane Storage Tank Piping and Removal:
1. Remove as much of LP liquid as possible from piping and tank. Remove as much of remaining gas vapors in piping and tank. LPG vapors will be recovered, burned, or vented to atmosphere.
2. Reference decommissioning procedures detailed in FM Global Data Sheet 7-55 (LPG), paragraph 2.3.3. Also, reference FM Global Data Sheet 7-59 (Inerting and Purging) for additional procedures using inert gases to purge LPG tank and piping.

3.02 PIPE AND PIPE FITTINGS GENERAL

A. Pipe Sleeves:
1. Lay out work in advance of pouring concrete and furnish and set sleeves necessary to complete work.
2. Below grade Sleeves: Provide Schedule 40 galvanized steel sleeves with anchor/weep flange on pipes passing through concrete or masonry construction. Extend sleeve 1-inch above finished floor or behind wall. Provide "Link-Seal" Type S sleeve sealing system slab on grade. Provide "Link-Seal" Type FS passing through 1-hour fire-rated building assembly with UL rated assemblies. Provide fire-rated assemblies per local AHJ requirements.
3. PE Riser Casing: Provide riser casing to protect anodeless riser assemblies for polyethylene piping systems for corrosion. Polyethylene piping that is installed in vault or any other below grade enclosure will be provided with riser casing to protect piping. Provide "Link-Seal" Type S or similar product to seal annular space gastight.

B. Conform to applicable codes and industry standards.

C. Install uninsulated piping so that unrestrained direct contact with structure or other system installations is avoided. Where contact with or passage through sleeve or structural features cannot be avoided; firmly anchor piping to, or isolated from, structure to prevent noise transmission and occurrence of physical damage.
D. Expansion and Flexibility: Install work with due regard for expansion and contraction to prevent damage to piping or equipment. Provide piping offsets, approved type expansion joints, anchors, or other means to control pipe movement and to minimize pipe forces.

E. See 3.01 General Installation Requirements above.

F. Install per manufacturers written installation instructions and requirements.

3.03 VALVES FOR METALLIC PIPING

A. Installation of Metallic Piping:
   1. Drips and Sediment Traps: Install drips at points where condensate may collect. Include outlets of service meters. Locate where readily accessible for cleaning and emptying. Do not install where condensate would be subject to freezing. Install only in heated space.
      a. Construct drips and sediment traps using tee fitting with bottom outlet plugged or capped. Use minimum-length nipple of 3 pipe diameters, but not less than 3-inches long, and same size as connected pipe. Install with space between bottom of drip and floor for removal of plug or cap.
   2. Install LP fuel gas piping at uniform grade of 0.1 percent slope upward toward risers.
   3. Use concentric reducer fittings to make reductions in pipe sizes.
   4. Connect branch piping from top or side of horizontal piping.
   5. Install unions in pipes 2-inches and smaller, adjacent to each valve, at final connection to each piece of equipment, and elsewhere as indicated. Unions are not required on flanged devices.
   6. Install strainer on inlet of each line pressure regulator and automatic and electrically operated valve.
   7. Install flanges on valves, specialties, and equipment having 2-1/2-inches and larger connections.
   8. Pressure Piping Routing:
      a. Route piping, except as otherwise indicated, vertically and horizontally (sloped to drain). Orient horizontal routes parallel with roadway or adjacent wall/fence.
      b. Install piping as shown or described by diagrams, details and notations on Drawings or, if not indicated, install piping to provide shortest route which does not obstruct usable space or block access for servicing LP storage tank and its equipment.
   9. Preparation:
      a. Unions:
         1) Insulating (Dielectric) Unions: Comply with manufacturer's instructions for installing unions wherever piping of dissimilar metals are adjoined. Install unions in manner which will prevent galvanic action and inhibit corrosion.
         2) Standard Unions: Install where indicated on Drawings and on each side of pieces of equipment to permit easy removal of equipment.

B. Valve Installation:
   1. Install valves where required for proper operation of piping and equipment, including valves in branch lines where necessary to isolate Sections of piping. Locate valves so as to be accessible and so that separate support can be provided when necessary.
   2. Install valves with stems pointed up, in vertical position where possible, but in no case with stems pointed downward from horizontal plane unless unavoidable. Install valve drains with hose-end adapter for each valve that must be installed with stem below horizontal plane.
   3. Valves provided in HDPE piping will be installed in manner that will protect valve from excessive torsional or shearing loads when valve is operated.
   4. Valve boxes provided for HDPE piping will be installed so external loads are not transmitted to valve or piping.

C. Valve Adjusting and Cleaning:
   1. Inspect valves for leaks. Adjust or replace packing to stop leaks. Replace valve if leak persists.

D. Valve Identification:
   1. General: Provide valve tag on every valve, relief valve, regulator, and control device in each piping system. Exclude check valves, valves within factory fabricated equipment units. List each tagged valve in valve schedule for each piping system.

E. See 3.01 General Installation Requirements above.

F. Install per manufacturers written installation instructions and requirements.

3.04 ABOVEGROUND LIQUID PROPANE STORAGE TANKS (AST)

A. Upon completion of installation, fill new storage tank to capacity with liquid propane. Provide initial test for leaks. After equipment testing and commissioning has been completed, refill tank to capacity.

B. Provide signage per UFC, NFPA and local AHJ requirements.

C. Provide at a minimum 6-inch thick concrete pad sized 2-feet larger on each side and ends of tank. Anchor tank per project structural engineers requirements. For example, 1/2-inch stainless steel stud anchor with minimum 4-inch embedment. Coordinate and provide exact size/thickness of concrete pad with tank manufacturer.

D. See 3.01 General Installation Requirements above.

E. Install per manufacturers written installation instructions and requirements.

3.05 HIGH-PRESSURE REGULATOR FOR DISTRIBUTION PIPING SYSTEM

A. Provide high-pressure regulator, primary regulator and flexible connection at tank.

B. Install accessories in locations as required, but not limited to items shown on drawings.

C. See 3.01 General Installation Requirements above.

D. Install per manufacturers written installation instructions and requirements.

3.06 PRIMARY REGULATOR FOR DISTRIBUTION PIPING SYSTEM

A. Provide secondary, primary regulator and isolation valve on building exterior adjacent to structure.

B. Install accessories in locations as required, but not limited to items shown on drawings.

C. See 3.01 General Installation Requirements above.

D. Install per manufacturers written installation instructions and requirements.

3.07 SECONDARY REGULATOR FOR BUILDING PIPING SYSTEM

A. See 3.01 General Installation Requirements above.

B. Install per manufacturers written installation instructions and requirements.

END OF SECTION
PART 1 - GENERAL

1.01 SUMMARY
   A. Work Included:
      1. Ductwork, Joints and Fittings
      2. Insulated Flexible Duct
      3. Drain Pans
      4. Ductwork Joint Sealers and Sealants

1.02 RELATED SECTIONS
   A. Contents of Division 23, HVAC and Division 01, General Requirements apply to this Section.
   B. In addition, reference the following:
      1. Section 23 05 29, Hangers and Supports for HVAC Piping, Ductwork and Equipment.
      2. Section 23 05 93, Testing, Adjusting, and Balancing for HVAC.

1.03 REFERENCES AND STANDARDS
   A. References and Standards as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

1.04 SUBMITTALS
   A. Submittals as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.
   B. In addition, provide:
      1. Welding Certificates
      2. Field Quality Control Reports

1.05 QUALITY ASSURANCE
   A. Quality assurance as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.
   B. In addition, meet the following:
      1. NFPA Compliance:
         a. NFPA 90A Installation of Air Conditioning and Ventilating Systems.
         b. NFPA 90B, Installation of Warm Air Heating and Air Conditioning Systems.
      2. Comply with NFPA 96, Ventilation Control and Fire Protection of Commercial Cooking Operations, Ch. 3, Duct System for range hood ducts, unless otherwise indicated.
      3. Comply with SMACNA's HVAC Duct Construction Standards - Metal and Flexible for acceptable materials, material thicknesses, and duct construction methods, unless otherwise indicated. Provide sheet metal materials free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.
      4. If required, provide ductwork pressure testing per Section 23 05 93, Testing, Adjusting and Balancing for HVAC.

1.06 WARRANTY
   A. Warranty of materials and workmanship as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

1.07 SYSTEM DESCRIPTION
   A. Duct system design, as indicated, has been used to select size and type of air-moving and distribution equipment and other air system components. Duct design is generally diagrammatic and is not meant to be scaled. Major changes to layout or configuration of duct system must be specifically approved in writing by Architect. Accompany requests for layout modifications with calculations showing that proposed layout will provide original design results without increasing system total pressure.
PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Ductwork, Joints, and Fittings:
   1. Ductmate
   2. Lindab Inc
   3. Nexus Inc
   4. SEMCO
   5. United McGill Corporation
   6. Ward Industries
   7. Or approved equivalent

B. Insulated Flexible Duct:
   1. ATCO
   2. Flexmaster
   3. J.P. Lamborn Co.
   4. Hart and Cooley
   5. Or approved equivalent

C. Ductwork Joint Sealers and Sealants
   1. Ductmate
   2. Durodyne
   3. Hardcast
   4. United McGill Corporation
   5. Vulkem
   6. Foster
   7. Childer
   8. Or approved equivalent

2.02 DUCTWORK, JOINTS AND FITTINGS

A. Materials:

B. Fabricate ducts, elbows, transitions, offsets, branch connections, and other construction according to SMACNA's HVAC Duct Construction Standards - Metal and Flexible and complying with requirements for metal thickness, reinforcing types and intervals, tie-rod applications, and joint types and intervals.
   1. Lengths: Fabricate rectangular ducts in lengths appropriate to reinforcement and rigidity class required for pressure class.
   2. Deflection: Duct systems not-to-exceed deflection limits according to SMACNA's HVAC Duct Construction Standards - Metal and Flexible.
   3. Transverse Joints: Prefabricated slide-on joints and components constructed using manufacturer's guidelines for material thickness, reinforcement size and spacing, and joint reinforcement.

C. Formed-On Flanges: construct according to SMACNA's HVAC Duct Construction Standards - Metal and Flexible, Figure 1-4, using corner, bolt, cleat, and gasket details.
   1. Duct Size: Maximum 30-inches wide and up to 2-inch wg pressure class.
   2. Longitudinal Seams: Pittsburgh lock sealed with noncuring polymer sealant.
   3. Cross Breaking or Cross Beading: Cross break or cross bead duct sides 19-inches and larger and 0.0359-inch thick or less, with more than 10 SF of nonbraced panel area unless ducts are lined.

D. Round, Spiral Lock-Seam Ducts: Fabricate supply ducts of material specified in this Section according to SMACNA's HVAC Duct Construction Standards - Metal and Flexible.
1. Ducts up to 20-inches in Diameter: Interior, center-beaded slip coupling, sealed before and after fastening, attached with sheet metal screws.
2. Ducts 21- to 72-inches in Diameter: Three-piece, gasketed, flanged joint consisting of two internal flanges with sealant and one external closure band with gasket.
3. Ducts Larger than 72-inches in Diameter: Companion angle flanged joints per SMACNA HVAC Duct Construction Standards-Metal and Flexible, Figure 3-2.
4. Round Ducts: Prefabricated connection system consisting of double-lipped, EPDM rubber gasket. Manufacture ducts according to connection system manufacturer's tolerances.

E. 90-Degree Tees and laterals and Conical Tees: Fabricate to comply with SMACNA's HVAC Duct Construction Standards-Metal and Flexible, with metal thicknesses specified for longitudinal-seam straight ducts.

F. Diverging-Flow Fittings: Fabricate with reduced entrance to branch taps and with no excess material projecting from fitting onto branch tap entrance.

G. Fabricate elbows using die-formed, gored, pleated, or mitered construction. Bend radius of die-formed, gored, and pleated elbows to be 1.5 times duct diameter. Unless elbow construction type is indicated, fabricate elbows as follows:
   1. Mitered-Elbow Radius and Number of Pieces: Welded construction complying with SMACNA's HVAC Duct Construction Standards-Metal and flexible, unless otherwise indicated.
   2. Round Mitered Elbows: Welded construction with the following metal thickness for pressure classes from minus 2- to plus 2-inch wg (minus 500 to plus 500 Pa):
      a. Ducts 3- to 36-inches in Diameter: 0.034-inch.
      b. Ducts 37- to 50-inches in Diameter: 0.040-inch.
      c. Ducts 52- to 60-inches in Diameter: 0.052-inch.
      d. Ducts 62- to 84-inches in Diameter: 0.064-inch.
   3. Round Mitered Elbows: Welded construction with the following metal thickness for pressure classes from 2- to 10-inch wg:
      a. Ducts 3- to 26-inches in Diameter: 0.034-inch.
      b. Ducts 27- to 50-inches in Diameter: 0.040-inch.
      c. Ducts 52- to 60-inches in Diameter: 0.052-inch.
      d. Ducts 62- to 84-inches in Diameter: 0.064-inch.
   4. 90-Degree, Two-Piece, Mitered Elbows: Use only for supply systems or for material-handling Class A or B exhaust systems and only where space restrictions do not permit using radius elbows. Fabricate with single-thickness turning vanes.
   5. Round Elbows
      a. 8-inches and Less in Diameter: Fabricate die-formed elbows for 45 and 90-degree elbows and pleated elbows for 30, 45, 60 and 90 degrees only. Fabricate nonstandard bend-angle configurations or non-standard diameter elbows with gored construction.
      b. 9 through 14-inches in Diameter: Fabricate gored or pleated elbows for 30, 45, 60 and 90 degrees unless space restrictions require mitered elbows. Fabricate nonstandard bend-angle configurations or nonstandard diameter elbows with gored construction.
      c. Larger than 14-inches in Diameter and All Flat-Oval Elbows: Fabricate gored elbows unless space restrictions require mitered elbows.
   6. Die-Formed Elbows for Sizes through 8-inches in Diameter and Pressures 0.040-inch thick with two-piece welded construction.
   7. Round Gored-Elbow Metal Thickness: Same as non-elbow fittings specified above.
   8. Pleated Elbows for Sizes through 14-inches in Diameter and Pressures through 10-inch wg (2500 Pa): 0.022-inch.
   9. Not acceptable:
      a. Corrugated or flexible metal duct.
      b. Adjustable elbows.
2.03 INSULATED FLEXIBLE DUCT
A. Construction: Standard factory fabricated product. Inner wall: Impervious vinyl or chlorinated polyethylene, permanently bonded to a vinyl or zinc-coated spring steel helix.
B. Insulation: Fiberglass blanket insulation covered by an outer wall of vinyl or fiberglass-reinforced metalized vapor barrier.
C. Listing: UL 181 listed Class 1 flexible air duct material. Overall thermal transmission: No more than 0.25 BTU/in or hr/sq. degrees F at 75 degrees F differential, per ASTM C335.
D. Vapor transmission value no more than 0.10 perm, per ASTM E96
E. Pressure Rating: 4-inch wg positive pressure and 1-inch wg negative pressure.
F. Performance Air Friction Correction Factor: 1.3 maximum at 95 percent extension. Working air velocity: Minimum 2000 FPM.
G. Flame Spread Rating: No more than 25.
H. Smoke Development Rating: No more than 50 as tested per ASTM E84.
I. Insertion Loss: Minimum attenuation of 29 DB for 10-foot straight length at 8-inch diameter at 500 Hz.

2.04 DRAIN PANS
A. Primary Drain Pans: Stainless Steel, Fabricated in accordance with ASTM A167 and A480.

2.05 DUCTWORK JOINT SEALERS AND SEALANTS
A. Joint Sealers and Sealants: Non-hardening, water resistant, mildew and mold resistant.
B. Low Emitting Materials Requirement: Adhesives, sealants and sealant primers must comply with South Coast Air Quality Management District (SCAQMD) Rule #1168.
C. Type: Heavy mastic or liquid used alone or with tape, suitable for joint configuration and compatible with substrates, and recommended by manufacturer for pressure and leakage class of ducts.
D. Surface Burning Characteristics: Flame spread of zero, smoke developed of zero, when tested in accordance with ASTM E 84.
E. Water Based Sealant for Brush-On Application: Flexible, adhesive sealant, resistant to UV light, UL-181A, and UL-181-B listed, complying with NFPA requirements for Class 1 ducts. Min. 69 percent solids, nonflammable. Hardcast Versa-Grip 181; Childers CP-146; Foster 32-19 for SMACNA 1/2, 1, 2, 3, 4, 6, and 10-inch WG duct classes, and SMACNA Seal Class A, B, or C.
F. Flanged Joint Mastic: One-part, acid-curing, silicone, elastomeric joint sealant complying with ASTM C920, Type S, Grade NS, Class 25, Use O.
G. Flange Gaskets: Butyl rubber or EPDM polymer with polyisobutylene plasticizer.
H. Polyurethane Sealant: General-purpose, exterior use, non-brittle sealant for gunned application. Vulkem 616 or equal.

PART 3 - EXECUTION
3.01 GENERAL INSTALLATION REQUIREMENTS
A. General: Use the following pressure class(es) in design of ductwork specified in this section unless otherwise noted on Drawings.

<table>
<thead>
<tr>
<th>SYSTEM</th>
<th>PRESSURE IP (inches of water)</th>
<th>LEAKAGE CLASS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Medium pressure supply (fan to</td>
<td>0.5-inch higher than air handlers discharge pressure (min 4-inch</td>
<td>A</td>
</tr>
<tr>
<td>terminal unit)</td>
<td>pressure class).</td>
<td></td>
</tr>
</tbody>
</table>

SISTERS SCHOOL DISTRICT - PHASE III A
SECTION 23 3100
HVAC DUCTS AND CASINGS

<table>
<thead>
<tr>
<th>Low pressure supply (downstream of terminal unit)</th>
<th>+ 1-inch</th>
</tr>
</thead>
<tbody>
<tr>
<td>Return main (&gt;24-inch)</td>
<td>0.5-inch more negative than return/exhaust fan pressure or -2-inch pressure class, whichever is more negative.</td>
</tr>
<tr>
<td>Return branch (&lt;24-inch)</td>
<td>0.5-inch more negative than return/exhaust fan pressure or -2-inch pressure class, whichever is more negative.</td>
</tr>
<tr>
<td>General exhaust</td>
<td>0.5-inch more negative than return/exhaust fan pressure or -2-inch pressure class, whichever is more negative.</td>
</tr>
<tr>
<td>Kitchen grease exhaust</td>
<td>-6-inch</td>
</tr>
<tr>
<td>Lab medium pressure exhaust (lab valve/terminal unit to fan)</td>
<td>-6-inch</td>
</tr>
<tr>
<td>Lab low pressure exhaust (upstream of lab valve/terminal unit)</td>
<td>-1-inch</td>
</tr>
<tr>
<td>Hazardous exhaust</td>
<td>-6-inch</td>
</tr>
</tbody>
</table>

B. Ductwork Installation:
1. General: Install entire duct system in accordance with drawings, Specifications, and latest issues of local Mechanical Code, NFPA 90A, and SMACNA Duct Construction Manual. At Contractor's option, rectangular ductwork may be resized to maintain an equivalent air velocity and friction rate, while maintaining a maximum aspect ratio of 3. Remove markings and tagging from ductwork exterior surface in mechanical rooms and other locations where ductwork is exposed.
2. The duct layout shown on the Contract Drawings is diagrammatic in nature. Coordinate the ductwork routing and layout, and make alterations to the ductwork routing and layout to eliminate physical interferences. Where deviations in the ductwork routing as shown in the Contract Drawings are required, alterations may be made so as not to compromise the air flow, pressure drop, and sound characteristics of the duct fitting or duct run as shown on the Contract Drawings. In the event Architect determines that the installed ductwork is inconsistent with the above mentioned criteria, remove and replace at no additional cost to the Owner.
3. Install ducts with fewest possible joints.
4. Install fabricated fittings for changes in directions, size, shape, and for connections.
5. Install couplings tight to duct wall surface with a minimum of projections into duct. Secure couplings with sheet metal screws. Install screws at intervals of 12-inches, with a minimum of 3 screws in each coupling.
6. Install ducts, unless otherwise indicated, vertically and horizontally and parallel and perpendicular to building lines; avoid diagonal runs.
7. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.
9. Conceal ducts from view in finished spaces. Do not encase horizontal runs in solid partitions unless specifically indicated.
10. Coordinate layout with suspended ceiling, air duct accessories, lighting layouts, and similar finish work.
11. Electrical and IT Equipment Spaces: route ducts to avoid passing through transformer vaults, electrical equipment spaces, IDF/MPOE rooms, and enclosures.
12. Non-Fire-Rated Partition Penetrations: Where ducts pass through interior partitions and exterior walls and are exposed to view, conceal spaces between construction openings and ducts or duct insulation with sheet metal flanges of same metal thickness as ducts. Overlap openings on 4 sides by at least 1-1/2-inches.

13. Fire- and Smoke-Rated Partition Penetrations: Where ducts pass through interior partitions and exterior walls, install appropriately rated fire, smoke or combination fire and smoke dampers as governed by Building Code and AHJ, including sleeves, and firestopping sealant.


15. Protect duct interiors from the elements and foreign materials until building is enclosed. Follow SMACNA's Duct Cleanliness for New Construction Advanced Level.

16. Paint interiors of metal ducts, that do not have duct liner, for 24-inches upstream of registers and grilles. Apply one coat of flat, black, latex finish coat over a compatible duct material.

17. Install ductwork in the location and manner shown and detailed. Review deviations required by job conditions with Architect prior to any fabrication. Provide fittings for construction per SMACNA.

C. Flanged Take-Offs:
1. Install at branch takeoffs to outlets using round or flex duct.
2. Flanged take-offs secured with minimum 8-inch screw spacing (three screws minimum).
3. Provide ductwork taps and branches off of main ducts at 45 degrees whether shown on Drawings or not (drawings are diagrammatic).

D. Cleaning:
1. 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.
2. Grille and Exposed Duct Cleaning:
   a. After completion of ductwork installation, operate each fan system (excluding exhaust fans) for a minimum of 30 minutes prior to installation of ceiling grilles and diffusers. After grilles and diffusers are installed, clean out accumulation of particles from grilles and diffusers prior to acceptance.
   b. Clean exterior surface of ducts exposed to public view of chalk, pencil and pen marks, labels, sizing tags, dirt, dust, etc., so that upon completion of installation, ducts are left in clean and unblemished manufactured conditions.
   c. Exposed duct and grilles to remain free of dust entrained streaks due to leakage at joints and grille connections during warranty period. Clean leaks, seal and refinish to match existing if visible streaks develop.

3.02 DUCTWORK, JOINTS AND FITTINGS INSTALLATION

A. Duct Materials - Applied Locations:
1. General: Use the following materials in design of ductwork specified in this Section unless otherwise noted on the Drawings.

<table>
<thead>
<tr>
<th>Location or Application</th>
<th>Material</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply, Return, Transfer, and Exhaust - Low Pressure (downstream of terminal units)</td>
<td>Single Wall, Galvanized Steel</td>
</tr>
<tr>
<td>Supply, Return, and Exhaust - Medium Pressure (upstream of terminal units)</td>
<td>Single Wall, Galvanized Steel</td>
</tr>
<tr>
<td>General Exhaust Branch Serving Air Inlet in Shower Room or Toilet Room with Shower</td>
<td>Single Wall, Aluminum or Type 304 Stainless Steel</td>
</tr>
</tbody>
</table>
B. Ductwork Installation:
1. Fabricate radius elbows with centerline radius not less than 1-1/2 duct diameters.
2. Do not install duct size transition pitch angles which exceed 30 degrees for reductions in duct size in the direction of airflow, and 15 degrees for expansions in duct size in the direction of airflow.
3. Install fixed turning vanes in square throat rectangular elbows and in tees.
4. Fabricate duct turns with the inside (smallest) radius at least equal to the duct width (supply ducts) and 1.5 times radius (return and exhaust ducts). Where necessary, square elbows may be used, with maximum available inside radius and with fixed turning vanes. In healthcare settings such as hospitals and medical office buildings, square elbows and turning vanes allowed on supply ductwork only.

3.03 INSULATED FLEXIBLE DUCT INSTALLATION
A. Provide sheet metal plenum or rigid elbow and connect to diffusers and grilles with ductwork connections. Refer to Drawings for more information. Provide straight section of flexible duct with minimum length of 2-feet and maximum length of 5-feet and connect to sheet metal plenums and rigid elbows connected to diffusers and grilles, unless noted otherwise.
1. Provide round neck grilles/diffusers or square-to-round transitions. Flexible duct connections directly to diffuser and grilles is not allowed.
2. Flexible duct allowed in concealed spaces above lay-in ceilings only.

3.04 DRAIN PANS INSTALLATION
A. Install where shown on Drawings. Drain provided by Division 22, Plumbing. Provide drain (sized per code) connection from each drain pan and pipe to nearest floor drain through trap and 10-inch air gap. Drain pans over 6-feet in length require drain connections from both ends. Pitch drain pans in direction of air flow and to drain. Support secondary drain pan independently from equipment.

3.05 DUCTWORK JOINT SEALERS AND SEALANTS INSTALLATION
A. Joints and Seam Joint Sealing:
1. Seal duct seams and joints according to SMACNA’s HVAC Duct Construction Standards - Metal and Flexible for duct pressure class indicated.
2. For 1/2- and 1-inch wg pressure classes, seal transverse joints.
3. For 2- and 3-inch wg pressure classes, seal transverse joints and longitudinal seams.
4. For pressure classes more than 3-inch wg, seal transverse joints, longitudinal seams and duct wall penetrations including screw, fastener, pipe, rod, and wire.
5. Fasteners such as sheet-metal screws, machine screws or rivets to be cadmium plated.
6. Rectangular Ductwork: Where intermediate joint reinforcement is required for duct of negative pressure class, pre-drill stiffening flange and provide fastener maximum 8-inches on center. Where retaining flanges are welded to duct wall, paint welds with zinc coating.
7. Single Wall Round Ductwork: Joint to incorporate beaded slip collar with minimum #8 sheet metal screws 8-inches on center. Seal ductwork as specified in this Section.
8. Seal joints and seams. Apply sealant to make end connectors before insertion, and afterward to cover entire joint and sheet metal screws.
9. Double Wall Round Ductwork: Joint to incorporate beaded slip collar or flanged connection, with minimum #8 sheet metal screws 8-inches on center. Seal ductwork as specified in this Section.
10. Duct sizes indicated are inside clear dimensions. For lined ducts, maintain sizes inside lining.
11. Provide openings in ductwork where required to accommodate thermometers and control devices. Provide pitot 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.

12. Locate ducts with sufficient space around equipment to allow normal operating and maintenance activities as well as Code required clearances.

END OF SECTION
SECTION 23 3300 - AIR DUCT ACCESSORIES

PART 1 - GENERAL

1.01 SUMMARY
A. Work Included:
   1. Sheet Metal Materials
   2. Backdraft Dampers
   3. Dampers
   4. Concealed Damper Hardware
   5. Access Doors
   6. Duct Test Holes
   7. Turning Vanes
   8. Flexible Connectors
   9. Flexible Exhaust Extractor Arms

1.02 RELATED SECTIONS
A. Contents of Division 23, HVAC and Division 01, General Requirements apply to this Section.

1.03 REFERENCES AND STANDARDS
A. References and Standards as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

1.04 SUBMITTALS
A. Submittals as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.
B. In addition, provide:
   1. Manufacturer's catalog data and fabrication/installation drawings for each factory fabricated duct accessory. Include leakage, pressure drop and maximum back pressure data.
   2. Shop Drawings: Indicate air duct accessories.
   3. Manufacturer's installation instructions: Provide instructions for each factory fabricated duct accessory.
   4. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
      a. See Division 01, General Requirements, Product Requirements for additional provisions.
      b. Extra Fusible Links: One of each type and size.

1.05 QUALITY ASSURANCE
A. Quality assurance as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.
B. In addition, meet the following:
   1. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this Section, with minimum five years of documented experience.
   2. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.
   3. AMCA 500 - Test Methods for Louvers, Dampers and Shutters.
   4. AMCA 511 - Certified Ratings Program for Air Control Devices.
   7. NFPA 92B - Smoke Control Systems in Atria, Covered Malls and Large Areas.

1.06 WARRANTY
A. Warranty of materials and workmanship as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.
PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Backdraft Dampers:
   1. Air Balance
   2. Cesco
   3. Greenheck
   4. Nailor
   5. Ruskin
   6. Or approved equivalent.

B. Dampers:
   1. Air Balance
   2. Cesco
   3. Greenheck
   4. Nailor
   5. Ruskin
   6. Or approved equivalent.

C. Concealed Damper Hardware, Cable System:
   1. Young Regulator Company
   2. Or approved equivalent.

D. Access Doors:
   1. Ductmate
   2. Cesco
   3. Ruskin
   4. Nailor
   5. Outdoor Installation: Karp MX insulated exterior access door.
   6. Or approved equivalent.

E. Duct Test Holes:
   1. Ventlok
   2. Or approved equivalent.

F. Turning Vanes:
   1. Aerodyne
   2. Ductmate Industries
   3. Duro Dyne Corp
   4. Metalaire Inc.
   5. Ward Industries
   6. Or approved equivalent.

G. Flexible Connectors:
   1. Duro Dyne Corp.
   2. Ventfabrics Inc.
   3. Ward Industries
   4. Or approved equivalent.

H. Flexible Exhaust Extractor Arms:
   1. Nederman
   2. Plymovent
   3. Or approved equivalent.

2.02 SHEET METAL MATERIALS

A. Comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods, unless otherwise indicated.
B. Galvanized Sheet Steel: Lock-forming quality; complying with ASTM A 653/A 653M. Galvanizing: 1-1/4 ounces per square foot total both sides; ducts to have mill-phosphatized finish for surfaces exposed to view.

C. Stainless Steel: ASTM A 480/A 480M.


F. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts; compatible materials for aluminum and stainless-steel ducts.

G. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36-inches or less; 3/8-inch minimum diameter for lengths longer than 36-inches.

2.03 BACKDRAFT DAMPERS

A. Basis-of-Design: Ruskin CB D6.

B. Description: Multiple-blade gravity balanced with center pivoted blades with sealed edges, assembled in rattle free manner with 90-degree stop, adjustment device to permit setting for varying differential static pressure.

C. Frame: 0.125-inch thick 6063-T5 extruded aluminum channel with galvanized steel braces at mitered corners. Provide mounting flange.

D. Blades: Single piece, overlap frame, parallel action, horizontal orientation, minimum 0.07-inch 6063-T5 extruded aluminum material, maximum 6-inch width.

E. Bearings: Corrosion-resistant synthetic, formed as single piece with axles.

F. Blade Seals: Extruded vinyl, mechanically attached to blade edge.

G. Blade Axles: Corrosion-resistant, synthetic formed as single piece with bearings, locked to blade.

H. Tie Bars and Brackets: Galvanized steel.

I. Return Spring: Adjustable tension.

J. Damper Capacity:
   2. Open Position: Maximum air velocity of 2,500-feet per minute.

K. Counterbalances: Adjustable zinc plated steel weights mechanically attached to blade. Must be capable of operating over wide range of pressures.

L. Finish: Mill aluminum.

M. Temperature Rating: -40 degrees F to 200 degrees F.

N. Operation of Blade:
   1. Start to Open: 0.01-inch wg
   2. Fully Open: 0.05-inch.

O. Pressure Drop: Maximum 0.15-inch wg at 1,500-feet per minute through 24-inch by 24-inch damper.

P. Factory Sleeve: Minimum 20 gauge thickness, 12-inches in length.

Q. Screen: At outdoor intake or discharge. 1/4-inch aluminum.

2.04 DAMPERS

A. Basis-of-Design: Ruskin MD 35.

B. General Description: Factory fabricated, with required hardware and accessories. Stiffen damper blades for stability. Include locking device to hold single-blade dampers in a fixed position without vibration. Close duct penetrations for damper components to seal duct consistent with pressure class.
1. Pressure Classes of 3-Inch wg (750 Pa) or Higher: End bearings or other seals for ducts with axles full length of damper blades and bearings at both ends of operating shaft.

C. Rectangular Volume Dampers: Multiple- or single-blade, parallel- or opposed-blade design with linkage concealed in frame and suitable for horizontal or vertical applications.
1. Steel Frames: Hat-shaped, galvanized sheet steel channels, minimum 16 gauge thick, with mitered and welded corners; frames with flanges where indicated for attaching to walls and flangeless frames where indicated for installing in ducts.
   a. Roll-Formed Steel Blades: 16 gauge thick, galvanized sheet steel.
   b. Aluminum Frames: Hat-shaped, 10 gauge thick, aluminum sheet channels; frames with flanges where indicated for attaching to walls; and flangeless frames where indicated for installing in ducts.
   c. Roll-Formed Aluminum Blades: 10 gauge thick aluminum sheet.
   d. Extruded-Aluminum Blades: Minimum 1/2-inch diameter, plated steel, hex shaped, mechanically attached to blade.
   e. Bearings: Molded synthetic sleeve, turning in extruded hole in frame.
   f. Tie Bars and Brackets: Galvanized steel.
   g. Mill galvanized.
   i. Capacity:
      1) Closed Position: Maximum pressure of 3-inches wg.
      2) Open Position: Maximum air velocity of 1,500-feet per minute across 24-inch by 24-inch damper.

D. Round Volume Dampers: Single-blade suitable for horizontal or vertical applications.
1. Steel Frames: Galvanized, roll formed, minimum of 20 gauge thick with beads at each end.
9. Capacity:
   b. Open Position: Maximum air velocity of 1,500-feet per minute.
10. Leakage: Maximum 40 cfm at 1-inch wg for 20-inches diameter damper.
11. Pressure Drop: Maximum 0.02-inch wg at 1,500-feet per minute through 20-inch diameter dampers.

E. Jackshaft: 1-inch diameter, galvanized-steel pipe rotating within pipe-bearing assembly mounted on supports at each mullion and at each end of multiple-damper assemblies.
1. Length and Number of Mountings: Appropriate to connect linkage of each damper in multiple-damper assembly.
2. Damper Hardware: Zinc-plated, die-cast core with dial and handle made of 3/32-inch thick zinc-plated steel, and a 3/4-inch hexagon locking nut. Include center hole to suit damper operating-rod size. Include 2-inch elevated platform for insulated duct mounting.

2.05 CONCEALED DAMPER HARDWARE
A. Concealed Damper Hardware: For dampers above non-removable ceilings (gyp, plaster, decorative, etc.) where access panels have not been shown on Architectural drawings or in locations where dampers are more than 2-feet above the ceiling, provide:
1. Concealed Damper Regulator: Young Regulator Company Model 315 or approved equivalent.
2. Cable System: Young Regulator Company or approved equivalent.
3. Controller: Young Regulator Company 270-275 or approved equivalent.
4. Control wrenches, wire stops, casing nuts, and stainless steel wire.
5. Paint cover plate to match ceiling color or as directed by Architect.

2.06 ACCESS DOORS
A. Duct Pressure Class 2-inch WC and Greater: Sandwich-type design with threaded locking bolt assembly. Closed cell neoprene gasket permanently bonded to inside panel. Zinc-coated steel wing nuts or polypropylene molded knobs with threaded metal inserts - zinc coated bolts sealed to inner panel.
B. Duct Pressure Class 1-1/2-inch WC and Less: Galvanized steel assembly incorporating frame, door, hinges, and latch(es). Frame tabbed for attachment to duct panel. Double wall door panel with 1-inch insulation. Open cell neoprene gasket attached to frame. Cam latches for tight closure.
C. Plenum Doors: Extruded aluminum frames with extruded santoprene seals. Double-wall 20 gauge galvanized steel door panel with fiberglass insulation.
D. Size: Maximum size available to fit rectangular duct panel dimension or round duct diameter. Plenum doors minimum 2-feet wide by 4-feet high.
E. For outdoor installation, only provide waterproof access doors installed vertically.

2.07 DUCT TEST HOLES
A. Temporary Test Holes: Cast iron or cast aluminum to suit duct material, including screw cap and gasket. Size to allow insertion of pitot tube and other testing instruments and of length to suit duct insulation thickness.
B. Permanent Test Holes: Factory fabricated, air tight flanged fittings with screw cap. Provide extended neck fittings to clear insulation.

2.08 TURNING VANES
A. Fabricate to comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for vanes and vane runners. Vane runners to automatically align vanes.
B. Manufactured Turning Vanes: For medium pressure ductwork, ductwork upstream of terminal units, and in ductwork with equal inlet width and height dimensions and outlet width and height dimension, provide double thickness airfoil turning vanes. Low pressure ductwork and ductwork downstream of terminal units use either single thickness or double thickness turning vanes. For mitered rectangular elbows with changes in size from inlet to outlet, only use single thickness turning vanes. Use 2-inch radius vanes spaced on centers of 1.5-inches for single thickness. Use 2-inch radius vanes spaced on centers of 2.125-inches for double thickness.
C. Acoustic Turning Vanes: Fabricate airfoil-shaped aluminum extrusions with perforated faces and fibrous-glass fill.

2.09 FLEXIBLE CONNECTORS
A. General Description: Flame-retardant or noncombustible fabrics, coatings, and adhesives complying with UL 181, Class 1.
B. Metal-Edged Connectors: Factory fabricated with a fabric strip 4-inches wide attached to two strips of 2-3/4-inch wide, 0.028-inch thick, galvanized sheet steel or 0.032-inch thick aluminum sheets. Select metal compatible with ducts.
   1. Minimum Weight: 26 ounces per square yard.
   2. Tensile Strength: 480 pounds of force per in the warp and 360 pounds of force per inch in the filling.
   3. Service Temperature: -40 degrees F to 200 degrees F.

2.10 FLEXIBLE EXHAUST EXTRACTOR ARMS
A. General: Exhaust extraction system, designed for source collection of fumes or dust, consisting of 360 degrees swivel mounting elbow, jointed steel internal support bracket, wire reinforced PVC hose, and polycarbonate hood with damper and handle positioner.
PART 3 - EXECUTION

3.01 DUCT ACCESSORIES GENERAL INSTALLATION
   A. Inspect areas to receive air duct accessories. Notify Engineer of conditions that would adversely affect the installation of the dampers. Do not proceed until conditions are corrected.
   B. Install duct accessories according to applicable details in SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for metal ducts.
   C. Provide duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel, stainless-steel accessories in stainless-steel ducts, and aluminum accessories in aluminum ducts.
   D. Do not compress or stretch damper frames into duct or opening.
   E. Handle dampers using sleeve or frame. Do not lift dampers using blades, actuators, or jack shafts.
   F. Adjust duct accessories for proper settings.

3.02 SHEET METAL MATERIALS INSTALLATION
   A. Install bracing for multiple sections to support assembly weights and hold against system pressure. Install bracing as needed.

3.03 BACKDRAFT DAMPERS INSTALLATION
   A. Install backdraft dampers on exhaust fans or exhaust ducts nearest to outside and where indicated. Provide at outside air intakes where motorized dampers are not shown on drawings.

3.04 DAMPERS INSTALLATION
   A. Where installing volume dampers in ducts with liner, avoid damage to and erosion of duct liner.
   B. Provide balancing dampers at points on supply, return, and exhaust systems where branches lead from larger ducts for air balancing. Install at a minimum of two duct widths from each branch takeoff. Provide balancing dampers for all air inlets and outlets.
   C. Install dampers square and free from racking with blade running horizontally.

3.05 CONCEALED DAMPER HARDWARE INSTALLATION
   A. Coordinate location in Reflected Ceiling Plan and color of concealed damper hardware with Architect prior to installation.

3.06 ACCESS DOORS INSTALLATION
   A. Install duct access doors to allow for inspecting, adjusting, and maintaining accessories and terminal units as follows:
      1. On both sides of duct coils.
      2. Downstream from volume dampers, turning vanes and equipment.
      3. Adjacent to fire or smoke dampers, providing access to reset or reinstall fusible links.
      4. To interior of ducts for cleaning; before and after each change in direction, at maximum 50-foot (15-m) spacing.
      5. Install the following sizes for duct-mounting, rectangular access doors:
         a. One-Hand or Inspection Access: 8-inches by 5-inches.
      6. Install the following sizes for duct-mounting, round access doors:
         a. One-Hand or Inspection Access: 8-inches in diameter.
         c. Head and Hand Access: 12-inches in diameter.

7. Label access doors.

3.07 DUCT TEST HOLES INSTALLATION
A. Provide test holes at fan inlets and outlets where indicated and where required for air testing and balancing.

3.08 TURNING VANES INSTALLATION
A. Vanes must be installed, eliminating every other vane is not allowed.
B. Single thickness vanes cannot be over 36-inches long without intermediate vane runner.
C. Install per SMACNA and fasten/support to prevent vibration, noise, and to maintain proper alignment at design velocity

3.09 FLEXIBLE CONNECTORS INSTALLATION
A. Install flexible connectors immediately adjacent to equipment in ducts associated with fans and motorized equipment supported by vibration isolators. Provide sheet metal weather cover over flexible connections located outdoors. Attach sheet metal to either equipment side or ductwork side, but not both.
B. Per NFPA, do not use flexible connectors on grease exhaust fans
C. For fans developing static pressures of 5-inch wg and higher, cover flexible connectors with loaded vinyl sheet held in place with metal straps.
D. Adjust the following types in the following locations:
1. FC-I: Indoors.

3.10 FLEXIBLE EXHAUST EXTRACTOR ARM INSTALLATION
A. Mount swivel mounting bracket on wall or ceiling. Provide structural support in accordance with manufacturer's requirements.
B. Balance exhaust fan system in accordance with Section 23 05 93, Testing, Adjusting and Balancing. Provide measurement showing appropriate capture velocity is achieved at extractor hood.

END OF SECTION
PART 1 - GENERAL

1.01 SUMMARY
   A. Work Included:
      1. Centrifugal Fans
      2. Ceiling Exhaust Fans
      3. In-Line Centrifugal Fans

1.02 RELATED SECTIONS
   A. Contents of Division 23, HVAC and Division 01, General Requirements apply to this Section.

1.03 REFERENCES AND STANDARDS
   A. References and Standards as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

1.04 SUBMITTALS
   A. Submittals as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.
   B. In addition, provide:
      1. Certified fan performance curves with system operating conditions indicated.
      2. Certified fan sound-power ratings.
      3. Motor ratings and electrical characteristics, plus motor and electrical accessories.
      4. Material gauges and finishes, including color charts.
      5. Dampers, including housings, linkages, and operators.

1.05 QUALITY ASSURANCE
   A. Quality assurance as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.
   B. In addition, meet the following:
      1. Motors: Premium efficiency per Section 23 05 13, Common Motor Requirements for HVAC Equipment. Electrically Commutated Motors (ECM) where scheduled on Drawings.
      2. Sound power levels as scheduled on Drawings. If not scheduled, within 5 percent of Basis of Design at design flow.
      3. Project Altitude: Base air ratings on sea-level conditions for project sites below 2,000 feet in elevation. Base air ratings on actual site elevations for project sites above 2,000 feet in elevation.
      4. Operating Limits: Classify according to AMCA 99.
      5. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
      6. AMCA Compliance: Products are to comply with performance requirements and are to be licensed to use the AMCA-Certified Ratings Seal.
      7. NEMA Compliance: Motors and electrical accessories are to comply with NEMA standards.
      8. UL Standard: HVAC Fans are to comply with UL 705. Fans used in grease exhaust applications are to be UL 762 listed for grease exhaust.

1.06 WARRANTY
   A. Warranty of materials and workmanship as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

1.07 DELIVERY, STORAGE, AND HANDLING
   A. Deliver fans as factory-assembled unit, to the extent allowable by shipping limitations, with protective crating and covering.
B. Disassemble and reassemble units, as required for moving to final location, according to manufacturer's written instructions.
C. Lift and support units with manufacturer's designated lifting or supporting points.

1.08 COORDINATION
A. Coordinate size and location of structural-steel support members.
B. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases.
C. Coordinate installation of roof curbs, equipment supports, and roof penetrations.

1.09 EXTRA MATERIALS
A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents. Belts: One set for each belt-driven unit.

PART 2 - PRODUCTS

2.01 MANUFACTURERS
A. Centrifugal Fans:
   1. Greenheck
   2. Twin City
   3. Loren Cook Company
   4. PennBarry.
   5. American Fan
   6. Or approved equivalent.
B. Ceiling Exhaust Fans:
   1. Cook
   2. Greenheck
   3. Carnes
   4. Broan
   5. PennBarry
   6. Twin City
   7. Or approved equivalent.
C. In-Line Centrifugal Fans:
   1. Greenheck
   2. Cook
   3. Carnes
   4. PennBarry
   5. Twin City
   6. Or approved equivalent.

2.02 CENTRIFUGAL FANS
A. Description: Centrifugal or utility type centrifugal fans, as indicated, standard factory finish, AMCA rated, single width, single inlet, double width, double inlet, forward curved, backward inclined, or airfoil blades as scheduled.
B. Wheel and Inlet:
   1. Backward Inclined: Steel or aluminum construction with smooth curved inlet flange, heavy back plate, backwardly curved blades welded or riveted to flange and back plate; cast iron or cast steel hub riveted to back plate and keyed to shaft with set screws.
   2. Forward Curved: Black enameled or galvanized steel construction with inlet flange, back plate, shallow blades with inlet and tip curved forward in direction of airflow, mechanically secured to flange and back plate; steel hub swaged to back plate and keyed to shaft with set screw.
3. Airfoil Wheel: Steel construction with smooth curved inlet flange, heavy back plate die formed hollow airfoil shaped blades continuously welded at tip flange, and back plate; cast iron or cast steel hub riveted to back plate and keyed to shaft with set screws.

4. Radial: Steel construction with inlet flange, heavy reinforced back plate, plate blades with reinforcing gussets and wearing strips, welded or riveted to back plate and flange, cast iron or cast steel, hub riveted to back plate and keyed to shaft with set screws.

5. Statically and dynamically balance wheel within its own bearings with maximum balance quality grade at bearings of G16 (0.20 in/sec peak velocity, filter-in as measured at fan RPM) for 5 hp and below and G6.3 (0.15 in/sec peak velocity, filter-in as measured at fan RPM) for 7.5 hp and above per ANSI S2.19. AMCA 210 rated.

C. Housing:
1. Heavy gauge steel, spot welded for AMCA 99 Class I and II fans, and continuously welded for Class III, adequately braced, designed to minimize turbulence with spun inlet bell and shaped cut.
2. Removable angles and bolts for attaching flexible connections and discharge dampers on fan outlet.
3. Housing Discharge Arrangement: Adjustable to eight standard positions.

D. Bearings and Drives
1. Bearings: Heavy duty pillow block type, self-greasing ball bearings, with ABMA 9 L-10 life at 100,000 hours.
2. Shafts: Hot rolled steel, ground and polished, with keyway, protectively coated with lubricating oil, and shaft guard. Provide anti-corrosive coating.
3. Drive: Cast iron or steel sheaves, dynamically balanced, keyed. Variable and adjustable pitch sheaves for motors 5 hp and under, selected so required rpm is obtained with sheaves set at mid-position fixed sheave for 7.5 hp and over, matched belts, and drive rated as recommended by manufacturer or minimum 1.5 times nameplate rating of motor.
4. Belts: Oil resistant, nonsparking, and nonstatic; matched sets for multiple belt drives.
5. Belt Guard: Fabricate to SMACNA Duct Construction Standards - Metal and Flexible; 0.106-inch thick, 3/4-inch diamond mesh wire screen welded to steel angle frame or equivalent, prime coated. Secure to fan or fan supports without short circuiting vibration isolation, with provision for adjustment of belt tension, lubrication, and use of tachometer with guard in place.

E. Motor: Integrally mounted, 1800 RPM maximum, with pre-lubricated sealed ball bearings. ODP for motors located indoors and TEFC for motors exposed to moisture.

F. Accessories:
1. Discharge Dampers: Parallel blade heavy duty steel or aluminum, where scheduled. Damper assembly with blades constructed of two plates formed around and welded to shaft, channel frame, sealed ball bearings, with blades linked out of air stream to single control lever. Motorized where indicated and gravity actuated with counterweight, where motorized is not indicated.
2. Inlet/Outlet Screens: Galvanized steel welded grid, removable.
3. Access Doors: Shaped to conform to scroll, with quick opening latch type handles and gaskets.
4. Scroll Drain: 1/2-inch steel pipe coupling welded to low point of fan scroll.
5. Weather Hoods: Heavy gauge protective covers over bearings and shaft assembly for fans exposed to weather.
6. AMCA 99 Type B spark proof construction where scheduled.
7. Vibration isolation as scheduled and specified. Reference Section 23 05 48 Vibration and Seismic Controls for HVAC Piping and Equipment.

2.03 CEILING EXHAUST FANS
A. Description: Centrifugal fan, direct drive, cabinet and exhaust grille. AMCA rated. Sound level as scheduled or less. Fan shrouds, motor, and fan wheel are to be removable for service.
B. Wheel: Double width, double inlet, forward curved blades:
C. Housing: Acoustically insulated steel casing, factory standard finish, bottom access through grille, ducted outlet, egg crate inlet grille. Provide stainless steel grille where scheduled.
D. Drives: Direct drive.
E. Back draft damper.
F. Accessories:
   1. Disconnect plug.
   2. Hooded wall cap.
   3. Louved wall discharge with bird screen.
G. Motor: Integrally mounted with pre-lubricated sealed ball bearings.
   1. Variable-Speed Controller: Where scheduled on Drawings, provide solid-state control to reduce speed from 100 percent to less than 50 percent.
   2. Disconnect Switch: Where not shown on Division 26, Electrical Drawings, provide nonfusible type, with thermal-overload protection mounted inside fan housing factory wired through an internal aluminum conduit.
   4. Time-Delay Switch: Assembly with single-pole rocker switch, timer, and cover plate.
   5. Motion Sensor: Motion detector with adjustable shutoff timer.
   6. Electrically Commutated Motor (ECM) where indicated on Fan Schedule on Drawings.
H. Filter: Washable commutated motor to fit between fan and grille.

2.04 IN-LINE CENTRIFUGAL FANS

A. Description: In-line, belt-driven, centrifugal fans consisting of housing, wheel, outlet guide vanes, fan shaft, bearings, motor and disconnect switch, drive assembly, mounting brackets, and accessories.
B. Wheel: Cast aluminum backward inclined with inlet cone statically and dynamically balanced within its own bearings.
C. Housing:
   1. Heavy gauge aluminum louvered wall discharge housing, factory standard finish.
   2. Removable panels for access to all interior components.
   3. Horizontal or vertical configuration, as indicated.
   4. Inlet and discharge duct collars.
   5. 1-inch thick, 1.5 pounds per cubic foot density fiberglass liner.
   6. Aluminum straightening vanes.
   7. Support bracket adaptable to floor, sidewall, or ceiling mounting.
D. Bearings and Drives:
   1. Bearings: Heavy duty pillow block type, self greasing ball bearings with ABMA 9 life at 50,000 hours.
   2. Shafts: Hot rolled steel, ground and polished, with keyway, protectively coated with lubricating oil.
   3. Drive: Cast iron or steel sheaves, dynamically balanced, keyed. Variable and adjustable pitch sheaves for motors 5 hp and under, selected so required rpm is obtained with sheaves set at mid-position. Fixed sheave for 7.5 hp and over, matched belts, and drive rated as recommended by manufacturer or minimum 1.5 times nameplate rating of motor. Motor mounted on adjustable base, with adjustable sheaves, enclosure around belts within fan housing, and lubricating tubes from fan bearings extended to outside of fan housing.
      a. Inverter duty motor for use with variable frequency drive where indicated on Fan Schedule on Drawings.
E. Accessories:
   1. Belt guard.
2. Motor cover for outdoor applications.
3. Inlet and outlet guard.
4. AMCA 99 Type B spark proof construction where scheduled.
5. Variable-Speed Controller: Where scheduled on Drawings, provide solid-state control to reduce speed from 100 percent to less than 50 percent.
6. Discharge Dampers: Parallel blade heavy duty steel or aluminum, where scheduled. Damper assembly with blades constructed of two plates formed around and welded to shaft, channel frame, sealed ball bearings, with blades linked out of air stream to single control lever. Motorized where indicated and gravity actuated with counterweight, where motorized is not indicated.

F. Inlet/Outlet Screens: Galvanized steel welded grid, removable.
G. Vibration Isolation: Wheel and motor mounted on integral double deflection neoprene isolators.
H. Vibration isolation as scheduled and specified. Reference Section 23 05 48 Vibration and Seismic Controls for HVAC Piping and Equipment.
   1. Motor: Integrally mounted, 1800 RPM maximum, with pre-lubricated sealed ball bearings. ODP for motors located indoors and TEFC for motors exposed to moisture.

PART 3 - EXECUTION

3.01 GENERAL INSTALLATION REQUIREMENTS
A. Install in accordance with manufacturer's instructions.
B. Install power ventilators level and plumb.
C. Fans used for exhaust of moist air are to be constructed of aluminum construction and be warranted for their application in moist conditions.
D. Fans used in welding, chemical, and/or fume exhaust applications are to be of spark-proof construction and are to be protected with coatings as required to protect parts in the air stream from the chemicals and materials the fan will be exposed to.
E. Support suspended units from structure threaded steel rods and vibration isolation device scheduled on Drawings.
F. In seismic zones, restrain support units.
G. Install units with clearances for service and maintenance.
H. Provide fixed sheaves required for final air balance.
I. Provide safety screen where inlet or outlet is exposed.
J. Pipe scroll drains to nearest floor drain.
K. Provide backdraft dampers on discharge of exhaust fans and as indicated on Drawings.
L. Duct installation and connection requirements are specified in other Division 23, HVAC Sections. Drawings indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connectors per Section 23 33 00, Air Duct Accessories.
M. Install ducts adjacent to power ventilators to allow service and maintenance.
N. Ground equipment.
O. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.
P. Equipment Startup Checks:
   1. Verify that shipping, blocking, and bracing are removed.
   2. Verify that unit is secure on mountings and supporting devices and that connections to ducts and electrical components are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.
   3. Verify that cleaning and adjusting are complete.
4. Disconnect fan drive from motor, verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearing operation. Reconnect fan drive system, align and adjust belts, and install belt guards.
5. Verify lubrication from bearings and other moving parts.
6. Verify that manual and automatic volume control and fire and smoke dampers in connected ductwork systems are in fully open position.
7. Disable automatic temperature-control operators.

Q. Starting Procedures:
1. Energize motor and adjust fan to indicated rpm.
2. Measure and record voltage and amperage.

R. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation. Remove malfunctioning units, replace with new units, and retest.

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

T. Shut unit down and reconnect automatic temperature-control operators.

U. Replace fan and motor pulleys as required to achieve design airflow.

V. Provide totally enclosed fan cooled motors when motor is located outdoors, whether under a cover or not, or exposed to moisture.

W. Repair or replace malfunctioning units. Retest as specified above after repairs or replacements are made.

X. Adjust damper linkages for proper damper operation.

Y. Adjust belt tension.

Z. Lubricate bearings.

AA. On completion of installation, internally clean fans according to manufacturer's written instructions. Remove foreign material and construction debris. Vacuum fan wheel and cabinet.

AB. After completing system installation, including outlet fitting and devices, inspect exposed finish. Remove burrs, dirt, and construction debris and repair damaged finishes.

AC. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain HVAC fans. Train Owner's maintenance personnel on procedures and schedules for starting and stopping, troubleshooting, servicing, and maintaining equipment and schedules.

3.02 CENTRIFUGAL FANS
A. See 3.1, General Installation Requirements above.

3.03 CEILING EXHAUST FANS
A. Ceiling Exhaust Fans: Suspend units from structure; use steel wire or metal straps.
B. See 3.1, General Installation Requirements above.

3.04 IN-LINE CENTRIFUGAL FANS
A. See 3.1, General Installation Requirements above.

END OF SECTION
SECTION 23 3700 - AIR OUTLETS AND INLETS

PART 1 - GENERAL

1.01 SUMMARY
A. Work Included:
   1. Grilles, Registers, Diffusers
   2. Louvers

1.02 RELATED SECTIONS
A. Contents of Division 23, HVAC and Division 01, General Requirements apply to this Section.

1.03 REFERENCES AND STANDARDS
A. References and Standards as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

1.04 SUBMITTALS
A. Submittals as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.
B. In addition, provide:
   1. Data Sheet: For each type of air outlet and inlet, and accessory furnished; indicate construction, finish, and mounting details.
   2. Performance Data: Include throw and drop, static-pressure drop, and noise ratings for each type of air outlet and inlet.
   3. Schedule of diffusers, registers, and grilles indicating drawing designation, room location, quantity, model number, size and accessories furnished.

1.05 QUALITY ASSURANCE
A. Quality assurance as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.
B. In addition, meet the following:
   1. Air Distribution Diffuser, Register, and Grille Schedule lists Basis of Design, with any specialty accessories, construction, finish or other criteria noted on schedule. Submitted air distribution must match criteria of Basis of Design:
      a. Construction materials and appearance.
      b. Frame/installation method.
      c. Isothermal throw plus or minus 5 percent at design flows shown on drawings.
      d. Noise Criteria: NC value plus or minus 1 at design flows shown on drawings.
      e. Accessories: Equal to Basis of Design.

1.06 WARRANTY
A. Warranty of materials and workmanship as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

PART 2 - PRODUCTS

2.01 MANUFACTURERS
A. General: Manufacturer's standard products of categories and types required for each application as referenced in other Division 23, HVAC sections, where more than a single type is specified for the application, provide single selection for each product category.
B. Grilles, Registers, Diffusers:
   1. Anemostat
   2. Carnes
   3. Environmental Air Products
   4. Kruger
   5. Metalaire
   6. Nailor
7. Price Co.
8. Shoemaker
9. Titus
10. Tuttle & Bailey
11. Seiho
12. Or approved equivalent.

C. Louvers:
1. Ruskin Manufacturing
2. Pottorff
3. Carnes
4. Cesco
5. Greenheck
6. Or approved equivalent.

2.02 GRILLES, REGISTERS, DIFFUSERS

A. Diffuser, Register and Grille Schedule lists Basis of Design, with specialty accessories, construction, finish or other criteria noted on schedule. Submitted air distribution must match criteria of Basis of Design, including accessories and finish:
2. Pressure drop equal to or less than Basis of Design at CFM on Drawings.
3. Throw: Isothermal jet throw plus or minus 5 percent of Basis of Design at CFM listed on Drawings.
4. Noise Criteria: Plus or minus 1 NC of Basis of Design at CFM listed on Drawings. If Basis of Design NC is below registered level, submitted must match. NC rating with 10 dB room factor or less.

B. Provide 1-, 2-, 3-, or 4-way deflection as indicated on Drawings.

C. Register Dampers: Dampers utilized with grilles. Opposed blade dampers utilizing a side operated worm drive which provides external duct operation. Slot the end of the shaft to receive a screwdriver. Factory assembled side operator. Construct of the same material as the grille. Manufacturer same as grilles/diffuser.

D. Coordinate mounting frames with ceiling construction type. Verify per reflected ceiling plans.

2.03 LOUVERS

A. General: Frame and sill styles compatible with adjacent substrate, specifically manufactured to fit into construction openings with accurate fit and adequate support for weatherproof installation. Reference Drawings and Specifications for types of substrate which will contain each type of louver. Construct of aluminum extrusions, ASTM B221, Alloy 6063-T5. Weld units or use stainless steel fasteners. On inside face of exterior louvers, provide anodized aluminum wire bird screen mounted in removable extruded aluminum frames. AMCA licensed performance ratings.

B. Blades set 3 to 5-inches on center, 37.5 degree angle with rain hook on blade, minimum blade thickness 0.080-inch, drainable blade style. Minimum 57 percent free area for 48-by 48-inch unit. Maximum water penetration 0.01 ounce water psf free area at 1000 FPM. Maximum intake pressure drop of 0.10-inch wg at 750 FPM free velocity. Provide downspouts in jambs, designed to drain water from louver for minimum water cascade from blade to blade. Provide drain gutter in head frame and each blade.

C. Reference Drawings for free area required.

D. Provide access door in duct to clean birdscreen.

E. Finish: Factory Kynar 500 fluoropolymer spray finish color to be selected by Architect. Conform to AAMA 605.2. Apply coating following cleaning, and pretreatment. Dry louvers before final finish application. 1.2 mils total dry film thickness when baked at 450 degrees F for ten minutes.
PART 3 - EXECUTION

3.01 GENERAL INSTALLATION

A. Install in accordance with manufacturer’s instructions. Provide seismic supports, clips, and bracing per local code. Coordinate installation of framing. Provide complete coverage of rough openings by integral device flanges or auxiliary frames. Where above ceiling location is unconditioned space, caulk rough openings; repair and re-paint locations where dust entrainment streaks develop due to unsealed openings.

B. Damp locations, such as lockers, restrooms, showers, natatoriums, whirlpool/spas, to have aluminum construction even if scheduled otherwise; mounting hardware to be stainless steel.

C. Check location of outlets and inlets and make necessary adjustments in position to conform with architectural features, symmetry, and lighting arrangement.

D. Unless otherwise shown on drawings, for ceiling mounted air outlets with adjustable airflow pattern controllers mounted at a height of 12 feet or less, adjust the air outlets for horizontal air distribution, and adjust to vertical air distribution for ceiling height above 12 feet.

E. Exterior color of grilles per Architect. White finish if not otherwise scheduled or noted by Architect. Paint ductwork visible behind air outlets and inlets matte black.

F. Ceiling Membrane: Protect ceiling membrane per code. Fire caulk around openings. Provide listed radiation damper in rated roof/ceiling or floor/ceiling assemblies as required per code.

G. After installation of diffusers, registers, and grilles, inspect exposed finish. Clean exposed surfaces to remove burrs, dirt, and smudges. Replace diffusers, registers, and grilles that have damaged finishes.

3.02 GRILLES, REGISTERS AND DIFFUSERS INSTALLATION

A. Coordinate with Architectural Reflected Ceiling Plan(s).

B. Install diffusers to ductwork with air tight connection. 18-inch straight duct section or acoustic plenum at connection. Provide square to round adapters where required for connection to round ducts.

C. Provide integral balancing dampers for diffusers, and grilles and registers where duct manual balancing dampers are not shown or specified.

END OF SECTION
SECTION 23 5100 - BREECHINGS, CHIMNEYS AND STACKS

PART 1 - GENERAL

1.01 SUMMARY
   A. Work Included:
      1. Gas-Fired Equipment Vents

1.02 RELATED SECTIONS
   A. Contents of Division 23, HVAC and Division 01, General Requirements apply to this Section.
   B. In addition, reference the following:

1.03 REFERENCES AND STANDARDS
   A. References and Standards as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

1.04 SUBMITTALS
   A. Submittals as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.
   B. In addition, provide:
      1. Product Data: Provide data indicating factory built chimneys, including dimensional details of components and flue caps, dimensions and weights, electrical characteristics and connection requirements.
      2. Shop Drawings: Indicate general construction, dimensions, weights, support and layout of breechings. Submit layout drawings indicating plan view and elevations.
      3. Manufacturer's Instructions: Include installation instructions, and indicate assembly, support details, and connection requirements.
      4. Submit venting system design and calculations.

1.05 QUALITY ASSURANCE
   A. Quality assurance as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

1.06 WARRANTY
   A. Warranty of materials and workmanship as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

1.07 DEFINITIONS
   A. Breeching: Vent connector.
   B. Chimney: Primarily vertical shaft enclosing at least one vent for conducting flue gases outdoors.
   C. Smoke Pipe: Round, single wall vent connector.
   D. Vent: That portion of venting system designed to convey flue gases directly outdoors from vent connector or from an appliance when vent connector is not used.
   E. Vent Connector: That part of venting system that conducts flue gases from flue collar of an appliance to chimney or vent, and may include draft control device.

1.08 DESIGN REQUIREMENTS
   A. Factory built vents and chimneys used for venting natural draft appliances comply with NFPA 211 and be UL listed and labeled.
PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Gas-Fired Equipment Vents:
   1. Positive Pressure Vent:
      a. Silkirk Corporation
      b. Or approved equivalent.
   2. Positive Pressure ABS/PVC Vent:
      a. Charlotte Pipe
      b. Or approved equivalent.
   3. Gravity Vent Systems:
      a. AMPRO by Hart & Cooley
      b. Ecco Manufacturing
      c. Industrial Chimney Company
      d. Selkirk Corporation
      e. M&G DuraVent
      f. Or approved equivalent.

2.02 GAS-FIRED EQUIPMENT VENTS

A. Positive Pressure Factory Built/85 Plus Percent Efficient Equipment:
      Construction to match manufacturer required flue rating. Inner wall minimum 0.035-inch-thick AL29-4C stainless steel. Outer wall minimum 0.025-inch-thick aluminized steel. Provide minimum 1-inch space between the inner and outer walls. List system by UL as 1400F Factory Built Chimneys with 2-inch clearance to combustibles for use with No. 2 fuel oil-fired equipment. Manufacturer system to join sections, sealing gastight up to minimum 60-inch wg for temperatures up to 600F. Fittings, roof penetrations, thimbles supports, etc. of same manufacture and construction as straight sections.

B. Positive Pressure ABS/PVC Vent
   1. Schedule 40, pressure-rated ABS or PVC pipe; must meet gas-fired equipment manufacturer requirements for installation (solid core or otherwise to meet temperature requirements).
   2. Combination vent/intake from manufacturer, roof/sidewall flashing.

C. Gravity Vent Systems:
   1. Type "B" factory fabricated, UL listed, doublewall flue, with aluminum inner wall, galvanized steel outer wall and 1/2-inch air space between unless noted otherwise. Provide twist-lock connectors, tall cone flashing, storm collar, and round birdproof/weatherproof top.

PART 3 - EXECUTION

3.01 GENERAL INSTALLATION REQUIREMENTS

A. Install in accordance with manufacturer's written instructions and guidelines.
B. Install in accordance with NFPA 54.

3.02 GAS-FIRED EQUIPMENT VENTS

A. General: Vent-type to match equipment manufacturer requirements: Category 1. Maintain clearances to combustible materials per code; double-wall, insulation, thimbles, etc. at reduced clearance locations as necessary. Vent termination clearances from buildings, building openings, ventilation intakes, etc. per code.

B. Atmospheric Gas-Fired Vents:
   1. Install venting in accordance with the manufacturer's recommendations and the requirements of the UL listing of the system.
   2. Extend venting to 4 feet minimum above the roof. Maintain clearances from other buildings, openings, intakes, etc. per code unless otherwise indicated. Provide guy wire supports for vents terminating 6 feet or higher above the roof.
C. Pressurized Gas-Fired Vents:
   1. Install venting in accordance with the manufacturer's recommendations and the requirements of the UL listing of the system. Concentric vent/intake systems to be installed per manufacturer's recommendations, minimum 12 inches above snow level.
   2. Maintain slope of vent per manufacturer's recommendations. Clearances to other buildings, openings, intakes, etc. per code unless otherwise indicated.
   3. ABS or PVC venting systems to be sized per manufacturer recommendations for minimum and maximum lengths. Total developed length must not exceed equipment listing; additional elbows may be required to meet minimum developed length.

END OF SECTION
PART 1 - GENERAL

1.01 SUMMARY
A. Work included:
   1. Low Intensity Tubular Infrared Heaters

1.02 RELATED SECTIONS
A. Contents of Division 23, HVAC and Division 01, General Requirements apply to this Section.

1.03 REFERENCES AND STANDARDS
A. References and Standards as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

1.04 SUBMITTALS
A. Submittals as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

1.05 QUALITY ASSURANCE
A. Quality assurance as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

1.06 WARRANTY
A. Warranty of materials and workmanship as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

PART 2 - PRODUCTS

2.01 MANUFACTURERS
A. Low Intensity Tubular Infrared Heaters:
   1. Reznor
   2. Roberts-Gordon
   3. Modine
   4. Or approved equivalent.

2.02 LOW INTENSITY TUBULAR INFRARED HEATERS
A. Units: Packaged, factory assembled, pre-wired unit consisting of cabinet, burner, heat exchanger, radiant tube, reflector, controls. Propane.
B. Cabinet:
   2. Gas Burner:
      a. Gas Burner: Forced draft type with adjustable combustion air supply.
      b. Gas valve provides 100 percent safety gas shut-off; 24 volt combining pressure regulation, safety pilot, manual set (On-Off), pilot filtration, automatic electric valve.
      c. Electronic pilot ignition, electric spark igniter.
      d. Non-corrosive burner air blower with permanently lubricated motor.
      e. Combustion air from space or ducted from outside as scheduled shown.
      f. Exhaust log draft or vacuum as scheduled/shown.
   3. Heat Exchanger: Aluminized tubular steel combustion chamber with aluminized steel tube with aluminum reflector, including end-caps.
C. Reflectors: Polished surface for downward directing of heat.
D. Controls:
   1. Operating Controls: Low voltage room thermostat cycles burner to maintain room temperature setting.
2. Gas Burner Safety Controls: Thermo-couple sensor prevents opening of solenoid gas valve until pilot flame is proven and stops gas flow on ignition failure for vacuum-type exhaust. Provide vacuum proving interlock.

E. Performance: Radiant heat percentage as scheduled.

PART 3 - EXECUTION

3.01 GENERAL INSTALLATION REQUIREMENTS

A. Installation:
   1. Install in accordance with NFPA 90A, including manufacturer's installation instructions.
   2. Install gas fired units in accordance with NFPA 54 and applicable codes.
   3. Provide vent connections in accordance with NFPA 211.
   4. Install unit heaters with vibration isolation.
   5. Install low voltage thermostats where shown on Drawings.
   6. Provide connection to electrical power and low voltage power systems coordinate with Division 26.

B. Examination:
   1. Verify space is ready for installation of units and openings are as indicated on shop drawings.
   2. Verify proper power supply is available.
   3. Verify proper fuel supply is available for connection.

C. Schedules: See Drawings.

3.02 LOW INTENSITY TUBULAR INFRARED HEATERS

A. Install per manufacturers written instructions and requirements.

B. See General Installation Requirements above.

C. Schedules: See Drawings.

END OF SECTION
SECTION 23 7400 - ROOFTOP PACKAGED AIR CONDITIONING UNITS

PART 1 - GENERAL

1.01 SUMMARY
   A. Work Included: Materials, installation and testing of roof-mounted, packaged direct expansion air conditioning units in the following configuration:
      1. Rooftop Packaged Air Conditioning Units Constant Volume (up to 20 tons).

1.02 RELATED SECTIONS
   A. Contents of Division 23, HVAC and Division 01, General Requirements apply to this Section.

1.03 REFERENCES AND STANDARDS
   A. References and Standards as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.
   B. In addition, meet the following:

1.04 SUBMITTALS
   A. Submittals as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

1.05 QUALITY ASSURANCE
   A. Quality assurance as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.
   B. In addition, meet the following
      1. Interior surfaces of units to meet erosion and growth resistance requirements as well as construction requirements for equipment of ASHRAE 62.1, latest edition.
      2. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
      3. Fabricate and label refrigeration system to comply with ASHRAE 15, "Safety Code for Mechanical Refrigeration."
      4. Energy-Efficiency Ratio: Meet minimum requirements shown on drawings.
      5. Coefficient of Performance: Meet minimum requirements shown on drawings.
      7. ARI Certification: Provide ARI certified and listed units.
      8. ARI Compliance for Units with Capacities Less Than 135,000 Btuh (39.6 kW): Rate rooftop air-conditioner capacity according to ARI 210/240, "Unitary Air-Conditioning and Air-Source Heat Pump Equipment."
      9. ARI Compliance for Units with Capacities 135,000 Btuh (39.6 kW) and More: Rate rooftop air-conditioner capacity according to ARI 340/360, "Commercial and Industrial Unitary Air-Conditioning and Heat Pump Equipment."

1.06 WARRANTY
   A. Warranty of materials and workmanship as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.
   B. In addition, provide:
      1. Provide total 5 years manufacturer's warranty for compressor(s), including parts and labor.
      2. Provide 5 year manufacturer warranty on heat exchanger.
1.07 EXTRA MATERIALS
A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Fan Belts: one set for each belt-drive fan.
   2. Filters: one set of filters for each unit.

PART 2 - PRODUCTS
2.01 MANUFACTURERS
A. Rooftop Package Air Conditioning Units, Constant or Variable Volume (up to 20 tons):
   1. Carrier Corporation
   2. Trane Company
   3. York/Johnson Controls
   4. Daikin Applied
   5. AAON
   6. Lennox International
   7. Or approved equivalent.

2.02 ROOFTOP PACKAGE AIR CONDITIONING UNITS, CONSTANT OR VARIABLE VOLUME (UP TO 20 TONS)
A. Description: Factory assembled and tested; designed for outdoor installation; consisting of compressor, indoor and outside refrigerant coils, indoor fan and outside coil fan, refrigeration and temperature controls, gas furnace heat exchanger, filters, dampers and other accessories/devices listed in this specification and the drawings.
B. Casing: Galvanized steel construction with enamel paint finish, removable panels or access doors with neoprene gaskets for inspection and access to internal parts, minimum 3/4-inch thick thermal insulation, knockouts for electrical and piping connections, exterior condensate drain connection, and lifting lugs. Single wall Construction. Finished panel surfaces to withstand a minimum 1000-hour salt spray test in accordance with ASTM B117 standard for salt spray resistance. Unit base to overhang the roof curb for positive water runoff and to seat on the roof curb gasket to provide a positive weather tight seal.
C. Indoor Fan: Double width, double inlet (DWDI) forward curved, centrifugal directly driven by multi speed belt driven by single-speed variable speed motor.
   1. Fan assembly to have adjustable pitched sheaves on the motor. Bushings to be used on sheaves to allow for easy removal of the pulleys from the fan and motor shaft. Fixed bore pulleys fastened to the shaft by setscrews will not be allowed. Drives selected with a 1.2 service factor.
   2. Fan assemblies statically and dynamically balanced at the factory, including a final trim balance, prior to shipment. Fan assemblies to employ solid steel fan shafts. Bearings sized to provide a L-50 life of 250,000 hours.
   3. Provide fan motors heavy-duty, 1800 rpm, open drip-proof (ODP). Motors efficiencies to meet EPAct premium efficiencies. Motors mounted on an adjustable base that provides for proper alignment and belt tension adjustment.
   4. Fan design to allow for the fan and motor assembly to slide out of the rooftop unit for ease of servicing the equipment.
D. Outside Coil Fan: Condenser fans to be direct drive, axial type designed for low tip speed and vertical air discharge. Condenser fan rpm to be 1140 rpm maximum. Fan blades constructed of steel and riveted to a steel center hub. Condenser fan motors to be heavy-duty, non reversing type with permanently lubricated ball bearing and thermal protection. Motor design to be totally enclosed air over (TEAO).
E. Refrigerant Coils: Aluminum fin and seamless copper tube in steel casing with equalizing-type vertical distributor. Coils factory leak tested with high pressure air under water. Provide condenser coils protected from incidental contact to coil fins by a coil guard.
F. Compressor: Number as scheduled. Hermetic scroll compressor with integral vibration isolators, internal overcurrent and overtemperature protection, internal pressure relief.

G. Refrigeration System:
1. Compressor with an automatic-reset control that shuts compressor off after five minutes.
2. Outside coil and fan.
3. Indoor coil and fan.
4. Four-way reversing valve and suction line accumulator.
5. Thermal expansion valve with replaceable thermostatic element and liquid line filter drier.
6. Refrigerant dryer.
7. High-pressure switch.
8. Low-pressure switch.
9. Thermostat for coil freeze-up protection during low-ambient temperature operation or loss of air.
10. Low-ambient switch.
11. Brass service valves installed in discharge and liquid lines.
12. Refrigerant gauge parts.
13. Charge of refrigerant (R-410a or R-407c) and oil.
14. Independent refrigerant circuits where unit has multiple compressors.

H. Drain Pan: Stainless steel, positively sloped drain pan provided with the cooling coil. Drain pan to extend beyond the leaving side of the coil and underneath the cooling coil connections. Drain pan to have a minimum slope of 1/8-inch per foot to provide positive draining. The slope of the drain pan to be in two directions and comply with ASHRAE Standard 62.1. Drain pan to be connected to a threaded drain connection extending through the unit base.

I. Filters: 2-inch thick throwaway filters in filter rack. Filters similar to Farr 30/30.

J. Heat Exchanger: stainless-steel construction for propane gas fired burners with the following controls:
1. Redundant single or dual gas valve with manual shutoff.
2. Direct-spark pilot ignition.
3. Electronic flame sensor.
4. Induced-draft blower with airflow safety switch.
5. Flame rollout switch.
6. High temperature limit switch.

K. Outdoor/Return Air Section: A return air plenum to be provided with an outdoor air hood. Hood to allow outdoor air to enter at the back of the return air plenum. Hood to include moisture eliminator filters to drain water away from the entering air stream. Return air plenum to allow return air to enter from the bottom of the unit. Upon unit shut down during unoccupied periods, the outdoor air damper to be power driven closed.

L. Outside-Air Damper: Linked damper blades, for 0 to 30 percent outside air, with manual slide and fully modulating, spring return damper motor. Upon unit shut down during unoccupied periods, the outdoor air damper to be power driven closed. Damper blades to be gasketed with side seals and jamb seals to provide an air leakage rate of no more than 4 cfm/square foot of damper area at 1-inch differential pressure per ASHRAE 90.1 Energy Standard. Leakage rate to be tested in accordance with AMCA standard 500.

M. Economizer: Return- and outside-air dampers with neoprene seals, outside-air filter, and hood. Upon unit shut down during unoccupied periods, the outdoor air damper to be power driven closed. Damper blades to be gasketed with side seals and jamb seals to provide an air leakage rate of no more than 4 cfm/square foot of damper area at 1-inch differential pressure per ASHRAE 90.1 Energy Standard. Leakage rate to be tested in accordance with AMCA standard 500.
1. Damper Motor: Fully modulating spring return with adjustable minimum position.
2. Control: Electronic-control system uses outside-air temperature to adjust mixing dampers.
3. Relief Damper: Gravity actuated with bird screen and hood.
N. Power Connection: Provide for single connection of power to unit with Unit-mounted disconnect switch accessible from outside unit and control-circuit transformer with built-in circuit breaker.

O. Electrical: Unit wiring to comply with NEC requirements and with applicable UL standards. Electrical components to be UL recognized where applicable. Wiring and electrical components provided with the unit to be number and color coded and labeled according to the electrical diagram provided for easy identification. The unit to be provided with a factory wired weatherproof control panel. Unit to have a single point power connection for main power connection. A terminal board to be provided for low voltage control wiring. Each compressor and condenser fan motor to be furnished with contactors and thermal overload protection. Supply fan motors to have a factory installed and wired control contactor. Knockouts to be provided in the bottom of the main control panels for field wiring entrance.

P. Unit Controls: Solid-state control board and components contain at least the following features:
   1. Indoor fan on/off relay.
   2. Default control to ensure proper operation after power interruption.
   3. Service relay output.
   4. Unit diagnostics and diagnostic code storage.
   5. Field-adjustable control parameters.
   6. Economizer control.
   7. Gas valve delay between first- and second-stage firing.
   8. Indoor-air quality control with carbon dioxide sensor.
   9. Low-ambient control, allowing operation down to 0 degrees F (minus 18 deg C).
  10. Minimum run time.
  11. Night setback mode.
  12. Return-air temperature limit.
  13. Low-refrigerant pressure control.

Q. DDC: Install stand-alone control module providing link between unit controls and DDC system. Control module to be compatible with temperature-control system through BACnet interface.

R. Accessories:
   2. Service Outlets: Two, 115-V, ground-fault, circuit-interrupter type.
   3. Condensate drain trap.
   4. Dirty-filter switch.
   5. Hail guards of steel, painted to match casing with matching corrosion protection.
   6. Step-down or Flush diffuser with aluminum grilles, insulated diffuser box with flanges, and interior transition.

S. Roof Curb:
   1. 14 gauge galvanized steel with corrosion-protection coating, gasketing, and factory-installed wood nailer; complying with NRCA standards; minimum height of 14-inches.
   2. Isolation Curb: Rigid upper and lower steel structure with vibration isolation springs having 2-inch static deflection and vertical and horizontal restraints; with elastomeric waterproof membrane.
   3. Insulate interior of the curb with 2-inches of 1.5 pound neoprene coated fiberglass insulation.
   4. Provide seismic restraints to secure the unit to the curb in accordance with Code.

PART 3 - EXECUTION

3.01 GENERAL INSTALLATION REQUIREMENTS

A. Examine areas and conditions under which units are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected.
B. Roof curb to be mounted level on roof in accordance to NRCA manuals and details. Secure to structure per engineered/sealed seismic installation details.

C. Unit to be secured to curb per seismic installation details.

D. Provide external vibration isolation or isolation curb to prevent transmission of unit-borne sound and vibration to building structure. Provide flexible connections for electrical power, fuel piping and steam piping.

E. Seal openings between curb, roof opening, ducts, electrical conduits, piping, and building interior.

F. Protect the roof from damage during installation. Secure factory touch-up paint to repair scratches and minor damage to equipment prior to Start-up. Comb evaporator and condenser coils to repair any minor fin damage.

G. Control wiring from roof-mounted equipment must be routed in conduit from above roof to inside building or must be routed through roof curb inside unit. Control wiring must not be exposed to weather.

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

I. Perform the following field quality-control tests and inspections and prepare test reports:
   1. After installing rooftop air conditioners and after electrical circuitry has been energized, test units for compliance with requirements.
   2. Inspect for and remove shipping bolts, blocks, and tie-down straps.
   3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
   4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

J. Remove malfunctioning units, replace with new units, and retest as specified above.

K. Engage a factory-authorized service representative to perform startup service.

L. Protect or remove energy recovery devices prior to starting the units to ensure damage does not occur to the devices or media. Replace at no cost to Owner if devices/media get damaged or are no longer in "as-new" condition.

M. Complete installation and startup checks according to manufacturer's written instructions and do the following:
   1. Inspect for visible damage to unit casing.
   2. Inspect for visible damage to furnace combustion chamber.
   3. Inspect for visible damage to compressor, air-cooled outside coil, energy recovery devices, internal coils, and fans.
   4. Inspect internal insulation.
   5. Verify that labels are clearly visible.
   6. Verify that clearances have been provided for servicing.
   7. Verify that controls are connected and operable.
   8. Verify that filters are installed.
   9. Clean outside coil and inspect for construction debris.
  10. Clean furnace flue and inspect for construction debris.
  11. Connect and purge gas line.
  13. Inspect operation of barometric dampers.
  14. Lubricate bearings on fan.
  15. Inspect fan-wheel rotation for movement in correct direction without vibration and binding.
  16. Adjust fan belts to proper alignment and tension.
  17. Start unit according to manufacturer's written instructions.
     a. Coordinate starting of refrigeration system during winter with manufacturer.
b. Complete startup sheets and attach copy with Contractor's startup report.
18. Inspect and record performance of interlocks and protective devices; verify sequences.
19. Operate unit for an initial period as recommended or required by manufacturer.
20. Perform the following operations for both minimum and maximum firing and adjust burner for peak efficiency. Adjust pilot to stable flame.
   a. Measure gas pressure on manifold.
   b. Measure combustion-air temperature at inlet to combustion chamber.
   c. Measure flue-gas temperature at furnace discharge.
   e. Measure supply-air temperature and volume when burner is at maximum firing rate and when burner is off. Calculate useful heat to supply air.
22. Adjust and inspect high-temperature limits.
23. Inspect outside-air dampers for proper stroke and interlock with return-air dampers.
24. Start refrigeration system and measure and record the following:
   a. Coil leaving-air, dry- and wet-bulb temperatures.
   b. Coil entering-air, dry- and wet-bulb temperatures.
   c. Outside-air, dry-bulb temperature.
   d. Outside-air-coil, discharge-air, dry-bulb temperature.
25. Inspect controls for correct sequencing of heating, mixing dampers, refrigeration, and normal and emergency shutdown.
26. Measure and record the following minimum and maximum airflows. Plot fan volumes on fan curve.
   a. Supply-air volume.
   b. Return-air volume.
   c. Relief-air volume.
   d. Outside-air intake volume.
27. Simulate maximum cooling demand and inspect the following:
   a. Compressor refrigerant suction and hot-gas pressures.
   b. Short circuiting of air through outside coil or from outside coil to outside-air intake.
28. Verify operation of remote panel, including pilot-light operation and failure modes. Inspect the following:
   a. High-limit heat exchanger.
   b. Warm-up for morning cycle.
   c. Freezestat operation.
   d. Economizer to limited outside-air changeover.
   e. Alarms.
29. After startup and performance testing, change filters, vacuum heat exchanger and cooling and outside coils, lubricate bearings, adjust belt tension, and inspect operation of power vents.

N. Adjust initial temperature, humidity, and CO2 set points.
O. Set field-adjustable switches and circuit-breaker trip ranges as indicated.
P. Occupancy Adjustments: Within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to site outside normal occupancy hours for this purpose, without additional cost.
Q. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain rooftop air conditioners. Reference Division 01, General Requirements.
3.02 ROOFTOP PACKAGE AIR CONDITIONING UNITS, CONSTANT OR VARIABLE VOLUME (UP TO 20 TONS) INSTALLATION

A. Verify gas flue clearance from adjacent air intakes and building openings per local code and latest version of ASHRAE 62.1 prior to installation. Provide manufacturer’s flue extension(s) if unable to maintain horizontal clearances.

B. Piping installation requirements are specified in other Division 23, HVAC Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

C. Install piping adjacent to machine to allow service and maintenance.
   1. Gas Piping: Comply with applicable requirements in Division 23, HVAC. Connect gas piping to burner, full size of gas train inlet, and connect with union and shutoff valve with sufficient clearance for burner removal and service.

D. Duct installation requirements are specified in other Division 23, HVAC Sections. Drawings indicate the general arrangement of ducts. The following are specific connection requirements:
   1. Install ducts to termination in roof curb.
   2. Remove roof decking only as required for passage of ducts. Do not cut out decking under entire roof curb.
   3. Terminate return-air duct through roof structure.
   4. Fill void between roof and bottom of unit with 3-pound density acoustic batt.
   5. Install normal-weight, 3000 PSI (20.7 MPa), compressive strength (28-day) concrete mix inside roof curb, 4-inches thick.

E. Electrical System Connections: Comply with applicable requirements in Division 26, Electrical Sections for power wiring, switches, and motor controls.

F. Ground equipment according to Division 26, Electrical.

G. Tighten electrical connectors and terminals according to manufacturer’s published torque-tightening values. If manufacturer’s torque values are not indicated, use those specified in UL 486A and UL 486B.

END OF SECTION
SECTION 23 8200 - TERMINAL HEAT TRANSFER EQUIPMENT

PART 1 - GENERAL

1.01 SUMMARY
   A. Work Included:
      1. Electric Wall Heaters

1.02 RELATED SECTIONS
   A. Contents of Division 23, HVAC and Division 01, General Requirements apply to this Section.

1.03 REFERENCES AND STANDARDS
   A. References and Standards as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

1.04 SUBMITTALS
   A. Submittals as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

1.05 QUALITY ASSURANCE
   A. Quality assurance as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

1.06 WARRANTY
   A. Warranty of materials and workmanship as outlined in Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

PART 2 - PRODUCTS

2.01 MANUFACTURERS
   A. Electric Wall Heaters:
      1. Trane
      2. Markel
      3. Qmark
      4. Chromalox
      5. Or approved equivalent.

2.02 ELECTRIC WALL HEATERS
   A. Description: Wall mounted forced air unit heater, including enclosure for recessed mounting, fan and motor, heating elements and wall box. UL listed and wired per NEC.
   B. Cabinet: 20 gauge zinc coated steel, 16 gauge painted exterior grille.
   C. Fan and Motor: Propeller type fan, totally enclosed motor with permanently lubricated bearings and thermal overload protection, vandal proof.
   D. Heating Element: Sealed tubular type with finned heating elements, manual reset thermal limit safety switch, fan purge limit to dissipate residual heat on heater shutdown.

PART 3 - EXECUTION

3.01 GENERAL INSTALLATION REQUIREMENTS
   A. Avoid interference with structure and with work of other trades, preserving adequate headroom and clearing doors and passageways. Check each piece of equipment for defects, verifying that items function properly and that adjustments have been made.
   B. Prior to acceptance, thoroughly clean exposed portions of terminal heat transfer equipment, remove shipping labels and traces of foreign substance. Touch up scratched surfaces of radiant panels with factory matching paint.
3.02 ELECTRIC WALL HEATERS INSTALLATION

A. Damaged Coils: Make every effort to prevent damage to both built-up coils and coils of packaged equipment. Comb damaged coil fins to be straight.

B. Install per manufacturer's instructions. Comply with NEC and UL listings.

C. Install heaters in place with box trim flush with finished wall.

D. Install thermostat as shown on drawings. Provide control wiring from thermostat to unit.

END OF SECTION
SECTION 26 0000 - ELECTRICAL BASIC REQUIREMENTS

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Work included in 26 00 00, Electrical Basic Requirements applies to Division 26, Electrical work to provide materials, labor, tools, permits, incidentals, and other services to provide and make ready for Owner's use of electrical systems for proposed project.

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

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

1.02 RELATED SECTIONS

A. Contents of Section applies to Division 26, Electrical Contract Documents.

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

1.03 REFERENCES AND STANDARDS

A. References and Standards per Division 00, Procurement and Contracting Requirements and Division 01, General Requirements, individual Division 26, Electrical Sections and those listed in this Section.

B. Codes to include latest adopted editions, including current amendments, supplements and local jurisdiction requirements in effect as of the date of the Contract Documents, of/from:
   1. State of Oregon:
      a. OAR - Oregon Administrative Rules
      b. OESC - Oregon Electrical Specialty Code
      c. OFC - Oregon Fire Code
      d. OMSC - Oregon Mechanical Specialty Code
      e. OPSC - Oregon Plumbing Specialty Code
      f. OSSC - Oregon Structural Specialty Code
      g. OEESC - Oregon Energy Efficiency Specialty Code
      h. Oregon Elevator Specialty Code
C. Reference standards and guidelines include but are not limited to the latest adopted editions from:
   1. ABA - Architectural Barriers Act
   2. ADA - Americans with Disabilities Act
   3. ANSI - American National Standards Institute
   4. APWA - American Public Works Association
   5. ASCE - American Society of Civil Engineers
   6. ASHRAE Guideline 0, the Commissioning Process
   7. ASTM - ASTM International
   8. CFR - Code of Federal Regulations
   9. EPA - Environmental Protection Agency
   10. ETL - Electrical Testing Laboratories
   11. FCC - Federal Communications Commission
   12. FM - FM Global
   13. IBC - International Building Code
   14. IEC - International Electrotechnical Commission
   15. IEEE - Institute of Electrical and Electronics Engineers
   16. IES - Illuminating Engineering Society
   17. ISO - International Organization for Standardization
   18. MSS - Manufacturers Standardization Society
   19. NEC - National Electric Code
   20. NECA - National Electrical Contractors Association
   21. NEMA - National Electrical Manufacturers Association
   22. NETA - National Electrical Testing Association
   23. NFPA - National Fire Protection Association
   24. OSHA - Occupational Safety and Health Administration
   25. UL - Underwriters Laboratories Inc.

D. See Division 26, Electrical individual Sections for additional references.

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

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

1.04 SUBMITTALS

A. See Division 01, General Requirements for Submittal Procedures as well as individual Division 26, Electrical Sections.

B. Provide drawings in format and software release equal to the design documents. Drawings to be the same sheet size and scale as the Contract Documents.

C. In addition:
   1. "No Exception Taken" constitutes that review is for general conformance with the design concept expressed in the Contract Documents for the limited purpose of checking for conformance with information given. Any action is subject to the requirements of the Contract Documents. Contractor is responsible for the dimensions and quantity and will confirm and correlate at the job site, fabrication processes and techniques of construction, coordination of the work with that of all other trades, and the satisfactory performance of the work.
   2. Provide product submittals and shop drawings in electronic format only. Electronic format must be submitted via zip file via e-mail or posted to ftp site. For electronic format, provide one zip file per specification division containing a separate file for each Specification.
Section. Individual submittals sent piecemeal in a per Specification Section method will be returned without review or comment. All transmissions/submissions to be submitted to Architect. Deviations will be returned without review.

3. Product Data: Provide manufacturer's descriptive literature for products specified in Division 26, Electrical Sections.

4. Identify/mark each submittal in detail. Note what differences, if any, exist between the submitted item and the specified item. Failure to identify the differences will be considered cause for disapproval. If differences are not identified and/or not discovered during the submittal review process, Contractor remains responsible for providing equipment and materials that meet the specifications and drawings.
   a. Label submittal to match numbering/references as shown in Contract Documents. Highlight and label applicable information to individual equipment or cross out/remove extraneous data not applicable to submitted model. Clearly note options and accessories to be provided, including field installed items. Highlight connections by/to other trades.
   b. Include technical data, installation instructions and dimensioned drawings for products, fixtures, equipment and devices installed, furnished or provided. Reference individual Division 26, Electrical specification Sections for specific items required in product data submittal outside of these requirements.
   c. See Division 26, Electrical individual Sections for additional submittal requirements outside of these requirements.

5. Maximum of two reviews of complete submittal package. Arrange for additional reviews and/or early review of long-lead items; Bear costs of these additional reviews at Engineer's hourly rates. Incomplete submittal packages/submittals will be returned to contractor without review.

6. Resubmission Requirements: Make corrections or changes in submittals as required, and in consideration of Engineer’s comments. Identify Engineer’s comments and provide an individual response to each of the Engineer’s comments. Cloud changes in the submittals and further identify changes which are in response to Engineer's comments.

7. Structural/Seismic: Provide weights, dimensions, mounting requirements and like information required for mounting, seismic bracing, and support. Indicate manufacturer's installation and support requirements to meet ASCE 7-10 requirements for non-structural components. Provide engineered seismic drawings and equipment seismic certification. Equipment Importance Factor as specified in Division 01 and in Structural documents.

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

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

10. Substitutions and Variation from Basis of Design:
   a. The Basis of Design designated product establishes the qualities and characteristics for the evaluation of any comparable products by other listed acceptable manufacturers if included in this Specification or included in an approved Substitution Request as judged by the Design Professional.
   b. If substitutions and/or equivalent equipment/products are being proposed, it is the responsibility of parties concerned, involved in, and furnishing the substitute and/or equivalent equipment to verify and compare the characteristics and requirements of that furnished to that specified and/or shown. If greater capacity and/or more materials and/or more labor is required for the rough-in, circuitry or connections than for the item specified and provided for, then provide compensation for additional charges required for the proper rough-in, circuitry and connections for the equipment being furnished. No additional charges above the Base Bid, including resulting charges for work performed under other Divisions, will be allowed for such revisions. Coordinate with the requirements of "Submittals". For any product marked "or
approved equivalent", a substitution request must be submitted to Engineer for approval prior to purchase, delivery or installation.

11. Shop Drawings: Provide coordinated shop drawings which include physical characteristics of all systems, device layout plans, and control wiring diagrams. Reference individual Division 26, Electrical specification Sections for additional requirements for shop drawings outside of these requirements.
   a. Provide Shop Drawings indicating access panel locations, size and elevation for approval prior to installation.

12. Samples: Provide samples when requested by individual Sections.

13. Resubmission Requirements:
   a. Make any corrections or change in submittals when required. Provide submittals as specified. The engineer will not be required to edit and/or interpret the Contractor’s submittals. Indicate changes for the resubmittal in a cover letter with reference to page(s) changed and reference response to comment. Cloud changes in the submittals.
   b. Resubmit for review until review indicates no exception taken or "make corrections as noted".

14. Operation and Maintenance Manuals, Owners Instructions:
   a. Submit, at one time, electronic files (PDF format) on CD/DVD of manufacturer's operation and maintenance instruction manuals and parts lists for equipment or items requiring servicing. Submit data when work is substantially complete and in same order format as submittals. Include name and location of source parts and service for each piece of equipment.
      1) Include copy of approved submittal data along with submittal review letters received from Engineer. Data to clearly indicate installed equipment model numbers. Delete or cross out data pertaining to other equipment not specific to this project.
      2) Include copy of manufacturer's standard Operations and Maintenance for equipment. At front of each tab, provide routine maintenance documentation for scheduled equipment. Include manufacturer's recommended maintenance schedule and highlight maintenance required to maintain warranty. Furnish list of routine maintenance parts, including part numbers, sizes, quantities, relevant to each piece of equipment.
      3) Include Warranty per Division 00, Procurement and Contracting Requirements and Division 01, General Requirements, Section 26 00 00, Electrical Basic Requirements and individual Division 26, Electrical Sections.
      4) Include product certificates of warranties and guarantees.
      5) Include copy of complete parts list for equipment. Include available exploded views of assemblies and sub assemblies.
      6) Include commissioning reports.
      7) Include copy of startup and test reports specific to each piece of equipment.
      8) Engineer will return incomplete documentation without review. Engineer will provide one set of review comments in Submittal Review format. Contractor must arrange for additional reviews; Contractor to bear costs for additional reviews at Engineer's hourly rates.
   b. Thoroughly instruct Owner in proper operation of equipment and systems. Where noted in individual Sections, training will include classroom instruction with applicable training aids and systems demonstrations. Field instruction per Section 26 00 00, Electrical Basic Requirements, Demonstration.
   c. Copies of certificates of code authority inspections, acceptance, code required acceptance tests, letter of conformance and other special guarantees, certificates of warranties, specified elsewhere or indicated on Drawings.

15. Record Drawings:
   a. Maintain at site at least one set of drawings for recording "As-constructed" conditions. Indicate on drawings changes to original documents by referencing revision
document, and include buried elements, location of conduit, and location of concealed electrical items. Include items changed by field orders, supplemental instructions, and constructed conditions.

b. Record Drawings are to include equipment and fixture/connection schedules that accurately reflect “as constructed or installed” for project.

c. At completion of project, input changes to original project on Revit Model and make one set of black-line drawings created from Revit Model in version/release equal to contract drawings. Submit Revit disk and drawings upon substantial completion.

d. See Division 26, Electrical individual Sections for additional items to include in record drawings.

1.05 QUALITY ASSURANCE

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

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

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

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

E. Provide products that are UL listed.

1.06 WARRANTY

A. Provide written warranty covering the work for a period of one year from date of Substantial Completion in accordance with Division 00, Procurement and Contracting Requirements and Division 01, General Requirements, Section 26 00 00, Electrical Basic Requirements and individual Division 26, Electrical Sections.

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

1.07 COORDINATION DOCUMENTS

A. Prior to construction, coordinate installation and location of HVAC equipment, ductwork, grilles, diffusers, piping, plumbing equipment/fixtures, fire sprinklers, plumbing, lights, cable tray and electrical services with architectural and structural requirements, and other trades (including ceiling suspension and tile systems), and provide maintenance access requirements. Coordinate with submitted architectural systems (i.e. roofing, ceiling, finishes) and structural systems as submitted, including footings and foundation. Identify zone of influence from footings and ensure systems are not routed within the zone of influence.

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

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

D. Submit final Coordination Drawings with changes as Record Drawings at completion of project.
PART 2 - PRODUCTS

2.01 MANUFACTURERS
   A. Provide like items from one manufacturer.

2.02 MATERIALS
   A. Base contract upon furnishing materials as specified. Materials, equipment, and fixtures used for construction are to be new, latest products as listed in manufacturer's printed catalog data and are to be UL or ETL approved or have adequate approval or be acceptable by state, county, and city authorities. Equipment/fixture supplier is responsible for obtaining State, County, and City acceptance on equipment/fixtures that are not UL approved or are not listed for installation.
   B. Articles, fixtures, and equipment of a kind to be standard product of one manufacturer.
   C. Names and manufacturer's names denote character and quality of equipment desired and are not to be construed as limiting competition.
   D. Hazardous Materials:
      2. Comply with Division 00, Procurement and Contracting Requirements and Division 01, General Requirements for this project relating to hazardous materials.
      3. Do not use any materials containing a hazardous substance. If hazardous materials are encountered, do not disturb; immediately notify Owner and Architect. Hazardous materials will be removed by Owner under separate contract.

2.03 ACCESS PANELS
   A. See Division 01, General Requirements and Division 08, Openings for products and installation requirements.
   B. Confirm Access Panel requirements in Division 01, General Requirements, Division 08, Openings and individual Division 26, Electrical Sections. In the absence of specific requirements, comply with the following:
      1. Provide flush mounting access panels for service of systems and individual components requiring maintenance or inspection. Where access panels are located in fire-rated assemblies of building, rate access panels accordingly.
         a. Ceiling access panels to be minimum of 24-inch by 24-inch.
         b. Wall access panels to be minimum of 12-inch by 12-inch.
         c. Provide screwdriver operated catch.
   d. Manufacturers and Models:
      1) Drywall: Karp KDW.
      2) Plaster: Karp DSC-214PL.
      3) Masonry: Karp DSC-214M.
      4) 2 hour rated: Karp KPF-350FR.
      5) Manufacturers: Milcor, Elmdor, Acudor, or approved equivalent.

PART 3 - EXECUTION

3.01 ACCESSIBILITY AND INSTALLATION
   A. Confirm Accessibility and Installation requirements in Division 00, Procurement and Contracting Requirements, Division 01, General Requirements, Section 26 00 00, Electrical Basic Requirements and individual Division 26, Electrical Sections.
   B. Install equipment requiring access (i.e., junction boxes, light fixtures, power supplies, motors, etc.) so that they may be serviced, reset, replaced or recalibrated by service people with normal service tools and equipment. Do not install equipment in passageways, doorways, scuttles or crawlspace which would impede or block the intended usage.
   C. Install equipment and products complete as directed by manufacturer's installation instructions. Obtain installation instructions from manufacturer prior to rough-in of equipment and examine
instructions thoroughly. When requirements of installation instructions conflict with Contract Documents, request clarification from Architect prior to proceeding with installation. This includes proper installation methods, sequencing, and coordination with other trades and disciplines.

D. Earthwork:
1. Confirm Earthwork requirements in Contract Documents. In the absence of specific requirements, comply with individual Division 26, Electrical Sections and the following:
   a. Perform excavation, dewatering, shoring, bedding, and backfill required for installation of work in this Division in accordance with related earthwork Sections. Contact utilities and locate existing utilities prior to excavation. Repair any work damaged during excavation or backfilling.
   b. Excavation: Do not excavate under footings, foundation bases, or retaining walls.
   c. Provide protection of underground systems. Review the project Geotechnical Report for references to corrosive or deleterious soils which will reduce the performance or service life of underground systems materials.

E. Firestopping:
1. Confirm requirements in Division 07, Thermal and Moisture Protection. In the absence of specific requirements, comply with individual Division 26, Electrical Sections and the following:
   a. Coordinate location and protection level of fire and/or smoke rated walls, ceilings, and floors. When these assemblies are penetrated, seal around piping and equipment with approved firestopping material. Install firestopping material complete as directed by manufacturer's installation instructions. Meet requirements of ASTM E814, Standard Test Method for Fire Tests of Through-Penetration Fire Stops.

F. Plenums:
1. In plenums, provide plenum rated materials that meet the requirements to be installed in plenums. Immediately notify Architect/Engineer of discrepancy.

G. Start up equipment, in accordance with manufacturer's start-up instructions, and in presence of manufacturer's representative. Test controls and demonstrate compliance with requirements. Replace damaged or malfunctioning controls and equipment.

H. Provide miscellaneous supports/metals required for installation of equipment and conduit.

3.02 SEISMIC CONTROL

A. Confirm Seismic Control requirements in Division 01, General Requirements, Structural documents, and individual Division 26 Electrical Sections.

B. General:
1. Earthquake resistant designs for Electrical (Division 26) equipment and distribution, i.e. power distribution equipment, generators, UPS, etc. to conform to regulations of jurisdiction having authority.
2. Restraints which are used to prevent disruption of function of piece of equipment because of application of horizontal force to be such that forces are carried to frame of structure in such a way that frame will not be deflected when apparatus is attached to a mounting base and equipment pad, or to structure in normal way, utilizing attachments provided. Secure equipment and distribution systems to withstand a force in direction equal to value defined by jurisdiction having authority.
3. Provide stamped shop drawings from licensed Structural Engineer of seismic bracing and seismic movement assemblies for conduit and equipment. Submit shop drawings along with equipment submittals.
4. Provide stamped shop drawings from licensed Structural Engineer of seismic flexible joints for conduit crossing building expansion or seismic joints. Submit shop drawings along with seismic bracing details.
5. Provide means to prohibit excessive motion of electrical equipment during earthquake.
3.03 REVIEW AND OBSERVATION
A. Confirm Review and Observation requirements in Division 00, Procurement and Contracting Requirements, Division 01, General Requirements, Section 26 00 00, Electrical Basic Requirements and individual Division 26, Electrical Sections.
B. Notify Architect, in writing, at following stages of construction so that they may, at their option, visit site for review and construction observation:
   1. Underground conduit installation prior to backfilling.
   2. Prior to covering walls.
   3. Prior to ceiling cover/installation.
   4. When main systems, or portions of, are being tested and ready for inspection by AHJ.
C. Final Punch:
   1. Prior to requesting a final punch visit from the Engineer, request from Engineer the Electrical Precloseout Checklist, complete the checklist confirming completion of systems’ installation, and return to Engineer. Request a final punch visit from the Engineer, upon Engineer’s acceptance that the electrical systems are ready for final punch.
   2. Costs incurred by additional trips required due to incomplete systems will be the responsibility of the Contractor.

3.04 CONTINUITY OF SERVICE
A. Confirm requirements in Division 00, Procurement and Contracting Requirements and Division 01, General Requirements. In the absence of specific requirements in Division 01, General Requirements, comply with individual Division 26, Electrical Sections and the following:
   1. During remodeling or addition to existing structure, while existing structure is occupied, present services to remain intact until new construction, facilities or equipment is installed.
   2. Prior to changing over to new service, verify that every item is thoroughly prepared. Install new wiring, and wiring to point of connection.
   3. Coordinate transfer time to new service with Owner. If required, perform transfer during off-peak hours. Once changeover is started, pursue to its completion to keep interference to a minimum.
      a. If overtime is necessary, there will be no allowance made by Owner for extra expense for such overtime or shift work.
   4. No interruption of services to any part of existing facilities will be permitted without express permission in each instance from Owner. Requests for outages must state specific dates, hours and maximum durations, with outages kept to these specific dates, hours and maximum durations. Obtain written permission from Owner for any interruption of power, lighting or signal circuits and systems.
      a. Organize work to minimize duration of power interruption.
      b. Coordinate utility service outages with utility company.

3.05 CUTTING AND PATCHING
A. Confirm requirements in Division 00, Procurement and Contracting Requirements and Division 01, General Requirements. In the absence of specific requirements in Division 01, General Requirements, comply with individual Division 26, Electrical Sections and the following:
   1. Proposed floor cutting/core drilling/sleeve locations to be approved by Project Structural Engineer. Submit proposed locations to Architect/Project Structural Engineer. Where slabs are of post tension construction, perform x-ray scan of proposed penetration locations and submit scan results including proposed penetration locations to Project Structural Engineer/Architect for approval. Where slabs are of waffle type construction, show column cap extent and cell locations relative to proposed penetration(s).
   2. Cutting, patching and repairing for work specified in this Division including plastering, masonry work, concrete work, carpentry work, and painting included under this Section will be performed by skilled craftsmen of each respective trade in conformance with appropriate Division of Work.
3. Additional openings required in building construction to be made by drilling or cutting. Use of jack hammer is specifically prohibited. Patch openings in and through concrete and masonry with grout.

4. Restore new or existing work that is cut and/or damaged to original condition. Patch and repair specifically where existing items have been removed. This includes repairing and painting walls, ceilings, etc. where existing conduit and devices are removed as part of this project. Where alterations disturb lawns, paving, and/or walks, surfaces to be repaired, refinished and left in condition matching existing prior to commencement of work.

5. Additional work required by lack of proper coordination will be provided at no additional cost to the Owner.

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

3.07 DELIVERY, STORAGE AND HANDLING
   A. Confirm requirements in Division 00, Procurement and Contracting Requirements and Division 01, General Requirements. In the absence of specific requirements, comply with individual Division 26, Electrical Sections and the following:
      1. Handle materials delivered to project site with care to avoid damage. Store materials on site inside building or protected from weather, dirt and construction dust. Products and/or materials that become damaged due to water, dirt, and/or dust as a result of improper storage and handling to be replaced before installation.
      2. Protect equipment to avoid damage. Close conduit openings with caps or plugs. Keep motors and bearings in watertight and dustproof covers during entire course of installation.
      3. Protect bus duct and similar items until in service.

3.08 DEMONSTRATION
   A. Confirm Demonstration requirements in Division 00, Procurement and Contracting Requirements, Division 01, General Requirements, and individual Division 26, Electrical Sections.
   B. Upon completion of work and adjustment of equipment, test systems and demonstrate to Owner's Representative, Architect, and Engineer that equipment furnished and installed or connected under provisions of these Specifications functions in manner required. Provide field instruction to Owner's Maintenance Staff as specified in Division 01, General Requirements, Section 26 00 00, Electrical Basic Requirements and individual Division 26, Electrical Sections.
   C. Manufacturer's Field Services: Furnish services of a qualified person at time approved by Owner, to instruct maintenance personnel, correct defects or deficiencies, and demonstrate to satisfaction of Owner that entire system is operating in satisfactory manner and complies with requirements of other trades that may be required to complete work. Complete instruction and demonstration prior to final job site observations.

3.09 CLEANING
   A. Confirm Cleaning requirements in Division 01, General Requirements, Section 26 00 00, Electrical Basic Requirements and individual Division 26, Electrical Sections.
   B. Upon completion of installation, thoroughly clean electrical equipment, removing dirt, debris, dust, temporary labels and traces of foreign substances. Throughout work, remove construction debris and surplus materials accumulated during work.

3.10 INSTALLATION
   A. Confirm Installation requirements in Division 00, Procurement and Contracting Requirements and Division 01, General Requirements, Section 26 00 00, Electrical Basic Requirements and individual Division 26, Electrical Sections.
B. Install equipment and fixtures in accordance with manufacturer's installation instructions, plumb and level and firmly anchored to vibration isolators. Maintain manufacturer's recommended clearances.

C. Start up equipment, in accordance with manufacturer's start-up instructions, and in presence of manufacturer's representative. Test controls and demonstrate compliance with requirements. Replace damaged or malfunctioning controls and equipment.

D. Provide miscellaneous supports/metals required for installation of equipment.

3.11 PAINTING

A. Confirm requirements in Division 01, General Requirements and Division 09, Finishes. In the absence of specific requirements, comply with individual Division 26, Electrical Sections and the following:

1. Ferrous Metal: After completion of work, thoroughly clean and paint exposed supports constructed of ferrous metal surfaces (i.e., hangers, hanger rods, equipment stands, etc.) with one coat of black asphalt varnish for exterior or black enamel for interior, suitable for hot surfaces.

2. In Electrical Room, on roof or other exposed areas, equipment not painted with enamel to receive two coats of primer and one coat of rustproof enamel, colors as selected by Architect.

3. See individual equipment Specifications for other painting.

4. Structural Steel: Repair damage to structural steel finishes or finishes of other materials damaged by cutting, welding or patching to match original.

5. Conduit: Clean, primer coat and paint interior/exterior conduit exposed in public areas with two coats paint suitable for metallic surfaces. Color selected by Architect.

6. Covers: Covers such as manholes, vaults and the like will be furnished with finishes which resist corrosion and rust.

3.12 ACCESS PANELS

A. Confirm Access Panel requirements in Division 01, General Requirements. In the absence of specific requirements in Division 01, General Requirements, comply with individual Division 26, Electrical Sections and the following:

1. Coordinate locations/sizes of access panels with Architect prior to work.

3.13 DEMOLITION

A. Confirm requirements in Division 01, General Requirements and Division 02, Existing Conditions. In the absence of specific requirements, comply with individual Division 26, Electrical Sections and the following:

1. It is the intent of these documents to provide necessary information and adjustments to electrical system required to meet code, and accommodate installation of new work.

2. Coordinate with Owner so that work can be scheduled not to interrupt operations, normal activities, building access or access to different areas. Owner will cooperate to best of their ability to assist in coordinated schedule, but will remain final authority as to time of work permitted.

3. Examination:
   a. Determine exact location of existing utilities and equipment before commencing work, compensate Owner for damages caused by failure to locate and preserve utilities. Replace damaged items with new material to match existing.
   b. Verify that abandoned wiring and equipment serve only abandoned facilities.
   c. Demolition drawings are based on casual field observation and existing record documents.
      1) Verify accuracy of information shown prior to bidding and provide such labor and material as is necessary to accomplish work.
      2) Verify location and number of electrical outlets, luminaires, panels, etc. in field.
   d. Report discrepancies to Architect before disturbing existing installation.
      1) Promptly notify Owner if utilities are found which are not shown on Drawings.
4. Execution:
   a. Remove existing luminaires, switches, receptacles, and other electrical equipment and devices and associated wiring from walls, ceilings, floors, and other surfaces scheduled for remodeling, relocation, or demolition unless shown as retained or relocated on Drawings.
   b. Provide temporary wiring and connections to maintain electrical continuity of existing systems during construction. Remove or relocate electrical boxes, conduit, wiring, equipment, and luminaires, as encountered in removed or remodeled areas in existing construction affected by this work.
   c. Remove and restore wiring which serves usable existing outlets clear of construction or demolition.
   d. If existing junction boxes will be made inaccessible, or if abandoned outlets serve as feed through boxes for other existing electrical equipment which is being retained, provide new conduit and wire to bypass inaccessible junction boxes and abandoned outlets.
   e. If existing conduits pass through partitions or ceiling which are being removed or remodeled, provide new conduit and wire to reroute clear of construction or demolition and maintain service to existing load.
   f. Extend circuiting and devices in existing walls to be furred out.
   g. Remove abandoned wiring to source of supply.
   h. Remove exposed abandoned conduit, including abandoned conduit above accessible ceiling finishes. Cut conduit flush with walls and floors, and patch surfaces.
   i. Disconnect abandoned outlets and remove devices. Remove abandoned outlets if conduit servicing them is abandoned and removed. Provide blank cover for abandoned outlets which are not removed.
   j. Disconnect and remove abandoned panelboards and distribution equipment.
   k. Disconnect and remove electrical devices and equipment serving utilization equipment that has been removed.
   l. Existing lighting which is to remain, leave luminaires in proper working order.
   m. Repair adjacent construction and finishes damaged during demolition work.
   n. Maintain access to existing electrical installations which remain active. Modify installation or provide access panel as appropriate.

3.14 ACCEPTANCE
A. Confirm requirements in Division 00, Procurement and Contracting Requirements and Division 01, General Requirements. In the absence of specific requirements, comply with individual Division 26, Electrical Sections and the following:
   1. System cannot be considered for acceptance until work is completed and demonstrated to Architect that installation is in strict compliance with Specifications, Drawings and manufacturer's installation instructions, particularly in reference to following:
      a. Cleaning
      b. Operation and Maintenance Manuals
      c. Training of Operating Personnel
      d. Record Drawings
      e. Warranty and Guaranty Certificates
      f. Start-up/Test Document and Commissioning Reports

3.15 FIELD QUALITY CONTROL
A. Confirm Field Quality Control requirements in Division 01, General Requirements, Section 26 00 00, Electrical Basic Requirements and individual Division 26, Electrical Sections.
B. Tests:
   1. Conduct tests of equipment and systems to demonstrate compliance with requirements specified. Reference individual Specification Sections for required tests. Document tests and include in operation and maintenance manuals.
2. During site evaluations by Architect or Engineer, provide appropriate personnel with tools to remove and replace trims, covers, and devices so that proper evaluation of installation can be performed.

3.16 LETTER OF CONFORMANCE

A. Provide Letter of Conformance, copies of manufacturers' warranties and extended warranties with a statement that Electrical items were installed in accordance with manufacturer's recommendations, UL listings and FM Global approvals. Include Letter of Conformance, copies of manufacturers’ warranties and extended warranties in Operation and Maintenance Manuals.
SECTION 26 0509 - EQUIPMENT WIRING

PART 1 - GENERAL

1.01 SUMMARY
   A. Work Included:
      1. Equipment connections, whether furnished by Owner or other Divisions of the Contract.
      2. Equipment grounding.

1.02 RELATED SECTIONS
   A. Contents of Division 26, Electrical and Division 01, General Requirements apply to this Section.

1.03 REFERENCES AND STANDARDS
   A. References and Standards as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.

1.04 SUBMITTALS
   A. Submittals as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.
   B. In addition:
      1. Verify mechanical and utilization equipment electrical characteristics with Drawings and equipment submittals prior to ordering equipment. Submit confirmation of this verification as a part of, or addendum to, the electrical product submittals.

1.05 QUALITY ASSURANCE
   A. Quality assurance as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements apply to this Section.

1.06 WARRANTY
   A. Warranty of materials and workmanship as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.

PART 2 - PRODUCTS

2.01 MATERIALS
   A. Materials and Equipment for Equipment Wiring: As specified in individual Sections.

2.02 GENERAL
   A. Unless otherwise noted, the following voltage and phase characteristics apply to motors:
      1. 3/4 HP and Under: 120 volt, 1 phase.
      2. 1 HP and Over: 480 volt, 3 phase.
   B. Safety Switches: Provide as required by NEC and as specified in Section 26 28 16, Enclosed Switches and Circuit Breakers.

PART 3 - EXECUTION

3.01 EXAMINATION
   A. Prior to submittal of product data for electrical distribution equipment, obtain and examine product data and shop drawings for equipment furnished by the Owner and by other trades on the project. Update the schedule of equipment electrical connections accordingly, noting proper ratings for overcurrent devices, fuses, safety disconnect switches, conduit and wiring, and the like. As a minimum, this requirement applies to equipment furnished by Owner and equipment furnished under the following divisions of work under this contract:
      1. Division 08, Openings
      2. Division 10, Specialties
      3. Division 11, Equipment
      4. Division 22, Plumbing
      5. Division 23, HVAC, Heating, Ventilating and Air Conditioning
      6. Division 27, Communications
7. Division 28, Electronic Safety and Security

3.02 INSTALLATION

A. Do not install unrelated electrical equipment or wiring on mechanical equipment without prior approval of Engineer.

B. Provide moisture tight equipment wiring and switches in ducts or plenums used for environmental air.

C. Connect motor and appliance/utilization equipment complete from panel to motor/equipment as required by code.

D. Install motor starters and controllers for equipment furnished by others.

E. Appliance/Utilization Equipment:
   1. Provide appropriate cable and cord cap for final connection unless equipment is provided with same. Provide receptacle configured to receive cord cap.
   2. Verify special purpose outlet NEMA configuration and ampere rating with equipment supplier prior to ordering wiring devices and coverplates.

F. Motorized Projection Screens:
   1. Provide control wiring between remote switch control as shown on Drawings and screen motor per manufacturer shop drawings. Provide continuous concealed raceway for control wiring and power to screen motors.
   2. Coordinate with Division 11, Equipment and Drawing requirements.

G. Rolldown Doors:
   1. Provide control wiring between door controller, wall switch controller and limit switches for door.
   3. Coordinate with Division 08, Openings and Drawing requirements.

3.03 FIELD QUALITY CONTROL

A. Perform field inspection and testing in accordance with Division 01, General Requirements.

3.04 SYSTEMS STARTUP

A. Provide field representative to prepare and start equipment.
   1. Test and correct for proper rotation of polyphase motors.

B. Adjust for proper operation within manufacturer's published tolerances.

C. Demonstrate proper operation of equipment to Owner's designated representative.

END OF SECTION
SECTION 26 0519 - LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.01 SUMMARY
A. Work Included:
   1. Lugs and Pads
   2. Wires and Cables
   3. Splices
   4. Connectors

1.02 RELATED SECTIONS
A. Contents of Division 26, Electrical and Division 01, General Requirements apply to this Section.

1.03 REFERENCES AND STANDARDS
A. References and Standards as required by Section 26 00 00, Electrical Basic Requirements and
   Division 01, General Requirements.

1.04 SUBMITTALS
A. Submittals as required by Section 26 00 00, Electrical Basic Requirements and Division 01,
   General Requirements.
B. In addition, provide:
   1. Cable insulation test reports in project closeout documentation.

1.05 QUALITY ASSURANCE
A. Quality assurance as required by Section 26 00 00, Electrical Basic Requirements and Division
   01, General Requirements.

1.06 WARRANTY
A. Warranty of materials and workmanship as required by Section 26 00 00, Electrical Basic
   Requirements and Division 01, General Requirements.

PART 2 - PRODUCTS

2.01 MANUFACTURERS
A. Lugs and Pads:
   1. Anderson
   2. Ilsco
   3. Panduit
   4. Thomas & Betts
   5. 3M
   6. Or approved equivalent.
B. Wires and Cables:
   1. General
      a. General Cable
      b. Okonite
      c. Southwire
      d. Alcan/Stabiloy
      e. Nexans/Energex 8000
      f. Or approved equivalent.
   2. Metal Clad Cable - Type MC or Type HCF-MC:
      a. Alflex
      b. AFC
      c. General Cable
      d. Southwire
      e. Or approved equivalent.
C. Splices:
   1. Branch Circuit Splices:
      a. Ideal
      b. 3M Scotchlok
      c. Uraseal, Inc.
      d. Or approved equivalent.

D. Connectors:
   1. Anderson Power Products
   2. Burndy
   3. Ilsco
   4. 3M
   5. Thomas & Betts
   6. Or approved equivalent.

2.02 LUGS AND PADS
A. Ampacity: Cross-sectional area of pad for multiple conductor terminations to match ampere rating of panelboard bus or equipment line terminals.
B. Copper Pads: Drilled and tapped for multiple conductor terminals.
C. Lugs: Compression type for use with stranded branch circuit or control conductors; mechanical lugs for use with solid branch and feeder circuit conductors.

2.03 WIRES AND CABLES
A. Copper, 600 volt rated throughout. Conductors 12 AWG and 10 AWG, solid or stranded. Conductors 8 AWG and larger, stranded. 12 AWG minimum conductor size. Minimum insulation rating of 90 degrees C. Insulation Type: THWN-2, XHHW-2 or THHN-2.
B. Aluminum, 600 volt rated throughout. Conductors 4 AWG and larger, compact stranded. Aluminum Association 8000(AA-8000) Series alloy conductor material built to ASTM B801 specifications. Connectors and terminations to be those listed by Underwriters Laboratories Standard 486-B and marked “AL7CU” for 60C and 75C rated circuits. Connections and terminations to be installed strictly in accordance with manufacturers recommendations.
C. Phase color to be consistent at feeder terminations; A-B-C, top to bottom, left to right, front to back.
D. Color Code Conductors as Follows:

<table>
<thead>
<tr>
<th>PHASE</th>
<th>208 VOLT WYE</th>
<th>480 VOLT</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Black</td>
<td>Brown</td>
</tr>
<tr>
<td>B</td>
<td>Red</td>
<td>Orange</td>
</tr>
<tr>
<td>C</td>
<td>Blue</td>
<td>Yellow</td>
</tr>
<tr>
<td>Neutral</td>
<td>White</td>
<td>Gray or White w/colored strip</td>
</tr>
<tr>
<td>Ground</td>
<td>Green</td>
<td>Green</td>
</tr>
</tbody>
</table>

E. MC Cable: Not allowed.
F. AC Cable (Armored Cable): Not allowed.
G. NMB Cable: Not allowed.
H. SO Cord: Annealed copper conductors, 600 volt rated. Minimum size No. 12 AWG with ground wire. Maximum of six conductors and ground per cable. 90 degrees C rated thermoset jacket.

2.04 SPLICES
A. Branch Circuits: Twist on, high temperature, grounding type wing nuts.
1. Ideal Industries Wing-Nut Twist-On Connectors.
2. 3M Scotchlok Twist-On Wire Connectors.

**2.05 CONNECTORS**

A. Split bolt connectors not allowed.

B. **Aluminum Cable Compression Connections:**
   1. Provide UL-listed compression lugs that are marked AL7CU or AL9CU and have passed UL 486B or UL 486C testing procedures.
   2. Construction: Electro tin plated high conductivity aluminum. Connector marked with wire size, die index, color-coded and the proper number and location of crimps. Factory pre-filled with oxide inhibiting compound.
   3. Aluminum cable connection to aluminum bus bar: Use 2-hole aluminum compression lug and aluminum hardware. Apply UL-listed lubricant to hardware and surfaces before tightening.
   4. Aluminum cable connection to copper bus bar: Use 2-hole aluminum compression lug, plated steel hardware and Belleville washer. Apply UL-listed lubricant to hardware and surfaces before tightening.
   5. Aluminum cable connection to mechanical lugs and equipment identified as not suitable for aluminum conductor termination: Provide aluminum compression lug with stranded copper wire/cable pigtail. Equip lug compression body with insulating cover.
   6. Aluminum cable connection to dry-type transformer lugs.
   7. **Aluminum Termination Hardware:**
      a. Bolts: Anodized alloy 2023-T4 and conforming to ANSI B18.2.1 and to ASTM B211 or B221 chemical and mechanical property limits.
      b. Nuts: Aluminum alloy 6061-T6 or 6262-T9 and conforming to ANSI B18.2.2.
      c. Washers: Flat aluminum alloy Alclad 2024-T4, Type A plain, standard wide series conforming to ANSI B27.2. SAE or narrow series washers are not permitted.

C. **Conductor Branch Circuits:** Wire nuts with integral spring connectors for conductors 12 AWG through 8 AWG. Push-in type connectors where conductors are not required to be twisted together are not acceptable.

**PART 3 - EXECUTION**

**3.01 GENERAL INSTALLATION REQUIREMENTS**

A. Install per manufacturer instructions and NEC and OSSC.

B. **Field Quality Control:**
   1. Test conductor insulation on feeders of 100 amp and greater for conformity with 1000 volt megohmmeter. Use Insulated Cable Engineers Association testing procedures. Minimum insulation resistance acceptable is 1 megohm for systems 600 volts and below. Notify Architect if insulation resistance is less than 1 megohm.
   2. **Test Report:** Prepare a typed tabular report indicating the testing instrument, the feeder tested, amperage rating of the feeder, insulation type, voltage, the approximate length of the feeder, conduit type, and the measured resistance of the megohmmeter test. Submit test reports with project closeout documents.
   3. Inspect and test in accordance with NETA Standard ATS, except Section 4.
   4. Perform inspections and tests listed in NETA Standard ATS, Section 7.3.2.

**3.02 LUGS AND PADS**

A. Thoroughly clean surfaces to remove all dirt, oil, great or paint.

B. Use torque wrench to tighten per manufacturer's directions.

**3.03 WIRES AND CABLES**

A. **General:**
1. Do not install or handle thermoplastic insulated wire and cable in temperatures below +14 degrees F (-10 C).
2. Install conductors in raceways having adequate, code size cross-sectional area for wires indicated.
3. Install conductors with care to avoid damage to insulation.
4. Do not apply greater tension on conductors than recommended by manufacturer during installation.
5. Use of pulling compounds is permitted. Clean residue from exposed conductors and raceway entrances after conductor installation. Do not use pulling compounds for installation of conductors connected to GFCI circuit breakers or GFCI receptacles.
6. Do not use aluminum wire to make connections to mechanical equipment.
7. Aluminum Conductor Splices, Joints and Terminations:
   a. Join conductors using compression splice barrels or bolted compression lugs.
   b. Terminate conductors using compression lugs. Apply number of compression indents as directed by the manufacturer instructions. Uraseal splice kits are also acceptable.
8. Conductor Size and Quantity:
   a. Install no conductors smaller than 12 AWG unless otherwise shown.
   b. Provide required conductors for a fully operable system.
9. Provide dedicated neutrals (one neutral conductor for each phase conductor) in all 120V circuits and all 277V circuits.
10. Conductors in Cabinets:
    a. Cable and tree wires in panels and cabinets for power and control. Use plastic ties in panels and cabinets.
    b. Tie and bundle feeder conductors in wireways of panelboards.
    c. Hold conductors away from sharp metal edges.
11. Homeruns:
    a. Do not change intent of branch circuit homeruns without approval. Homeruns for 20A branch circuits may be combined to a maximum of six current carrying conductors including neutral conductors in homeruns. Apply derating factors as required per NEC. Increase conductor size as needed.
12. Identify wire and cable under the provisions of Section 26 05 53, Identification for Electrical Systems. Identify each conductor with its panel and circuit number as indicated.
13. Use of MC Cable is limited to the following conditions. Installations that do not comply with the following conditions are to be removed and replaced with no additional expense to the Owner.
   a. 15 and 20 amp branch wiring where following conditions apply:
      1) Where there is a suspended ceiling with accessible space above (example: suspended acoustic ceiling tile).
      2) For drops to ceiling mounted luminaires in areas with accessible ceiling space.
      3) Do not use for homeruns from branch circuit panel to first device or luminaire in circuit.
      4) Do not use in walls in areas where MC cable cannot be fished into the walls after construction is completed. For example: walls with glazing or solid beams overhead, partial height walls, etc.
      5) No single run of MC cable longer than 50-feet.

3.04 SPLICES
A. Make slices complete and promptly after wire installation. Provide single wire pigtails for luminaire and device connections. Wire nuts may be used for luminaire wire connections to single wire circuit conductor pigtails.
B. Make splices for No. 8 and larger wires with mechanically applied pressure type connectors. Make all taped joints with Scotch 33+ or equal, applied in half-lap layers without stretching to deform. Uraseal splice kits are also acceptable through 250 KCMIL.
C. Remove insulation with a stripping tool designed specifically for that purpose. A pocket knife is not an acceptable tool. Leave all conductors nick-free.

3.05 CONNECTORS
   A. Install to assure a solid and safe connection.
   B. Do not connect copper and aluminum wiring without UL listed connectors that are listed for the purposes.

END OF SECTION
SECTION 26 0526 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.01 SUMMARY
A. Work Included:
   1. Grounding Electrodes
   2. Connectors and Accessories
   3. Grounding Busbar
   4. Grounding Conductor
   5. Grounding Test Well

1.02 RELATED SECTIONS
A. Contents of Division 26, Electrical and Division 01, General Requirements apply to this Section.

1.03 REFERENCES AND STANDARDS
A. References and Standards as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.

1.04 SUBMITTALS
A. Submittals as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.
B. In addition, provide:
   1. Test reports of ground resistance for service and separately derived system grounds.

1.05 QUALITY ASSURANCE
A. Quality assurance as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.
B. In addition, meet the following:
   1. Comply with the requirements of ANSI/NFPA 70.

1.06 WARRANTY
A. Warranty of materials and workmanship as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.

PART 2 - PRODUCTS

2.01 MANUFACTURERS
A. Grounding Electrodes:
   1. Erico
   2. Thomas & Betts
   3. Talley
   4. Or approved equivalent.
B. Connectors and Accessories:
   1. Burndy Hyground Compression System
   2. Erico/Cadweld
   3. Amp Ampact Grounding System
   4. Pipe Grounding Clamp:
      a. Burndy GAR Series
      b. O Z Gedney
      c. Thomas & Betts
      d. Or approved equivalent.
C. Grounding Busbar:
   1. Chatsworth
   2. Erico
3. Schneider Electric/Square D
4. Panduit
5. Or approved equivalent.

D. Grounding Conductor
1. General Cable
2. Okonite
3. Southwire
4. Or approved equivalent

E. Grounding Test Well
1. Erico
2. Harger
3. Thompson
4. Or approved equivalent

2.02 GROUNDING ELECTRODES
   A. Ground Rods: Copper-clad steel, minimum 3/4-inch diameter, 10-feet long, tapered point, chamfered top.

2.03 CONNECTORS AND ACCESSORIES
   A. Grounding Connectors: Hydraulic compression tool applied connectors or exothermic welding process connectors or powder actuated compression tool applied connectors.
   B. Pipe Grounding Clamp: Mechanical ground connector with cable parallel or perpendicular to pipe.

2.04 GROUNDING BUSBAR
   A. Grounding Busbar: 1/4-inch thick by 4-inch high by 10-inch long copper grounding busbar with insulators that meet ANSI J-STD-607-A specifications. UL 467 listed. Hole patterns in busbar to accommodate two-hole lugs, four-hole configuration.

2.05 GROUNDING CONDUCTOR
   A. Grounding Electrode Conductor: Soft-draw bare stranded copper for wire sizes larger than #10 AWG Bare. Solid copper for wire sizes #10 AWG and smaller.
   B. Equipment Grounding Conductor: Green insulated, insulation type to match that of associated feeder or branch circuit wiring, size as indicated on drawings.

2.06 GROUNDING TEST WELL
   A. Grounding Well:
      1. Well Pipe: 8-inch diameter by 12-inch long clay tile pipe with belled end.
      2. Well Cover: Cast iron with legend "GROUND" embossed on cover. Provide lip on bottom of cover, sized to match interior pipe diameter to hold cover in place.

PART 3 - EXECUTION

3.01 GENERAL INSTALLATION REQUIREMENTS
   A. Verify site conditions prior to beginning work.
   B. Bond Sections of service equipment enclosure to service ground bus.
   C. Separately Derived Systems: Ground each separately derived system per NEC Article 250.
   D. Corrosion inhibitors: Apply a corrosion inhibitor to contact surfaces when making grounding and bonding connections. Use corrosion inhibitor appropriate for protecting a connection between metals used.
   E. Grounding system resistance to ground not to exceed 5 ohms. Make necessary modifications or additions to grounding electrode system for compliance. Submit final tests to assure that this requirement is met.
F. Resistance of grounding electrode system: measure using a four-terminal fall-of-potential method as defined in IEEE 81. Take ground resistance measurements before electrical distribution system is energized and in normally dry conditions, not less than 48 hours after last rainfall. Take resistance measurements of separate grounding electrode systems before systems are bonded together below grade. Combined resistance of separate systems may be used to meet required resistance, but specified number of electrodes must still be provided.

G. Inspect and test in accordance with NETA Standard ATS, Except Section 4.

H. Perform inspections and tests listed in NETA Standard AB, Section 7.13.

3.02 GROUNDING ELECTRODES INSTALLATION

A. Concrete-Encased Electrode ("Ufer Ground"):  
1. From service equipment ground bus provide grounding electrode conductor to footing/foundation rebar.
2. Bond #4 grounding electrode conductor to one minimum 20-foot long, 3/4-inch diameter independent steel rebar(s).
3. Protect grounding electrode conductor from footing/foundation to service equipment grounding bus with rigid PVC conduit where grounding electrode conductor passes through concrete floor or other concrete structure. Do not use rigid metal conduit for grounding electrode conductor protection.

B. Ground Rod Electrode:  
1. Verify that final backfill and compaction have been completed before driving rod electrodes.
2. Bond #6 grounding electrode conductor to driven ground rods as indicated on Drawings.
3. Tap at center ground rod and extend grounding electrode conductor to service grounding bus. Install grounding electrode conductor to service grounding bus in rigid PVC conduit for physical protection where grounding electrode conductor passes through concrete floor or other concrete structure.

C. Metal Underground Water Service: Bond water service pipe to service equipment ground bus or to the grounding electrode system. Connect to water pipe on utility side of isolating fittings or meters, bond across water meters.

D. Other Metal Piping Systems: Bond gas piping system, fire sprinkler piping system and other metal piping systems to service equipment ground bus or to the grounding electrode system.

E. Bond together metal siding not attached to grounded structure; bond to grounding electrode system.

3.03 CONNECTORS AND ACCESSORIES INSTALLATION

A. Install per manufacturer's instructions.

3.04 GROUNDING BUSBAR INSTALLATION

A. Install per manufacturer's instructions.

3.05 GROUNDING CONDUCTOR INSTALLATION

A. Raceways:  
1. Ground metallic raceway systems. Bond to ground terminal with code size jumper except where code size or larger equipment grounding conductor is included with circuit, use grounding bushing with lay-in lug.
2. Connect metal raceways, which terminate within an enclosure but without mechanical connection to enclosure, by grounding bushings and ground conductor to grounding bus.
3. Where equipment supply conductors are in flexible metallic conduit, install stranded copper equipment grounding conductor from outlet box to equipment frame.
4. Install equipment grounding conductor, code size minimum unless noted on drawings, in metallic and nonmetallic raceway systems.

B. Feeders and Branch Circuits:
   1. Provide continuous green insulated copper equipment grounding conductors for feeders and branch circuits.
   2. Where installed in a continuous solid metallic raceway system and larger sizes are not detailed, provide insulated equipment grounding conductors for feeders and branch circuits sized in accordance with the latest adopted edition of NEC Article 250, Table 250-122.

C. Bond boxes, cabinets, enclosures and panelboard equipment grounding conductors to enclosure with specified conductors and lugs. Install lugs only on thoroughly cleaned contact surfaces.

D. Motors, Equipment and Appliances: Install code size equipment grounding conductor to (motor) equipment frame or manufacturer's designated ground terminal.

E. Receptacles: Connect ground terminal of receptacle and associated outlet box to equipment grounding conductor. Self grounding nature of receptacle devices does not eliminate equipment grounding conductor bolted to outlet box.

F. Install ground grid under access floors where indicated. Construct grid of #2 AWG bare copper stranded wire installed on 24-inch centers both ways. Bond each access floor pedestal to grid.

G. Bond together each metallic raceway, pipe, duct and other metal object entering space under access floors. Bond to underfloor ground grid. Use #2 AWG bare copper conductor.

H. Bond electrostatic discharge (ESD) flooring integral grounding conductor to electrically grounded connectors or structures at two opposite locations, in the area of the ESD flooring installation.

3.06 GROUNDING TEST WELL INSTALLATION
   A. Provide grounding test well with cover at each rod location. Install test well pipe top flush with finished grade.
   B. Install per manufacturer's instructions

END OF SECTION
SECTION 26 0529 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS AND EQUIPMENT

PART 1 - GENERAL

1.01 SUMMARY
A. Work Included:
   1. Anchors, Threaded Rod and Fasteners
   2. Support Channel, Hangers and Supports

1.02 RELATED SECTIONS
A. Contents of Division 26, Electrical and Division 01, General Requirements apply to this Section.

1.03 REFERENCES AND STANDARDS
A. References and Standards as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.

1.04 SUBMITTALS
A. Submittals not required for this Section.

1.05 QUALITY ASSURANCE
A. Quality assurance as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.
   B. In addition, meet the following:
      1. Manufacturers regularly engaged in the manufacture of bolted metal framing support systems, whose products have been in satisfactory use in similar service for not less than 10 years.
      2. Support systems to be supplied by a single manufacturer.
      3. Engineering Responsibility: Design and preparation of Shop Drawings and calculations for each multiple pipe support, trapeze, equipment hangers/supports, and seismic restraint by a qualified Structural Professional Engineer.
         a. Professional Engineer Qualifications: A professional engineer who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of hangers and supports that are similar to those indicated for this Project in material, design, and extent.

1.06 WARRANTY
A. Warranty of materials and workmanship as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.

1.07 PERFORMANCE REQUIREMENTS
A. General: Provide conduit and equipment hangers and supports in accordance with the following:
   1. When supports, anchorages, and seismic restraints for equipment and supports, anchorages and seismic restraints for conduit, cable tray and equipment are not shown on the Drawings, the Contractor is responsible for their design.
   2. Connections to structural framing shall not introduce twisting, torsion, or lateral bending in the framing members. Provide supplementary steel as required.
B. Engineered Support Systems: The following support systems to be designed, detailed, and bear the seal of a professional engineer registered in the State of Oregon.
   1. Support frames such as conduit racks or stanchions for conduit and equipment which provide support from below.
   2. Equipment and piping support frame anchorage to supporting slab or structure.
C. Provide channel support systems, for conduits to support multiple conduits capable of supporting combined weight of support systems and system contents.
D. Provide heavy-duty steel trapezes for piping to support multiple conduit capable of supporting combined weight of supported systems and system contents.

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

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

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Anchors, Threaded Rod and Fasteners:
   1. Anchor It
   2. Epcon System
   3. Hilti-Hit System
   4. Power Fast System
   5. Or approved equivalent.

B. Support Channel, Hangers and Supports:
   1. B-Line
   2. Kindorf
   3. Superstrut
   4. Unistrut
   5. Or approved equivalent.

2.02 ANCHORS, THREADED ROD AND FASTENERS

A. Anchors, Threaded Rod 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. Concrete Inserts: Cast in concrete for support fasteners for loads up to 800 lbs.

C. Anchors and Fasteners:
   1. Do not use powder-actuated anchors.
   2. Concrete Structural Elements: Use precast inserts.
   3. Steel Structural Elements: Use beam clamps.
   7. Sheet Metal: Use sheet metal screws.

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

E. Bolts: Low carbon steel externally and internally threaded fasteners conforming with requirements of ASTM A307; include necessary nuts and plain hardened washers. For structural steel elements supporting mechanical material or equipment from building structural members or connection thereto, use fasteners conforming to ASTM A325.

F. Miscellaneous Materials: Provide incidental accessory materials, tools, methods, and equipment required for fabrication.

2.03 SUPPORT CHANNEL, HANGERS AND SUPPORTS

A. Hangers and Supports - General: Corrosion-resistant materials of size and type adequate to carry the loads of equipment and conduit, including weight of wire in conduit.
   2. Coating: Hot dip galvanized.

B. Pipe Straps: Two-hole galvanized or malleable iron.

C. Luminaire Chain: 90 lb. test with steel hooks.
D. Miscellaneous Metal: Provide miscellaneous metal items specified hereunder, including materials, fabrication, fastenings and accessories required for finished installation, where indicated on Drawings or otherwise not shown on drawings that are necessary for completion of the project. The Contractor is responsible for their design.

1. Fabricate miscellaneous units to size shapes and profiles indicated or, if not indicated, of required dimensions to receive adjacent other work to be retained by framing. Except as otherwise shown, fabricate from structural steel shapes and plates and steel bars, of welded construction using mitered joints for field connection. Cut, drill and tap units to receive hardware and similar items.

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

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

G. Miscellaneous Materials: Provide incidental accessory materials, tools, methods, and equipment required for fabrication.

PART 3 - EXECUTION

3.01 GENERAL INSTALLATION REQUIREMENTS

A. Fabrication - Miscellaneous Metals

1. General: Verify dimensions prior to fabrication. Form metal items to accurate sizes and configurations as indicated on Drawings and otherwise required for proper installation; make with lines straight and angles sharp, clean and true; drill, countersink, tap, and otherwise prepare items for connections with work of other trades, as required. Fabricate to detail of structural shapes, plates and bars; weld joints where practicable; provide bolts and other connection devices required. Include anchorages; clip angles, sleeves, anchor plates, and similar devices. Hot dipped galvanize after fabrication items installed in exterior locations. Set accurately in position as required and anchor securely to building construction. Construct items with joints formed for strength and rigidity, accurately machining for proper fit; where exposed to weather, form to exclude water.

2. Finishes:
   a. Ferrous Metal: After fabrication, but before erection, clean surfaces by mechanical or chemical methods to remove rust, scale, oil, corrosion, or other substances detrimental to bonding of subsequently applied protective coatings. For metal items exposed to weather or moisture, galvanize in manner to obtain G90 zinc coating in accordance with ASTM A123. Provide other non-galvanized ferrous metal with one coat of approved rust-resisting paint primer, in manner to obtain not less than 1.0 mil dry film thickness. Touch-up damaged areas in primer with same material, before installation. Apply zinc coatings and paint primers uniformly and smoothly; leave ready for finish painting as specified elsewhere.
   b. Metal in contact with Concrete, Masonry and Other Dissimilar Materials: Where metal items are to be erected in contact with dissimilar materials, provide contact surfaces with coating of an approved zinc-chromate primer in manner to obtain not less than 1.0 mil dry film thickness, in addition to other coatings specified in these specifications.
   c. For Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and apply galvanizing repair paint to comply with ASTM A780.

3.02 ANCHORS, THREADED ROD AND FASTENERS INSTALLATION

A. Safety factor of 4 required for every fastening device or support for equipment installed. Supports to withstand four times the weight of equipment it supports.

B. Do not use other trade's fastening devices as supporting means for luminaires, equipment or materials.
C. Do not fasten supports to pipes, ducts, mechanical equipment, or conduit.
D. Do not use supports or fastening devices to support other than one particular item.
E. Securely suspend junction boxes, pull boxes or other conduit terminating housings located above suspended ceiling from floor above or roof structure to prevent sagging and swaying.
F. Provide seismic bracing per IBC requirements.
G. Install surface-mounted cabinets and panelboards with minimum of four anchors.
H. Use spring lock washers under fastener nuts for strut.
I. Cutting and Drilling
   1. Do not drill or cut structural members without prior permission from Architect.

3.03 SUPPORT CHANNEL, HANGERS AND SUPPORTS 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.
B. Safety factor of 4 required for every fastening device or support for equipment installed. Supports to withstand four times the weight of equipment it supports.
C. Verify mounting height of luminaires prior to installation when heights are not detailed.
D. Install vertical support members for equipment and luminaires, straight and parallel to building walls.
E. Install horizontal support members straight and parallel to ceilings or finished floor unless otherwise noted.
F. Provide independent supports to structural member for luminaires, materials, or equipment installed in or on ceiling, walls or in void spaces or over suspended ceilings.
G. Do not use other trade's fastening devices as supporting means for luminaires, equipment or materials.
H. Do not fasten supports to pipes, ducts, mechanical equipment, or conduit.
I. Do not use supports or fastening devices to support other than one particular item.
J. Support conduits within 18-inches of outlets, boxes, panels, cabinets and deflections unless more stringently required by NEC.
K. Maximum distance between supports not to exceed 8 foot spacing unless otherwise required by NEC.
L. Support flexible conduits and metal clad cable within 12-inches of outlets, boxes, panels, cabinets and deflections unless otherwise required by NEC.
M. Maximum distance between supports for flexible conduits and metal clad cable not to exceed 48-inches spacing unless otherwise required by NEC.
N. Maximum distance between supports for auxiliary gutters and wireways unless otherwise required by NEC is as follows:
   1. Sheet metal auxiliary gutters and wireways - 4-feet apart horizontally and 10-feet vertically.
   2. Non-metallic auxiliary gutters and wireways - 30-inches apart horizontally and 3-feet vertically.
O. Install strut hangers as instructed by strut manufacturer. Suspend strut hangers as instructed by strut manufacturer for the load, with a maximum spacing of 8-feet on center and within 2-feet of outlet box, cabinet, junction box or other channel raceway termination unless otherwise required by NEC.
P. Coordinate routing of conduit racks with materials and equipment installed by other trades. Where conduit racks are exposed to view, coordinate location and installation with Architect for optimal appearance.
Q. Securely suspend junction boxes, pull boxes or other conduit terminating housings located above suspended ceiling from floor above or roof structure to prevent sagging and swaying.

R. Provide seismic bracing per IBC requirements.

S. Where service disconnects are mounted on building exterior, physically attach service disconnect to the building or structure served.

T. Install surface-mounted cabinets and panelboards with minimum of four anchors.

U. Use sheet metal channel to bridge studs above and below cabinets and panelboards recessed in hollow partitions.

V. Wet and Damp Locations:
   1. In wet and damp locations use steel channel supports to stand cabinets and panelboards 1-inch off wall.

END OF SECTION
PART 1 - GENERAL

1.01 SUMMARY
A. Work Included:
   1. Rigid Metal Conduit (RMC)
   2. Polyvinyl Chloride (PVC) Externally Coated Galvanized Rigid Metal Conduit
   3. Electrical Metallic Tubing (EMT)
   4. Flexible Metal Conduit (FMC)
   5. Liquidtight Flexible Metal Conduit (LFMC)
   6. Electrical Polyvinyl Chloride (PVC) Conduit
   7. Conduit Fittings

B. Provide a complete system of conduit and fittings, with associated couplings, connectors, and fittings, as shown on drawings and described in these specifications.

1.02 RELATED SECTIONS
A. Contents of Division 26, Electrical and Division 01, General Requirements apply to this Section.
B. In addition, reference the following:
   1. Section 26 05 29, Hangers and Supports for Electrical Systems and Equipment
   2. Section 26 05 34, Boxes

1.03 REFERENCES AND STANDARDS
A. References and Standards as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.

1.04 SUBMITTALS
A. Submittals as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.

1.05 QUALITY ASSURANCE
A. Quality assurance as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.

1.06 WARRANTY
A. Warranty of materials and workmanship as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.

1.07 DEFINITIONS
A. Raceway system is defined as consisting of conduit, tubing, duct, and fittings including but not limited to connectors, couplings, offsets, elbows, bushings, expansion/deflection fittings, and other components and accessories. Complete electrical raceway installation before starting the installation of conductors and cables.

PART 2 - PRODUCTS

2.01 MANUFACTURERS
A. Rigid Metal Conduit (RMC):
   1. Allied Tube & Conduit
   2. Beck Manufacturing Inc.
   3. Picoma
   4. Wheatland Tube Company
   5. Or approved equivalent.

B. Polyvinyl Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit:
   1. Allied Tube & Conduit
   2. Thomas & Betts Corporation
   3. Robroy Industries
4. O'kote Inc.
5. Or approved equivalent.

C. Electrical Metallic Tubing (EMT):
1. Allied Tube & Conduit
2. Beck Manufacturing WL
3. Picoma
4. Wheatland Tube Company
5. Or approved equivalent.

D. Flexible Metal Conduit (FMC):
1. AFC Cable Systems Inc.
2. Electri-Flex Company
3. International Metal Hose
4. Or approved equivalent.

E. Liquidtight Flexible Metal Conduit (LFMC):
1. AFC Cable Systems Inc.
2. Electri-Flex Company
3. International Metal Hose
4. Or approved equivalent.

F. Electrical Polyvinyl Chloride (PVC) Conduit:
1. AFC Cable Systems Inc.
2. Electri-Flex Company
3. International Metal Hose
4. JM Eagle
5. Or approved equivalent.

G. Conduit Fittings:
1. Bushings:
   a. Insulated type for Threaded Rigid, IMC, or EMT without Factory Installed Plastic Throat Conductor Protection:
      1) Thomas & Betts 1222 Series
      2) O-Z Gedney B Series
      3) Or approved Equivalent.
2. Raceway Connectors and EMT Couplings:
   a. Thomas & Betts Series
   b. O-Z Gedney Series
   c. Or approved Equivalent.
3. Expansion/Deflection Fittings:
   a. EMT: O-Z Gedney Type TX
   b. RMC: O-Z Gedney Type AX, DX and AXDX, Crouse & Hinds XD
   c. PVC: O-Z Gedney Type DX with PVC adapters, Carlon E945 Series, Kraloy OPEJ Series
   d. Or approved equivalent.

2.02 RIGID METAL CONDUIT (RMC)
A. UL 6, ANSI C80.1. Hot dipped galvanized steel conduit after thread cutting.
   1. Fittings: NEMA FB2.10.

2.03 POLYVINYL CHLORIDE (PVC) EXTERNALLY COATED GALVANIZED RIGID METAL CONDUIT
A. Description: UL 6, ANSI C80.1, and NEMA RN 1; rigid steel conduit with external PVC coating.
   1. PVC Coating: Minimum 40 mils in thickness.
B. Fittings and Conduit Bodies: NEMA FB 1; steel fittings with external PVC coating to match conduit.
2.04 ELECTRICAL METALLIC TUBING (EMT)
   A. Description: UL 797, ANSI C80.3; steel galvanized tubing.
   B. Fittings: NEMA FB 1; steel, compression type.

2.05 FLEXIBLE METAL CONDUIT (FMC)
   A. Description: UL 1, Interlocked steel construction.
   B. Fittings: NEMA FB 2.20.

2.06 LIQUIDTIGHT FLEXIBLE METAL CONDUIT (LFMC)
   A. Description: UL 360, inner core made from spiral wound strip of heavy gauge, hot dipped galvanized low carbon steel. 3/4-inch through 1-1/4-inch trade sizes to have a square lock core and contain an integral bonding strip of copper. 1-1/2-inch and larger to have fully interlocked core. Jacket material to be moisture, oil and sunlight resistant flexible PVC.
   B. Fittings: NEMA FB 2.20.

2.07 ELECTRICAL POLYVINYL CHLORIDE (PVC) CONDUIT
   A. Description: UL 651, NEMA TC 2; Schedule 40 PVC.
   B. Fittings: NEMA TC 3.

2.08 CONDUIT FITTINGS
   A. Bushings:
      1. Insulated type for Threaded Rigid, IMC Conduit or Raceway Connectors without factory-installed plastic throat conductor protection.
      2. Insulated grounding type for Threaded Rigid, IMC Conduit and Conduit Connectors.
   B. Raceway Connectors and EMT Couplings:
      1. Steel connectors, couplings, and conduit bodies, hot-dip galvanized.
      2. Connector locknuts to be steel, with threads meeting ASTM tolerances. Locknuts to be hot-dip galvanized.
      3. Connector throats (EMT, flexible conduit, metal clad cable and cordset connectors) to have factory installed plastic inserts permanently installed. For normal cable or conductor exiting angles from raceway, the cable jacket or conductor insulation to bear only on plastic throat insert.
      4. Steel gland, Tomic or Breagle connectors and couplings are recognized for this Contract as having acceptable raceway to fitting electrical conductance.
      5. Set screw connectors and couplings, without integral compression glands, are recognized for this Contract as not having acceptable raceway to fitting electrical conductance. A ground conductor sized per this Specification must be included and bonded within raceway assembly utilizing this type connector or coupling.
   C. Provide expansion/deflection fittings for EMT.

PART 3 - EXECUTION

3.01 GENERAL INSTALLATION REQUIREMENTS
   A. Finished Surfaces: Schedule raceway installation to avoid conflict with installed wall and ceiling surfaces. If unavoidable, coordinate work and repairs with Architect.
   B. Conduit Size:
      1. Minimum Size: 3/4-inch for power and control, unless otherwise noted. 3/4-inch for communication/data, unless otherwise noted. 3/4-inch for signal systems, unless otherwise noted.
   C. Underground Installations:
      1. More than 5-feet from Foundation Wall: Use PVC.
      2. Within 5-feet from Foundation Wall: Use PVC coated RMC.
      3. In or Under Slab on Grade: Use PVC.
D. In Slab Above Grade:
   1. Use PVC.
   2. Maximum Size Conduit in Slab: Contact Structural Engineer for maximum outside diameter of conduit.

E. Provide two pull strings/tapes in empty conduits. Types:
   1. Utility Company Conduit: Polyester measure/pulling tape, Greenlee 4436 or approved equivalent. Coordinate exact requirements with utility company.
   2. Feeders: Polyester measure/pulling tape, Greenlee 4436 or approved.
   3. Branch Circuits and Low Voltage: Greenlee Poly Line 431 or approved.
   4. If fish tape is used for pulling line or low voltage wiring, fiberglass type to be used. Metal fish tapes will not be allowed.
   5. Secure pull string/tape at each end.
   6. Provide caps on ends of empty conduit to be used in future.
   7. Label both ends of empty conduits with location of opposite end.

F. Elbows: Use fiberglass or PVC coated RMC for underground installations.


H. Verify that field measurements are as shown on drawings.

I. Plan locations of conduit runs in advance of the installation and coordinate with ductwork, plumbing, ceiling and wall construction in the same areas.

J. Locate penetrations and holes in advance where they are proposed in the structural sections such as footings, beams, and walls. Penetrations are acceptable only when the following occurs:
   1. Where shown on the structural drawings.
   2. As approved by the Structural Engineer prior to construction, and after submittal of drawing showing location, size, and position of each penetration.

K. Verify routing and termination locations of conduit prior to rough-in.

L. Conduit routing is shown on drawings in approximate locations unless dimensioned. Route as required to complete wiring system.

M. Install raceways securely, in neat and workmanlike manner, as specified in NECA 1, Standard Practices for Good Workmanship in Electrical Construction.

N. Install steel conduit as specified in NECA 101, Standard for Installing Steel Conduits.

O. Install nonmetallic conduit in accordance with manufacturer's instructions.

P. Inserts, anchors and sleeves.
   1. Coordinate location of inserts and anchor bolts for electrical systems prior to concrete pour.
   2. Coordinate location of sleeves with consideration for other building systems prior to concrete pour.

Q. Conduit Supports:
   1. Arrange supports to prevent misalignment during wiring installation.
   2. Support conduit using coated steel or malleable iron straps, lay-in adjustable hangers, clevis hangers, and split hangers.
   3. Group related conduits; support using conduit rack. Construct rack using steel channel. Provide space on each for 25 percent additional conduits.
   4. Do not support conduit with wire or perforated pipe straps. Remove wire used for temporary supports.
   5. Do not attach conduit to ceiling support wires.

R. Flexible steel conduit length not-to-exceed 6-feet, 3-feet in concealed walls. Provide sufficient slack to reduce the effect of vibration.
S. Install conduit seals at boundaries where ambient temperatures differ by 10 degrees F or more as shown on the drawings. Install seals on warm side of partition.

T. Seal raceways stubbing up into electrical equipment. Plug raceways with conductors with duct-seal. Cap spare raceways and plug PVC raceway products with plastic plugs as made by Underground Products, or equal, shaped to fit snugly into the stubup.

U. Seal raceways penetrating an exterior building wall to prevent moisture and vermin from entering into the electrical equipment.

V. Use suitable caps on spare and empty conduits to protect installed conduit against entrance of dirt and moisture.

W. Keep 277/480 volt wiring independent of 120/208 volt wiring. Keep power wiring independent of communication system wiring.

X. Keep emergency system wiring independent of other wiring systems per NEC 700.

Y. Installation of conduit in structural concrete that is less than 3-inches thick is prohibited without the approval of the Structural Engineer. Maintenance pads, and curbs are exempted.

Z. Raceways Embedded in Floor Slabs:
   1. Do not install raceways in slab without the approval of the Structural Engineer.
   2. Do not let raceways interfere with placement of floor slab reinforcement components.
   3. Install raceways between the upper and the lower layers of reinforcing steel.
   4. Space raceways not less than 8-inches on centers except where they converge at panels or junction boxes.
   5. Raceways running parallel to slabs supports, such as beams, columns and structural walls, to be installed not less than 12-inches from such supporting elements.
   6. Branch circuit homeruns are not permitted in slab, route branch circuit homeruns above grade exposed in approved areas or above lay-in ceiling spaces.
   7. Route conduits in or under slabs point-to-point.
   8. Do not cross conduits in slab.

AA. Arrange conduit to maintain headroom and present neat appearance.

AB. Do not install conduits on surface of building exterior, along vapor barrier, across roof, on top of parapet walls, or across floors, unless otherwise noted on drawings.

AC. Exposed conduits are permitted only in following areas:
   1. Mechanical rooms, electrical rooms or spaces where walls, ceilings and floors will not be covered with finished material.
   2. Existing walls that are concrete or block construction.
   3. Where specifically noted on Drawings.
   4. Route exposed conduit parallel and perpendicular to walls, tight to finished surfaces and neatly offset into boxes.

AD. Do not install conduits or other electrical equipment in obvious passages, doorways, scuttles or crawl spaces which would impede or block area passage's intended usage.

AE. Install continuous conduit and raceways for electrical power wiring and signal systems wiring.

AF. Route conduit installed above accessible ceilings parallel and perpendicular to walls.

AG. Maintain adequate clearance between conduit and piping.

AH. Keep conduits a minimum of 12-inches away from steam or hot water radiant heating lines (at or above 104 degrees F) or 3-inches away from waste or water lines.

AI. Cut conduit square using saw or pipecutter; deburr cut ends.

AJ. Bring conduit to shoulder of fittings; fasten securely.

AK. Use conduit hubs to fasten conduit to cast boxes in damp and wet locations.

AL. Install no more than the equivalent of three 90 degree bends between boxes. Use conduit bodies to make sharp changes in direction, as around beams.
AM. Use hydraulic one shot bender to fabricate elbows for bends in metal conduit larger than 2-inch size.
AN. Avoid moisture traps; provide junction box with drain fitting at low points in conduit system.
AO. Provide suitable fittings to accommodate expansion and deflection where conduit crosses seismic, control, and expansion joints.
AP. Conduit Terminations for Signal Systems: Provide a plastic bushing on the end of conduit used for signal system wiring.
AQ. Feeders: Do not combine or change feeder runs.
AR. Install conduit to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Division 07, Thermal and Moisture Protection.
AS. Route conduit through roof openings for piping and ductwork wherever possible. Where separate roofing penetration is required, coordinate location and installation method with roofing installation and installer.

3.02 RIGID METAL CONDUIT (RMC) INSTALLATION
A. Outdoor Locations Above Grade: RMC.
B. Damp Locations: RMC up to 2-inches in diameter.
C. Dry Locations:
   1. Concealed: RMC.
   2. Exposed: RMC.
D. Dry, Protected: RMC.
E. In areas exposed to severe mechanical damage: RMC.
F. For security conduits installed exposed and subject to tampering: RMC.
G. In hazardous areas per NEC 501: RMC.

3.03 POLYVINYL CHLORIDE (PVC) EXTERNALLY COATED GALVANIZED RIGID METAL CONDUIT INSTALLATION
A. Use PVC coated RMC 36-inch radius ells for power service conduits and 48-inch radius ells for telephone service conduits.

3.04 ELECTRICAL METALLIC TUBING (EMT) INSTALLATION
A. Damp Locations: EMT up to 2-inches in diameter.
B. Dry Locations:
   1. Concealed: EMT.
   2. Exposed: EMT.
C. Dry, Protected: EMT.

3.05 FLEXIBLE METAL CONDUIT (FMC) INSTALLATION
A. Dry Locations: Motors, recessed luminaires and equipment connections subject to movement or vibration, use flexible metallic conduit.
B. Install 12-inch minimum slack loop on flexible metallic conduit.

3.06 LIQUIDTIGHT FLEXIBLE METAL CONDUIT (LFMC) INSTALLATION
A. Use PVC coated liquidtight flexible metallic conduit for motors and equipment connections subject to movement or vibration and subjected to any of following conditions: Exterior location, moist or humid atmosphere, corrosive environments, water spray, oil, or grease.
B. Install 12-inch minimum slack loop on liquidtight flexible metallic conduit.

3.07 ELECTRICAL POLYVINYL CHLORIDE (PVC) CONDUIT INSTALLATION
A. Install in accordance with manufacturer’s instructions.
B. Provide equipment grounding conductor in PVC conduit runs containing power conductors.
C. Underground Installation:
   1. Areas subject to vehicular traffic: Schedule 80 PVC.
   2. Utility primary and secondary conduit: Schedule 80 PVC.
   3. Other underground applications: Schedule 40 PVC, except where prohibited by the NEC or local codes.

D. Convert PVC conduit to Rigid Metal Conduit (RMC) prior to emerging from underground, concrete encasement, or concrete slab.

E. Provide expansion fittings to compensate for expansion and contraction per NEC 352.44.

F. PVC elbows are not acceptable. Use fiberglass or PVC coated RMC.

G. Trim cut ends inside and outside to remove rough edges.

H. Provide bushings when entering a box, fitting or other enclosure.

3.08 CONDUIT FITTINGS INSTALLATION

A. Conduit Joints: Assemble conduits continuous and secure to boxes, panels, luminaires and equipment with fittings to maintain continuity. Provide watertight joints where embedded in concrete, below grade or in damp locations. Seal metal conduit with metal thread primer. Rigid conduit connections to be threaded, clean and tight (metal to metal). Threadless connections are not permitted for RMC and IMC. Seal conduits where penetrating below raised floor area.

B. 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.

C. Use set screw type fittings only in dry locations. When set screw fittings are utilized provide insulated continuous equipment ground conductor in conduit, from overcurrent protection device to outlet.

D. Use compression fittings in dry locations, damp and rain-exposed locations. Maximum size permitted in damp locations and locations exposed to rain is 2-inches in diameter.

E. Use threaded type fittings in wet locations, hazardous locations, and damp or rain-exposed locations where conduit size is greater than 2-inches.

F. Use PVC coated, threaded type fittings in corrosive environments.

G. Use insulated type bushings with ground provision at switchboards, panelboards, safety disconnect switches, junction boxes that have feeders 60 amperes and greater.

H. Condulets and Conduit Bodies:
   1. Do not use condulets and conduit bodies in conduits for signal wiring, in feeders 100 amp and larger, or for conductor splicing.

I. Sleeves and Chases - Floor, Ceiling and Wall Penetrations: Provide necessary rigid conduit sleeves, openings and chases where conduits or cables are required to pass through floors, ceilings or walls.

J. Expansion Joints:
   1. Provide conduits crossing expansion joints where cast in concrete with expansion-deflection fittings, installed per manufacturer's recommendations.
   2. Secure conduits 3-inches and larger to building structure on opposite sides of a building expansion joint with an expansion-deflection fitting across joint installed per manufacturer's recommendations.
   3. Provide conduits less than 3-inches where not cast in concrete with junction boxes securely fastened on both sides of expansion joint, connected together with 15-inches of slack (minimum of 15-inches longer than straight line length) flexible conduit and copper green ground bonding jumper. In lieu of this flexible conduit, an expansion-deflection fitting, as indicated for conduits 3-inch and larger may be installed.
   4. Verify expansion/deflection requirements with Structural Engineer prior to installation.

K. Seismic Joints:
1. No conduits cast in concrete allowed to cross seismic joint.
2. Provide conduits with junction boxes securely fastened on both sides of seismic joint, connected together with 15-inches of slack (minimum of 15-inches longer than straight line length) flexible conduit and copper green ground bonding jumper. Prior to installation, verify with Architect that 15-inches is adequate for designed movement, and if not, increase this length as required.
3. Provide conduits less than 3-inches where not cast in concrete with junction boxes securely fastened on both sides of expansion joint, connected together with 15-inches of slack (minimum of 15-inches longer than straight line length) flexible conduit and copper green ground bonding jumper. In lieu of this flexible conduit, an expansion-deflection fitting, as indicated for conduits 3-inch and larger may be installed.

L. Provide rigid conduit coupling flush with surface of slab or wall for conduit stubbed in concrete slab or wall to serve electrical equipment or an outlet under table or to supply shop tool, etc. Provide plug where conduit is to be used in future.

END OF SECTION
PART 1 - GENERAL

1.01 SUMMARY
A. Work Included:
   1. Outlet Boxes
   2. Floor Boxes
   3. Pull and Junction Boxes
   4. Box Extension Adapter
   5. Conduit Fittings
   6. Weatherproof Outlet Boxes
B. Provide electrical boxes and fittings for a complete installation. Include but not limited to outlet boxes, junction boxes, pull boxes, bushings, locknuts and other necessary components.

1.02 RELATED SECTIONS
A. Contents of Division 26, Electrical and Division 01, General Requirements apply to this Section.
B. In addition, reference the following:
   1. Section 26 05 33, Raceways
   2. Section 26 05 53, Identification for Electrical Systems

1.03 REFERENCES AND STANDARDS
A. References and Standards as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.

1.04 SUBMITTALS
A. Submittals as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.

1.05 QUALITY ASSURANCE
A. Quality assurance as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.

1.06 WARRANTY
A. Warranty of materials and workmanship as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.

PART 2 - PRODUCTS

2.01 MANUFACTURERS
A. Outlet Boxes:
   1. Hubbell
   2. Thomas & Betts
   3. Cooper/Crouse-Hinds
   4. Or approved equivalent.
B. Floor Boxes:
   1. Wiremold/Walker
   2. FSR
   3. Hubbell
   4. Thomas & Betts
   5. MonoSystems
   6. Cooper/Crouse-Hinds
   7. Or approved equivalent.
C. Pull and Junction Boxes:
   1. Cooper/Crouse-Hinds
   2. Hoffman
3. Or approved equivalent.

D. Box Extension Adapter:
   1. Hubbell
   2. Thomas & Betts
   3. Cooper/Crouse-Hinds
   4. Or approved equivalent.

E. Conduit Fittings:
   1. O-Z Gedney
   2. Hubbell
   3. Thomas & Betts
   4. Cooper/Crouse-Hinds
   5. Or approved equivalent.

F. Weatherproof Outlet Boxes:
   1. Pass and Seymour
   2. Hubbell
   3. Thomas & Betts
   4. Cooper/Crouse-Hinds
   5. Intermatic
   6. Or approved equivalent.

2.02 OUTLET BOXES

A. Luminaire Outlet: 4-inch octagonal box, 1-1/2-inches deep with 3/8-inch luminaire stud if required. Provide raised covers on bracket outlets and on ceiling outlets.

B. Device Outlet: Installation of one or two devices at common location, minimum 4-inches square, minimum 1-1/2-inches deep. Single- or two-gang flush device raised covers.

C. Telecom Outlet: Provide 4-inches square, minimum 2-1/8-inch deep box with two-gang plaster ring.

D. Multiple Devices: Three or more devices at common location. Install one-piece gang boxes with one-piece device cover. Install one device per gang.

E. Masonry Boxes: Outlets in concrete.

F. Construction: For interior locations, provide galvanized steel outlet wiring boxes, of the type, shape and size, including depth of box, to suit each respective location and installation; constructed with stamped knockouts in back and sides, and with threaded holes with screws for securing box covers or wiring devices.

G. Accessories: Provide outlet box accessories for each installation, including mounting brackets, wallboard hangers, extension rings, luminaire studs, cable clamps and metal straps for supporting outlet boxes, compatible with outlet boxes being used and meeting requirements of individual wiring situations.

H. Noise Control: Provide acoustic putty pad to back side of each outlet box installed in acoustic rated walls.

2.03 FLOOR BOXES

A. Floor Boxes:
   1. Multi-Gang Box, Slab on Grade Basis of Design: Wiremold RFB4-CI series cast iron housing with S40CC series aluminum finish, steel flanged activation for use with matching carpet or tile insert. Rubber gasket protects interior from water and debris. Provide with two duplex receptacles and blank inserts for two future data outlets. Provide matching carpet or tile insert in activation cover.
   2. Multi-Gang Box, Concrete Finish Floor Basis of Design: Same as above, except use Wiremold S40BB series aluminum finish, steel flanged activation.
   3. Provide floor boxes sized minimum 3-7/16-inches deep with 1-inch factory knockouts.
2.04 PULL AND JUNCTION BOXES
A. Construction: Provide ANSI 49 gray enamel painted sheet steel junction and pull boxes, with screw-on covers; of type shape and size, to suit each respective location and installation; with welded seams and equipped with stainless steel nuts, bolts, screws and washers.

B. Location:
1. Provide junction boxes above accessible ceilings for drops into walls for receptacle outlets from overhead.
2. Provide junction boxes and pull boxes to facilitate installation of conductors and limiting accumulated angular sum of bends between boxes, cabinets and appliances to 270 degrees.

C. In-Ground Cast Metal Box: NEMA 250, Type 6, outside flanged, recessed cover box for flush mounting:
1. Construction: Galvanized cast iron.
2. Cover: Smooth cover with neoprene gasket and stainless steel cover screws.
3. Cover Legend: ELECTRIC.

D. Fiberglass Handholes: Die molded glass fiber hand holes:
1. Cable Entrance: Pre-cut 6- x 6-inch cable entrance at center bottom of each side.
2. Cover: Fiberglass weatherproof cover with nonskid finish.
3. Cover Legend: ELECTRIC.

2.05 BOX EXTENSION ADAPTER
A. Construction: Diecast aluminum.

B. Location: Install over flush wall outlet boxes to permit flexible raceway extension from flush outlet to fixed or movable equipment.

2.06 CONDUIT FITTINGS
A. Requirements: Provide corrosion-resistant punched-steel box knockout closures, conduit locknuts and plastic conduit bushings of the type and size to suit each respective use and installation.

2.07 WEATHERPROOF OUTLET BOXES
A. Construction: Provide corrosion-resistant cast metal weatherproof outlet wiring boxes, of the type, shape and size, including depth of box, with threaded conduit ends, cast metal face plate with spring-hinged waterproof cap suitably configured for each application, including face plate, gasket, blank plugs and corrosion proof fasteners. Weatherproof boxes to be constructed to have smooth sides, gray finish.

PART 3 - EXECUTION
3.01 GENERAL INSTALLATION REQUIREMENTS
A. Coordinate locations of floor boxes and wall mounted wiring device boxes with architectural and structural floor plans prior to rough-in.

B. Install boxes securely, in a neat and workmanlike manner, as specified in NECA 1, Standard Practice of Good Workmanship in Electrical Construction.

C. Secure boxes rigidly to substrate upon which they are being mounted, or solidly embed boxes in concrete or masonry.

D. Install in locations as shown on Drawings, and as required for splices, taps, wire pulling, equipment connections, and as required by NEC. Locate boxes and conduit bodies so as to ensure accessibility of electrical wiring.

E. Set wall mounted boxes at elevations to accommodate mounting heights specified in this Section.

F. Electrical boxes are shown on drawings in approximate locations unless dimensioned.
1. Adjust box locations up to 10-feet if required to accommodate intended purpose.
G. Install boxes to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Division 07, Thermal and Moisture Protection.

H. Locate flush mounting box in masonry wall to require cutting of masonry unit corner only. Coordinate masonry cutting to achieve neat opening.

I. Install flush mounting box without damaging wall insulation or reducing its effectiveness.

J. Support boxes independently of conduit, except cast box that is connected to two rigid metal conduits both supported within 12-inches of box.

K. Box Color Coding and Marking: Reference Section 26 05 53, Identification for Electrical Systems.

L. Adjust boxes to be parallel with building lines. Boxes not plumb to building lines are not acceptable.

M. Install knockout closures in unused box openings.

N. Clean interior of boxes to remove dust, debris, and other material.

O. Clean exposed surfaces and restore finish.

3.02 OUTLET BOXES INSTALLATION

A. Mount outlet boxes, unless otherwise required by ADA, or noted on drawings, following distances above finished floor:
   1. Control Switches:
      a. 48-inches to the top of outlet box.
      b. 4-inches above top of backsplash at countertops/workstations, not-to-exceed 44-inches above finished floor to the top of outlet box per ADA requirements.
   2. Receptacles: 15-inches to the bottom of outlet box.
   3. Telecom Outlets: 15-inches to the bottom of outlet box.
   4. Other Outlets: As indicated in other sections of specifications or as detailed on drawings.

B. Inaccessible Ceiling Areas: Install outlet and junction boxes no more than 6-inches from ceiling access panel or from removable recessed luminaire.

C. Flush Outlets in Insulated Spaces: Maintain integrity of insulation and vapor barrier.

D. Coordinate electrical device locations and elevations (switches and receptacles) with architectural drawings to prevent mounting devices in mirrors, backsplashes, and behind cabinets.

E. Locate outlet boxes to allow luminaires positioned as shown on reflected ceiling plan.

F. Align adjacent wall mounted outlet boxes for switches, thermostats, and similar devices. Adjacent boxes not aligned vertically to be adjusted at no additional cost to Owner.

G. Use flush mounting outlet box in finished areas.

H. Do not install flush mounting box back-to-back in walls; provide minimum 6-inches separation. Provide minimum 24-inches in acoustic rated walls.

I. In acoustical walls, apply acoustic putty pad on outlet box prior to installation of acoustical blanket.

J. Secure flush mounting box to interior wall and partition studs. Accurately position to allow for surface finish thickness.

K. Use stamped steel bridges to fasten flush mounting outlet box between studs.

L. Use adjustable steel channel fasteners for hung ceiling outlet box.

M. Use gang box where more than one device is mounted together. Do not use sectional box.

N. Use gang box with plaster ring for single device outlets.

O. Adjust flush-mounting outlets to make front flush with finished wall material.
3.03 FLOOR BOXES INSTALLATION
   A. Use cast floor boxes for installations in slab on grade.
   B. Set floor boxes level.
   C. Adjust floor boxes flush with finish flooring material.

3.04 PULL AND JUNCTION BOXES INSTALLATION
   A. Install pull boxes and junction boxes above accessible ceilings and in unfinished areas only.
   B. Inaccessible Ceiling Areas: Install outlet and junction boxes no more than 6-inches from ceiling access panel or from removable recessed luminaire.
   C. Do not fasten boxes to ceiling support wires.
   D. Large Pull Boxes: Use hinged enclosure in interior dry locations, surface-mounted cast metal box in other locations.

3.05 BOX EXTENSION ADAPTER INSTALLATION
   A. Match material to box.
   B. Install gaskets at exterior and wet locations.

3.06 CONDUIT FITTINGS INSTALLATION
   A. Install set-screw fittings so the screws can be seen from below.
   B. Tighten compression fittings per manufacturer's instructions.

3.07 WEATHERPROOF OUTLET BOXES INSTALLATION
   A. Use cast outlet box in exterior locations exposed to weather and wet locations.
   B. Install gaskets.

END OF SECTION
SECTION 26 0553 - IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.01 SUMMARY
   A. Work Included:
      1. Equipment Nameplates
      2. Device Labels
      3. Wire Markers
      4. Underground Warning Tape

1.02 RELATED SECTIONS
   A. Contents of Division 26, Electrical and Division 01, General Requirements apply to this Section.

1.03 REFERENCES AND STANDARDS
   A. References and Standards as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.

1.04 SUBMITTALS
   A. Submittals not required for this Section.

1.05 QUALITY ASSURANCE
   A. Quality assurance as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.
   B. In addition, meet the following:
      1. Manufacturer's Qualifications: Firms regularly engaged in manufacture of identification devices of types and sizes required.
      2. Manufacturer's standard products of categories and types required for each application as referenced in other Division 26, Electrical Sections. Where more than a single type is specified for application, provide single selection for each product category.
      3. Codes and Standards: Comply with ANSI A13.1 for lettering size, length of color field, colors, and viewing angles of identification devices unless otherwise indicated.

1.06 WARRANTY
   A. Warranty of materials and workmanship as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.

PART 2 - PRODUCTS

2.01 MANUFACTURERS
   A. Equipment Nameplates:
      1. B & I Nameplates
      2. Intellicum
      3. JBR Associates
      4. Or approved equivalent.
   B. Device Labels:
      1. Kroy
      2. Brady
      3. Or approved equivalent.
   C. Wire Markers:
      1. Brady
      2. Panduit
      3. Sumitomo
      4. Or approved equivalent.
   D. Underground Warning Tape:
      1. Allen Systems
2.02 EQUIPMENT NAMEPLATES

A. Engraved phenolic plastic, laminate, minimum 1/8-inch thick in the size indicated, with beveled edge border matching letter color. Federal specification L-P-387. All upper case letters in engraver standard letter style of the size and wording indicated. Punched for mechanical fastening, except where adhesive mounting is necessary due to substrate. Embossed tape style labels are not acceptable.

B. Color:
   1. Normal (Utility): White letters on black background.

C. Letter Size:
   1. Use 1/2-inch letters minimum for identifying major equipment and loads, including switchgear, switchboards, etc.
   2. Use 1/4-inch or 1/2-inch letters minimum for identifying panels, breakers, etc.
   3. Use 3/16-inch minimum for identifying source, voltage, current, phase, and wire configurations.

D. Fasteners: Self-tapping stainless steel screws, except contact-type permanent adhesive where screws cannot or should not penetrate the substrate.

E. The Architect, Engineer, Commissioning Agent and Owner reserve the right to make modifications to the nameplates as necessary.

F. Locations:
   1. Distribution panels, and branch panels.
   2. Main breakers and distribution breakers in distribution panels.
   3. Equipment including, but not limited to, motor controllers, disconnects, and VFDs.
   4. Low-voltage equipment enclosures including, but not limited to, fire alarm panels, access control panels, and lighting control panels.
   5. Distribution transformers.

2.03 DEVICE LABELS

A. Extra strength, laminated adhesive tape, with 3/16-inch black letters on clear background. Use only for identification of individual wall switches and receptacles. Indicate device name, source panel, and source circuits. Panel and circuit designation written in permanent marker on the back of the plate and inside the back-box. Do not provide punch tape style labels.

B. Label all junction boxes to show system identification, source circuit, or raceway origin. In finished areas, utilize device label. In unfinished areas or above ceilings, use of permanent ink marker is acceptable.

2.04 WIRE MARKERS

A. Description: Vinyl-cloth self-adhesive type wire markers.

B. Locations: Each conductor at panelboard gutters, pull boxes, and junction boxes.

C. Power and Lighting Circuits: Branch circuit or feeder number as indicated on drawings and source panel.

D. Control Circuits: control wire number indicated on schematic and interconnection diagrams on drawings or shop drawings.

2.05 UNDERGROUND WARNING TAPE

A. Description: 6-inch wide inert polyethylene plastic tape, 4-mil thick, detectable type, colored per APWA recommendations unless otherwise noted with suitable warning legend describing buried electrical lines.
PART 3 - EXECUTION

3.01 GENERAL INSTALLATION REQUIREMENTS
   A. Coordinate designations used on Drawings with equipment nameplates and device labels.
   B. Install nameplates and labels parallel to equipment lines.
   C. Identify empty conduit and boxes with intended use.
   D. Provide typewritten branch panel schedules with protective clear transparent covers accounting for every breaker installed. Use actual room designations assigned by name or number near completion of the work, and not the designations shown on drawings.
   E. Provide color coded boxes as follows:
      1. Fire Alarm: Red.

3.02 EQUIPMENT NAMEPLATES
   A. Degrease and clean surfaces to receive nameplates.
   B. Secure equipment nameplates to equipment front using self-tapping stainless steel screws.
   C. Secure equipment nameplates to inside surface of door on panelboard that is recessed in finished locations.
   D. Verify emergency system distribution equipment nameplate colors with Architect/Owner.
   E. Panels to include name source, voltage, current phase, wire configuration and fault current rating. Transformers to include source KVA, and secondary voltage, phase, and wire configuration.
   F. Provide nameplates for flush mounted branch panelboards identifying name on front door. On inside of door provide nameplate as noted above. Verify with Architect/Owner if nameplate on outside of door is required.
   G. Provide a second label at branch panelboards listing the means of identification of branch circuit conductors. This identification legend to consist of the color code used for each voltage system (208Y/120V and 480Y/277V). See Specification Section 26 05 19, Low-Voltage Electrical Power Conductors and Cables, for required conductor color code for this project. Include identification of both voltage systems on each label, regardless of the voltage of the panelboard to which the label is affixed. Comply with requirements of NEC 210.5.

3.03 DEVICE LABELS
   A. Reference 3.01, General Installation Requirements.
   B. Install per manufacturer's instructions and recommendations.
   C. Degrease and clean surfaces to receive labels.

3.04 WIRE MARKERS
   A. Reference 3.01, General Installation Requirements.
   B. Install per manufacturer's instructions and recommendations.
   C. Provide wire markers on each conductor for power, control, signalling and communications circuits.
   D. Where switches control remote lighting or power outlets, or where switches or outlets in same location serve different purposes, such as light, power, intercom, etc. or different areas, such as corridor and outside, provide plates with 1/8-inch black letters indicating function of each switch or outlet. Also label the function of light switches where two or more are mounted in same locations.

3.05 UNDERGROUND WARNING TAPE
   A. Reference 3.01, General Installation Requirements.
   B. Install per manufacturer's instructions and recommendations.
C. Identify underground raceways using underground warning tape. Install one continuous tape per underground raceway at 6- to 8-inches below finish grade. Where multiple underground raceways are buried in a common trench and exceeds 16-inch width, install multiple warning tapes not over 10-inches apart (edge to edge) over the entire group of underground raceways.

END OF SECTION
SECTION 26 0573 - ELECTRICAL DISTRIBUTION SYSTEM STUDIES

PART 1 - GENERAL

1.01 SUMMARY
A. Work Included:
   1. Protective Devices
   2. Protective Device Study
   3. Short Circuit Study

1.02 RELATED SECTIONS
A. Contents of Division 26, Electrical and Division 01, General Requirements apply to this Section.

1.03 REFERENCES AND STANDARDS
A. References and Standards as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.
B. In addition, meet the following:
   1. IEEE 242, Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems.
   2. IEEE 399, Recommended Practice for Industrial and Commercial Power Systems Analysis.

1.04 SUBMITTALS
A. Submittals as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.
B. In addition provide:
   1. Power system studies required under this Section with submittals for electrical equipment, including overcurrent protective devices.
   2. Electrical equipment ordered prior to submittal of power system studies are not compliant with these specifications, and are subject to removal and replacement at no cost to Owner where not in compliance with Code and Contract Documents for selective coordination.
      a. Provide written verification with Stamp or Seal and signature of preparing Engineer.

1.05 QUALITY ASSURANCE
A. Quality assurance as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.
B. In addition, meet the following:
   1. Study Preparer Qualifications: Qualified engineer of switchgear manufacturer or approved professional engineer.
      a. Experienced in preparation of studies of similar type and magnitude.
      b. Familiar with software analysis products specified.
      a. Acceptable Software Products:
         1) EasyPower
         2) EDSA Micro Corporation.
         3) Operation Technology, Inc; ETAP.
         4) SKM Systems Analysis, Inc; Power Tools for Windows.
   3. Contractor Responsibility: Provide project-related data needed by study preparer, including equipment, wire sizes, insulation types, conduit types, actual circuit lengths and available fault currents from utility. Provide information in a timely matter to allow studies to be completed prior to release of equipment.

1.06 WARRANTY
A. Warranty of materials and workmanship as required by 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.
PART 2 - PRODUCTS

2.01 GENERAL

A. Analyze specific electrical and utilization equipment (according to NEC definition), actual protective devices to be used, and actual feeder lengths to be installed.
   1. Scope of Studies: New distribution wiring and equipment, from primary source to buses and branch circuit panelboards.
   2. Primary Source, for Purposes of Studies: Utility company primary protective devices.
   4. Report: State methodology and rationale employed in making each type of calculation; identify computer software package(s) used.

B. One-Line Diagrams: Prepare schematic drawing of electrical distribution system, with electrical equipment and wiring to be protected by protective devices; identify nodes on diagrams for reference on report that includes:
   1. Calculated fault impedance, X/R ratios, utility contribution, and short circuit values (asymmetric and symmetric) at main switchboard bus and downstream devices containing protective devices.
   2. Breaker and fuse ratings.
   3. Transformer kVA and voltage ratings, percent impedance, X/R ratios, and wiring connections.
   4. Identification of each bus, with voltage.
   5. Conduit materials, feeder sizes, actual lengths, and X/R ratios.

2.02 PROTECTIVE DEVICES

A. Provide protective devices of ratings and settings as required so that protective device closest to fault will open first.

B. Replace existing protective devices to achieve specified performance.

C. Analyze and determine ratings and settings of protective devices to minimize damage caused by fault and so that protective device closest to fault will open first.
   1. Required Ratings and Settings: Derive required ratings and settings of protective devices in consideration of upstream protective device settings and optimize system to ensure selective coordination.
   3. Identify any equipment that is underrated as specified.
   4. Identify specified protective devices that will not achieve required protection or coordination but with minor changes can be made to do so; provide such modified devices at no additional cost to Owner and identify them on submittals as "revised in accordance with Protective Device Coordination Study"; minor changes include different trip sizes in same frame, time curve characteristics of induction relays, CT ranges, etc.
   5. Identify specified protective devices that will not achieve required protection or coordination and cannot be field adjusted to do so, and for which adequate devices would involve change to contract sum.
   6. In all cases where adequate protection or coordination cannot be achieved at no extra cost to Owner, provide a discussion of alternatives and logical compromises for best achievable coordination.
   7. Do not order, furnish, or install protective devices that do not meet performance requirements unless specifically approved by Engineer.

D. Protective Device Rating and Setting Chart: Summarize in tabular format required characteristics for each protective device based on analysis; include:
   1. Device identification.
   2. Relay CT ratios, tap, time dial, and instantaneous pickup.
E. Specified equipment has been designed and selected to achieve specified performance; ensure that equipment actually installed provides that performance.
F. In addition to requirements specified elsewhere, provide overcurrent protective devices having ratings and settings in accordance with results of system studies.

2.03 PROTECTIVE DEVICE STUDY
A. Analyze and determine ratings and settings of protective devices to minimize damage caused by fault and so that protective device closest to fault will open first.
1. Required Ratings and Settings: Derive required ratings and settings of protective devices in consideration of upstream protective device settings and optimize system to ensure selective coordination.
2. Identify any equipment that is underrated as specified.
3. Identify existing protective devices that will not achieve required coordination and cannot be field adjusted to do so.
4. Identify specified protective devices that will not achieve required protection or coordination but with minor changes can be made to do so; provide such modified devices at no additional cost to Owner and identify them on submittals as "revised in accordance with Protective Device Coordination Study"; minor changes include different trip sizes in same frame, time curve characteristics of induction relays, CT ranges, etc.
5. Identify specified protective devices that will not achieve required protection or coordination and cannot be field adjusted to do so, and for which adequate devices would involve change to contract sum.
6. In all cases where adequate protection or coordination cannot be achieved at no extra cost to Owner, provide a discussion of alternatives and logical compromises for best achievable coordination.
7. Do not order, furnish, or install protective devices that do not meet performance requirements unless specifically approved by Architect.
B. Protective Device Rating and Setting Chart: Summarize in tabular format required characteristics for each protective device based on analysis; include:
1. Device identification.
2. Relay CT ratios, tap, time dial, and instantaneous pickup.
3. Circuit breaker sensor rating, long-time, short-time, and instantaneous settings, and time bands.
4. Fuse rating and type.
5. Ground fault pickup and time delay.
6. Input level and expected response time at two test points that are compatible with commonly available test equipment and ratings of protective device.
7. Highlight devices that as furnished by Contractor will not achieve required protection.

2.04 SHORT CIRCUIT STUDY
A. Calculate fault impedance to determine available 3-phase short circuit and ground fault currents at each bus and piece of equipment during normal conditions, alternate operations, emergency power conditions, and other operations that could result in maximum fault conditions.
1. Show fault currents available at key points in system down to fault current of 1,000 A at 480 V and 208 V.
2. Include motor contributions in determining momentary and interrupting ratings of protective devices.
PART 3 - EXECUTION

3. Primary Fault Level Assumptions: Obtain data from utility company.

3.01 FIELD QUALITY CONTROL
   A. Provide services of qualified field engineer and necessary tools and equipment to test, calibrate, and adjust installed protective devices to conform to requirements determined by coordination analysis.
   B. Adjust installed protective devices having adjustable settings to conform to requirements determined by coordination analysis.
   C. Adjust solid-state protective modules for motors prior to applying load to motor.
   D. Submit report showing final adjusted settings of protective devices.

3.02 ELECTRICAL POWER SYSTEM STUDIES
   A. Short Circuit Analysis Study.
      1. Provide complete short circuit study, equipment interrupting and withstand evaluation. Study to include complete electrical distribution system, including simultaneous contributions from normal and alternative sources of power. Include complete low voltage distribution systems as specified in this Section.
      2. Study Basis: thoroughly cover normal and alternative operation modes that can produce maximum fault conditions, including simultaneous motor contributions.
      3. Perform study in accordance with applicable ANSI/IEEE Standards.
      4. Study Input Data: Utility company short circuit single and three phase contribution, and X/R ratio; resistance and reactance components of each feeder, busway and branch impedance; motor and generator contributions; applicable circuit parameters and contribute to short circuit duty.
      5. Calculate short circuit momentary duties and interrupting duties on basis of maximum available fault current at each switchgear bus, switchboard, motor control center, panelboards, transfer switches, busway plug connection point, dry-type transformer primary and secondary locations, other significant locations throughout system affected by available fault current (including large HVAC units, uninterruptible power supplies, etc.).
      6. Perform equipment evaluation study to determine adequacy of overcurrent protection devices by tabulating and comparing short circuit ratings of these devices with available fault current. Notify Owner in writing where problem areas or inadequacies appear in electrical equipment.
      7. Study Report: In bound final report, include sheets listing tabulated information from study, including feeder impedances, motor, utility and generator impedances and fault contributions, and resulting short circuit current including asymmetrical, symmetrical, three, five and eight cycle fault current levels, and line-to-neutral and three-phase-bolted-fault current levels at each calculated point in electrical distribution system.
   B. Protective Device Study:
      1. Perform time-current coordination analysis with aid of computer software intended for this purpose. Include determination of settings, ratings, or types for overcurrent protective devices supplied.
      2. Where necessary, make an appropriate compromise between system protection and service continuity with service continuity considered more important than system protection.
      3. Provide sufficient number of computer generated log-log plots to indicate degree of system protection and coordination by displaying time-current characteristics of series connected overcurrent devices and other pertinent system parameters.
      4. Computer printouts accompany log-log plots and will contain descriptions for each of devices shown, settings of adjustable devices, short-circuit current availability at device location when known, and device identification numbers to aid in locating devices on log-log plots and system one-line diagram.
5. Study includes separate, tabular computer printout containing suggested device settings of adjustable overcurrent protective devices, equipment where device is located, and device number corresponding to device on system one-line diagram.

6. Provide computer generated system one-line diagram which clearly identifies individual equipment buses, bus numbers, device identification numbers and maximum available short-circuit current at each bus when known.

7. Discussion Section which evaluates degree of system protection and service continuity with overcurrent devices, along with recommendations as required for addressing system protection or device coordination deficiencies.

8. Call significant deficiencies in protection and/or coordination to attention of Engineer and recommendations made for improvements as soon as they are identified.

9. Contractor responsible for supplying pertinent electrical system conductor, circuit breaker, generator, and other component and system information in timely manner to allow time-current analysis to be completed prior to final installation.

END OF SECTION
SECTION 26 0900 - CONTACTORS AND CONTROL DEVICES

PART 1 - GENERAL

1.01 SUMMARY

A. Work Included:
   1. Emergency Lighting Relays

1.02 RELATED SECTIONS

A. Contents of Division 26, Electrical and Division 01, General Requirements apply to this Section.

1.03 REFERENCES AND STANDARDS

A. References and Standards as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.

B. In addition, meet the following:

1.04 SUBMITTALS

A. Submittals as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.

B. In addition, provide:
   1. Shop Drawings: Submit to NEMA ICS 1 indicating control panel layouts, wiring connections and diagrams, dimensions, support points.
   2. Product Data: Provide for each component showing electrical characteristics and connection requirements.
   3. 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.

1.05 QUALITY ASSURANCE

A. Quality assurance as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements apply to this Section.

1.06 WARRANTY

A. Warranty of materials and workmanship as outlined in Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Emergency Lighting Relay:
   1. Nine 24
   2. Bodine
   3. Wattstopper
   4. Or approved equivalent.

2.02 EMERGENCY LIGHTING RELAY

A. UL924 listed for connected load of 20 amps at 277 volt or 120 volt.

B. UL rated N.C. contacts, minimum 20 amps rating.

C. Integral surge protection.

D. Two separate status emergency lighting indicators for troubleshooting:
   1. Amber LED indicates presence of normal utility power.
   2. Red LED indicates presence of unswitched emergency power.

E. Manual and/or automatic diagnostic testing feature.
PART 3 - EXECUTION

3.01 GENERAL INSTALLATION REQUIREMENTS

A. Testing:
   1. Test to ensure that control devices, components, equipment and systems are calibrated, adjusted and operate in accordance with approved drawings and specifications.
      a. Daylight sensing automatic lighting controls.
      b. Occupant sensing automatic lighting controls.
      c. Automatic time switches for lighting control.
      d. Emergency lighting controls.
   2. Functionally test all control devices to ensure operation in accordance with approved drawings and specifications.
   3. Prepare and complete report of test procedures and results and file with the Owner.

B. Install items per manufacturers written instructions.

3.02 EMERGENCY LIGHTING RELAYS

A. Emergency Relay (UL924):
   1. Provide unswitched emergency circuit, and unswitched and switched normal circuit to UL924 relay for control of emergency luminaires with remaining room luminaires on normal power.
   2. Install each relay within dedicated 4-11/16-inch junction box with double-gang plaster ring for wall or ceiling flush-mount as indicated on Drawings. Where location in ceiling would interfere with removal of ceiling tiles, install relay flush-mounted in nearest wall at ceiling level. Do not locate behind wall switch.

END OF SECTION
PART 1 - GENERAL

1.01 SUMMARY

A. Work Included:
   1. Materials and Components
   2. Hardware Features

B. Extent of lighting control system work is indicated by drawings, and by the requirements of this Section. It is defined to include lighting relay control panels, switch inputs, and wiring.

C. Requirements are indicated elsewhere in these specifications for work including, but not limited to, raceways and electrical boxes and fittings required for installation of control equipment and wiring.

D. Basis-of-Design: Relay panel layout on Drawings are designed based on the Greengate product line. Approved manufacturers listed are allowed on condition of meeting the specified conditions including connectivity with building control systems (fire alarm, security, BAS), fail-safe operation of emergency lighting in compliance with UL 924, and separation of normal and life safety circuits. Provide additional relay enclosures and communications accessories as needed to provide the same level of functionality as shown on Drawings and required in specifications. Remove and replace electrical equipment not meeting these conditions at no cost to Owner.

1.02 RELATED SECTIONS

A. Contents of Division 26, Electrical and Division 01, General Requirements apply to this Section.

1.03 REFERENCES AND STANDARDS

A. References and Standards as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.

1.04 SUBMITTALS

A. Submittals as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.

B. In addition, provide:
   1. Product Data: Submit manufacturer's data on lighting control system and components, including recommended spare parts list.
   2. Shop Drawings: Submit drawings of lighting control panel and accessories including, but not necessarily limited to the riser diagram / system diagram, low voltage relay panels, power and communications wiring and termination, input/output schedules and sequence of operation for each control zone.

1.05 QUALITY ASSURANCE

A. Quality assurance as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.

B. In addition, meet the following:
   1. Test the control panels and list under the UL 916 Energy Management Equipment standards.
   3. Comply with applicable OEESC requirements regarding electrical wiring standards.
   4. NEMA Compliance: Comply with applicable portions of the NEMA standards regarding the types of electrical equipment enclosures.
   5. Component Pretesting: Control equipment to undergo strict inspection standards. Previously test the equipment and burn-in at the factory prior to installation.

1.06 WARRANTY

A. Warranty of materials and workmanship as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.
B. In addition, provide:
   1. Provide a 3-year warranty on hardware and software. Systems that provide special warranties based on installation are not acceptable.

PART 2 - PRODUCTS

2.01 MANUFACTURERS
   A. Greengate Lighting Control Panels Litekeeper 8
   B. Leviton Lighting Controls
   C. WattStopper
   D. Intelligent Lighting Controls
   E. Lighting Control and Design
   F. Or approved equivalent.

2.02 MATERIALS AND COMPONENTS
   A. System Description:
      1. The lighting control system consists of low voltage relay control panels with 64 programmable switch inputs and up to 8 relays.
      2. Each low voltage lighting control panel is microprocessor controlled. Accomplish programming through either the RS-232 port or through the network connection or with an integral 2 x 16 - 32 character self-prompting LCD display and programming keypad.
      3. Programmable intelligence includes time-of-day control, 32 holiday dates, a Warn Off to warn occupants of an impending off, timed inputs, preset control, auto daylight savings, astronomical clock w/offsets, and local control, digital switches and network overrides.
      4. When control panel provides a Warn Off (flash the lights) to inform the occupants of an impending off command, the Warn Off command will allow 10 extra minutes for the occupants to override their lights or exit the premises.
      5. Control panels permits lighting to be overridden ON for after-hours use or cleaning. Provide these overrides with hard-wired inputs or voice-guided touch-tone telephone control.
      6. Control panel enclosures offer a maximum space of 8 relays.
   B. Basis of Design: Lighting relay panels on Drawings are designed based on Greengate Lighting Control Panels Litekeeper product line. Approved manufacturers listed below are allowed on condition of meeting the specified conditions including the available space for the equipment (including Code required working clearances). Remove and replace electrical equipment installed not meeting these conditions at no cost to Owner.

2.03 HARDWARE FEATURES
   A. Diagnostic Aids:
      1. Each control panel to incorporate diagnostic aids for confirmation of proper operation, or in case of failure these aids to guide the individual in rapid troubleshooting of the system.
      2. The control panels to employ both a backlit LCD and LED's to indicate:
         a. POWER (LED)
         b. SYSTEM OK (LED)
         c. ON/OFF STATUS of EACH RELAY (LED & LCD)
         d. SYSTEM CLOCK AND DATE (LCD)
         e. PROGRAMMING CONFIRMATION (LCD)
   B. Status Indication of Relays: System will provide visible status indication of relays through the window of each control panel. Visual indication to disclose ON/OFF status and relay number. Systems that do not provide relay status while the enclosure door is closed are not acceptable.
   C. Operator Interface: The control panel programming interface resides in firmware in the control panel. The programming interface to consist of a circuit board mounted keypad and 2 line x 16
character LCD display. The integral keypad to provide access to the main programming features. Keypad to permit user to manually command any or all relays individually. Keypad to also allow user to link switch inputs and time schedules to relay outputs. Each panel to control its own loads from internal memory. A control system that relies on a central control computer/processor or external time clocks is not permitted. Systems that utilize blocking diode technology for relay assignments are not acceptable.

D. Overrides: Controller to provide timers for each override. Provide each override timer capable of 0-999 minutes. Software to enable or disable overrides based on Priorities, Masks or Time of Day scheduling.

E. Digital Switch: Lighting controller to support digitally addressable LED annunciated switches. Maximum total number of digital switches that may exist on the lighting control network is 16,320. Each Subnet to support 64 buttons. The digital switch network requires CAT 5 cable between switches. Digital switches to control any relay group combination on the Greengate Lighting Control Panels network. Provide data communications status feedback for system checkout and troubleshooting (transmit and receive LED’S) visible on the interface.

1. Digital switch configuration system to permit custom labeling for multiple button switch locations. Provide Decora® form and function Digital switch configuration.

F. Dry Contact Inputs: Control system to permit 8 dry contact inputs for override purposes. Support momentary 3 wire or 2 wire (toggle) inputs. Support maintained contacts as 2 wire (SPST) inputs. Provide dry contact inputs (24VDC at 12 ma. internally supplied to the inputs). 24VDC power supply is provided with an auto-resettable fuse. Should an inappropriate electrical connection be made, design to protect the board and switches until the fault is removed. Software link switch input to any number of relays for override control. Control panel to have dry contact inputs on the logic board. Control systems that utilize separate accessories to allow for dry contact switches are not acceptable. Control systems that do not supply both digital switches and analog switches from the same controller are not permitted.

G. Photocell Control: Controller to accept dry contact ambient light sensors. Controller to provide power for the sensor thereby eliminating any external power supply. Sensors to provide for outdoor and indoor applications and issue a command to the controller once the threshold is reached. Sensor to provide user adjustable dead band control.

H. Remote Overrides: Controller to accept remote commands issued from other inputs. Controller to provide this feature without the need to add extra equipment to the controller. Remote overrides can be issued from the Telephone Interface Module (TIM), Photocells, Motion Sensors, Digital or Dry Contact Switches. Lighting systems that need to add extra equipment to receive remote overrides are not acceptable.

I. Service Override and Priority Override: Control panel to provide a three position master-service override for the control unit. Provide service override that is not accessible from the exterior. Systems that provide a service override on the exterior of the controller are not acceptable.

J. Modular Design:

1. Control system to employ modular connectors to avoid repeat wiring in case of component failure. Mount the system CPU board on quick-release spring pins that permit an entire change out of the processor and input board.

2. Connections for the switch inputs to incorporate modular connectors. Provide modular relay board designed for rapid field replacement or upgrading. Systems that do not employ modular connectors are not acceptable.

K. Battery Back-up: The system to utilize a memory back-up device that is system integrated and non-serviceable. Protect the data in RAM against power interruptions lasting as long as 10 years. Provide maintenance free power interrupt protection circuit.

L. Multi-tapped Transformer: The control panel incorporates the use of a multi-tapped transformer. No specification of voltage for each control location is required by panel. The voltages of 120 and 277VAC available with each standard control panel.
M. Status Indication of Relays: System to provide visible status indication of relays through the window of each control panel. Visual indication to disclose ON/OFF status and relay number.

N. Lockable Enclosure: Enclose each control panel in a lockable NEMA Class 1 enclosure and provide pre-punched knockouts.

O. Relays: Electrically held 20amp 120/277VAC relays. Relays must be specified Normally Open or Normally Closed. Rate the relays for 10 million mechanical operations.

1. Standard Relay Card (SRM-NO): System to utilize normally open control relays, which are rated to 20 amps at 120/277VAC. Magnetically hold the relays and provide on a card of eight relays per card. Provide wire terminations able to accept 10 AWG. Rate the relays for 10 million mechanical operations. Provide a limited 10-year warranty on the individual relay cards. Systems that do not offer a limited 10-year warranty on installations are not acceptable.

2. Line Voltage Barriers: Controller to provide as an option the ability to provide a barrier for either voltage separation or emergency circuit separation. Paint the barrier red to denote the difference.

3. RS-232 port: Controller to provide an RJ-12 connection for RS-232 communications. Permit programming through either a local connection or remotely through a modem. The Keeper Enterprise software accessory includes a six wire communication cable to connect to the controller. Systems that do not include an on-board RS-232 port for communications are not acceptable.

4. Stand Alone Hardware Accessories:
   a. Ethernet Interface Module (EIM): Internet Connection Specifications: The control system accessory provides access to control panels over a TCP/IP connection by converting sent information into RS-232 communication capable information. This unit operates on standard 110VAC. Manufacturer to provide proper cabling from controller to Ethernet Interface Modules. RJ-45 connections are the responsibilities of others.

PART 3 - EXECUTION

3.01 GENERAL INSTALLATION REQUIREMENTS

A. Installation: Install the control system and fully wire as shown on the drawings by the installing contractor. Complete electrical connections to control circuits, and override wiring.

B. Documentation: Provide accurate record drawings to the Owner for correct programming and proper maintenance of the control system. Record Drawings to indicate the load controlled by each relay and the relay panel number.

C. Operation and Maintenance Manuals: Provide factory operation and maintenance manuals.

3.02 PRODUCT SUPPORT AND SERVICE

A. Factory Support: Provide factory telephone support available at no cost to the Owner. Factory assistance to consist of solving programming or application questions concerning the control equipment.

3.03 SYSTEM ACCEPTANCE

A. Test to ensure that control devices, components, equipment and systems are calibrated, adjusted and operate in accordance with approved drawings and specifications.

B. Functionally test sequences of operation to ensure operation in accordance with approved drawings and specifications.

C. Prepare and complete report of test procedures and results and file with the Owner.

D. An operational user program to exist in the control system. Program to execute and perform functions required to effectively operate the site according to the requirements.

E. Demonstration of program integrity during normal operation and pursuant to a power outage.

F. Provide a minimum of 2 hours training on the operation and use of the control system.

G. Lighting System Control Testing and Commissioning:
1. Test lighting controls to ensure that control devices, components, equipment and systems are calibrated, adjusted and operate in accordance with Drawings and Specifications. Provide functional testing of sequences of operation to ensure operation in accordance with Drawings and Specifications. Provide complete report of test procedures and results to engineer and insert approved copy into project closeout documents.

2. Testing to Include:
   a. Daylight Automatic Controls
   b. Occupant Sensing Automatic Controls
   c. Automatic Time and Override Controls for Interior Lighting
   d. Automatic Time and Photo Controls for Exterior Lighting

END OF SECTION
SECTION 26 0923 - OCCUPANCY AND VACANCY SENSORS

PART 1 - GENERAL

1.01 SUMMARY
   A. Work Included:
      1. Occupancy/Vacancy Sensors (Ceiling and Wall mounted)
      2. Combined Occupancy Sensor/Wall Switches ("Sensor/Switches")

1.02 RELATED SECTIONS
   A. Contents of Division 26, Electrical and Division 01, General Requirements apply to this Section.

1.03 REFERENCES AND STANDARDS
   A. References and Standards as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.

1.04 SUBMITTALS
   A. Submittals as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.
   B. In addition, provide:
      1. Provide wiring diagrams indicating low voltage and line voltage wiring requirements.
      2. Provide, on reproducible architectural floor plan, a layout of sensors indicating their sensing distribution.

1.05 QUALITY ASSURANCE
   A. Quality assurance as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.
   B. In addition, meet the following:
      1. Use manufacturer's published testing and adjusting procedures to adjust sensors time delay, daylight sensitivity, and passive infrared sensitivity to satisfaction of the Owner.
      2. Prepare and complete report of test procedures and results. Submit these test procedures and results to Owner and Architect.

1.06 WARRANTY
   A. Warranty of materials and workmanship as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.

PART 2 - PRODUCTS

2.01 MANUFACTURERS
   A. Occupancy/Vacancy Sensors (Ceiling and Wall mounted):
      1. Passive Infrared Occupancy/Vacancy Sensors:
         a. Sensor Switch
         b. WattStopper
         c. Leviton
         d. Hubbell
         e. Greengate
         f. Or approved equivalent.
      2. Ultrasonic Occupancy/Vacancy Sensors:
         a. WattStopper
         b. Leviton
         c. Hubbell
         d. Greengate
         e. Sensor Switch
         f. Or approved equivalent.
      3. Dual Technology Occupancy/Vacancy Sensors:
         a. WattStopper
b. Leviton
c. Hubbell
d. Greengate
e. Sensor Switch
f. Or approved equivalent.

B. Combined Occupancy/Vacancy Sensor:
1. Sensor Switch
2. WattStopper
3. Leviton
4. Hubbell
5. Greengate
6. Or approved equivalent.

C. Basis of Design: Occupancy/Vacancy sensor layout on Drawings are designed based on WattStopper product line. Approved manufacturers listed are allowed on condition of meeting the specified conditions including complete sensor coverage of the area controlled and switching of luminaires in the area controlled. Provide additional sensors and power switch packs as needed to provide the same level of functionality as shown on Drawings or required in Specifications. Remove and replace electrical equipment installed not meeting these conditions at no cost to Owner.

2.02 GENERAL
A. Occupancy sensor designation indicates sensors automatically turn lights ON when the sensor detects the presence of a person and will automatically turn lights OFF when no presence is detected for a specified amount of time (automatic-on and automatic-off).

B. Vacancy sensor designation requires someone to manually turn the lights ON. The sensor will then automatically turn the lights OFF when no presence is detected for a specified amount of time (manual-on and automatic-off).

C. Provide occupancy sensors to sense presence of human activity within desired space and enable or disable on/off manual lighting control function provided by local switches.

D. Upon detection of human activity by detector, sensor initiates time delay to maintain lights on for present period of time. Field adjustable time delay setting from 30 seconds to 15 minutes.

E. Factory set sensors for maximum sensitivity.

F. LED lamp built into sensor indicates when occupant is detected.

G. Provide zero cross relay control with sensors and sensor/switched; relay contacts close and open with AC voltage signal is at zero.

H. Where line voltage sensors and sensor/switches are used, provide to match voltage of controlled circuit.

I. Line Voltage Sensors, Control Units, and Relays: UL listed.

2.03 OCCUPANCY/VACANCY SENSORS (CEILING AND WALL MOUNTED)
A. Passive Infrared Sensors:
1. Sensor Function: Detects human presence in floor area being controlled by detecting changes in Infrared energy. Sensor detects small movements, i.e., when people are writing while seated at a desk.
2. Provide temperature compensated dual element pyro-electric sensor and with multi element Fresnel lens.
4. Provide daylight filter to ensure that sensor is insensitive to short-wavelength infrared waves, i.e., those emitted by sun.
5. Adjustments and mounting hardware under removable cover to prevent tampering with adjustments and hardware.
6. Sensor utilizes advanced digital signal processing technology to reduce false offs without reducing sensitivity.

7. Ceiling-Mounted Sensor:
   a. Programmable to operate as an occupancy sensor (automatic-on and automatic-off) or a vacancy sensor (manual-on and automatic-off).
   b. 360 degree sensor range; coverage: 1200 SF, unless otherwise noted on drawings.
   c. Low Voltage Sensor: 24VDC power. Sensor operates remote power switch packs. Multiple sensors can be wired in parallel allow coverage of large areas.
   d. Basis of Design: Wattstopper CI-300 Series.

B. Ultrasonic Occupancy/Vacancy Sensors:
1. Sensor Function: Detects human presence in controlled floor area by detecting Doppler shifts in 40kHz ultrasound created by sensor.

2. Sensors are precision crystal controlled and do not interfere with each other when two or more are placed in same area. Sensor includes advanced digital signal processing to reduce false on signals without decreasing sensitivity, as well as immunity to RFI/EMI sources.


4. Low Voltage Sensor: 24VDC power. Sensor operates remote power switch packs. Multiple sensors can be wired in parallel allow coverage of large areas.

5. Provide adjustments and mounting hardware under removable cover to prevent tampering.

6. Ceiling-Mounted Sensor:
   a. Programmable to operate as an occupancy sensor (automatic-on and automatic-off) or a vacancy sensor (manual-on and automatic-off).
   b. Maximum protrusion of 1.1-inches and blend in aesthetically with ceiling.
   c. Coverage: 360 degree sensor range; coverage: 2,000 SF, unless otherwise noted on Drawings.

7. Ceiling Mounted Sensor - Hallway Sensor Coverage:
   a. Programmable to operate as an occupancy sensor (automatic-on and automatic-off) or a vacancy sensor (manual-on and automatic-off).
   b. Maximum protrusion of 1.5-inches and blend in aesthetically with ceiling.
   c. Coverage: 90 linear feet.
   d. Basis of Design: Wattstopper UT-300-3 Series.

C. Dual Technology Sensors:
1. Sensor Function: Combined capability of passive infrared with ultrasonic or microphonic technology as described above.

2. Function: Upon a person entering a space, motion must be sensed by both technologies before lighting will be turned on. After this has occurred, detection by either technology will hold lighting on. Sensors retrigger time delay where only one motion is necessary to turn on lights within 5 seconds after turning off.

3. Ceiling-Mounted Sensor:
   a. Programmable to operate as an occupancy sensor (automatic-on and automatic-off) or a vacancy sensor (manual-on and automatic-off).
   b. 360 degree sensor range; coverage: 1000 SF for half-step motion, unless otherwise noted on Drawings.
   c. Low Voltage Sensor: 24VDC power. Sensor operates remote power switch packs. Multiple sensors can be wired in parallel allow coverage of large areas.

2.04 COMBINED OCCUPANCY/VACANCY SENSOR/WALL SWITCHES ("SENSOR/SWITCHES")
A. Completely self-contained sensor system that fits into standard single gang box. Internal transformer power supply, latching dry contact relay switching mechanism compatible with
electronic ballasts, compact fluorescent, and inductive loads. Triac and other harmonic generating devices are not allowed.

B. Passive infrared sensor technology includes advanced signal processing to reduce false triggers without increasing sensitivity. LED indicator blinks when occupant sensed.

C. Rated to switch loads: 800 watts incandescent or 120-volt ballast; 1000 watts 277 volt ballast. Zero-crossing technology switches lighting off when AC voltage is at zero, minimizes contact wear.

D. Provide adjustable daylight feature that holds lighting "off" when desired footcandle level is present.

E. Provide integral off override switch with no leakage current to load or ground.

F. Vandal-resistant lens.

G. Includes neutral wire to meet NEC 2014 Code.

H. Finish: Color as selected by Architect.

I. Alerts for impending shut-off: light flash, audible, both or none.

J. Standard Sensor/Switch:
   1. Programmable to operate as an occupancy sensor (automatic-on and automatic-off) or a vacancy sensor (manual-on and automatic-off). Factory set to manual on/auto off.
   2. 180 degree sensor range; coverage: 150 SF for desktop activity.

K. Sensor/Slide Dimmer:
   1. Line voltage slider dimmer allows for manual adjustment of lighting levels from 100 percent to 10 percent; compatible with two-wire line voltage 100 percent to 10 percent electronic dimming ballasts. Separate manual button for override "off" control.
   2. 180 degree sensor range; coverage: 300 SF for desktop activity.

PART 3 - EXECUTION

3.01 GENERAL INSTALLATION REQUIREMENTS

A. Install occupancy/vacancy sensors as directed by manufacturer's instructions. Complete connections to control circuits, occupancy sensors, power supply pack and low voltage wiring.

B. Provide power packs for sensor to control number of circuits and/or switch legs within its area of coverage.

C. Field adjust each sensor to maximize its coverage of room space.

D. Relocate sensors with ultrasonic technology to avoid being closer to HVAC diffusers and power packs than recommended by manufacturer.

E. Field set time delay for each device as described in drawings.

F. Lighting System Testing and Commissioning:
   1. Test lighting controls to ensure that control devices, components, equipment and systems are calibrated, adjusted and operate in accordance with Drawings and Specifications. Provide functional testing of sequences of operation to ensure operation in accordance with Drawings and Specifications. Provide complete report of test procedures and results to engineer and insert approved copy into project closeout documents.
   2. Testing includes:
      a. Daylight Automatic Controls
      b. Occupant Sensing Automatic Controls
      c. Automatic Time and Override Controls for Interior Lighting
      d. Automatic Time and Photo Controls for Exterior Lighting

END OF SECTION
PART 1 - GENERAL

1.01 SUMMARY
A. Work Included:
   1. Two-Winding Transformers

1.02 RELATED SECTIONS
A. Contents of Division 26, Electrical and Division 01, General Requirements apply to this Section.

1.03 REFERENCES AND STANDARDS
A. References and Standards as required by Section 26 00 00, Electrical Basic Requirements and
   Division 01, General Requirements.
B. In addition, meet the following:
   1. UL 1561: Dry-Type General Purpose and Power Transformers.

1.04 SUBMITTALS
A. Submittals as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.

1.05 QUALITY ASSURANCE
A. Quality assurance as required by Section 26 00 00, Electrical Basic Requirements and Division
   01, General Requirements.
B. In addition, meet the following:
   1. Production test each unit according to NEMA Standard 20.

1.06 WARRANTY
A. Warranty of materials and workmanship as required by Section 26 00 00, Electrical Basic
   Requirements and Division 01, General Requirements.

PART 2 - PRODUCTS

2.01 MANUFACTURERS
A. Eaton
B. Federal Pacific
C. General Electric
D. Jefferson Electric
E. Siemens
F. Schneider Electric/Square D
G. Or approved equivalent.
H. Basis of Design: Schneider Electric/Square D. Manufacturers listed are allowed on condition of
   meeting specified conditions including available space for equipment and Code required
   working clearances. Remove and replace equipment installed that does not meet these
   conditions at no cost to Owner.

2.02 TWO-WINDING TRANSFORMERS
A. Description: Factory assembled, air cooled dry type transformer. Efficiency compliant with
   Federal Code 10 CFR Part 431 and DOE 2016 efficiency requirements. NEMA TP-1 efficiency
   levels are not acceptable.
B. Primary Voltage: 480 volts, 3 phase.
C. Secondary Voltage: 208Y/120 volts, 3 phase.
D. Windings: Copper or Aluminum.
E. Insulation system and average winding temperature rise for rated kVA as follows:
1. 1-15 kVA: Class 220 with 150 degrees C rise.
2. 16-500 kVA: Class 220 with 150 degrees C rise.

F. Maximum Winding Temperature: Do not exceed 30 degrees C rise above 40 degrees C ambient at warmest point at full load.

G. Winding Taps:
   1. Transformers Less than 15 kVA: Two 5 percent below rated voltage, full capacity taps on primary winding.

H. Conductor Termination Lugs: Compression.

I. Sound Levels: NEMA ST 20.

J. Basic Impulse Level: 10 kV.

K. Impedence: 3 to 5 percent, unless otherwise noted on drawings. Minimum reactance 2 percent.

L. Ground core and coil assembly to enclosure by means of a visible flexible copper grounding strap.

M. Mounting:
   1. 1-15 kVA: Suitable for wall mounting.
   2. 16-75 kVA: Suitable for wall mounting.
   3. Larger than 75 kVA: Suitable for floor mounting.

N. Coil Conductors: Continuous windings with terminations brazed or welded.

   1. Interior: Type 1.
   2. Exterior: Type 3R.
   3. Ventilated.
   4. Provide lifting eyes or brackets.

P. Isolate core and coil from enclosure using vibration-absorbing mounting pads.


PART 3 - EXECUTION
3.01 INSTALLATION

A. Set transformers plumb and level.

B. Use flexible conduit, 2-feet minimum length with slack, for connections to transformer case. Make conduit connections to side panel of enclosure.

C. Mount wall-mounted transformers using integral flanges or accessory brackets furnished by manufacturer. Mount to allow a minimum of 6-feet, 6-inches headroom below unit.

D. Mount trapeze-mounted transformers as indicated.

E. Provide seismic restraints.

F. Provide grounding and bonding in accordance with Section 26 05 26, Grounding and Bonding of Electrical Systems.

G. Clearance: Minimum 6-inches clear on sides and back. Front clearance per NEC 110.26. Maintain minimum clearance from combustible materials per NEC. Comply with manufacturers recommendations.

   1. Provide 8-inches diameter by 24-inches (above and below grade) concrete filled steel bollards where subject to vehicular traffic.
   2. Where grouped with switchgear refinish as required so that transformers and switchgear match in color.
I. Unacceptable Humming and Noise Levels: Revise installation as required to achieve a noise level less than or equal to those defined in NEMA ST-20 for associated transformer size or replace with a new unit with an acceptable sound level.

J. Provide equipment nameplates per Section 26 05 53, Identification for Electrical Systems.

K. Provide arc flash labels.

3.02 FIELD QUALITY CONTROL

A. Perform field inspection, testing, and adjusting.

B. Perform inspections and tests listed in accordance with manufacturers requirements. In addition including following:
   1. Perform turns ratio tests at tap positions.
   2. Verification that as-left tap connections are as specified.
   3. Perform excitation-current tests on each phase.
   4. Measure resistance of each winding at each tap connection.
   5. Overpotential test on high- and low-voltage windings-to-ground.

C. Check for damage and tight connections prior to energizing transformers.

3.03 ADJUSTING

A. Measure primary and secondary voltages and make appropriate tap adjustments.

END OF SECTION
SECTION 26 2416 - PANELBOARDS

PART 1 - GENERAL

1.01 SUMMARY
   A. Work Included:
      1. Power Distribution Panelboards
      2. Panelboards

1.02 RELATED SECTIONS
   A. Contents of Division 26, Electrical and Division 01, General Requirements apply to this Section.
   B. In addition, reference the following:
      1. Section 26 05 73, Electrical Distribution System Studies.
      2. Section 26 28 00, Overcurrent Protective Devices.

1.03 REFERENCES AND STANDARDS
   A. References and Standards as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.
   B. In addition, meet the following:
      1. UL 67, Standards for Panelboards.

1.04 SUBMITTALS
   A. Submittals as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.

1.05 QUALITY ASSURANCE
   A. Quality assurance as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.

1.06 WARRANTY
   A. Warranty of materials and workmanship as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.

PART 2 - PRODUCTS

2.01 MANUFACTURERS
   A. Power Distribution Panelboards:
      1. Eaton
      2. General Electric
      3. Siemens
      4. Schneider Electric/Square D
      5. Or approved equivalent.
   B. Panelboards:
      1. Eaton
      2. General Electric
      3. Siemens
      4. Schneider Electric/Square D
      5. Or approved equivalent.
   C. Manufacturers listed above are allowed on condition of meeting specified conditions including available space for equipment, Code required working clearances. Prior to submitting bid, manufacturer to provide documentation to Engineer verifying specific conditions, including those mentioned above, can be met. Remove and replace electrical equipment installed, at no cost to the Owner, that does not meet these conditions.
   D. Basis of Design: Schneider Electric/Square D. Manufacturers listed are allowed on condition of meeting specified conditions including available space for the equipment and Code required
working clearances. Remove and replace electrical equipment installed that does not meet these conditions at no cost to Owner.

2.02 POWER DISTRIBUTION PANELBOARDS

A. Description: NEMA PB 1 Type 1, circuit breaker type.

B. Integrated Equipment Rating: Provide fully rated integrated equipment rating greater than the available fault current. Series rated panelboards are not acceptable. Reference drawings for available fault current. If drawings do not have available fault current shown, then coordinate with serving electrical utility. Final rating based on the protective device study completed under the provisions of Division 26, Electrical Distribution System Studies.

C. Panelboard Bus: Non-reduced Copper or Aluminum, ratings as indicated on drawings. Bus bar with suitable electroplating (tin) for corrosion control at connection. Provide copper ground bus in each panelboard.

D. Lugs: Compression type.

E. Molded Case Circuit Breakers: With integral thermal and instantaneous magnetic trip in each pole; UL listed. For air conditioning equipment branch circuits provide circuit breakers UL listed as Type HACR.

F. Molded Case Circuit Breakers with Current Limiters: With replaceable current limiting elements, in addition to integral thermal and instantaneous magnetic trip in each pole; UL listed.

G. Circuit Breaker Accessories: Trip units and auxiliary switches as indicated.

H. Fully equip unused spaces for future devices, including manufacturer required connections and mounting hardware.

I. Cabinet Front: Surface type hinged door with flush lock, metal directory frame, finished in manufacturer's standard gray enamel.

2.03 PANELBOARDS

A. Description: Panelboards 400 amps or less. NEMA PB1, Type 1 as indicated on drawings, circuit breaker type. Maximum enclosure depth: 6-inches for surface mounted, 5 3/4-inches for flush mounted.

B. Maximum Width: 20-inches.

C. Integrated Equipment Rating: Provide fully rated integrated equipment rating greater than the available fault current. Series rated panelboards are not acceptable. Reference drawings for available fault current. If drawings do not have available fault current shown, then coordinate with serving electrical utility. Final rating based on the protective device study completed under the provisions of Division 26, Electrical Distribution System Studies.

D. Panelboard Bus Non-Reduced: Copper or Aluminum, ratings as indicated on drawings. Bus bar with suitable electroplating (tin) for corrosion control at connection. Provide copper ground bus in each panelboard.

E. Lugs: Compression type for conductors.

F. Provide double lugs and/or feed-through lugs for feed through feeders.

G. Molded Case Circuit Breakers: Thermal magnetic trip circuit breakers, bolt-on type, with common trip handle for poles; UL listed. Predrill bus for bolt-on breakers.
   1. Type SWD for lighting circuits.
   2. Type HACR for air conditioning equipment circuits.
   3. Class A ground fault interrupter circuit breakers where scheduled.
   4. Class B ground fault equipment protection circuit breakers for heat trace and other circuits as required by Code. Provide shunt trip circuit breakers where scheduled; provide wiring to remote trip switch/contacts as indicated on Drawings.
   5. Do not use tandem circuit breakers.

H. Accessories: Provide where indicated: shunt trip, arc-fault circuit interrupter (AFCI), Class A ground fault circuit interrupter (GFCI), auxiliary switch and alarm switch.
I. Cabinet Front: Provide flush or surface mounting as shown on the schedules, drawings, or otherwise noted. Cabinet front with concealed hinged front cover door-in-door construction, metal directory frame with heavy clear plastic protector, flush lift latch and lock, two keys per panel all keyed alike.

J. Provide boxes with removable blank end walls and interior mounting studs. Provide interior support bracket for ease of interior installation.

K. Furnish surface mounted cabinet boxes without knockouts.

L. Minimum Integrated Short Circuit Rating:
   1. 10,000 amperes symmetrical for 240 V panelboards.
   2. 14,000 amperes symmetrical for 480 V panelboards.
   3. Minimum rating as indicated on the Drawings or Panel Schedules.

PART 3 - EXECUTION

3.01 GENERAL INSTALLATION REQUIREMENTS

A. Install panelboards in accordance with NEMA PB 1.1, NECA 1 and manufacturers installation instructions.

B. Install panelboards level and plumb. Install recessed panelboards flush with wall finishes.

C. Height: 6-feet 6-inches to top of panelboard; install panelboards taller than 6-feet 6-inches with bottom no more than 4-inches (100 mm) above floor.

D. Provide filler plates for unused spaces in panelboards.

E. Provide typed circuit directory for each branch circuit panelboard. Include all "spaces" and "spares." Revise directory to reflect circuiting changes and as-installed conditions. Use final Owner designated room names and numbers, and not designations shown on drawings.

F. Provide engraved plastic nameplates per Section 26 05 53, Identification for Electrical Systems.

G. Provide 6, 1-inch spare conduits out of each recessed panelboard to an accessible location above ceiling. Identify each as SPARE.

H. Provide permanent identification number in or on panelboard dead-front adjacent to each breaker pole position. Horizontal centerline of numbers to correspond with centerline of circuit breaker pole position.

I. Ground and bond panelboard enclosure per NEC.

J. Paint:
   1. Standard factory finish unless noted otherwise.
   2. Panelboards located in finished interior areas in view of building occupants; paint to match adjacent wall surface. Color and paint preparation as specified by Architect. Covers to be painted off wall, then installed over dried, painted wall surface.

K. Provide handle guards on each circuit supplying obviously constant loads such as fire alarm, security, lighting controls, refrigerators and freezers, fire protection, etc.

L. Provide interior wiring diagram, neutral wiring diagram, UL label, and short circuit rating on interior or in booklet format inserted in sleeve inside panel cover.

M. Verify available recessing depth and coordinate wall framing with other divisions.

N. Maintain fire rating of wall where panels are installed flush in fire rated walls.

O. Perform inspections and tests in accordance with manufacturer's requirements.

P. Thoroughly clean exterior and interior of each panelboard in accordance with manufacturer's installation instructions.

Q. Vacuum construction dust, dirt, and debris out of each panelboard.

R. Where enclosure finish is damaged, touch up finish with matching paint in accordance with manufacturer's specifications and installation instructions.
3.02 POWER DISTRIBUTION PANELBOARDS INSTALLATION

A. Breakers being added to existing panelboards: Coordinate breaker type and short circuit rating with existing panelboard. Breakers to match existing in manufacturer's type and AIC rating. Provide new typed circuit directory.

B. Provide handle tie to branch circuit breakers of multiwire branch circuits for simultaneous disconnection of circuits. Handle tie will be identified for use with circuit breakers provided. Reconfigure assigned circuits as necessary so that circuit breakers associate with multiwire branch circuits are physically adjacent, record changes in panelboard schedules and circuiting plans for record drawings.

C. Shunt Trip Circuit Breakers: Provide wiring to remote trip switch/contacts as indicated on Drawings.

D. Measure steady state load currents at each panelboard feeder; rearrange circuits in panelboard to balance phase loads to within 20 percent of each other. Maintain proper phasing for multi-wire branch circuits.

3.03 PANELBOARDS INSTALLATION

A. Breakers being added to existing panelboards: Coordinate breaker type and short circuit rating with existing panelboard. Breakers to match existing in manufacturer's type and AIC rating. Provide new typed circuit directory.

B. Provide handle tie to branch circuit breakers of multiwire branch circuits for simultaneous disconnection of circuits. Handle tie will be identified for use with circuit breakers provided. Reconfigure assigned circuits as necessary so that circuit breakers associate with multiwire branch circuits are physically adjacent, record changes in panelboard schedules and circuiting plans for record drawings.

C. Shunt Trip Circuit Breakers: Provide wiring to remote trip switch/contacts as indicated on Drawings.

D. Measure steady state load currents at each panelboard feeder; rearrange circuits in panelboard to balance phase loads to within 20 percent of each other. Maintain proper phasing for multi-wire branch circuits.

END OF SECTION
SECTION 26 2713 - ELECTRICAL METERING

PART 1 - GENERAL

1.01 SUMMARY
A. Work Included:
   1. Utility Metering Equipment

1.02 RELATED SECTIONS
A. Contents of Division 26, Electrical and Division 01, General Requirements apply to this Section.

1.03 REFERENCES AND STANDARDS
A. References and Standards as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.

1.04 SUBMITTALS
A. Submittals as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.

1.05 QUALITY ASSURANCE
A. Quality assurance as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.

1.06 WARRANTY
A. Warranty of materials and workmanship as required by Section 26 00 00, Electrical Basic Requirements Division 01, General Requirements.

PART 2 - PRODUCTS

2.01 MANUFACTURERS
A. Manufacturers:
   1. Utility Metering Equipment
      a. Meter Base:
         1) Circle AW.
         2) Or approved equivalent.
      b. Metering Equipment Enclosure:
         1) General Electric
         2) Schneider Electric/Square D
         3) Eaton Electrical
         4) Siemens
         5) Or approved equivalent.

2.02 UTILITY METERING EQUIPMENT
A. Meter Base: Surface mounted meter socket enclosure. Provide meter base(s) for energy/demand and reactive energy/demand bases as required by serving electric utility.
B. Terminal Cabinet: Provide terminal cabinet that meets serving utility company's requirements. Provide separate C.T. cabinet as detailed.
C. Provide fault withstand rating greater than utility determined available fault current.
D. C.T. Enclosure: Provide enclosure that meets serving utility company's requirements. Provide separate C.T. cabinet as detailed.

PART 3 - EXECUTION

3.01 UTILITY METERING INSTALLATION
A. Meter Bases: Locate to provide acceptable access for meter reading and maintenance. Locate to minimize risk of physical damage.
B. Metering Equipment: Install current transformers supplied by serving electric utility.
C. Verify utility requirements prior to bidding and provide associated work required by local utility including but not limited to:
   1. Service underground primary including conduit, pull cord, excavation and backfill.
   2. Underground pull vaults.
   3. Pole risers.
   4. Transformer pads, and vaults.
   5. Secondary service lateral raceways.
   7. Service metering equipment.

END OF SECTION
1.01 SUMMARY
A. Work Included: Provision of materials, installation and testing of:
   1. Wall Switches
   2. Receptacles
   3. Finish Plates
   4. Wall Dimmers
   5. Surface Covers

1.02 RELATED SECTIONS
A. Contents of Division 26, Electrical and Division 01, General Requirements apply to this Section.

1.03 REFERENCES AND STANDARDS
A. References and Standards as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.
   B. In addition, meet the following:
      1. UL 943, Ground Fault Circuit Interrupters (Class A GFCI).

1.04 SUBMITTALS
A. Submittals as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.
   B. In addition, provide:
      1. Wall switches and Dimmers
      2. Receptacles
      3. Wall Plates
      4. In-Use Cover

1.05 QUALITY ASSURANCE
A. Quality assurance as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.

1.06 WARRANTY
A. Warranty of materials and workmanship as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.

PART 2 - PRODUCTS
2.01 MANUFACTURERS
A. Wall Switches:
   1. Toggle Type Characteristics:
      a. Cooper AH1201
      b. Hubbell HBL1221
      c. Leviton 1221
      d. Legrand P&S PS20AC1
      e. Or approved equivalent.

B. Receptacles:
   1. Commercial Grade:
      a. 20 Amp:
         1) Cooper 5362
         2) Hubbell 5362
         3) Bryant CBR520
         4) Leviton 5362S
         5) Legrand P&S 5362
         6) Or approved equivalent.
2. Ground Fault Circuit Interrupter (GFCI) Receptacle:
   a. Cooper TWRSGF20
   b. Hubbell GFTWRST20
   c. Legrand P&S 2097TRWR
   d. Or approved equivalent.

C. Finish Plates:
   1. Bryant
   2. Cooper
   3. Hubbell
   4. Leviton
   5. Legrand P&S
   6. Or approved equivalent.

D. Wall Dimmers:
   1. Lutron Maestro Series
   2. Or approved equivalent.

E. Surface Covers:
   1. Aluminum with Gasket, Blanks, Single Gang:
      a. Bell 240-ALF
      b. Carlon
      c. Or approved equivalent.
   2. 2-Gang:
      a. Bell 236-ALF
      b. Carlon
      c. Or approved equivalent.
   3. While-in-Use Weatherproof Cover:
      a. Die Cast Cover:
         1) Intermatic
         2) Hubbell
         3) Cooper
         4) Or approved equivalent.

F. Provide lighting switches and receptacles of common manufacturer and appearance.

2.02 WALL SWITCHES
A. Characteristics: Toggle type, quiet acting, 20 amp, 120/277 volt, UL listed for motor loads up to 80 percent of rated amperage, extra heavy duty.
B. Finish: Color as Selected by Architect.

2.03 RECEPTACLES
A. Duplex Receptacles Characteristics: Straight parallel blade, 125 volt, 2 pole, 3 wire grounding.
B. Ground Fault Circuit Interrupter (GFCI) Receptacle: Feed through type, back-and-side wired, tamper-resistant, weather resistant self-testing, 20 amp, 125VAC.
D. Finish:
   1. Same exposed finish as switches.

2.04 FINISH PLATES
A. Finish Plates: Type 302 stainless steel with smooth satin finish.
B. Provide telephone/signal device plates; activated outlets to have coverplates to match modular jack.
2.05 WALL DIMMERS
A. Provide wall dimmers compatible with type of load controlled (i.e. line voltage, low voltage, 2-wire, 3-wire, 0-10v). Finish to match wall switches. Size dimmers to accept connected load. Do not cut fins. Where dimmers are ganged together, provide a single multi gang coverplate.
B. LED indicator dots show by what percentage controlled lighting is dimmed. Programmable settings for maximum and minimum trim settings, and rate of change in lighting levels.

2.06 SURFACE COVERS
A. Material: Galvanized steel, 1/2-inch raised industrial type with openings appropriate for devices installed on surface receptacles.
B. Cast Box and Extension Adaptors: Aluminum with gasket, blanks single gang or 2-gang.
C. While-in-Use Weatherproof Cover: NEMA 3R when closed over energized plug. Vertical mount for duplex receptacle. Provide continuous use cover with cover capable of closing over energized cord cap with bottom aperture for cord exit.
   1. Die cast cover with closed cell neoprene foam gasket: Capable of being locked closed to prevent tampering or unauthorized use.

PART 3 - EXECUTION
3.01 GENERAL INSTALLATION REQUIREMENTS
A. See Architectural elevations for location and mounting height of wiring devices. Review Architectural elevations prior to rough-in and contact Architect immediately if conflicts are found between Architectural and Electrical Drawings. Do not rough-in devices until conflicts are resolved.
B. Install wiring devices and finish plates plumb with building lines, equipment cabinets and adjacent devices. Devices not plumb will be fixed at no additional cost to Owner.
C. Orientation:
   1. Install wiring devices with long dimension oriented vertically at centerline height shown on drawings or as specified.
   2. Vertical Alignment: When more than one device is shown on drawings in close proximity to each other, but at different elevations, align devices on a common vertical center line for best appearance. Verify with Architect.
   3. Horizontal Alignment: When more than one device is shown on drawings in close proximity to each other with same elevation, align devices on a common horizontal center line for best appearance. Verify with Architect.
D. Provide labeling per Section 26 05 53, Identification for Electrical Systems.
E. Test wiring devices to ensure electrical continuity of grounding connections, and after energizing circuitry, to demonstrate compliance with requirements. Test receptacles for line to neutral, line to ground and neutral to ground faults. Correct any defective wiring.

3.02 WALL SWITCHES INSTALLATION
A. At time of substantial completion, replace those items which have been damaged.

3.03 RECEPTACLES INSTALLATION
A. Upon installation, adhere to proper and cautious use of convenience receptacles. At time of substantial completion, replace those items which have been damaged, including those burned and scored by faulty receptacles or cord caps.
B. GFCI Receptacles: One GFCI receptacle may not be used to provide GFCI protection to downstream duplex receptacles on the same branch circuit.

3.04 FINISH PLATES INSTALLATION
A. Do not install items until finish painting is complete. Replace scratched and paint splattered finish plates and wiring devices.
3.05 WALL DIMMERS INSTALLATION
   A. Install per manufacturer's recommendations and wiring diagrams.

3.06 SURFACE COVERS INSTALLATION
   A. Do not install items until finish painting is complete. Replace scratched and paint splattered finish plates and wiring devices.

END OF SECTION
SECTION 26 2800 - OVERCURRENT PROTECTIVE DEVICES

PART 1 - GENERAL

1.01 SUMMARY
   A. Work Included:
      1. Fuses
      2. Molded Case Circuit Breakers

1.02 RELATED SECTIONS
   A. Contents of Division 26, Electrical and Division 01, General Requirements apply to this Section.

1.03 REFERENCES AND STANDARDS
   A. References and Standards as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.

1.04 SUBMITTALS
   A. Submittals as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.
   B. In addition, provide:
      1. Product data and instantaneous let-through current curves and average melting time current curves for fuses supplied to project.
      2. Product data and time/current trip curves for circuit breakers supplied to project.

1.05 QUALITY ASSURANCE
   A. Quality assurance as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements apply to this Section.

1.06 WARRANTY
   A. Warranty of materials and workmanship as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.

PART 2 - PRODUCTS

2.01 MANUFACTURERS
   A. Fuses:
      1. Bussmann
      2. Ferraz-Shawmut
      3. Littelfuse
      4. McGraw-Edison
      5. Or approved equivalent.
   B. Molded Case Circuit Breakers:
      1. Eaton Electrical
      2. General Electric
      3. Schneider Electric/Square D
      4. Or approved equivalent.

2.02 FUSES
   A. Characteristics:
      1. Dual element, time delay, current limiting, nonrenewable type, rejection feature.
      2. Combination Loads: UL Class RK1, RK5, or J, 1/10 to 600 amp. UL Class L, above 600 amps.
      3. Motor Loads: UL Class RK5, 1/10 to 600 amp.
      4. Fuse pullers for complete range of fuses.

2.03 MOLDED CASE CIRCUIT BREAKERS
   A. 1-, 2- or 3-pole bolt-on, single handle common trip, 600VAC or 250VAC as indicated on Drawings.
B. Overcenter toggle-type mechanism, quick-make, quick-break action. Trip indication is by handle position.
C. Calibrate for operation in 40 degrees C ambient temperature.
D. 15 to 150 Amp Breakers: Permanent trip unit containing individual thermal and magnetic trip elements in each pole.
E. 151 to 400 Amp Breakers: Adjustable magnetic trip elements. Provide push-to-trip button on cover of breaker for mechanical tripping.

PART 3 - EXECUTION

3.01 GENERAL INSTALLATION REQUIREMENTS

A. Coordination:
   1. Obtain and review the submitted product data for equipment furnished by the Owner, and furnished under other Divisions of this contract, particularly under Divisions 22 and 23.
   2. Confirm the equipment nameplate maximum overcurrent protection (MOCP) and make accommodations and adjustments to overcurrent protective devices as necessary to coordinate with the nameplate rating.

B. Install all items in accordance with manufacturers written instructions.

3.02 FUSES

A. Fuses: For each class and ampere rating of fuse installed, provide the following quantities of spares for quantity of fuses installed:
   1. 0 to 24: Provide 6 spare.
   2. 25 to 48: Provide 9 spare.
   3. 49 and Above: Provide 12 spare.

3.03 MOLDED CASE CIRCUIT BREAKERS

A. Provide testing of ground fault interrupting breakers.
B. Provide circuit breakers, as specified and on Drawings, for installation in panelboards, individual enclosures or combination motor starters.
C. Provide ground fault interrupter circuit breakers for equipment in damp or wet locations.
D. Provide device on handle to lock breaker in "ON" position for breakers feeding time switches, night lights and similar circuits required to be continuously energized.
E. Shunt Trip Circuit Breakers: Provide wiring to remote trip switch/contacts as indicated on Drawings.
F. Provide multi-pole branch circuit breakers for multiwire branch circuits for simultaneous disconnection of circuits.
SECTION 26 2816 - ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 - GENERAL

1.01 SUMMARY

A. Work Included:
   1. Toggle Type Disconnect Switches
   3. Safety Switches
   4. Enclosed Circuit Breakers
   5. Molded Case Switches

1.02 RELATED SECTIONS

A. Contents of Division 26, Electrical and Division 01, General Requirements apply to this Section.
B. In addition, reference the following:
   1. Section 26 05 73, Electrical Distribution System Studies.
   2. Section 26 24 16, Panelboards.
   3. Section 26 28 00, Overcurrent Protective Devices.

1.03 REFERENCES AND STANDARDS

A. References and Standards as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.

1.04 SUBMITTALS

A. Submittals as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.

1.05 QUALITY ASSURANCE

A. Quality assurance as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.

1.06 WARRANTY

A. Warranty of materials and workmanship as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Toggle Type Disconnect Switches:
   1. Cooper
   2. Hubbell
   3. Leviton
   4. Pass & Seymour
   5. Slater
   6. Or approved equivalent.

B. Manual Motor Starters:
   1. Eaton Electrical
   2. General Electric
   3. Schneider Electric/Square D
   4. Or approved equivalent.

C. Safety Switches:
   1. Eaton Electrical
   2. GE Industrial
   3. Schneider Electric/Square D
   4. Or approved equivalent.

D. Enclosed Circuit Breakers:
ENCLOSED SWITCHES AND CIRCUIT BREAKERS

1. Eaton Electrical
2. GE Industrial
3. Schneider Electric/Square D
4. Or approved equivalent.

E. Molded Case Switches:
1. Eaton Electrical
2. General Electric
3. Schneider Electric/Square D
4. Or approved equivalent.

2.02 TOGGLE TYPE DISCONNECT SWITCHES
A. Rating: 120 or 277 volt, 1 or 2 pole, 20 amp, 1 hp maximum.
B. Enclosure:
   1. NEMA 1: Dry locations/Indoors.
   2. NEMA 3R: Damp or wet locations/Outdoors.
C. Handle lockable in 'off' position.

2.03 MANUAL MOTOR STARTERS
A. Quick-Make, Quick-Break. Thermal overload protection. Device labeled with maximum voltage, current, and horsepower.
B. Enclosure:
   1. NEMA 1: Dry locations/Indoors.
   2. NEMA 3R: Damp or wet locations/Outdoors.

2.04 SAFETY SWITCHES
A. Heavy duty fusible type and non-fusible type (as indicated on drawings), dual rated, quick-make, quick-break with fuse rejection feature for use with Class R fuses only, unless other fuse type is specifically noted.
B. Clearly marked for maximum voltage, current, and horsepower.
C. Operable handle interlocked to prevent opening front cover with switch in 'on' position.
D. Switches rated for maximum available fault current.
E. Handle lockable in 'off' position.
F. Enclosure:
   1. NEMA 1: Dry locations/Indoors.
   2. NEMA 3R: Damp or wet locations/Outdoors.
G. Fusible Switch Assemblies: NEMA KS 1, quick-make, quick-break, load interrupter enclosed knife switch with externally operable handle. Provide interlock to prevent opening front cover with switch in ON position. Handle lockable in OFF position. Fuse clips: Provide fuse rejection feature for Class R or J fuses up to 600 amp. Remove if circuit breaker type is used. Provide switches of 30 to 200 amp with plug-on line side connections.
H. Fusible Switch Assemblies, 800 Amperes and Larger: Bolted pressure contact switches. Fuse Clips: Designed to accommodate Class L fuses. Provide with shunt-trip and ground fault capabilities. Remove if circuit breaker type is used.

2.05 ENCLOSED CIRCUIT BREAKERS
A. Molded case circuit breakers:
   1. 1-, 2-, or 3-pole bolt on, single-handle common trip, 600VAC or 250VAC as indicated on drawings.
   2. Overcenter toggle-type mechanism, quick-make, quick-break action. Trip indication is by handle position.
   3. Calibrate for operation in 40C ambient temperature.
4. 15 to 150 Amp Breakers: Permanent trip unit containing individual thermal and magnetic trip elements in each pole.
5. 151 to 400 Amp Breakers: Variable magnetic trip elements. Provide push-to-trip button on cover of breaker for mechanical tripping.
6. Provide handle mechanisms that are lockable in the open (off) position.
7. Circuit breakers to have minimum symmetrical interrupting capacity as indicated on Drawings.

B. Enclosure:
   1. NEMA 1: Dry locations/Indoors.
   2. NEMA 3R: Damp or wet locations/Outdoors.

2.06 MOLDED CASE SWITCHES

A. Removable cover, galvanized steel enclosure, powder coat painted.
B. Provide cover padlock provision.
C. Provide trip unit with no overcurrent, overload, or low level fault protection. Trip unit to be high instantaneous magnetic fixed trip type with magnetic trip reset at factory to interrupt high fault currents at or above preset level.
D. Enclosure:
   1. NEMA 1: Dry locations/Indoors.
   2. NEMA 3R: Damp or wet locations/Outdoors.

PART 3 - EXECUTION

3.01 GENERAL INSTALLATION REQUIREMENTS

A. Obtain and review the submitted product data for equipment furnished by the Owner, and furnished under other Divisions of this contract, particularly under Divisions 22 and 23.
B. Confirm the equipment nameplate maximum overcurrent protection (MOCP) and make accommodations and adjustments to switches, fuses and circuit breakers as necessary to coordinate with the nameplate rating.
C. Install in accordance with manufacturer's instructions.
D. Provide engraved nameplates per Section 26 05 53, Identification for Electrical Systems.
E. Provide arc flash labels per Section 26 05 73, Electrical Distribution System Studies.
F. Apply neatly typed adhesive tag on inside door of each fusible switch indicating NEMA fuse class and size installed.

3.02 TOGGLE TYPE DISCONNECT SWITCHES

A. Install fuses in fusible disconnect switches. Coordinate fuse ampere rating with installed equipment. Do not provide fuses of lower ampere rating than motor starter thermal units.
B. Install products, systems and equipments in accordance with manufacturers written instructions and requirements.
C. See General Installation Requirements above.

3.03 MANUAL MOTOR STARTERS

A. Provide disconnecting means within sight of each motor controller and of each motor. Motor controller disconnecting means equipped with lock-out/tag-out padlock provisions do not require a disconnect switch at the controlled motor location. Locate disconnect means in view of and not inside of equipment, such that tools are not needed to remove covers to access the disconnecting means.
B. Install products, systems and equipments in accordance with manufacturers written instructions and requirements.
C. See General Installation Requirements above.
3.04 SAFETY SWITCHES
   A. Install products, systems and equipments in accordance with manufacturers written instructions and requirements.
   B. See General Installation Requirements above.

3.05 ENCLOSED CIRCUIT BREAKERS
   A. Install products, systems and equipments in accordance with manufacturers written instructions and requirements.
   B. See General Installation Requirements above.

3.06 MOLDED CASE SWITCHES
   A. Install products, systems and equipments in accordance with manufacturers written instructions and requirements.
   B. See General Installation Requirements above.

END OF SECTION
PART 1 - GENERAL

1.01 SUMMARY

A. Work Included:
   1. PV Module and Array Specifications (Base Bid PV System)
   2. Grid-Interactive Inverter (GII) and Utility Interconnections
   3. Communications

1.02 RELATED SECTIONS

A. Contents of Division 26, Electrical and Division 01, General Requirements apply to this Section.

1.03 REFERENCES AND STANDARDS

A. References and Standards as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.

1.04 SUBMITTALS

A. Submittals as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.

B. In addition provide:
   1. Overview of major system components and principals of operation.
   2. Complete parts lists, including electrical components, mechanical hardware and other equipment required for installing the systems. (Must include description, make, model/part number and source for the equipment provided.)
   3. Diagram indicating overall layout of entire system, including PV array, and location of GII and combiner boxes with respect to the array.
   4. Electrical schematics and diagrams showing major components and devices, including conductor types and sizes, connections of individual modules and array source circuits, terminations at junction boxes, connection to surge suppression devices and the GII, and the GII interface with the utility grid.
   5. Mechanical drawings showing details of module/array mechanical support structure and instructions for assembling and installing arrays on rooftops.
   6. Complete assembly and installation instructions for mounting array, junction boxes and enclosures, routing conduit, wiring arrays, and terminating conductors at array, combiner boxes and GII.
   7. Procedures for operating, disconnecting, servicing and maintaining complete system and individual components.
   8. Warranty information on individual components as required in this bid document.
   9. Equipment manufacturer's specifications and operations manuals, including those for PV modules, GII, overcurrent devices, disconnects and optional equipment
   10. Qualifications for installer(s), including minimum 5 grid-interactive PV projects of minimum 15 kilowatts at STC within 200 miles of the project site.

1.05 QUALITY ASSURANCE

A. Quality assurance as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.

B. In addition, meet the following:
4. System designed and installed by a qualified installer with a minimum of 5 years of experience in installation of commercial photovoltaic systems.

1.06 WARRANTY
A. Warranty of materials and workmanship as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.

B. In addition, provide:
1. Provide minimum 20 year warranty on power output of PV modules.
2. Provide GII with minimum 10 year replacement warranty from the manufacturer covering parts and labor.

PART 2 - PRODUCTS

2.01 MANUFACTURERS
A. PV Module and Array Specifications (Base Bid PV System): Solar World XL Mono
   1. Mono Polycrystalline Modules:
      a. Panasonic
      b. Solar World
      c. Conergy Power
      d. Schott Perform
      e. Sharp
      f. Or approved equivalent.

B. Base Bid Inverter:
   1. Central Inverter Systems:
      a. Fronius IG Plus
      b. Solectria PVI
      c. SMA Sunny Boy (single phase)
      d. Power-One Aurora PVI
      e. Or approved equivalent.

2.02 PV MODULE AND ARRAY SPECIFICATIONS (BASE BID PV SYSTEM)
A. PV Modules: Mono crystalline. Minimum 17.54 percent efficiency.

B. Non-Thin Film Modules Include: Tempered glass, EVA laminate, weatherproof film. Black, anodized aluminum frames and trim strips. Rated for 1-inch diameter hailstones at 52 mph.

C. Performance requirements per module:
   1. Open circuit voltage (Voc) = 48.0 Vdc.
   2. Maximum power voltage (Vpm) = 48.0 Vdc.
   3. Short circuit current (Isc) = 9.82 Aec.
   4. Maximum power current (Ipm) = 9.17 Aec.
   5. Rated Power (Pmax) = 350 W (front side contribution).
   7. Type of output terminal: Lead wire with H4 connector.

D. Physical/mechanical characteristics:
   1. Dimensions 78.46-inches by 39.4-inches by 1.3-inches.
   2. Weight: 47.6 pounds.
   3. Operating temperature: -40 degrees C to +85 degrees C.

2.03 GRID-INTERACTIVE INVERTER (GII) AND UTILITY INTERCONNECTION
A. Design with GII built specifically for grid-interactive connection photovoltaic arrays to utility, and capable of automatic, continuous, and stable operation over the range of voltages, currents, and power levels for the size and type of arrays used.

B. Provide each GII to be compliant with IEEE 1547 (Standard for Interconnecting Distributed Resources with Electric Power Systems) and meet UL1741 (Inverters, Converters, Controllers and Interconnection System Equipment for Use with Distributed Energy Resources) or
equivalent product listing. GII to comply with the latest applicable ANSI and FCC standards and addenda dated prior to the award of the purchase order for this procurement.

C. Provide GII with communications connection for remote monitoring of inverter operation through the internet. Provide and configure software for receiving and tabulating this information through a graphic user interface accessible over the internet. Provide communications card in each GII to allow daisy-chained RS-485 connection between GII's, and interface card for internet communications. Software to provide DC voltage, current, power and energy production, AC voltage, current, power and energy production, operational status of the GII, and graphical record of past production for minimum of 365 previous days on 15 minute increments. Prior to construction, determine location and accessibility to LAN connection point.

D. Provide GII with minimum 10 year replacement warranty from the manufacturer covering parts and labor.

E. Base Bid Inverter SMA Sunny Boy 5000TL-US:
   1. GII Performance Criteria:
      a. 5,150-Watt maximum array input power.
      b. Maximum 600Vdc input voltage.
      c. Rated MPPT voltage range: 220 to 480 Vdc.
      d. Maximum DC input current: 10 Acdc per MPPT.
      e. 5,000-watt nominal AC power output.
      g. Less than 4 percent total harmonic distortion.
      h. 97.2 percent peak inverter efficiency.

F. GII physical criteria:
   1. LCD display.

2.04 COMMUNICATIONS
A. Provide internet portal account through inverter manufacturer to allow real time monitoring of total system and individual inverter power and energy production, with logs going back to at least 365 days.

B. Portal interface:
   1. In bar graph, show power (watts) and energy (kilowatt-hours) production on hourly basis for one day, daily basis for one month, and daily basis for one year. Provide means to examine past power and energy production for at least the previous 365 days.
   2. Program interface to allow end user to examine power and energy production for the total site, as well as for each individual GII.
   3. Supplemental Display Information: Show PV system size in KW, maximum output production in KW, quantity and manufacturer/model of GII and quantity and manufacturer of PV modules, installation date.
   4. Lifetime Energy Production: Show lifetime total equivalents (e.g. number of typical residences that could be powered for one day, number of cups of coffee that could be brewed with same energy, gallons of gasoline offset, etc.).
   5. Greenhouse Gas Offsets: Show offset quantities for clean energy produced (example: weight of carbon dioxide, nitrogen oxides, sulfur oxides).
   6. Environmental Information: Show current ambient temperature, cell temperature, irradiance, wind speed and direction.
   7. Integration of Other Meters: Show power and energy consumption from sub-metering on main electrical service; see Drawings for locations. Provide and connect to Veris H8163 Series and matching split-core CT.

C. Basis of Design:
   1. Tie inverters to internet-based data logger via RS-485 connection.
2. Tie data logger to internet portal via TCP/IP connecting via building local area network. Fronius Interface Card or approved equivalent.
3. Provide RS-485 and telecommunications cabling and connectivity under Division 27, Communications as required to fulfill Basis of Design.
4. Provide tele/data outlet in Main Electrical Room where directed by Owner to allow Owner to add flat screen monitor and/or computer for remote monitoring of PV power and energy production through kiosk, remote internet portal site.
5. Display Package: Provide internet gateway compatible with GII communications, including: Full weather station for display of environmental information specified in this Article, lobby kiosk display software and connectivity as required by Owner, system installer support portal for commissioning system, electrical demand measurement and connection from main electrical sub-meter to internet gateway. Fat Spaniel Insight Views Package, or approved equivalent.

PART 3 - EXECUTION

3.01 SYSTEM DESCRIPTION
A. These specifications cover the design and procurement of equipment, hardware and documentation required for the installation of grid-connected PV systems.
B. Provide complete system installation, in addition to documentation on the design, configuration, permit acquisition, installation, operation and maintenance of the complete system and individual components.
C. System designed for installation in Sisters, Oregon. Supplied equipment must be rated and warranted to withstand and operate under normal weather conditions at the site.
D. Each PV system will be connected to the utility electric grid through a grid-interactive power conditioner (inverter). The design and functional specification of the PV modules, power conditioners, utility interconnections, PV system electrical design, and PV array mechanical design are described in the following Sections.
E. Utility Coordination: Coordinate with local Utility Company prior to start of work for location of their net metering equipment, including CT enclosure provided under this Contract per the Drawings, and any additional utility required disconnects which will also be provided under this Contract.
F. Basis of Design: Provide PV system designed to meet or exceed the performance requirements of the equipment, listed in this specification, while staying under the physical size and weight requirements listed. Costs to allow approved alternative manufacturers and models to meet the performance requirements as specified are part of the scope of this Contract.

3.02 PV SYSTEM ELECTRICAL DESIGN
A. Provide electrical design and installation instructions for the PV systems conforming to the NEC. Article 690 of the NEC applies specifically to photovoltaic system safety, protection, control and interface with other sources. Other articles of NEC also apply. Comply with IEEE 1547, Standard for Interconnecting Distributed Resources with Electric Power Systems.
B. Electrical components, including overcurrent protection, disconnects, surge suppression devices, conduit, wiring and terminals must have UL or equivalent listing and have appropriate voltage, current and temperature ratings for the application. Special attention should be given to appropriate ratings for components used in DC circuits.
C. Wiring must be listed for 600VDC and 600VAC, and a temperature rating of 90C in wet locations. The use of exposed conductors or cabling (excluding grounds) is not acceptable, except MC cable connectors installed under PV modules. Exposed conduit to be painted to match surrounding area. Confirm color with Architect.
D. Ampacity calculations must take into account appropriate deratings as required. Conductors in the system are subject to a 125 percent NEC derate, and DC source circuit conductors and overcurrent devices must include an additional 125 percent derate for solar radiation enhancements. Appropriate temperature deratings for conductors used in module junction...
boxes must be considered for peak module operating temperatures, as well as deratings for instances where more than three current-carrying conductors are enclosed in a conduit.

E. Voltage drop in array DC source circuits should be limited to no more than 2 percent, including losses in conductors, and through all fuses, blocking diodes and termination points.

F. Overcurrent devices must have trip ratings no greater than the derated ampacity of the conductors that it protects.

G. Series connected strings of modules (source circuits) must include a series fuse as required by UL and NEC to prevent excessive reverse current flow through modules in source circuits. Parallel connections of modules in individual source circuits are not permitted. Parallel-connected cells within individual modules are allowable as long as the module listing allows for the series fuse required for this configuration.

H. Series connected strings of modules (source circuits) must also include a blocking diode to minimize overall array losses due to partial shading of source circuits. These diodes should have low voltage drop to meet the requirements above, and have a voltage and current ratings (at temperature) at least twice the open circuit voltage and short-circuit ratings of the source circuits.

I. Terminations must use listed box terminal or compression type connections. Twist on wire splices, crimped, soldered or taped connections are not permitted for the required field installed wiring. Proper torque specifications should be provided for the required field connections.

J. Module frames, metal enclosures, panel boards and the grid-interactive inverter (GII) should be provided with connections for bonding to a common grounding conductor and terminating at the ground electrode system at the utility service entrance point. In addition, provide for grounding the neutral of the GII output. The DC negative circuit may be common to the AC neutral in the GII design and under no circumstances should multiple connections to ground be specified for current carrying conductors in the system.

K. Provide a weathertight, vented, locking, pad mountable enclosure, suitable for housing the GII, AC/DC disconnect devices, and source circuit combiner boxes (as required). Enclosure rating: NEMA 4, 3R or better and have superior strength and corrosion resistance properties based on the project location.

3.03 PV ARRAY MECHANICAL DESIGN

A. Provide hardware as required for assembling the photovoltaic modules and panels, and structurally attaching them to the base support structure.

B. Coordinate PV array and equipment mounting with PV system mounting structures shown on Structural Drawings. Where array and supporting equipment deviate from Basis of Design, include cost of engineering services to update Structural Drawings and Structural Installation for submitted design. Array design that requires modification of building structure in addition to structure supporting PV array and equipment is not acceptable under this Contract.

C. Provide panel layout design with firefighter access and egress paths per local Codes.

D. Include a 36-inch wide pathway maintained along three sides of the solar roof. Exceptions to comply with Oregon Solar Installation Specialty Code. For arrays larger than 150-feet, measured in length or width, to have a 36-inch intermediate pathway for service, maintenance and egress. Disconnects, junction boxes, combiner boxes or gutters not to be located in any required pathway or cutout.

E. Array mounting hardware supplied by the bidder to be compatible with the site considerations and environment. Minimize risk from exposed fasteners, sharp edges, and potential damage to the modules or support structure. Emphasize corrosion resistance and durability of the mechanical hardware. Avoid use of ferrous metals, contact of dissimilar metals or wood or plastic components.

F. As these are high profile, publicly visible installations, the aesthetics of the overall installation is extremely important to the Owner. To create a uniform appearance of the array, spacing between individual modules and panels should be kept to a minimum. As much as possible,
conceal mechanical hardware, conduit, junction boxes and other equipment beneath and/or behind the array.

G. Be consistent with the ordering and labeling of source circuits in the array combiner boxes. Ease of access for array troubleshooting and maintenance is desired by allowing access to the back of the array for module junction box servicing, and removal/replacement of individual source circuits and modules if necessary.

**3.04 INSTALLATION**

A. Grid-Interactive Inverter:
   1. Provide fusing for incoming strings.
   2. Clean interiors and ensure airways for convective cooling are clear and debris-free.
   3. Verify that inverter display measures for AC voltage match measurement from a true-RMS AC digital voltmeter.
   4. Check that maximum power point tracking circuit is operational. Monitor array voltage from open circuit condition until it reaches a point where system power peaks and then starts to drop again. Provide chart of field measurements input and output voltage and current through the day as part of O&M manual.
   5. Provide factory required clearances and air space for cooling and ventilation.

B. Photovoltaic System Wiring:
   1. Field connections: Use crimp-on connectors that maintain connection even when screw loosens.
   2. Size wiring from inverter to PV modules based on less than 2 percent voltage drop in any string.
   3. Conceal flexible conduit and MC cable to underneath the PV modules. Outside of the PV modules, use rooftop conduit per Division 26, Electrical.
   4. PV module wiring to be secured to run parallel and perpendicular to module frame lines, as well as be secured to module and module support structure. Do not allow PV module wiring to rest unsupported against the roof surface.
   5. Provide strain reliefs and cable clamps on cable and cords for PV modules.
   6. Retorque terminations prior to completion of construction.

C. Grounding:
   1. Verify that one connection to DC circuits and one connection to AC circuits is being used for system grounding referenced to the same point. Bond to buildings main grounding system.
   2. Provide bonding for non-current carrying metal parts to ensure they are grounded properly.
   3. Grounding electrode to be installed in accordance with NEC Article 250.122 (AC) but not smaller than #6 AWG copper or #4 AWG Aluminum.
   4. Provide grounding electrodes at the location of ground and pole mounted arrays as close as possible. Bond to buildings main grounding system.

D. Signage:
   1. Post an "Interactive Point of Connection" sign per NEC Article 690.
   2. Place a sign at building service entrance indicating type and location of on-site interactive electric power production sources and disconnects per NEC Article 705.
   3. At each inverter, post a sign indicating:
      a. Label for Inverter.
      b. Operating current and voltage.
      c. Maximum system voltage.
      d. Short circuit current.

E. Install PV panels, inverter, wiring, protection device as per written installation instructions from the manufacturer.

F. Coordinate mounting of panels with structural engineer and roof system installer prior to submitting design documents.
3.05 TESTING
   A. Test each PV panel per manufacturer's written instructions prior to connection to inverter. String level testing is allowed. Document test results and submit in O&M manuals.
   B. Test inverters per manufacturer's written instructions. Document test results and submit results with O&M manuals.

3.06 DISPLAY COMMISSIONING AND TRAINING
   A. Coordinate with Owner for TCP/IP address for PV communications gateway prior to start of programming.
   B. Provide manufacturer supported programming and commissioning services as required for functionality of system as described above. Provide Owner minimum two 2-hour training sessions on separate days with factory support, for use of both internet portal and review installation of communications system. Provide audio/video record of both sessions. Hold either session no less than 30 days from date of substantial completion of the project.

END OF SECTION
PART 1 - GENERAL

1.01 SUMMARY
   A. Work Included:
      1. SPD for Service Entrance - Modular Type
      2. SPD for Distribution Panels - Nonmodular Type

1.02 RELATED SECTIONS
   A. Contents of Division 26, Electrical and Division 01, General Requirements apply to this Section.

1.03 REFERENCES AND STANDARDS
   A. References and Standards as required by Section 26 00 00, Electrical Basic Requirements and
      Division 01, General Requirements.
   B. In addition, meet the following:
      1. Listed per UL 1449, third edition, and complimentary listed per UL 1283 as FRI/EMI filter.
      2. Comply with ANSI/IEEE C62.45 test procedures for Category-C3 established in C62.41.2
         and CSA certified (C22.2).

1.04 SUBMITTALS
   A. Submittals as required by Section 26 00 00, Electrical Basic Requirements and Division 01,
      General Requirements.
   B. In addition, provide:
      1. Related SPD Specifications, Drawings, maintenance manuals, installation instructions, and
         UL 1449, third edition, listed surge suppression ratings of specified protection modes.
      2. Project Record Documents: Record actual locations of SPDs.
      3. Maintenance Data:
         a. Include module replacement instructions.
         b. Include maintenance and troubleshooting instructions for electronic components.

1.05 QUALITY ASSURANCE
   A. Quality assurance as required by Section 26 00 00, Electrical Basic Requirements and Division
      01, General Requirements.
   B. In addition, meet the following:
      1. Manufacturer's Qualifications: ISO 9001 certification SPD manufacturer's complete quality
         control and documentation procedures of firms regularly engaged in manufacturer's of
         SPD product for Category-C3 (ANSI/IEEE C62.41.2) and whose product has been of
         satisfactory service for not less than 5 years.
         a. Provide local support for SPD.
         b. Provide both service entrance and distribution panel SPD of same manufacturer.
      2. Manufacturer Qualifications: Company specializing in manufacturing products specified in
         this Section with minimum three years documented experience.

1.06 WARRANTY
   A. Warranty of materials and workmanship as required by Section 26 00 00, Electrical Basic
      Requirements and Division 01, General Requirements.

PART 2 - PRODUCTS

2.01 MANUFACTURERS
   A. Current Technology
   B. Eaton Electrical
   C. Lea International
   D. Liebert
   E. Schneider Electric/Square D
F. Surge Suppression Inc. (SSI)
G. Siemens
H. Or approved equivalent.

### 2.02 SPD FOR SERVICE ENTRANCE - MODULAR TYPE

A. List SPD in accordance with UL 1449 (third edition), Standard for Safety, Surge Protective Devices, and UL 1283, Electromagnetic Interference Filters.

B. Independently test SPD with Category-C3 high exposure waveform (20KV - 1.2/50 µs, 10 kA - 8/20 µs) per ANSI/IEEE C62.41.2.

C. Provide SPD with copper bus bars for surge current path. Small gauge round wiring, plug-in type connections, or printed circuit boards not to be used in path for surge current diversion. Equally distribute surge current to individually fused MOV components to ensure equal stressing and maximum performance. Surge suppression platform must provide equal impedance paths to each matched (plus or minus one volt) MOV.

D. Construct SPD using field replaceable surge current diversion modules (MOV based). Each module fused with user replaceable 200,000 AIC rated fuses. Monitor status of each module and MOV and indicate on front of SPD's enclosure as well as on each module.

E. Encapsulated SPD, whether modular or chase nipple units, utilizes an encapsulant that is UL listed and holds 94-V2 fire retardant rating. Allow no encapsulant compounds that incorporate epoxy.

F. Equip SPD with an audible alarm that activates when one of surge current modules have failed. Provide an alarm on/off switch to silence the alarm. Provide an alarm push-to-test switch to test alarm. Locate switches and alarm on front cover of SPD's enclosure. Equip unit with an Event Counter that will indicate how many surges, sags, swells and outages have occurred at the location.

G. Meet or exceed the following criteria:
   1. Maximum Single Impulse Current Rating: No less than 160 kA per phase. Manufacturers must provide documented proof of independent third party verification of single impulse current withstand capabilities.
   2. Pulse Life Test: Capable of protecting against and surviving 5000 ANSI/IEEE C62.41.2 Category-C3 transients without failure or degradation of UL 1449, third edition, clamp voltage by more than 10 percent.
   3. UL 1449, third edition, clamping voltage not to exceed the following:

<table>
<thead>
<tr>
<th>VOLTAGE</th>
<th>L-G</th>
<th>L-N</th>
<th>N-G</th>
</tr>
</thead>
<tbody>
<tr>
<td>208Y/120V</td>
<td>800V</td>
<td>800V</td>
<td>800V</td>
</tr>
<tr>
<td>480Y/277V</td>
<td>1200V</td>
<td>1200V</td>
<td>1200V</td>
</tr>
</tbody>
</table>

   4. ANSI/IEEE C62.41.2 (2002) Category-C3 clamping voltage not to exceed the following:

<table>
<thead>
<tr>
<th>VOLTAGE</th>
<th>L-N</th>
<th>L-S</th>
<th>N-G</th>
</tr>
</thead>
<tbody>
<tr>
<td>208Y/120V</td>
<td>470V</td>
<td>470V</td>
<td>470V</td>
</tr>
<tr>
<td>480Y/277V</td>
<td>920V</td>
<td>920V</td>
<td>800V</td>
</tr>
</tbody>
</table>

H. Provide response time that is no greater than five nanoseconds for any of individual protection modes.

I. Provide SPD designed to withstand maximum continuous operating voltage (MCOV) of not less than 115 percent of nominal RMS voltage.
   1. Provide visible indication of proper SPD connection and operation. Indicator lights indicates which phase as well as which module is fully operable.
   2. Equip SPD with the following items:
a. Provide connector along with dry contacts (normally open or normally closed) to allow connection to remote monitoring system.
b. Output of dry contacts indicates failure of phase or entire unit. 
3. Provide terminals for necessary power and ground connections.
4. Provide SPD with minimum EFI/RFI filtering of 30dB at 100KHZ with an insertion loss ratio of 316:1 using Military Standard 220A methodology.
5. Provide SPD with 10 year warranty, incorporating unlimited replacement parts if they are destroyed by transients during warranty period.

2.03 SPD FOR DISTRIBUTION PANELS - NONMODULAR TYPE
A. List SPD in accordance with UL 1449 (third edition), Standard for Safety, Surge Protective Devices, and UL 1283, Electromagnetic Interference Filters.
B. Independently test SPD with Category-C3 high exposure waveform (20KV - 1.2/50 μs, 10 kA - 8/20 μs) per ANSI/IEEE C62.41.2 (2002)
C. Provide SPD with copper bus bars for surge current path. Small gauge round wiring, plug-in type connections, or printed circuit boards not be used in path for surge current diversion. Equally distribute surge current to MOV components to ensure equal stressing and maximum performance. Surge suppression platform must provide equal impedance paths to each matched MOV.
D. Use no plug in component modules or printed circuit boards as surge current conductors. Hardwire internal components with connections utilizing low impedance conductors and compression fittings.
E. In order to isolate SPD under any fault condition, manufacturer to provide:
1. Individually fuse the MOV via copper fuse. Copper fuse provides protection during high (ka) surge events.
2. Equip MOVs with thermal fuse which allows disconnection of suppression component at overheating stage common during TOV.
F. Equip SPD with an audible alarm that activates when one of surge current modules have failed. Provide an alarm on/off switch to silence alarm. Provide an alarm push-to-test switch to test the alarm. Locate switches and alarm on the front cover of the SPD’s enclosure.
G. Provide SPD that Meet or Exceed the Following Criteria:
1. Provide maximum single impulse current rating at no less than 100 kA per phase. Manufacturers must provide documented proof of independent third party verification of single impulse current withstand capabilities.
2. Pulse Life Test: Capable of protecting against and surviving 2000 ANSI/IEEE C62.41.2 Category-C3 transients without failure or degradation of UL 1449 (third edition) clamp voltage by more than 10 percent.
3. UL 1449 (third edition) clamping voltage not to exceed the following:

<table>
<thead>
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<th>N-G</th>
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<tr>
<td>480Y/277V</td>
<td>1200V</td>
<td>1200V</td>
<td>1200V</td>
</tr>
</tbody>
</table>

4. Nominal discharge current of 20KA I (n).
H. Make SPD of solid-state components which operate bidirectionally.
I. Provide SPD with response time no greater than five nanoseconds for individual protection modes.
1. SPD designed to withstand maximum continuous operating voltage (MCOV) of not less than 115 percent of nominal RMS voltage.
2. Provide visible indication of proper SPD connection and operation. Provide 10 year warranty, incorporating unlimited replacements of SPD if they are destroyed by transients within warranty period.

J. Provide SPD designed to withstand maximum continuous operating voltage (MCOV) of not less than 115 percent of nominal RMS voltage.
   1. Provide terminals for necessary power and ground connections.
   2. Provide SPD with minimum EFI/RFI filtering of 30dB at 100KHZ with an insertion loss ratio of 316:1 using Military Standard 220A methodology.
   3. Provide SPD with 10 year warranty, incorporating unlimited replacement parts if they are destroyed by transients during warranty period.

PART 3 - EXECUTION

3.01 SPD FOR SERVICE ENTRANCE - MODULAR TYPE INSTALLATION
   A. Install SPD on load side of service entrance as directed by manufacturer's installation instructions. Provide 3 pole breaker for disconnect in service entrance equipment, size breaker to manufacturers installation instructions.
   B. Install one primary SPD at each utility service entrance to facility, according to manufacturer's recommendations.
   C. Integrate SPD unit into switch gear to maximize performance and reliability.
   D. Bond SPD's ground to service entrance ground.
   E. Maintenance Materials
      1. Furnish the following for Owner's use in maintenance of project:
         a. Replacement modules: One of each type and size.

3.02 SPD FOR DISTRIBUTION PANELS - NONMODULAR TYPE INSTALLATION
   A. Install one secondary SPD at each distribution panel location as indicated on Drawings. SPD unit to be integral to panelboard.

END OF SECTION
SECTION 26 5100 - LIGHTING

PART 1 - GENERAL

1.01 SUMMARY
A. Work Included:
   1. Luminaires
   2. LED Drivers
   3. Lamps
   4. Lighting Poles
B. Provide wiring for complete and operating lighting system.

1.02 RELATED SECTIONS
A. Contents of Division 26, Electrical and Division 01, General Requirements apply to this Section.

1.03 REFERENCES AND STANDARDS
A. References and Standards as required by Section 26 00 00, Electrical Basic Requirements and
   Division 01, General Requirements.
B. In addition, meet the following:
   1. NECA 500 - Commercial Lighting.
   2. UL 8750 – Light Emitting Diode (LED) equipment for use in lighting products.

1.04 SUBMITTALS
A. Submittals as required by Section 26 00 00, Electrical Basic Requirements and Division 01,
   General Requirements.
B. In addition, provide:
   1. Submit:
      a. LED Luminaires: Electrical ratings, dimensions, mounting, material, clearances,
         terminations, wiring, connection diagram, LM-79 photometric data, LM-80 lumen
         depreciation data.
      b. LED Drivers
      c. Lamps
   2. Submittal Cutsheets: Highlight, circle or otherwise graphically indicate which option(s) are
      being selected for the products submitted. Cutsheets that are not edited to indicate which
      products and options are submitted for this project or that list only catalog numbers to
      identify submitted options are not acceptable.
   3. Specified manufacturers are approved to submit bid. However, inclusion does not relieve
      manufacturer from supplying product as described.
   4. Provide the following operating and maintenance instructions as required by Section
      26 00 00, Electrical Basic Requirements:
      a. Luminaires
      b. LED Drivers
      c. Lamps
      d. Lighting Poles

1.05 QUALITY ASSURANCE
A. Quality assurance as required by Section 26 00 00, Electrical Basic Requirements and
   Division 01, General Requirements.
B. In addition, meet the following:
   1. Provide luminaires acceptable to code authority for application and location installed.
   2. Comply with applicable ANSI standards.
   3. Comply with applicable NEMA standards.
   4. Provide luminaires and lampholders that comply with UL standards and have been listed
      and labeled for location and use indicated by a testing agency acceptable by the AHJ (e.g.,
      UL, ETL, and the like).
5. Comply with NEC as applicable to installation and construction of luminaires.
6. Comply with fallout and retention requirements of IBC for diffusers, baffles, and louvers.
7. Provide LED luminaires from the same manufacturer and manufacturing LED source batch for similar applications (e.g., all LED downlights from a single manufacturer and batch, all linear LED products from single manufacturer and batch).

1.06 WARRANTY
A. Warranty as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.
B. In addition, provide:
   1. LED Luminaire Manufacturer's Warranty: Not less than 5 years for luminaire based on date of substantial completion. Includes normal cost of labor to replace luminaire. Replacement luminaire will match physical dimensions, physical appearance, chromaticity, lumen output and photometric characteristics of original installed equipment.

PART 2 - PRODUCTS
2.01 MANUFACTURERS
A. Luminaires:
   1. Reference description and manufacturers in Luminaire Schedule on Drawings.
   2. Or approved equivalent.
B. LED Drivers:
   1. Indoor Drivers:
      a. eldoLED Series
      b. Advance/Philips
      c. Osram Sylvania
      d. Or approved equivalent.
   2. Outdoor Drivers:
      a. Advance/Philips
      b. Osram Sylvania
      c. LG
      d. Or approved equivalent.
C. Lamps:
   1. LED (Light Emitting Diode) Lamps:
      a. Nichia
      b. Cree
      c. Osram Sylvania
      d. GE Lumination
      e. Or approved equivalent.
   2. Unless specific manufacturer not shown on this list is indicated in the Luminaire Schedule.
   3. Special types as indicated in Luminaire Schedule.
   4. Or approved equivalent.
D. Lighting Poles:
   1. Reference description and manufacturers in Luminaire Schedule on Drawings.
   2. Or approved equivalent.

2.02 LUMINAIRES
A. Luminaires: Reference description and manufacturers in Luminaire Schedule on drawings.
B. Where recessed luminaires are installed in cavities intended to be insulated, provide IC rated luminaires or other code approved installation.
C. UL label luminaires installed under canopies, roof or open porches, and similar damp or wet locations, as suitable for damp or wet location.
D. Suspended luminaires: Provide minimum 24-inch adjustability in aircraft cable length where used.

E. Recessed Luminaires: Frame compatible with ceiling material installed at particular luminaire location. Provide proper factory trim and frame for luminaire to fit location and ceiling material. Verify with Architectural Reflected Ceiling Plan prior to submittals.

F. Finishes:
   1. Manufacturer's standard finish (unless otherwise indicated) over corrosion resistant primer.
   2. Interior Light Reflecting Finishes: White or specular finish with not less than 85 percent reflectance.
   3. Exterior Finishes: As detailed in Luminaire Schedule or on drawings. Refer cases of uncertain applicability to Architect for resolution prior to release for fabrication.

G. Light Transmitting Components:
   1. Plastic diffusers, molded or extruded of 100 percent virgin acrylic.
   2. Prismatic acrylic, extruded, flat diffusers, 0.125-inch overall thickness, unless otherwise noted.

H. LED Luminaires:
   1. UL listing of luminaire includes drivers, transformers, enclosures, rated wire, communications devices and accessories needed for a complete and functional system.
   2. LM-79: Testing and measurement of absolute photometry, chromaticity (CCT) and luminaire power. Report provided by DOE certified independent testing laboratory. CCT as specified in Luminaire Schedule.
   5. LEDs in one module/luminaire: Supplied from same batch/bin and fall within 3-step MacAdam Ellipse, or as described in Luminaire Schedule, whichever is the more stringent requirement.
   6. Provide luminaires with integral LED thermal management system (heat sinking).
   7. Luminaires to be equipped with an LED driver that accepts 120V through 277V, 50Hz to 60Hz (universal). Component-to-component wiring within the luminaire will carry no more than 80 percent of rated current and be listed by UL for use at 600VAC at 302 degrees F/150 degrees C or higher. Plug disconnects to be listed by UL for use at 600VAC, 15A or higher.
   8. Provide luminaires with individual LED arrays/modules and drivers that are accessible and replaceable from exposed side of the luminaire.

2.03 LED DRIVERS

A. General:
   1. Performance: Meet dimming range called out in Luminaire Schedule, free from perceived flicker or visible stroboscopic flicker, smooth and continuous change in level (no visible steps in transitions), natural square law response to control input, and stable when input voltage conditions fluctuate over what is typically experienced in a commercial environment. Demonstration of this compliance to dimming performance will be necessary for substitutions or prior approval.
   2. Ten-year expected life while operating at maximum case temperature and 90 percent non-condensing relative humidity.
   3. Minimum efficiency of 85 percent, power factor greater than or equal to 0.90, compliance with reduction of hazardous substances (RoHS). Rated for operating temperature range of area in which driver is installed.
   4. Limit inrush current to minimize breaker tripping.
b. Preferred Specification: Meet or exceed 30 milliamp-squared-seconds at 277VAC for up to 50 watts of load and 75 amps at 240 microseconds at 277VAC for 100 watts of load.

5. Withstand up to a 1,000 volt surge without impairment of performance as defined by ANSI C62.41 Category A.

6. No visible change in light output with a variation of plus/minus 10 percent line voltage input.

7. Total Harmonic Distortion less than 20 percent percent and meet ANSI C82.11 maximum allowable THD requirements at full output. THD at no point in the dimming curve allows imbalance current to exceed full output THD.

8. Support automatic adaptation, allowing for future luminaire upgrades and enhancements and deliver improved performance:
   a. Adjustment of forward LED voltage, supporting 3V through 55V.
   b. Adjustment of LED current from 150mA to 1.4A at the 100 percent control input point in increments of 1mA.
   c. Adjustment for operating hours to maintain constant lumens (within 5 percent) over the 50,000 hour design life of the system, and deliver up to 20 percent energy savings early in the life cycle.

9. Operate for a (+/- 10 percent) supply voltage of 120V through 277VAC at 60Hz.

10. UL Recognized under the component program and modular for simple field replacement. Drivers that are not UL Recognized or not suited for field replacement will not be considered.

11. Ability to provide no light output when the analog control signal drops below 0.3 V, or the DALI/DMX digital signal calls for light to be extinguished and consume 0.5 watts or less in this standby. Control dead band between 0.3V and 0.65V included to allow for voltage variation of incoming signal without causing noticeable variation in luminaire to luminaire output.

B. Light Quality:
1. Over the entire range of available drive currents, driver to provide step-free, continuous dimming to black from 100 percent to 0.1 percent and 0 percent relative light output, or 100 percent to 1 percent light output and step to 0 percent where indicated. Driver to respond similarly when raising from 0 percent to 100 percent.
   a. Driver must be capable of 20 bit dimming resolution for white light LED drivers or 15 bit resolution for RGBW LED drivers.

2. Driver must be capable of configuring a linear or logarithmic dimming curve, allowing fine grained resolution at low light levels.

3. Drivers to track evenly across multiple luminaires at all light levels, and must have an input signal to output light level that allows smooth adjustment over the entire dimming range.

4. Driver and luminaire electronics to deliver illumination that is free from objectionable flicker as measured by flicker index (ANSI/IES RP-16-10). At all points within the dimming range from 100 percent to 0.1 percent luminare will have:
   a. LED dimming driver to provide continuous step-free, flicker free dimming similar to incandescent source.
   b. Base specification: Based on IEEE PAR1789, minimum output frequency should be greater than 1250 Hz.
   c. Preferred specification: Flicker index to be equal to incandescent, less than 1 percent at all frequencies below 1000 Hz.

C. Control Input:
1. Provide control protocol to match lighting control system specified for use with luminaire.

2. 4-Wire (0-10V DC Voltage Controlled) Dimming Drivers:
   b. Connect to devices compatible with 0 to 10V Analog Control Protocol, Class 2, capable of sinking 0.6 ma per driver at a low end of 0.3V. Limit the number of drivers on each 0-10V control output based on voltage drop and control capacity.
c. Meet ESTA E1.3 for RGBW LED drivers.

2.04 LAMPS
A. Provide lamps for luminaires.
B. Provide lamp catalogued for specified luminaire type.
C. Incandescent Lamps: Not allowed unless noted in Luminaire Schedule.
D. LED (Light Emitting Diode):
   1. LED manufacturer will include, but not be limited to, light source, luminaire, power supply and control interface with added components as needed for complete and functioning system.
      a. Comply with ANSI chromaticity standard for classifications of color temperature. See Luminaire Schedule for specified LED lamp color and color temperature. UL or ETL listed and labeled.
      b. Luminaire testing per IESNA LM-79 and LM-80 procedures.
      c. Lamp life for white LEDs: 50,000 plus hours with lamp failure occurring when LED produces 70 percent of initial rated lumens.
      d. Lamp life for color LEDs: 30,000 plus hours with lamp failure occurring when LED produces 50 percent of its initial rated lumens.
      e. LED Drivers: Reverse polarity protection, open circuit protection, require no minimum load. Minimum 80 percent efficiency. Class A noise rating.
      f. Dimming: LED system capable of full and continuous dimming.
      g. Correlated Color Temperature (CCT): See Luminaire Schedule for selection of color temperature for each luminaire. Ranges given below reflect maximum allowable tolerances for color temperature range for each nominal CCT.
         1) Nominal CCT:
            (a) 2700 K (2725 ± 145)
            (b) 3000 K (3045 ± 175)
            (c) 3500 K (3465 ± 245)
            (d) 4000 K (3985 ± 275)
      h. Color Rendering Index (CRI) to be greater than or equal to 80.
   2. Special types as indicated in Luminaire Schedule.

2.05 LIGHTING POLES
A. Provide direct buried exterior light poles with concrete bases or direct buried which are structurally supportive of pole under design loading.
B. Provide exterior poles clean and scratch free with base bolt covers to match pole and luminaire finish.
C. Provide poles and pole bases rated for a minimum of 100 MPH, unless otherwise noted. Wind EPA loading for quantity and type of luminaire it supports with a 1.3 gust factor.
D. Provide poles with gasketed handholes, stainless steel tamper resistant hardware, anchor bolts and ground lugs.
E. Description:
   1. Material: Steel.
   2. Shape: Square.
   5. Accessories: Slipfitter.

PART 3 - EXECUTION
3.01 GENERAL INSTALLATION REQUIREMENTS
A. Install per manufacturer's written installation instructions and requirements.
B. Install luminaires securely, in neat and workmanlike manner.
C. Install luminaires of types indicated where shown and at indicated heights in accordance with manufacturer's written instructions and with recognized industry practices to ensure that luminaires comply with requirements and serve intended purposes.

D. Wiring:
1. Recessed luminaires to be installed using flexible metallic conduit with luminaire conductors spliced to branch circuit conductors in nearby accessible junction box over ceiling. Junction box fastened to building structural member within 6-feet of luminaire.
2. Luminaires for lift out and removal from ceiling pattern without disconnecting conductors or defacing ceiling materials.
3. Flexible connections where permitted to exposed luminaires; neat and straight, without excess slack, attached to support device.
4. Install junction box, flexible conduit and high temperature insulated conductors for through wiring of recessed luminaires.

E. Relamp luminaires which have failed lamps at substantial completion.

F. Replace LED drivers deemed as excessively noisy by Architect, Engineer, or Owner.

G. Install suspended luminaires and exit signs using pendants supported from swivel hangers. Provide pendant length required to suspend luminaire at indicated height.

H. Support luminaires larger than 2- by 4-foot size independent of ceiling framing.

I. Locate recessed ceiling luminaires as indicated on architectural reflected ceiling plan.

J. Install surface mounted luminaires and exit signs plumb and adjust to align with building lines and with each other. Secure to prevent movement.

K. Exposed Grid Ceilings:
1. Support surface mounted luminaires in grid ceiling directly from building structure.
2. Provide auxiliary members spanning ceiling grid members to support surface mounted luminaires.
3. Fasten surface mounted luminaires to ceiling grid members using bolts, screws, rivets, or suitable clips.

L. Install recessed luminaires to permit removal from below.

M. Install recessed luminaires using accessories and firestopping materials to meet regulatory requirements for fire rating.

N. Install clips to secure recessed grid-supported luminaires in place.

O. Install wall mounted luminaires, emergency lighting units, and exit signs at height as indicated on Architectural Drawings.

P. Install accessories furnished with each luminaire.

Q. Make wiring connections to branch circuit using building wire with insulation suitable for temperature conditions within luminaire.

R. Bond products and metal accessories to branch circuit equipment grounding conductor.

S. Install specified lamps in each emergency lighting unit, exit sign, and luminaire.

T. Where manufactured wiring assemblies are used, ensure that wiring assembly manufacturer sends components to appropriate luminaire manufacturer for respective installation of proper components.

U. Coordination:
1. Coordination of Conditions: Coordinate ceiling construction, recessing depth and other construction details prior to ordering luminaires for shipment. Refer cases of uncertain applicability to Architect for resolution prior to release of luminaires for shipment. Where luminaires supplied do not match ceiling construction, replace luminaires at no cost to Owner.
2. Electrical drawings are schematic, identifying quantity and type of luminaires used and their approximate location, but are not to be used for dimensional purposes. Reference architectural drawings for exact locations, including mounting heights.

3. Provide lighting indicated on drawings with luminaire of the type designated and appropriate for location.

4. Provide LED luminaires with driver compatible to lighting control system as shown in drawings and as specified.

5. Where remote drivers are required, ensure adequate accessibility to driver. Upsize conductors between luminaire and driver to accommodate voltage drop.

V. Field Quality Control:
   1. Perform field inspection in accordance with Division 01, General Requirements.
   2. Operate each luminaire after installation and connection. Inspect for proper connection and operation.

W. Cleaning:
   1. Clean electrical parts to remove conductive and deleterious materials.
   2. Remove dirt and debris from enclosures.
   3. Clean paint splatters, dirt, dust, fingerprints, and debris from luminaires.
   4. Clean photometric control surfaces as recommended by manufacturer.
   5. Clean finishes and touch up damaged finishes per by manufacturer's instructions.

X. Demonstrate luminaire operation for minimum of two hours.

3.02 LUMINAIRES
A. Install per manufacturer's written installation instructions and requirements.
B. Align, mount and level luminaires uniformly. Use ball hangers for suspended stem mounted luminaires.
C. Avoid interference with and provide clearance from equipment. Where indicated locations for luminaires conflict with locations for equipment, change locations for luminaire by minimum distance necessary as directed by Architect.
D. Suspended Luminaires: Mounting heights indicate clearances between bottom of luminaire and finished floors.
E. Emergency Egress Luminaires: Provide unswitched emergency circuit to exit signs and emergency luminaires.
F. Interior Luminaire Supports:
   1. Support Luminaires: Anchor supports to structural slab or to structural members within a partition, or above a suspended ceiling.
   2. Maintain luminaire positions after cleaning and relamping.
   3. Support luminaires without causing ceiling or partition to deflect.
   4. Provide mounting supports for recessed and pendant mounted luminaires as required by IBC.
G. Adjusting:
   1. Aim and adjust luminaires as indicated.
   2. Focus and adjust floodlights, spotlights and other adjustable luminaires, with Architect, at such time of day or night as required.
   3. Align luminaires that are not straight and parallel/perpendicular to structure.
   4. Position exit sign directional arrows as indicated.

3.03 LED DRIVERS
A. Install lamps per manufacturer's installation instructions and requirements.
B. Where driver is remote mounted, size wiring based on type of driver, driver distance from luminaire, and voltage/power level, and manufacturer's installation instructions.
C. Protect 0-10V input from line voltage mis-connection, and so it will be immune and the output unresponsive to induced AC voltage on the control leads.
3.04 LIGHTING POLES

A. Install lighting poles per manufacturer's installation instructions and requirements.

B. Exterior Luminaire Supports:
   1. Provide concrete bases for pole-mounted lighting units and bollard lights at locations shown on site plan drawing(s). Provide concrete bases as shown on drawings or as recommended by manufacturer if not shown on drawings. Minimum base height above grade in automobile areas is 30-inches. Install luminaire poles plumb.
   2. Install pole concrete bases in undisturbed or compacted soil. Where soil is disturbed provide backfill and compaction per Division 31, Earthwork requirements.

END OF SECTION
SECTION 27 0000 - COMMUNICATIONS BASIC REQUIREMENTS

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Work included in 27 00 00, Communications Basic Requirements applies to Division 27, Communications work to provide materials, labor, tools, permits, incidentals, and other services to provide and make ready for Owner's use of communications systems for proposed project.

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

C. Definitions:

1. Provide: To furnish and install, complete and ready for intended use.
2. Furnish: Supply and deliver to project site, ready for unpacking, assembly and installation.
3. Install: Includes unloading, unpacking, assembling, erecting, installation, applying, finishing, protecting, cleaning and similar operations at project site as required to complete items of work furnished.
4. Approved or Approved Equivalent: To possess the same performance qualities and characteristics and fulfill the utilitarian function without any decrease in quality, durability or longevity. For equipment/products defined by the Contractor as “equivalent,” substitution requests must be submitted to Engineer for consideration, in accordance with Division 01, General Requirements, and approved by the Engineer prior to submitting bids for substituted items.
5. Authority Having Jurisdiction (AHJ): Indicates reviewing authorities, including local fire marshal, Owner's insurance underwriter, Owner's representative, and other reviewing entity whose approval is required to obtain systems acceptance.
6. Entrance Facility (EF): Area or location that contains entrance point (demarcation) cable and associated equipment for telecommunication services entering the building.
7. Equipment Room (ER): Area or location that contains backbone cabling associated with interbuilding cable or cable that connects buildings together in a campus environment. ERs may contain Main Cross-Connects, Intermediate Cross-Connects, Horizontal Cross-Connects, and Telecommunication Rooms.
8. Main Cross-Connect (MC): Area or location that contains telecommunications equipment for connecting backbone cable to/from Intermediate Cross-Connects and Horizontal Cross-Connects. Active telecommunications equipment will often be contained in this area to serve as the telecommunications hub or headend. Backbone cable from Local Exchange Carrier's point of demarcation will connect to building backbone cable or active telecommunications equipment at this location.
9. Intermediate Cross-Connect (IC): Area or location that contains telecommunications equipment for connecting backbone cable from the MC to backbone cable distributing to one or many Horizontal Cross-Connects. This location may contain active telecommunications equipment.
10. Horizontal Cross-Connect (HC): Area or location that contains telecommunications equipment, cable terminations and cross-connect wiring. HC is the recognized connection point between backbone and horizontal pathway facilities.
11. Telecommunications Room (TR): Area or location containing telecommunications equipment, cable terminations and cross-connect wiring. Three applications serviced by TRs are horizontal cable connections, backbone system interconnection and entrance facilities. The TR provides facilities (space, power, grounding, etc.) for housing telecommunications equipment. TR may contain a MC, IC or HC and a demarcation point or an interbuilding entrance facility.
12. Interbuilding Cable: Backbone cable associated with connecting buildings together in a multibuilding or campus environment.
13. Intrabuilding Cable: Backbone cable associated with connecting Entrance Facility, Equipment Rooms, Main Cross-Connects, Intermediate Cross-Connects, Horizontal Cross-Connects, and Telecommunication Rooms together on single floor or multifloor building.

1.02 RELATED SECTIONS

A. Contents of Section applies to Division 27, Communications Contract Documents.

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

1.03 REFERENCES AND STANDARDS

A. References and Standards per Division 00, Procurement and Contracting Requirements and Division 01, General Requirements, individual Division 27, Communications Sections and those listed in this Section.

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

C. Reference standards and guidelines include but are not limited to the latest adopted editions from:
   1. ABA - Architectural Barriers Act
   2. ADA - Americans with Disabilities Act
   3. ANSI - American National Standards Institute
      a. ANSI/TIA-568-C.0 - Generic Telecommunications Cabling for Customer Premises
      b. ANSI/TIA-568-C.1 - Commercial Building Telecommunications Cabling Standard
      c. ANSI/TIA-568-C.2 - Balanced Twisted-Pair Telecommunications Cabling and Components Standard
      e. ANSI/TIA-569-B - Commercial Building Standard for Telecommunications Pathways and Spaces
      f. ANSI/TIA-570-B - Residential Telecommunications Infrastructure
      g. ANSI/TIA-942 - Telecommunications Infrastructure Standard for Data Centers
      h. ANSI/TIA/EIA-606-A - Administration Standard for Commercial Telecommunications Infrastructure
      i. ANSI-J-STD-607-A - Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications
   4. APWA - American Public Works Association
   5. ASCE - American Society of Civil Engineers
   6. ASHRAE Guideline 0, the Commissioning Process
7. ASTM - ASTM International
8. BICSI - Building Industry Consulting Service International
   a. BICSI TDMM - Telecommunications Distribution Methods Manual
9. CFR - Code of Federal Regulations
10. EIA - Electronic Industries Association
11. EPA - Environmental Protection Agency
12. ETL - Electrical Testing Laboratories
13. FCC - Federal Communications Division
14. FM - FM Global
15. IBC - International Building Code
16. IEC - International Electrotechnical Commission
17. IEEE - Institute of Electrical and Electronics Engineers
18. ISO - International Organization for Standardization
19. MSS - Manufacturers Standardization Society
20. NEC - National Electric Code
21. NEMA - National Electrical Manufacturers Association
22. OSHA - Occupational Safety and Health Administration
23. TIA - Telecommunications Industry Association
24. UL - Underwriters Laboratories Inc.

D. See Division 27, Communications individual Sections for additional references.
E. Where code requirements are at variance with Contract Documents, meet code requirements as a minimum requirement and include costs necessary to meet these in Contract. Machinery and equipment are to comply with OSHA requirements, as currently revised and interpreted for equipment manufacturer requirements. Install equipment provided per manufacturer recommendations.
F. Whenever this Specification calls for material, workmanship, arrangement or construction of higher quality and/or capacity than that required by governing codes, higher quality and/or capacity take precedence.

1.04 SUBMITTALS
A. See Division 01, General Requirements for Submittal Procedures.
B. Provide drawings in format and software release equal to the design documents. Drawings to be the same sheet size and scale as the Contract Documents.
C. "No Exception Taken" constitutes that review is for general conformance with the design concept expressed in the Contract Documents for the limited purpose of checking for conformance with information given. Any action is subject to the requirements of the Contract Documents. Contractor is responsible for the dimensions and quantity and will confirm and correlate at the job site, fabrication processes and techniques of construction, coordination of the work with that of all other trades, and the satisfactory performance of the work.
D. Provide product submittals and shop drawings in electronic format only. Electronic format must be submitted via zip file via e-mail or posted to ftp site. For electronic format, provide one zip file per specification division containing a separate file for each Specification Section. Individual submittals sent piecemeal in a per Specification Section method will be returned without review or comment. Copy Architect on all transmissions/submissions.
E. Product Data: Provide manufacturer's descriptive literature for products specified in Division 27, Communications Sections.
F. Identify/mark each submittal in detail. Note what differences, if any, exist between the submitted item and the specified item. Failure to identify the differences will be considered cause for disapproval. If differences are not identified and/or not discovered during the submittal review
process, Contractor remains responsible for providing equipment and materials that meet the specifications and Drawings.

1. Label submittal to match numbering/references as shown in Contract Documents. Highlight and label applicable information to individual equipment or cross out/remove extraneous data not applicable to submitted model. Clearly note options and accessories to be provided, including field installed items. Highlight connections by/to other trades.

2. Include technical data, installation instructions and dimensioned drawings for products, fixtures, equipment and devices installed, furnished or provided. Reference individual Division 27, Communications specification Sections for specific items required in product data submittal outside of these requirements.

3. See Division 27, Communications individual Sections for additional submittal requirements outside of these requirements.

G. Maximum of two reviews of complete submittal package. Arrange for additional reviews and/or early review of long-lead items; Bear costs of additional reviews at Engineer's hourly rates. Incomplete submittal packages/submittals will be returned to contractor without review.

H. Resubmission Requirements: Make corrections or changes in submittals as required, and in consideration of Engineer’s comments. Identify Engineer’s comments and provide an individual response to each of the Engineer’s comments. Cloud changes in the submittals and further identify changes which are in response to Engineer’s comments.

I. Structural/Seismic: Provide weights, dimensions, mounting requirements and like information required for mounting, seismic bracing, and support. Indicate manufacturer's installation and support requirements to meet ASCE 7-10 requirements for non-structural components. Provide engineered seismic drawings and equipment seismic certification. Equipment Importance Factor as specified in Division 01 and in Structural documents.

J. Trade Coordination: Include physical characteristics, electrical characteristics, device layout plans, wiring diagrams, and connections as required per Division 27, Communications Coordination Documents. For equipment with electrical connections, furnish copy of approved submittal for inclusion in Division 26, Electrical submittals.

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

L. Substitutions and Variation from Basis of Design:
   1. The Basis of Design designated product establishes the qualities and characteristics for the evaluation of any comparable products by other listed acceptable manufacturers if included in this Specification or included in an approved Substitution Request as judged by the Design Professional.
   2. If substitutions and/or equivalent equipment/products are being proposed, it is the responsibility of parties concerned, involved in, and furnishing the substitute and/or equivalent equipment to verify and compare the characteristics and requirements of that furnished to that specified and/or shown. If greater capacity and/or more materials and/or more labor is required for the rough-in, circuitry or connections than for the item specified and provided for, then provide compensation for additional charges required for the proper rough-in, circuitry and connections for the equipment being furnished. No additional charges above the Base Bid, including resulting charges for work performed under other Divisions, will be allowed for such revisions. Coordinate with the requirements of “Submittals.” For any product marked “or approved equivalent,” a substitution request must be submitted to Engineer for approval prior to purchase, delivery or installation.

M. Shop Drawings:
   1. Provide coordinated Shop Drawings which include physical characteristics of all systems, device layout plans, and control wiring diagrams. Reference individual Division 27, Communications specification Sections for additional requirements for Shop Drawings outside of these requirements.
   2. Provide Shop Drawings indicating access panel locations, size and elevation for approval prior to installation.
N. Samples: Provide samples when requested by individual Sections.

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

P. Operation and Maintenance Manuals, Owners Instructions:
1. Submit, at one time, electronic files (PDF format) on CD/DVD of manufacturer's operation and maintenance instruction manuals and parts lists for equipment or items requiring servicing. Submit data when work is substantially complete and in same order format as submittals. Include name and location of source parts and service for each piece of equipment.
   a. Include copy of approved submittal data along with submittal review letters received from Engineer. Data to clearly indicate installed equipment model numbers. Delete or cross out data pertaining to other equipment not specific to this project.
   b. Include copy of manufacturer's standard Operations and Maintenance for equipment. At front of each tab, provide routine maintenance documentation for scheduled equipment. Include manufacturer's recommended maintenance schedule and highlight maintenance required to maintain warranty. Furnish list of routine maintenance parts, including part numbers, sizes, quantities, relevant to each piece of equipment: batteries, lamp lenses, speakers and filters.
   c. Include Warranty per Division 00, Procurement and Contracting Requirements and Division 01, General Requirements, Section 27 00 00, Communications Basic Requirements and individual Sections.
   d. Include product certificates of warranties and guarantees.
   e. Include copy of complete parts list for equipment. Include available exploded views of assemblies and subassemblies.
   f. Include copy of burn-in and test reports specific to each piece of equipment.
   g. Include copy of software/appliance programming.
   h. Include commissioning reports.
   i. Engineer will return incomplete documentation without review. Engineer will provide one set of review comments in Submittal Review format. Contractor must arrange for additional reviews; Contractor to bear costs for additional reviews at Engineer's hourly rates.
2. Thoroughly instruct Owner in proper operation of equipment and systems. Where noted in individual Sections, training will include classroom instruction with applicable training aids and systems demonstrations. Submit copy of material used for Owner instruction. Field instruction per Section 27 00 00, Communications Basic Requirements Article titled "Demonstration."
3. Copies of certificates of code authority inspections, acceptance, code required acceptance tests, and other special guarantees, certificates of warranties, specified elsewhere or indicated on Drawings.

Q. Record Drawings:
1. Maintain at site at least one set of drawings for recording “as-constructed” conditions. Indicate on Drawings changes to original documents by referencing revision document, and include buried elements, location of conduit, and location of concealed communication items. Include items changed by field orders, supplemental instructions, and constructed conditions.
2. Record Drawings are to include equipment and fixture/connection schedules that accurately reflect "as constructed or installed" for project.
3. At completion of project, input changes to original project on Revit Model and make one set of black-line Drawings created from Revit Model in version/release equal to Contract Drawings. Submit Revit disk and Drawings upon substantial completion.
4. Invert elevations and dimensioned locations for incoming utilities and site raceways below grade extending to 5-feet outside building line.
5. See Division 27, Communications individual Sections for additional items to include in Record Drawings.

1.05 QUALITY ASSURANCE

A. Regulatory Requirements: Work and materials installed to conform with all local, state, federal and other applicable laws and regulation.

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

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

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

E. Provide products that are UL listed.

F. Contractor Qualifications:
   1. Minimum of five years experience in the design, installation, testing and maintenance of communications systems.
   2. Must employ at least one full time BICSI certified Registered Communications Distribution Designer (RCDD) who is involved in reviewing work performed by contractor on this project.
   3. Maintain a local service facility which stocks spare devices and/or components for servicing systems.
   4. Have performed successful installation and maintenance of at least three projects similar in scope and size. Be able to provide project references for these three projects, including scope of Work, project type, Owner/user contact name and telephone number.
   5. The contractor selected for this project must be certified by the manufacturer of the approved products and utilize these components for completion of work.

1.06 WARRANTY

A. Provide written warranty covering the work for a period of one year from date of Substantial Completion in accordance with Division 00, Procurement and Contracting Requirements and Division 01, General Requirements, Section 27 00 00, Communications Basic Requirements and individual Division 27, Communications Sections.

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

1.07 COORDINATION DOCUMENTS

A. Prior to construction, coordinate installation and location of HVAC equipment, ductwork, grilles, diffusers, piping, plumbing equipment/fixtures, fire sprinklers, plumbing, lights, cable trays and electrical services with architectural and structural requirements, and other trades (including ceiling suspension and tile systems), and provide maintenance access requirements.
Coordinate with submitted architectural systems (i.e. roofing, ceiling, finishes) and structural systems as submitted, including footings and foundation. Identify zone of influence from footings and ensure systems are not routed within the zone of influence.

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

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

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

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Provide like items from one manufacturer, including but not limited to jacks, patch panels, equipment connection cords and wall plates.

2.02 MATERIALS

A. Base contract upon furnishing materials as specified. Materials, equipment, and fixtures used for construction are to be new, latest products as listed in manufacturer's printed catalog data and are to be UL approved or have adequate approval or be acceptable by State, County, and City authorities. Equipment/fixture supplier is responsible for obtaining state, county, and city acceptance on equipment/fixture not UL approved or not listed for installation.

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

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

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

PART 3 - EXECUTION

3.01 ACCESSIBILITY AND INSTALLATION

A. Confirm Accessibility and Installation requirements in Division 00, Procurement and Contracting Requirements, Division 01, General Requirements, Section 27 00 00, Communications Basic Requirements and individual Division 27, Communications Sections.

B. Install equipment requiring access (i.e., amplifiers, taps, zone controllers, volume controls, and storage devices) so that they may be serviced, reset, replaced or recalibrated by service people with normal service tools and equipment. Do not install equipment in obvious passageways, doorways, scuttles or crawlspaces which would impede or block intended usage.

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

D. Earthwork:
   1. Confirm Earthwork requirements in Contract Documents. In absence of specific requirements, comply with individual Division 27, Communications Sections and the following:
a. Perform excavation, dewatering, shoring, bedding, and backfill required for installation of work in this Division in accordance with related earthwork divisions. Contact utilities and locate existing utilities prior to excavation. Repair any work damaged during excavation or backfilling.

b. Excavation: Do not excavate under footings, foundation bases, or retaining walls.

c. Provide protection of underground systems. Review the project Geotechnical Report for references to corrosive or deleterious soils which will reduce the performance or service life of underground systems materials.

E. Firestopping:

1. Confirm Firestopping requirements in Division 07, Thermal and Moisture Protection. In absence of specific requirements, comply with individual Division 27, Communications Sections and the following:

   a. Coordinate location and protection level of fire and/or smoke rated walls, ceilings, and floors. When these assemblies are penetrated, seal around piping, ductwork and equipment with approved firestopping material. Install firestopping material complete as directed by manufacturer’s installation instructions. Meet requirements of ASTM E814, Standard Test Method for Fire Tests of Through-Penetration Fire Stops.

F. Plenums: In plenums, provide plenum rated materials that meet the requirements to be installed in plenums. Immediately notify Architect/Engineer of discrepancy.

3.02 SEISMIC CONTROL

A. Confirm Seismic Control requirements in Division 01, General Requirements, Structural documents, and individual Division 27 Communications Sections.

B. Earthquake resistant designs for Communications (Division 27) equipment and distribution, i.e. cabinets and racks, ceiling assemblies, raceways, ladder racking, etc. to conform to regulations of jurisdiction having authority.

C. Restraints which are used to prevent disruption of function of piece of equipment because of application of horizontal force to be such that forces are carried to frame of structure in such a way that frame will not be deflected when apparatus is attached to a mounting base and equipment pad, or to structure in normal way, utilizing attachments provided. Secure equipment and distribution systems to withstand a force in direction equal to value defined by jurisdiction having authority.

D. Provide stamped Shop Drawings from licensed Structural Engineer of seismic bracing and seismic movement assemblies for cabinets, racks, major equipment and overhead raceways. Engineer to design and provide stamped Shop Drawings cabinets, racks, major equipment and overhead raceway. Submit Shop Drawings along with equipment submittals.

E. Provide stamped Shop Drawings from licensed Structural Engineer of seismic flexible joints for piping and crossing building expansion or seismic joints. Submit Shop Drawings along with seismic bracing details.

F. Provide means to prohibit excessive motion of communications equipment during earthquake.

3.03 REVIEW AND OBSERVATION

A. Confirm Review and Observation requirements in Division 00, Procurement and Contracting Requirements and Division 01, General Requirements, Section 27 00 00, Communications Basic Requirements and individual Division 27, Communications Sections.

B. Notify Architect, in writing, at following stages of construction so that they may, at their option, visit site for review and construction observation:

1. Underground conduit installation prior to backfilling.

2. Prior to ceiling cover/installation.

3. When main systems, or portions of, are being tested and ready for inspection by AHJ.

C. Final Punch: Costs incurred by additional trips required due to incomplete systems will be the responsibility of the Contractor.
3.04 CUTTING AND PATCHING

A. Confirm Cutting and Patching Requirements in Division 00, Procurement and Contracting Requirements and Division 01, General Requirements. In absence of specific requirements, comply with individual Division 27, Communications Sections and the following:

1. Proposed floor cutting/core drilling/sleeve locations to be approved by Project Structural Engineer. Submit proposed locations to Architect/Project Structural Engineer. Where slabs are of post tension construction, perform x-ray scan of proposed penetration locations and submit scan results including proposed penetration locations to Project Structural Engineer/Architect for approval. Where slabs are of waffle type construction, show column cap extent and cell locations relative to proposed penetration(s).

2. Cutting, patching and repairing for work specified in this Division including plastering, masonry work, concrete work, carpentry work, and painting included under this Section will be performed by skilled craftsmen of each respective trade in conformance with appropriate Division of Work.

3. Additional openings required in building construction to be made by drilling or cutting. Use of jack hammer is specifically prohibited. Patch openings in and through concrete and masonry with grout.

4. Restore new or existing work that is cut and/or damaged to original condition. Patch and repair specifically where existing items have been removed. This includes repairing and painting walls, ceilings, etc. where existing conduit and devices are removed as part of this project. Where alterations disturb lawns, paving, and walks, surfaces to be repaired, refinished and left in condition matching existing prior to commencement of work.

5. Additional work required by lack of proper coordination will be provided at no additional cost to the Owner.

3.05 EQUIPMENT SELECTION AND SERVICEABILITY

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

3.06 DELIVERY, STORAGE AND HANDLING

A. Confirm requirements in Division 00, Procurement and Contracting Requirements and Division 01, General Requirements. In absence of specific requirements, comply with individual Division 27, Communications Sections and the following:

1. Handle materials delivered to project site with care to avoid damage. Store materials on site inside building or protected from weather, dirt and construction dust. Insulation and lining that becomes wet from improper storage and handling to be replaced before installation. Products and/or materials that become damaged due to water, dirt and/or dust as a result of improper storage to be replaced before installation.

2. Protect all equipment and conduit to avoid damage. Close conduit openings with caps or plugs. Keep motors and bearings in watertight and dustproof covers during entire course of installation.

3.07 DEMONSTRATION

A. Confirm Demonstration requirements in Division 00, Procurement and Contracting Requirements and Division 01, General Requirements, Section 27 00 00, Communications Basic Requirements and individual Division 27, Communications Sections.

B. Upon completion of work and adjustment of equipment and test systems, demonstrate to Owner's Representative, Architect and Engineer that equipment furnished and installed or connected under provisions of these Specifications functions in manner required. Provide field instruction to Owner's Maintenance Staff as specified in Division 01, General Requirements, Section 27 00 00, Communications Basic Requirements and individual Division 27, Communications Sections.

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

3.08 CLEANING

A. Confirm Cleaning requirements in Division 00, Procurement and Contracting Requirements, Division 01, General Requirements, Section 27 00 00, Communications Basic Requirements and individual Division 27, Communications Sections.

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

3.09 INSTALLATION

A. Confirm Installation requirements in Division 00, Procurement and Contracting Requirements and Division 01, General Requirements, Section 27 00 00, Communications Basic Requirements and individual Division 27, Communications Sections.

B. Install equipment and devices in accordance with manufacturer's installation instructions, plumb and level and firmly secured to mounting surfaces. Maintain manufacturer's recommended clearances.

C. Start up equipment, in accordance with manufacturer's start-up instructions, and in presence of manufacturer's representative. Test operation and demonstrate compliance with requirements. Replace damaged or malfunctioning equipment.

D. Provide miscellaneous supports/metals required for installation of equipment.

3.10 PAINTING

A. Confirm Painting requirements in Division 01, General Requirements and Division 09, Finishes. In absence of specific requirements, comply with individual Division 27, Communications Sections and the following:

1. Ferrous Metal: After completion of communications work, thoroughly clean and paint exposed supports constructed of ferrous metal surfaces in telecommunications rooms, i.e., hangers, hanger rods, equipment stands, with one coat of black asphalt varnish for exterior or black enamel for interior, suitable for hot surfaces.

2. In a telecommunications room, on roof or other exposed areas, equipment not painted with enamel to receive two coats of primer and one coat of rustproof enamel, colors as selected by Architect.

3. See individual equipment Specifications for other painting.

4. Structural Steel: Repair damage to structural steel finishes or finishes of other materials damaged by cutting, welding or patching to match original.

5. Conduit: Clean, primer coat and paint interior conduit exposed in finished areas with two coats paint suitable for metallic surfaces. Color selected by Architect.

6. Covers: Covers such as manholes, vaults and the like will be furnished with finishes which resist corrosion and rust.

3.11 ACCEPTANCE

A. Confirm requirements in Division 00, Procurement and Contracting Requirements and Division 01, General Requirements. In absence of specific requirements, comply with individual Division 27, Communications Sections and the following:

1. System cannot be considered for acceptance until work is completed and demonstrated to Architect that installation is in strict compliance with Specifications, Drawings and manufacturer's installation instructions, particularly in reference to following:
   a. Testing Reports
   b. Cleaning
   c. Operation and Maintenance Manuals
   d. Training of Operating Personnel
   e. Record Drawings
   f. Warranty and Guaranty Certificates, including extended manufacturer's warranties.
g. Start-up/test Documents and Commissioning Reports

3.12 FIELD QUALITY CONTROL

A. Confirm Field Quality Control requirements in Division 00, Procurement and Contracting Requirements and Division 01, General Requirements, Section 27 00 00, Communications Basic Requirements and individual Division 27, Communications Sections.

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

END OF SECTION
SECTION 27 0528 - PATHWAYS FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.01 SUMMARY
A. Work Included:
   1. Raceway
   2. Rigid Metal Conduit and Fittings
   3. Electrical Metallic Tubing and Fittings
   4. Conduit Accessories
   5. Penetration Sealing Systems
   6. Telecommunications Outlet Boxes
   7. Innerduct
   8. Innerduct Fittings
   9. J-Hooks
B. This Section specifies the requirements to provide communications conduit raceways, boxes, cable trays, innerduct and fittings.

1.02 RELATED SECTIONS
A. Contents of Division 27, Communications and Division 01, General Requirements apply to this Section.

1.03 REFERENCES AND STANDARDS
A. References and Standards as required by Section 27 00 00, Communications Basic Requirements and Division 01, General Requirements.

1.04 SUBMITTALS
A. Submittals as required by Section 27 00 00, Communications Basic Requirements and Division 01, General Requirements.
B. Provide plan drawings showing completions and as-built corrections which indicate type, size, placement, routing and/or length for raceway and cable tray components; e.g., manholes, handholes, conduit, boxes, enclosures, etc.

1.05 QUALITY ASSURANCE
A. Quality assurance as required by Section 27 00 00, Communications Basic Requirements and Division 01, General Requirements.

1.06 WARRANTY
A. Warranty of materials and workmanship as required by Section 27 00 00, Communications Basic Requirements and Division 01, General Requirements.

1.07 DEFINITIONS
A. Cabinet: A freestanding floor-mounted modular enclosure designed to house and protect rack-mounted electronic equipment.
B. Conduit: Round raceway.
C. Conduit Body: Separate portion of a conduit or tubing system that provides access through removable cover(s) to the interior of the system at a junction of two or more sections of the system or at a terminal point of the system.
D. Pull Box Enclosure: Box with a cover installed in one or more runs of raceway to facilitate pulling conductors through the raceway system. There are no openings in the cover.
E. Raceway: Enclosed channel designed expressly for holding wires or cables. Metal or insulating material and the term includes conduit, tubing, wireways, underfloor raceways and surface raceways; does not include cable tray.
F. Surface Raceway: Surface-mounted metal channel or plastic duct with snap-in removable covers for housing and protecting electrical wires and cables. Raceway and fittings are
designed so sections can be electrically and mechanically coupled together without subjecting cables to abrasion.

G. Wire Basket Runway Systems: Includes, but are not limited to straight sections of type wire basket runway cable trays, bends, tees, elbows, drop-outs, supports and accessories.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Raceway:
   1. Koppers Bitumastic
   2. Or approved equivalent.

B. Rigid Metal Conduit and Fittings:
   1. Sealing Fittings:
      a. Crouse-Hinds
      b. Or approved equivalent.

C. Electrical Metallic Tubing and Fittings:
   1. Allied Tube and Conduit
   2. Or approved equivalent.

D. Conduit Accessories:
   1. Expansion/Deflection Fittings:
      a. Appleton
      b. Or approved equivalent.
   2. Pulltape:
      a. George-Ingraham
      b. Or approved equivalent.
   3. Duct Plugs:
      a. Carlon
      b. Or approved equivalent.

E. Penetration Sealing Systems:
   1. SEMCO
   2. Or approved equivalent.

F. Telecommunications Outlet Boxes:
   1. Raco
   2. Or approved equivalent.

G. Innerduct:
   1. Carlon
   2. Or approved equivalent.

H. Innerduct Fittings:
   1. Carlon
   2. Or approved equivalent.

I. J-Hooks:
   1. Erico
   2. Or approved equivalent.

2.02 RACEWAYS

A. Raceways: Labeled and/or listed as acceptable to the AHJ as suitable for the use intended.

B. Table 1: Product Identification:

<table>
<thead>
<tr>
<th>Product Designation</th>
<th>Product Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>RGS</td>
<td>Rigid Galvanized Steel</td>
</tr>
<tr>
<td>EMT</td>
<td>Galvanized Steel Tubing</td>
</tr>
<tr>
<td>PVC</td>
<td>Polyvinylchloride Conduit</td>
</tr>
</tbody>
</table>
C. The product identification codes used for the Communications Raceways and Boxes in Part 2, Products, are summarized in Table 1.
D. Bitumastic material or plastic tape.

2.03 RIGID METAL CONDUIT AND FITTINGS
A. Conduit: Type RGS; Rigid galvanized steel.
B. Fittings and Conduit Bodies: In-line straight-through, threaded, galvanized steel fittings and Type C conduit bodies only; do not use bends or tees, e.g., Lbs.
   1. Bonding and Grounding Locknuts and Wedges: Malleable iron with set screws and lug screws.
   2. Insulated Bushing: Malleable iron with integral insulated throat, rated for 150C.
   3. Bonding and Grounding Bushing: Malleable iron with integral insulated throat, rated for 150C, with solderless lugs or lug screws.
   4. Sealing Fittings: Threaded type conduit seal fittings and sealing compound suitable for hazardous location installations in accordance with NEC:
      a. Crouse-Hind retrofit sealing fitting EYSR.
      b. Crouse-Hind CHICO A sealing compound.

2.04 ELECTRICAL METALLIC TUBING AND FITTINGS
A. Type EMT: Electrogalvanized steel tubing.
B. Fittings and Conduit Bodies:
   1. In-line straight-through steel or malleable iron fittings and Type C conduit bodies only; do not use bends or tees, e.g., Lbs.
   2. Wet Areas: Steel compression-type couplings and nipples.
   3. Dry Areas: Set screw-type couplings and nipples.
   4. Bonding Locknuts:
      a. Malleable iron with set screws and lug screws.
      b. Insulated Bushing: Malleable iron with integral insulated throat, rated for 150C.
      c. Bonding and Grounding Bushing: Malleable iron with integral insulated throat, rated for 150C, with solderless lugs or lug screws.

2.05 CONDUIT ACCESSORIES
A. Expansion/Deflection Fittings: Similar to Crouse-Hinds XD expansion/deflection coupling or Appleton DF Series deflection and expansion coupling.
B. Pulltape: Measuring and pulling tape constructed of synthetic fiber with plastic jacket, printed with accurate sequential footage marks; e.g., George-Ingraham 1/2-inch tape 9216-JK.
C. Duct Plugs:
   1. Aboveground Conduit Openings: Tapered PVC plugs with tab for pulltape; e.g., Carlon 4-inch PVC plugs with pull tab, P258NT.
   2. Underground or Underslab Conduit Openings: Removable screwtight compression type duct plugs with wing-nut and corrosion resistant hardware; e.g. Vikimatic 4-inch, Part Number 40D402U. Use appropriate part number according to duct size.

2.06 PENETRATION SEALING SYSTEMS
A. Firestopping: Provide fire barrier penetration sealing materials as specified in Division 07, Firestopping Section.
B. Duct Water Seal: Products suitable for closing underground and entrance duct openings, where innerduct or cable is installed, to prevent entry of gases, liquids, or rodents into the structure; e.g., SEMCO PR 851.

2.07 TELECOMMUNICATIONS OUTLET BOXES
A. Sheet Metal Outlet Boxes: Minimum 4-inch square by 2-1/8-inch deep, galvanized steel for use with single-gang plaster rings.
B. Five Square Outlet Boxes: Minimum 5-inch square by 2-7/8-inch deep with built-in cable management for use with single-gang plaster rings. Randl P/N T-55017 approved.

C. Nonmetallic Outlet Boxes: Minimum 4-inch square by 2-1/2-inch-deep. Provide gasketed, watertight single-gang cover.

D. Cast Boxes: 4-inch square by 2-1/8-inch deep cast Ferolloy, gasketed single-gang cover, threaded hubs.

E. Floor Boxes for Installation in Cast-In-Place Concrete Floors: Flush mounted and fully adjustable formed steel as shown on the Drawings. Floor boxes provided by Division 26, Electrical.

2.08 INNERDUCT

A. Outdoor Innerduct: 1-inch inside diameter corrugated, ribbed, or smooth walled, semi rigid PVC or heavy-wall polyethylene tubing.

B. Indoor Innerduct: 1-inch inside diameter corrugated, ribbed, or smooth walled, semi rigid nonflammable PVC tubing, which meets UL94V-O vertical flame test for general applications.


2.09 INNERDUCT FITTINGS

A. Couplings: Metallic or nonmetallic quick-connect, reverse threaded and Schedule 40 couplings for connecting sections of installed innerduct.

B. Innerduct Caps: Removable push-in caps for plugging 1-inch innerduct.

2.10 J-HOOKS

A. Constructed of galvanized steel, stainless steel or hot dipped zinc.

B. Wires or all-thread supports mounted to structure.

PART 3 - EXECUTION

3.01 GENERAL INSTALLATION REQUIREMENTS

A. Workmanship:
   1. Provide, condition, apply, install, connect and test manufactured products, materials, equipment and components in accordance with the manufacturer's specifications and printed instructions.
   2. The installation of system components to be carried out under the direction of qualified personnel. Appearance to be considered as important as mechanical and electrical efficiency. Workmanship to meet or exceed industry standards.
   3. Place support for raceways, cable trays, backboards, equipment racks and cabinets.

B. Protection During Construction: Protect products from the effects of moisture, corrosion and physical damage during construction. Except during installation activity in a section, keep openings in conduit, tubing and wireway capped with manufactured seals during construction.

C. Concrete Sleeves: Conduits routed perpendicular through floors, walls, or other concrete structures to pass through cast-in-place conduit sleeve openings wherever possible, or appropriate size holes to be bored to accommodate the installation of conduit sleeves. The size and location of the holes to not impair the structure's integrity.
   1. Concrete Boring: Bore a hole in the concrete with a diameter of 1/2 to 1-inch larger than the conduit sleeve to be installed. Grout around the conduit sleeve and finish to match existing surroundings.
   2. Conduits that rise vertically through a slab to be stubbed 6-inches above the floor and capped pending future use.

D. Drywall/Gypsum Board Sleeves: Install insulating throat bushings on both ends of conduit sleeves placed in fire-rated walls using drywall construction.
E. Where conduit enters a structure through a concrete roof or membrane waterproofed wall or floor:  
   1. Provide a watertight seal.  
   2. With Concrete Encasement: Install watertight entrance seal device on the accessible side.  
   3. Securely anchor malleable iron body of watertight entrance seal device into construction with one or more integral flanges.  
   4. Secure membrane waterproofing to watertight entrance seal device in a permanent, watertight manner.  
F. Provide continuous sleeving through walls, floors and ceilings separating each telecom outlet from its respective MER/TR room, using sleeve conduit size as required per Standards. Restore penetrations through rated assemblies to original fire rating per NFPA and local codes.  
G. Locate sleeves as shown on Drawings. Where sleeves are not shown on Drawings, install sleeves above suspended ceilings and locate to minimize length of pathway for future cable from telecom outlet to MER/TR rooms.  
H. Where sleeves are routed between rooms with floating ceilings, extend conduits horizontally 2-feet over edge of floating ceiling to avoid exposed cabling from being seen at floor level.  
I. Make floor penetrations no more than 4-inches from wall. Install conduit stubs to extend 4-inches from floor base. Cap conduits for protection.  
J. Provide removable heat-expanding pillows at fire barrier penetrations as specified in Firestopping section and described as Firestop Material Type 7 (indicated as FSM-7).  
K. Grounding: Provide ground connections and bonding continuity between raceway and wire basket runway sections, boxes, enclosures, cabinets and fittings as required per code and industry standard.  
L. Provide plenum rated products, components and accessories for installation in plenums.  

3.02 RACEWAYS  
A. Reference 3.01, General Installation Requirements.  
B. Install per manufacturer's written instructions and recommendations.  

3.03 RIGID METAL CONDUIT AND FITTINGS  
A. Reference 3.01, General Installation Requirements.  
B. Install per manufacturer's written instructions and recommendations.  
C. Conduit Type:  
   1. Install the following types of circular communications raceway in the locations listed unless otherwise indicated on the Drawings.  

3.04 ELECTRICAL METALLIC TUBING AND FITTINGS  
A. Reference 3.01, General Installation Requirements.  
B. Install per manufacturer's written instructions and recommendations.  
C. Conduit Type:  
   1. Install the following types of circular communications raceway in the locations listed unless otherwise indicated on the Drawings.  
      a. Interior Dry Locations, Exposed: EMT with set screw fittings.  
      b. Interior Dry Locations, Concealed (Not Embedded in Concrete): EMT with set screw fittings.  
      c. Interior Wet Locations: EMT with compression fittings.  
D. Conduit Bends and Sweeps:  
   1. Make changes in direction of communications conduit runs with sweeps of the longest possible radius.
2. Make sweeps in parallel or banked runs of conduits, 2-inches and larger in diameter, from the same center or centerline so that sweeps are parallel and of neat appearance.

3. Field-Made Bends and Sweeps:
   a. Use an acceptable hickey or conduit-bending machine.
   b. Do not heat metal raceways to facilitate bending.
   c. Before installing 4-inch field-made sweeps in duct banks, pull a 3-1/2-inch diameter by 12-inch long mandrel through duct sections to verify circularity and sweep radius.

4. The angular sum of the bends between pull points and/or pull boxes to not exceed 180 degrees.

5. Minimum Inside Bend Radius for Communications Conduit Bends, Sweeps, Boxes and Fittings:
   a. One-inch conduit, 11-inches
   b. Two-inch conduit, 21-inches
   c. Three-inch conduit, 36-inches
   d. Four-inch conduit, 48-inches
   e. Other sizes, 10 times the inside diameter of the conduit.

6. Do not install boxes, bends, elbows, tees, conduit bodies and other conduit fittings, which do not provide for the minimum inside cable bend radius specified in paragraph E above.
   a. Conduit Bodies: In-line straight-through Type C condulet fittings can be used as pull boxes for conduit up to a maximum of 2-inches ID. Other conduit fittings, which include direction changes such as E, L, LB, LR, LL, LRT, TA, TB and X, are not allowed.
   b. Refer design or installation conflicts with these requirements to the Architect.

3.05 CONDUIT ACCESSORIES
   A. Reference 3.01, General Installation Requirements.
   B. Install per manufacturer's written instructions and recommendations.
   C. Expansion/Deflection Fittings: Install per manufacturer's recommendation.
   D. Pulltape: Install per manufacturer's recommendation.
   E. Duct Plugs: Install per manufacturer's recommendation.

3.06 PENETRATION SEALING SYSTEMS
   A. Reference 3.01, General Installation Requirements.
   B. Install per manufacturer's written instructions and recommendations.
   C. Seal conduit entering structures at the first box or outlet to prevent the entrance of gases, liquids, or rodents into the structure.
      1. Empty Conduits: Removable screwtight duct plugs.
      2. Innerduct Installed: Suitable duct water seal between conduit and innerduct. Manufactured seals in empty innerduct.
      3. Cable Installed: Suitable duct water seal between conduit and cable, or between innerduct and cable.

3.07 TELECOMMUNICATIONS OUTLET BOXES
   A. Reference 3.01, General Installation Requirements.
   B. Install per manufacturer's written instructions and recommendations.
   C. Provide 4-inch by 4-inch by 2-1/8-inch deep outlet boxes for mounting telecommunications outlets with single-gang plaster rings as required, or as indicated on the Drawings.
   D. Do not install outlet boxes back to back in walls. Provide minimum 6-inch separation, except provide minimum 24-inch separation in acoustic-rated walls.
   E. Locate outlet boxes in masonry walls to require cutting of masonry unit corner only. Coordinate masonry cutting to achieve neat openings for outlet boxes. Use boxes with sufficient depth to permit conduit hubs to be located in masonry void spaces.
F. Provide knockout closures for unused openings.

G. Support telecommunications outlet boxes independently of conduit.

H. Use multiple-gang boxes where more than one device is mounted together; do not use sectional outlet boxes.

I. Install outlet boxes in walls without damaging wall insulation.

J. Coordinate mounting heights and locations of outlet boxes mounted above counters, benches and backsplashes.

K. Provide recessed outlet boxes in finished areas; secure boxes to interior wall and partition studs, accurately positioning to allow for surface finish thickness. Use stamped steel stud bridges for flush outlet boxes in hollow stud wall.

L. Provide cast outlet boxes in exterior and wet locations.

3.08 INNERDUCT

A. Reference 3.01, General Installation Requirements.

B. Install per manufacturer’s written instructions and recommendations.

C. Innerduct Type:
   3. Interior Locations Including Cable Tray Installations:
      b. Plenum Areas: Plenum-listed innerduct.

D. Provide innerduct for all fiber optic cables for the entire length of the cable run.

E. Pull innerduct through conduit or place innerduct in cable trays using continuous unspliced lengths of innerduct between pull boxes and/or section termination points as indicated on the Drawings.

F. Cut innerduct square. Deburr cut ends.

G. Bring innerduct to the shoulder of fittings and couplings and fasten securely.

H. Wipe innerduct and fittings clean and dry before joining. Apply full, even coat of cement to entire area that will be inserted into fitting. Let joint cure for 20 minutes minimum.

I. Provide suitable innerduct slack in pull boxes and at turns to ensure that there is no kinking or binding of the tubing.

J. Make changes in direction of communications innerduct runs with sweeps of the longest possible radius and at least 10 times the inside diameter of the innerduct.

K. During innerduct pulling, avoid excessive tension which can damage the innerduct. Inspect innerduct following placement and replace damaged sections.

L. Indoor Conduit Installation:
   1. Arrange innerduct neatly, cut to proper length and remove surplus. Provide trained and bundled innerduct pigtails extending at least 18-inches beyond exposed conduit openings.
   2. At locations where the ends of innerduct sections appear in a pull box, join the pulltape and then splice innerduct sections together using couplers which do not reduce the inside diameter of the innerduct.

M. Cable Tray Installation: Tie wrap innerduct to one side of vertical ladder rack every 2-feet minimum and to one side of horizontal ladder-type cable tray every 5-feet minimum.

N. Following installation, visually inspect innerduct, remove burrs at openings and, if necessary, clean innerduct interior.

O. Innerduct Pull Tape and Duct Plug Installation:
   1. Following innerduct installation, install pulltape (muletape) with preprinted foot markers in innerduct sections. Tie the pulltape securely at each end.
2. Verify lengths at the time of installation and provide as-built documentation.
3. Following innerduct and pulltape installation, cap or plug innerduct with manufactured seals to prevent moisture or foreign matter from entering until cable installation starts. Seal duct openings in underground or underslab innerduct sections immediately after installation using screwtight, removable, watertight and dust-tight duct plugs.

3.09 INNERDUCT FITTINGS
A. Reference 3.01, General Installation Requirements.
B. Install per manufacturer's written instructions and recommendations.
C. Wipe fittings clean and dry before joining. Apply full, even coat of cement to entire area that will be inserted into the fitting. Allow joints/assembly to cure for 20 minutes, minimum.
D. Install per manufacturer's recommendations.

3.10 J-HOOKS
A. Install J-hooks rated for Category 6 cable for support of cabling from the wire basket tray to the outlet location.
B. J-hooks are to be installed on dedicated wires or all thread rods mounted to structure. J-hooks are not to attach to ceiling grid wires.

END OF SECTION
SECTION 27 1101 - COMMUNICATION EQUIPMENT ROOMS

PART 1 - GENERAL

1.01 SUMMARY

A. Work Included:
   1. Telecommunications Backboards
   2. Wall Mount Cabinets
   3. Horizontal Wire Managers
   4. Telecommunications Grounding

B. The telecommunications equipment room is intended to house racks, cabinets and equipment necessary for the support of the voice and data cabling infrastructure as well as other low-voltage systems.

1.02 RELATED SECTIONS

A. Contents of Division 27, Communications and Division 01, General Requirements apply to this Section.

1.03 REFERENCES AND STANDARDS

A. References and Standards as required by Section 27 00 00, Communications Basic Requirements and Division 01, General Requirements.

B. Use this Section in conjunction with the other Division 27, Communications Sections and related Contract Documents to establish the total general requirements for the project technology systems and equipment.

1.04 SUBMITTALS

A. Submittals as required by Section 27 00 00, Communications Basic Requirements and Division 01, General Requirements.

B. Provide a copy of certified installer certificates and warranty certificates for products proposed.

1.05 QUALITY ASSURANCE

A. Quality assurance as required by Section 27 00 00, Communications Basic Requirements and Division 01, General Requirements.

1.06 WARRANTY

A. Warranty of materials and workmanship as required by Section 27 00 00, Communications Basic Requirements and Division 01, General Requirements.

1.07 SYSTEM DESCRIPTION

A. The communications room distribution subsystem refers to the passive components used to terminate cabling subsystems and distribute technology services. This subsystem includes but is not limited to installations in the Main Equipment Room (MER), Telecommunications Rooms (TR) and Entrance Facility (EF).

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Telecommunications Backboards:
   1. Reference 2.02A for requirements.
   2. Or approved equivalent.

B. Wall Mount Cabinets: Chatsworth; Model 11900-748.

C. Horizontal Wire Managers:
   1. 19-inches wide, two rack units high: Chatsworth; Model 30130-719.
   2. 19-inches wide, one rack unit high: Chatsworth; Model 30139-719.

D. Telecommunications Grounding:
   1. Telecommunications Grounding Busbar (TGB): Chatsworth; Model 13622-010.
2. Telecommunications Ground Accessories:
   a. One Hole Ground Terminal Block: Chatsworth; Model 08009-001.
   b. Two Hole Ground Terminal Block: Chatsworth; Model 40167-001.
   c. Two Hole Grounding Lug: Chatsworth.
   d. Cable Runway Ground Strap Kit: Chatsworth; Model 40164-001.

2.02 TELECOMMUNICATIONS BACKBOARDS
   A. 3/4-inch minimum thickness, A/C grade or better, void-free plywood, fire treated backboard.

2.03 WALL MOUNT CABINETS
   A. 48-inches high, 24-inches deep, 24-inches wide, wall mounted cabinet with plexiglass hinged door.

2.04 HORIZONTAL WIRE MANAGERS
   A. 19-inches wide, two rack units high.
   B. 19-inches wide, one rack unit high.

2.05 TELECOMMUNICATIONS GROUNDING
   A. Telecommunications Grounding Busbar (TGB): Solid copper busbar kit, 10-inches long,
      1/4-inch thick, wall-mounted with standoffs.
   B. Telecommunications Ground Accessories:
      1. One hole ground terminal block, holds two wires up to size #4.
      2. Two hole ground terminal block, holds two wires up to size 2/0.
      3. Two hole grounding lug.
      4. Cable runway ground strap kit.

PART 3 - EXECUTION

3.01 GENERAL INSTALLATION REQUIREMENTS
   A. Provide all components of the telecommunications system from a single manufacturer.
   B. Make floor penetrations no more than 4-inches from wall. Install conduit stubs to extend
      4-inches from floor base. Cap conduits for protection.
   C. Seismic installations require additional bracing of cabinets and overhead cable runways to
      building structure, as advised by and certified by a licensed structural engineer.
   D. Labeling:
      1. Label racks with the equipment room number and a unique identifier beginning with the
         telecom room number and the number one, i.e. TR1-1.
      2. Submit labeling schemes to the Owner for approval prior to testing and labeling.

3.02 TELECOMMUNICATIONS BACKBOARDS
   A. Mount plywood backboard vertically, 4-inches from floor.
   B. Mount backboards with the smooth “A” surface facing away from the wall. Paint the backboard
      with two coats of fire resistant paint prior to mounting.
   C. Install boards plumb, level and secured to studs or solid concrete or masonry walls. Use a
      minimum of six appropriate fasteners for every 16 SF of backboard. Anchors for attaching
      equipment boards include:
      1. Material/Substrate: Anchor type.
      2. Concrete/Masonry: Expansion anchors; wedge type with washer located on the backside
         of the board.
      3. Gypsum Wallboard: Togglebolts; use pan head type.
   D. Powder drive anchors, molly bolts and tappets are not allowed.

3.03 WALL MOUNT CABINETS
   A. Provide all components of the cabinet system (cabinet, mounting rails, cable managers, power
      strips and accessories) from a single manufacturer.
B. Attach cabinet to the wall so the front door can be opened fully without obstruction by other building, storage or architectural components. Follow the manufacturer's installation instructions when securing the cabinet to the wall and backboard. Do not attach the cabinet to sheetrock (gypsum wall board). Attach cabinet directly into studs through a 3/4-inch plywood backboard. Reference 2.02 for additional information. Use included hardware or the appropriate hardware as defined by local code or the AHJ.

C. Cables to enter/exit the cabinet through conduit knockouts in the sides and/or bottom of the cabinet through a rectangular cutout in the back of the cabinet.

D. Install and adjust to position all accessories, including cable managers, power strips, equipment-mounting rails, fan kits, etc. prior to installing equipment into the cabinet. Test fans and power strips/outlets prior to installing equipment.

E. Install per manufacturer's instructions and recommendations.

3.04 HORIZONTAL WIRE MANAGERS
   A. Reference 3.01, General Installation Requirements.
   B. Install per manufacturer's instructions and recommendations.

3.05 TELECOMMUNICATIONS GROUNDING
   A. Bond equipment cabinet to equipment room with #6 AWG or larger, stranded copper conductor.
   B. Connect the TGB to the main electrical main distribution panel and building steel using a 3/0 AWG or larger, stranded copper conductor. Coordinate exact routing and connection points with the electrical contractor.
   C. Two hole lugs are required on all ground cable connecting to the TGB.

END OF SECTION
SECTION 27 1300 - COMMUNICATIONS BACKBONE CABLEING

PART 1 - GENERAL

1.01 SUMMARY
   A. Work included:
      1. Copper Backbone Cable
      2. Fiber Optic Backbone Cable
      3. Copper Termination Hardware
      4. Fiber Optic Termination Hardware
      5. Fiber Patch Cords

1.02 RELATED SECTIONS
   A. Contents of Division 27, Communications and Division 01, General Requirements apply to this Section.

1.03 REFERENCES AND STANDARDS
   A. References and Standards as required by Section 27 00 00, Communications Basic Requirements and Division 01, General Requirements.
   B. Meet requirements of NFPA 780, Standards for Installation of Lightning Protection Systems.

1.04 SUBMITTALS
   A. Submittals as required by Section 27 00 00, Communications Basic Requirements and Division 01, General Requirements.
   B. In addition, provide:
      1. Procedures for cable labeling and identification, long term documentation methods and numbering scheme in accordance with ANSI/TIA/EIA-606-A.
      2. A copy of certified installer certificates and warranty certificates for products proposed.

1.05 QUALITY ASSURANCE
   A. Quality assurance as required by Section 27 00 00, Communications Basic Requirements and Division 01, General Requirements.
   B. Manufacturers to have a recognized certified installer program in place for system components proposed. Cable will be approved with manufacturer system installed.

1.06 WARRANTY
   A. Warranty of materials and workmanship as required by Section 27 00 00, Communications Basic Requirements and Division 01, General Requirements.
   B. In addition, provide:
      1. Labor, materials and documentation according to selected manufacturer requirements necessary to ensure that the Owner will be furnished with an Extended Product Warranty and Application Assurance of a minimum of 20 years in length. The Application Assurance Warranty will cover the failure of the wiring system to support current or future applications that are designed for the link/channel specifications of ANSI/TIA/EIA-568-C.
      2. Provide a warranty on the physical installation.
      3. Furnish necessary documentation required by the manufacturer immediately following 100 percent testing of cables.
      4. Administer the warranty process with the responsible manufacturer's representative. Provide warranty directly to the Owner from the manufacturer. Ensure that the manufacturer provides the Owner with the appropriate warranty certification within 90 calendar days of the final project completion.

1.07 SYSTEM DESCRIPTION
   A. Provide a standards-based cable system to serve backbone communication systems requirements as specified in these specifications and shown on Drawings. Closely follow ANSI/TIA/EIA, IEEE and ISO standards which apply to backbone communication systems.
B. Install interbuilding (OSP) backbone cables from the telecom cabinet in the Transportation Building to the existing MDF in the Main Building.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Copper Backbone Cable:
   1. CommScope Uniprise
   2. Leviton/Berk-Tek
   3. Panduit /General
   4. Or approved equivalent.

B. Fiber Optic Backbone Cable:
   1. CommScope Uniprise
   2. Leviton/Berk-Tek
   3. Panduit /General
   4. Or approved equivalent.

C. Copper Termination Hardware:
   1. General:
      a. CommScope Uniprise
      b. Leviton
      c. Panduit
      d. Or approved equivalent.
   2. Communication Entrance Protection:
      a. Circa
      b. Or approved equivalent.

D. Fiber Optic Termination Hardware:
   1. CommScope Uniprise
   2. Leviton
   3. Panduit
   4. Or approved equivalent.

E. Fiber Patch Cords:
   1. CommScope Uniprise
   2. Leviton
   3. Panduit
   4. Or approved equivalent.

2.02 COPPER BACKBONE CABLE

A. Intrabuilding or Interbuilding Indoor/Outdoor, UL listed for use indoors. Unshielded twisted pair, 100 ohm, 4-pair: Category 5e, Mohawk P/N M58762. No known equal.

2.03 FIBER OPTIC BACKBONE CABLE

A. Interbuilding Singlemode: 12 strand, 8.3 micron, high performance low water peak loose tube cable with maximum attenuation of 0.35 dB/km at 1310 nm and 0.25 dB/km at 1550 nm. Indoor/outdoor rated.

2.04 COPPER TERMINATION HARDWARE

A. Category 5e Patch Panels: 24 port, 8-position modular jack panel, high density, 6 port modules, Enhanced Category 5e, IDC terminals, T568A/B wiring scheme.

B. Communication Entrance Protection: Wall-mount 5-pin circuit protector blocks. Provide multi-pair tails or 110-style input/output terminations per application. Provide 5-pin, solid state surge arresters for each position on circuit protection panel.

2.05 FIBER OPTIC TERMINATION HARDWARE

A. High Density Fiber Termination Shelf:
1. 1.75-inch high shelf designed for mounting in 19-inch equipment racks and capable of accepting six adapter panels. The shelf will contain built-in slack management and be accessible from the front or rear with locking doors. 19-inch rack mount, 19-inches deep.

2. Fiber Adapter Panels: Adapter panel for high density termination shelf with six LC singlemode phosphor-bronze alignment sleeves.

B. Singlemode LC Connector: Ceramic tip LC style capable of being terminated on 8.3/125 fiber with 900 micron buffer.

2.06 FIBER PATCH CORDS

A. Singlemode Fiber Optic Jumpers: Factory terminated double ended, two strand singlemode cordage with LC connectors on each end, length as defined by the Owner.

PART 3 - EXECUTION

3.01 GENERAL INSTALLATION REQUIREMENTS

A. Miscellaneous Hardware: Provide supporting hardware, cable ties, labels, underground vault racking, bullet bonds, gel blocking kits, pull rope and other miscellaneous hardware for a complete and operable system.

B. Provide like items from one manufacturer, such as cable, patch panels, connectors, equipment connection cords and wall plates.

C. Communications Backbone Cabling includes cables, connectors, patch panels, connecting blocks and patch cords, as well as the necessary support systems, such as cable managers, tie wraps and D-rings.

D. Furnish and install materials necessary for a complete and working system.

E. Contractor must be a Certified Installer for selected manufacturer prior to, during and through completion of the system installation and must be able to provide the manufacturer's extended warranty.

F. Perform work in a neat and workmanlike manner.

G. Firestopping: Install all firestop systems in accordance with manufacturer's recommendations. Firestop systems to be completely installed and available for inspection by local inspection authorities prior to cable system acceptance.

H. Install cable after interior of building has been physically protected from the weather and mechanical work likely to damage cabling has been completed.

I. Before installing cabling, ensure cable pathways are completely and thoroughly cleaned:
   1. Inspect conduit, wireway, cable trays and innerduct systems prior to installation.
   2. Swab any additional enclosed raceway and innerduct systems.

J. Provide protection for exposed cables where subject to damage. Provide abrasion protection for any cable or wire bundles, which pass through holes or across edges of sheet metal.

K. Install cable ties and other cable management clamps via hand so they fit snugly. Do not over tighten or use mechanical tools which could compress, crimp, or otherwise change the physical characteristics of the cable jacket or distort the placement of twisted-pair components. Replace any cable exhibiting stresses due to over tightening of cable management devices.

L. Where possible, route cables in overhead cable trays and inside wire management systems attached to the equipment cabinets and racks. Use Velcro ties or ducts to restrain cabling installed outside of wire management systems on racks or in cabinets.

M. Limit cable raceway fill to less than the TIA/EIA-569-B maximum fill for the particular raceway type.

N. If a J-hook or trapeze system is used to support cable bundles, support cables at a maximum of 48 to 60-inch intervals. Cables are prohibited to rest on acoustic ceiling grids or panels.

O. Cable sizes are shown on Drawings. Verify as a minimum, two cable pairs are provided for each telephone user outlet. Install specified fiber optic cable between TRs as shown on drawings.
P. Install cable above fire-sprinkler systems and ensure the cable does not attach to the system or any ancillary equipment or hardware. Install cable system and support hardware so it does not obscure any valves, fire alarm conduit, boxes, or other control devices.

Q. Do not attach cables to ceiling grid or lighting fixture wires. Where support for cable is required, install appropriate carriers to support the cabling.

R. Any cable damaged or exceeding recommended installation parameters during installation will be replaced by the contractor prior to final acceptance at no cost to the Owner.

S. Unshielded Twisted Pair Cable Installation Practices:
   1. Install cable in accordance with manufacturer’s recommendations and best industry practices.
   2. Do not exceed the cable’s minimum bend radius and maximum pulling tension.
   3. Install unshielded twisted pair cable so there are no bends smaller than four times the cable outside diameter at any point in the run and at the termination field.

T. Provide the following minimum separation distances between pathways for copper communications cables and power wiring of 480 volts or less:
   1. Open or Nonmetal Communications Pathways:
      a. 12-inches from electric motors, fluorescent light fixtures and unshielded power lines carrying up to 3 kVA.
      b. 36-inches from electrical equipment and unshielded power lines carrying more than 5 kVA.
      c. 48-inches from large electrical motors or transformers.
   2. Grounded Metal Conduit Communications Pathways:
      a. 2-1/2-inches from electrical equipment and unshielded power lines carrying up to 2 kVA.
      b. 6-inches from electrical equipment and unshielded power lines carrying from 2 kVA to 5 kVA.
      c. 12-inches from electrical equipment and unshielded power lines carrying more than 5 kVA.
      d. 3-inches from power lines enclosed in a grounded metal conduit (or equivalent shielding) carrying from 2 kVA to 5 kVA.
      e. 6-inches from power lines enclosed in a grounded metal conduit (or equivalent shielding) carrying more than 5 kVA.

U. Determine requirements for plenum rated cable and devices. When doubt exists, seek prior determination in writing by AHJ.

V. Seal conduits entering from outside the building and install listed firestop material in conduits and sleeves to satisfy NEC and local codes.

W. Unshielded Twisted Pair Termination:
   1. Dress and terminate cables in accordance with the recommendations made in the ANSI/TIA/EIA-568-C.1 document, manufacturer's recommendations and best industry practices.
   2. Maintain the cable jacket within 1-inch of the termination point.
   3. Do not exceed 0.5-inch of pair untwist at the termination point.
   4. Do not exceed 4 times the outside diameter of the cable in the termination area for bend radiance compliance.
   5. Neatly bundle and dress cables to their respective panels or blocks. Feed each panel or block by an individual bundle separated and dressed back to the point of cable entrance into the rack or frame.

X. Testing Procedures:
   1. Test cables and termination hardware for defects in installation and to verify cabling system performance under installed conditions according to the requirements of ANSI/TIA/EIA-568-C. Verify pairs of each installed cable prior to system acceptance. Repair or replace any defect in the cabling system installation including but not limited to
cable, connectors, feed through couplers, patch panels and connector blocks in order to ensure 100 percent useable conductors in cables installed.

2. Test cables in accordance with this document, the ANSI/TIA/EIA standards, the manufacturer's procedures and best industry practice. If any of these are in conflict, bring any discrepancies to the attention of the project team for clarification and resolution.

3. Test Unshielded Twisted Pair cables as follows:
   a. Test twisted-pair copper cable links for continuity, pair reversals, shorts, opens and performance as indicated below. Additional testing is required to verify Category performance. Test cabling using a Level IV test unit for Category 6 performance compliance as specified in ANSI/TIA/EIA-568-C.
   b. Continuity: Test each pair of each installed cable using a test unit that shows opens, shorts, polarity and pair-reversals, crossed pairs and split pairs. Test shielded/screened cables with a device that verifies shield continuity in addition to the above stated tests. Record the test as pass/fail as indicated by the test unit in accordance with the manufacturers' recommended procedures and referenced to the appropriate cable identification number and circuit or pair number. Correct or repair any faults in the wiring and re-test the cable prior to final acceptance.
   c. Length: Test each installed cable link for installed length using a TDR type device. Test the cables from patch panel to patch panel, block to block, patch panel to outlet or block to outlet as appropriate. The cable length will conform to the maximum distances set forth in the ANSI/TIA/EIA-568-C standard. Record cable lengths, referencing the cable identification number and circuit or pair number. For multi-pair cables, record the shortest pair length as the length for the cable.

4. Follow the Standards requirements established in ANSI/TIA/EIA-568-C.

5. Perform testing with a Level IV tester. The basic tests required are:
   a. Wire Map
   b. Length
   c. Attenuation

6. Provide test results in electronic format, with the following minimum information per cable:
   a. Circuit ID
   b. Test result, “Pass” or “Fail”
   c. Date and Time of test
   d. Project Name

7. Fiber Test Documentation: Provide electronic CD disk and hard copy test reports from ANSI/TIA/EIA-526-14A Method B Standards. Calculate a “Loss Budget” for each cable length based on cable length and connectors. Provide as a minimum, OTDR test results in the form of a printed waveform and text table for both 850 nm and 1300 nm for multimode fiber and 1350 nm and 1510 nm for singlemode fiber. Test fibers and connector systems for end-to-end attenuation. Provide a power meter test on fiber optic strands at both wavelengths A to B, B to A and OSPL (OSPL is as defined as La + Lb). Include the results of unsatisfactory tests, with an explanation of how the problem was corrected. Clearly label connector and fiber loss on test waveforms.

8. Provide an electronic copy of the test results, in the native tester software format, to the Architect along with the printed test results.

9. Provide a fully functional version of the tester software for use by the Architect in reviewing the test results.

### 3.02 COPPER BACKBONE CABLE

A. Terminate 4-pair cables on protector blocks and extend to rack mounted patch panel. Terminate one pair per port.

B. Install per manufacturer’s instructions and recommendations.

C. Reference 3.01, General Installation Requirements.

D. Install backbone cables separately from horizontal distribution cables.

E. Co-install a pull cord (nylon; 1/8-inch minimum) with cable installed in conduit.
F. Where cables are installed in conduits, install the backbone and horizontal cables in separate conduits.

G. Where cables are installed in an air-return plenum, install riser-rated cable in metallic conduit.

H. Where backbone cables and distribution cables are installed in a cable tray, install backbone cables first, and bundle them separately from the horizontal distribution cables.

I. Attach large bundles of cables using metal clamps and/or metal banding to support the cables.

J. Labeling:
   1. Label cables using a machine printed label at each end of the cable at approximately 6-inches of the termination point. Do not use handwritten labels.
   2. Labels to denote to and from with room names and numbers.
   3. Provide the final cable ID matrix to the Architect for approval one week prior to cable installation.
   4. Note labeling information on the As-Built Drawings.

3.03 FIBER OPTIC BACKBONE CABLE

A. Install per manufacturer's instructions and recommendations.

B. Reference 3.01, General Installation Requirements.

C. Place fiber optic cable so as to maintain the minimum cable bend radius limits specified by the manufacturer or ten times the cable diameter, whichever is larger.

D. Place fiber optic cable runs in innerduct. Use care when handling fiber optic cable. Carefully monitor pulling tension so as not to exceed the limits specified by the manufacturer.

E. Terminate fiber optic cable in rack-mounted fiber optic termination units at each end using standard SC, ST, or LC style bulkhead connectors.

F. Splicing of fiber optic cable is prohibited.

G. Labeling:
   1. Label cables using a machine printed label at each end of the cable at approximately 6-inches of the termination point. Do not use handwritten labels.
   2. Labels to denote to and from with room names and numbers.
   3. Provide the final cable ID matrix to the Architect one week prior to cable installation.
   4. Note labeling information on the As-Built Drawings.

3.04 COPPER TERMINATION HARDWARE

A. Install per manufacturer's instructions and recommendations.

B. Reference 3.01, General Installation Requirements.

C. Dress and terminate cables in accordance with the recommendations made in the ANSI/TIA/EIA-568-B standard, manufacturer's recommendations and best industry practices.

D. Pair untwist at the termination is not to exceed 0.125-inch.

E. Bend radius of the cable in the termination area is not to exceed four times the outside diameter of the cable.

F. Dress cables to their respective panels or blocks. Feed each panel or block by an individual bundle, separated and dressed back to the point of cable entrance into the rack or frame.

G. Maintain the cable jacket to the termination point.

3.05 FIBER OPTIC TERMINATION HARDWARE

A. Install per manufacturer's instructions and recommendations.

B. Reference 3.01, General Installation Requirements.

C. Neatly coil fiber slack within the fiber space tray or enclosure.

D. Individually attach each cable to its respective fiber enclosure by mechanical means. Securely attach the cable strength member to the cable strain-relief bracket in the enclosure.
E. Clearly label each cable at the entrance to the enclosure. Cables labeled within the bundle will not be accepted.

3.06 FIBER PATCH CORDS

A. Install per manufacturer's instructions and recommendations.

B. Reference 3.01, General Installation Requirements.

C. Provide sufficient duplex fiber optic patch cords at each fiber termination point to cross-connect one-half the number and type of fibers terminated there. Assume a minimum of two duplex fiber optic jumpers per termination point for a 6-strand optical fiber. Provide lengths for a neat appearance not to exceed 15-feet. Coordinate connector requirements with Owner's Representative.

D. Field terminated patch cords are not allowed.

END OF SECTION
SECTION 27 1500 - COMMUNICATIONS HORIZONTAL CABLEING

PART 1 - GENERAL

1.01 SUMMARY

A. Work Included:
   1. Station Cabling
   2. Modular Jacks
   3. Work Area Outlets
   4. Patch Panels
   5. Patch Cords

1.02 RELATED SECTIONS

A. Contents of Division 27, Communications and Division 01, General Requirements apply to this Section.
B. Use this Section in conjunction with other Division 27, Communications specifications and related Contract Documents to establish the total general requirements for the project communications systems and equipment.

1.03 REFERENCES AND STANDARDS

A. References and Standards as required by Section 27 00 00, Communications Basic Requirements and Division 01, General Requirements.
B. Meet requirements of NFPA 780, Standard for the Installation of Lightning Protection Systems.

1.04 SUBMITTALS

A. Submittals as required by Section 27 00 00, Communications Basic Requirements and Division 01, General Requirements.
B. In addition, provide:
   1. Procedures for cable labeling and identification, long term documentation methods and numbering scheme in accordance with ANSI/TIA/EIA-606A.
   2. A copy of certified installer certificates and warranty certificates for products proposed.

1.05 QUALITY ASSURANCE

A. Quality assurance as required by Section 27 00 00, Communications Basic Requirements and Division 01, General Requirements.
B. Manufacturers to have a recognized certified installer program in place for system components proposed. Cable will be approved with manufacturer system installed.

1.06 WARRANTY

A. Warranty of materials and workmanship as required by Section 27 00 00, Communications Basic Requirements and Division 01, General Requirements.
B. In addition, provide:
   1. Labor, materials and documentation according to selected manufacturer requirements necessary to ensure that the Owner will be furnished with an Extended Product Warranty and Application Assurance of a minimum of 20 years in length. The Application Assurance Warranty will cover the failure of the wiring system to support current or future applications that are designed for the link/channel specifications of ANSI/TIA/EIA-568-C.1. These applications include, but are not limited to, 10BASE-T, 100BASE-T, 1000BASE-T, 10GBASE-T and 155 Mb/s ATM.
   2. A warranty on the physical installation.
   3. Necessary documentation required by the manufacturer immediately following 100 percent testing of cables.
C. Administer the warranty process with the responsible manufacturer’s representative. Provide warranty directly to the Owner from the manufacturer. Ensure that the manufacturer provides
the Owner with the appropriate warranty certification within 90 calendar days of the final project completion.

1.07 SYSTEM DESCRIPTION

A. Provide a standards-based cable system to serve horizontal communication systems requirements as specified and as shown on Drawings. Closely follow ANSI/TIA/EIA, IEEE and ISO standards.

B. The horizontal distribution subsystem refers to intrabuilding twisted-pair communications cabling connecting telecommunications rooms (TRs) to telecommunications outlets (TOs) located at individual work areas and consists of the following:
   1. Category 6 100 ohm, 4-pair, unshielded twisted pair cables from the TRs to the TOs.
   2. The horizontal system includes cables, jacks, patch panels and patch cords, as well as the necessary support systems, such as cable managers and faceplates.
   3. Cables are routed through conduit, open ceiling areas, non-ventilated spaces above ceiling tile and through plenum air-handling spaces above ceiling tile.
   4. Furnish and install materials necessary for a complete and working system.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Station Cabling:
   1. CommScope Uniprise
   2. Leviton / Berk-Tek
   3. Panduit/General
   4. Or approved equivalent.

B. Modular Jacks:
   1. CommScope Uniprise
   2. Leviton
   3. Panduit
   4. Or approved equivalent.

C. Work Area Outlets:
   1. CommScope Uniprise
   2. Leviton
   3. Panduit
   4. Or approved equivalent.

D. Patch Panels:
   1. CommScope Uniprise
   2. Leviton
   3. Panduit
   4. Or approved equivalent.

E. Patch Cords:
   1. CommScope Uniprise
   2. Leviton
   3. Panduit
   4. Or approved equivalent.

2.02 STATION CABLEING

A. Category 6 Unshielded Twisted Pair:
   1. 100 ohm, Category 6, 23 AWG, 4-pair unshielded twisted pair, CMP rated jacket, color blue.
   2. 100 ohm, Category 6, 23 AWG, 4-pair unshielded twisted pair, CMR rated jacket, color blue.
   3. 100 ohm, Category 6, 23 AWG, 4-pair unshielded twisted pair, Indoor/Outdoor rated, color black.
SECTION 27 1500
COMMUNICATIONS HORIZONTAL CABLELING

2.03 MODULAR JACKS
A. Category 6 Modular Jacks:
1. Eight-position modular jack, Category 6, IDC terminals, T568A/B wiring scheme
2. Each jack must be stamped or have icons to identify it as CAT 6.
3. Coordinate color with building finishes.

2.04 WORK AREA OUTLETS
A. Flush Mounted Faceplate:
1. Four-port faceplate, constructed from high impact thermo-plastic, with recessed label fields, mounts within a single-gang wall box.
2. Coordinate faceplate color with building finishes. Submit to Architect for approval prior to installation.
B. Dust Covers: Single port dust cover for modular openings, color to match faceplate.

2.05 PATCH PANELS
A. Category 6 Modular Patch Panels: 48 port, eight-position modular jack panel, high density, 6 port modules, Category 6, IDC terminals, T568A/B wiring scheme.

2.06 PATCH CORDS
A. Category 6 Modular Patch Cords: Factory terminated double ended, eight-position to eight-position, modular, stranded conductors, Category 6, 4 pair, color, blue. 3-feet and 5-feet.

PART 3 - EXECUTION
3.01 GENERAL INSTALLATION REQUIREMENTS
A. Miscellaneous Hardware: Provide supporting hardware, cable ties, labels, pull rope and other miscellaneous hardware for a complete and operable system.
B. Provide like items from one manufacturer, such as jacks, patch panels, equipment connection cords and wall plates.
C. Horizontal cabling includes cables, jacks, patch panels, connecting blocks and patch cords, as well as the necessary support systems, such as cable managers and faceplates.
D. Furnish and install materials necessary for a complete and working system.
E. Contractor must be a Certified Installer for selected manufacturer prior to, during and through completion of the system installation and must be able to provide the manufacturer's extended warranty.
F. Perform work in a neat and workmanlike manner.
G. Install cable after interior of building has been physically protected from the weather and mechanical work likely to damage cabling has been completed.
H. Before installing cabling, ensure cable pathways are completely and thoroughly cleaned.
1. Inspect conduit, cable trays and innerduct systems prior to installation.
2. Swab any additional enclosed raceway and innerduct systems.
I. Provide protection for exposed cables where subject to damage. Provide abrasion protection for any cable or wire bundles, which pass through holes or across edges of sheet metal.
J. Install cable ties and other cable management clamps via hand so it fits snugly. Do not over tighten or use mechanical tools which could compress, crimp, or otherwise change the physical characteristics of the cable jacket or distort the placement of twisted-pair components. Replace any cable exhibiting stresses due to over tightening of cable management devices.
K. Where possible, route cables in overhead cable trays and inside wire management systems attached to the equipment cabinets and racks. Use Velcro ties or ducts to restrain cabling installed outside of wire management systems on racks or in cabinets.
L. Co-install a pull cord (nylon; 1/8-inch minimum) with cable installed in conduit.
M. Limit cable raceway fill to less than the TIA/EIA-569-B maximum fill for the particular raceway type.

N. If a J-hook or trapeze system is used to support cable bundles, support horizontal cables at a maximum of 48- to 60-inch intervals. Cables are prohibited to rest on acoustic ceiling grids or panels.

O. Bundle horizontal distribution cables in groups of no more than 50 cables. Cable bundle quantities in excess of 50 cables may cause deformation of the bottom cables within the bundle and degrade cable performance.

P. Install cable above fire-sprinkler systems and ensure that the cable does not attach to the system or any ancillary equipment or hardware. Install cable system and support hardware such that it does not obscure any valves, fire alarm conduit, boxes, or other control devices.

Q. Do not attach cables to ceiling grid or lighting fixture wires. Where support for horizontal cable is required, install appropriate carriers to support the cabling.

R. Any cable damaged or exceeding recommended installation parameters during installation will be replaced by the contractor prior to final acceptance at no cost to the Owner.

S. Determine requirements for plenum rated cable and devices. When doubt exists, seek prior determination in writing by AHJ.

T. Unshielded Twisted Pair Cable Installation Practices:
   1. Install cable in accordance with manufacturer's recommendations and best industry practices.
   2. Install cables in continuous lengths from origin to destination (no splices).
   3. Do not exceed the cable's minimum bend radius and maximum pulling tension.
   4. Install unshielded twisted pair cable so that there are no bends smaller than four times the cable outside diameter at any point in the run and at the termination field.
   5. Do not exceed 25-lbf pulling tension on 4-pair UTP cable.

U. Provide the following minimum separation distances between pathways for copper communications cables and power wiring of 480 volts or less:
   1. Open or Nonmetal Communications Pathways:
      a. 12-inches from electric motors, fluorescent light fixtures and unshielded power lines carrying up to 3 kVA.
      b. 36-inches from electrical equipment and unshielded power lines carrying more than 5 kVA.
      c. 48-inches from large electrical motors or transformers.
   2. Grounded Metal Conduit Communications Pathways:
      a. 2 1/2-inches from electrical equipment and unshielded power lines carrying up to 2 kVA.
      b. 6-inches from electrical equipment and unshielded power lines carrying from 2 kVA to 5 kVA.
      c. 12-inches from electrical equipment and unshielded power lines carrying more than 5 kVA.
      d. 3-inches from power lines enclosed in a grounded metal conduit (or equivalent shielding) carrying from 2 kVA to 5 kVA.
      e. 6-inches from power lines enclosed in a grounded metal conduit (or equivalent shielding) carrying more than 5 kVA.

V. Unshielded Twisted Pair Termination:
   1. Coil cables in the in-wall or surface-mount boxes if adequate space is present to house the cable coil without exceeding the manufacturers bend radius. In hollow wall installations where box-eliminators are used, excess wire can be stored in the wall. Do not store more than 12-inches of UTP in an in-wall box, modular furniture raceway, or insulated walls. Loosely coil and store excess slack in accessible ceiling space above each drop location when there is not enough space present in the outlet box to store slack cable.
2. Dress and terminate cables in accordance with the recommendations made in the ANSI/TIA/EIA-568-C.1 document.
3. Terminate four pair cables on the jack and patch panels using T568B wiring scheme.
4. Maintain the cable jacket within 1-inch of the termination point.
5. Do not exceed 0.5-inch of pair untwist at the termination point.
6. Do not exceed four times the outside diameter of the cable in the termination area for bend radiance compliance.
7. Neatly bundle and dress cables to their respective panels or blocks. Feed each panel or block by an individual bundle separated and dressed back to the point of cable entrance into the rack or frame.

W. Testing Procedures:
1. Test cables and termination hardware for defects in installation and to verify cabling system performance under installed conditions according to the requirements of ANSI/TIA/EIA-568-C. Verify pairs of each installed cable prior to system acceptance. Repair or replace any defect in the cabling system installation including but not limited to cable, connectors, feed through couplers, patch panels and connector blocks in order to ensure 100 percent useable conductors in cables installed.
2. Test cables in accordance with this document, the ANSI/TIA/EIA standards, the manufacturer's procedures and best industry practice. If any of these are in conflict, bring any discrepancies to the attention of the project team for clarification and resolution.
3. Test Unshielded Twisted Pair Cables as Follows:
   a. Test twisted-pair copper cable links for continuity, pair reversals, shorts, opens and performance as indicated below. Additional testing is required to verify Category performance. Test horizontal cabling using a Level IV test unit for Category 6 performance compliance as specified in ANSI/TIA/EIA-568-C.
   b. Continuity: Test each pair of each installed cable using a test unit that shows opens, shorts, polarity and pair-reversals, crossed pairs and split pairs. Test shielded/screened cables with a device that verifies shield continuity in addition to the above stated tests. Record the test as pass/fail as indicated by the test unit in accordance with the manufacturers' recommended procedures and referenced to the appropriate cable identification number and circuit or pair number. Correct or repair any faults in the wiring and retest the cable prior to final acceptance.
   c. Length: Test each installed cable link for installed length using a TDR type device. Test the cables from patch panel to patch panel, block to block, patch panel to outlet or block to outlet as appropriate. The cable length will conform to the maximum distances set forth in the ANSI/TIA/EIA-568-C Standard. Record cable lengths, referencing the cable identification number and circuit or pair number. For multipair cables, record the shortest pair length as the length for the cable.
4. Follow the Standards requirements established in ANSI/TIA/EIA-568-C.
5. Perform testing with a Level IV tester. The basic tests required are:
   a. Wire Map
   b. Length
   c. Attenuation
   d. NEXT (Near-end Crosstalk)
   e. Return Loss
   f. ELFEXT Loss
   g. Propagation Delay
   h. Delay Skew
   i. PSNEXT (Power Sum Near-end Crosstalk Loss)
   j. PSELFEXT (Power Sum Equal Level Far-end Crosstalk Loss)
6. Provide test results in electronic format, with the following minimum information per cable:
   a. Circuit ID
   b. Test Result, "Pass" or "Fail"
   c. Date and Time of Test
d. Project Name

7. Provide an electronic copy of the test results, in the native tester software format, to the Architect along with the printed test results.
8. Provide a fully functional version of the tester software for use by the Architect in reviewing the test results.

X. Labeling:
1. Label horizontal cables using a machine printed label at each end of the cable at approximately 6-inches of the termination point. Do not use handwritten labels.
2. Label patch panel ports and TO ports with the cable identifier.
3. Labels to be Telecom Room number, patch panel number and patch panel port number. Provide the final cable ID matrix to the Architect for approval one week prior to cable installation.
4. Note labeling information on the record drawings.

Y. Coordination of Conditions: Structured cabling for wireless access points of a given description may be used in more than one type of ceiling or wall structure. Coordinate ceiling construction, wall types, recessing depth and other construction details prior to ordering special components indicated in the details for shipment. Where materials supplied do not match ceiling construction replace them at no cost to Owner.

3.02 STATION CABLING
A. Reference 3.01, General Installation Requirements.
B. Install per manufacturer's instructions and recommendations.

3.03 MODULAR JACKS
A. Reference 3.01, General Installation Requirements.
B. Install per manufacturer's instructions and recommendations.

3.04 WORK AREA OUTLETS
A. Reference 3.01, General Installation Requirements.
B. Install per manufacturer's instructions and recommendations.

3.05 PATCH PANELS
A. Reference 3.01, General Installation Requirements.
B. Install per manufacturer's instructions and recommendations.

3.06 PATCH CORDS
A. Field terminated patch cords and jumpers are not allowed. At a minimum, provide equipment connection cords for one-half the total number of cables installed at each termination point. For example: A telecommunications outlet with four Category 6 cables installed would require two Category 6 equipment connection cords at the work area outlet and two Category 6 equipment connection cords in the telecommunications equipment room for a total of four Category 6 equipment connection cords.

END OF SECTION
PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Work included in 28 00 01, Electronic Safety Basic Requirements applies to Division 28, Electronic Safety work to provide materials, labor, tools, permits, incidentals, and other services to provide and make ready for Owner's use of electronic safety systems for proposed project.

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

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

1.02 RELATED SECTIONS

A. Contents of Section apply to Division 28, Electronic Safety Contract Documents.

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

C. Contents of Division 26, Electrical apply to this Section.

1.03 REFERENCES AND STANDARDS

A. References and Standards per Division 00, Procurement and Contracting Requirements and Division 01, General Requirements, individual Division 28, Electronic Safety Sections and those listed in this Section.

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

C. Reference standards and guidelines include but are not limited to the latest adopted editions from:  
1. ABA - Architectural Barriers Act  
2. ADA - Americans with Disabilities Act  
3. ANSI - American National Standards Institute  
4. ASCE - American Society of Civil Engineers  
5. ASHRAE - American Society of Heating, Refrigerating and Air-Conditioning Engineers  
6. ASHRAE Guideline 0, the Commissioning Process  
7. ASME - American Society of Mechanical Engineers  
8. ASTM - ASTM International  
9. CFR - Code of Federal Regulations  
10. EPA - Environmental Protection Agency  
11. ETL - Electrical Testing Laboratories  
12. FM - FM Global  
13. ISO - International Organization for Standardization  
14. NEC - National Electric Code  
15. NEMA - National Electrical Manufacturers Association  
16. NFPA - National Fire Protection Association  
17. OSHA - Occupational Safety and Health Administration  
18. SMACNA - Sheet Metal and Air Conditioning Contractors' National Association  
19. UL - Underwriters Laboratories Inc.  

D. See Division 28, Electronic Safety individual Sections for additional references.  
E. Where code requirements are at variance with Contract Documents, meet code requirements as a minimum requirement and include costs necessary to meet these in Contract.  
F. Machinery and equipment are to comply with OSHA requirements, as currently revised and interpreted for equipment manufacturer requirements. Install equipment provided per manufacturer recommendations.  
G. Whenever this Specification calls for material, workmanship, arrangement or construction of higher quality and/or capacity than that required by governing codes, higher quality and/or capacity take precedence.  

1.04 SUBMITTALS  
A. See Division 01, General Requirements for Submittal Procedures.  
B. Provide drawings in format and software release equal to the design documents. Drawings to be the same sheet size and scale as the Contract Documents.  
C. "No Exception Taken" constitutes that review is for general conformance with the design concept expressed in the Contract Documents for the limited purpose of checking for conformance with information given. Any action is subject to the requirements of the Contract Documents. Contractor is responsible for the dimensions and quantity and will confirm and correlate at the job site, fabrication processes and techniques of construction, coordination of the work with that of all other trades, and the satisfactory performance of the work.  
D. Provide product submittals and shop drawings in electronic format only. Electronic format must be submitted via zip file via e-mail or posted to ftp site. For electronic format, provide one zip file per specification division containing a separate file for each Specification Section. Individual submittals sent piecemeal in a per Specification Section method will be returned without review or comment. Copy Architect on all transmissions/submissions.  
E. Product Data: Provide manufacturer's descriptive literature for products specified in Division 28, Electronic Safety Sections.  
F. Identify/mark each submittal in detail. Note what difference, if any, exist between the submitted item and the specified item. Failure to identify the differences will be considered cause for
disapproval. If differences are not identified and/or not discovered during the submittal review process, Contractor remains responsible for providing equipment and materials that meet the specifications and drawings.

1. Label submittal to match numbering/references as shown in Contract Documents. Highlight and label applicable information to individual equipment or cross out/remove extraneous data not applicable to submitted model. Clearly note options and accessories to be provided, including field installed items. Highlight connections by/to other trades.

2. Include technical data, installation instructions and dimensioned drawings for products, equipment and devices installed, furnished or provided. Reference individual Division 28, Electronic Safety specification Sections for specific items required in product data submittal outside of these requirements.

3. See Division 28, Electronic Safety individual Sections for additional submittal requirements outside of these requirements.

G. Maximum of two reviews of complete submittal package. Arrange for additional reviews and/or early review of long-lead items; Bear costs of additional reviews at Engineer's hourly rates. Incomplete submittal packages/submittals will be returned to contractor without review.

H. Resubmission Requirements: Make corrections or changes in submittals as required, and in consideration of Engineer's comments. Identify Engineer’s comments and provide an individual response to each of the Engineer’s comments. Cloud changes in the submittals and further identify changes which are in response to Engineer's comments.

I. Structural/Seismic: Provide weights, dimensions, mounting requirements and like information required for mounting, seismic bracing, and support. Indicate manufacturer's installation and support requirements to meet ASCE 7-10 requirements for non-structural components. Provide engineered seismic drawings and equipment seismic certification. Equipment Importance Factor as specified in Division 01 and in Structural documents.

J. Trade Coordination: Include physical characteristics, electrical characteristics, device layout plans, wiring diagrams, and connections as required per Division 28, Electronic Safety Coordination Documents. For equipment with electrical connections, furnish copy of approved submittal for inclusion in Division 26, Electrical and Division 28, Electronic Safety submittals.

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

L. Substitutions and Variation from Basis of Design:

1. The Basis of Design designated product establishes the qualities and characteristics for the evaluation of any comparable products by other listed acceptable manufacturers if included in this Specification or included in an approved Substitution Request as judged by the Design Professional.

2. If substitutions and/or equivalent equipment/products are being proposed, it is the responsibility of parties concerned, involved in, and furnishing the substitute and/or equivalent equipment to verify and compare the characteristics and requirements of that furnished to that specified and/or shown. If greater capacity and/or more materials and/or more labor are required for the rough-in, circuitry or connections than for the item specified and provided for, then provide compensation for additional charges required for the proper rough-in, circuitry and connections for the equipment being furnished. No additional charges above the Base Bid, including resulting charges for work performed under other Divisions, will be allowed for such revisions. Coordinate with the requirements of “Submittals.” For any product marked “or approved equivalent,” a substitution request must be submitted to Engineer for approval prior to purchase, delivery or installation.

3. Where manufacturer equipment or model numbers are indicated with no exceptions, substitutions will be rejected.

M. Shop Drawings:

1. Provide coordinated shop drawings which include physical characteristics of all systems, device layout plans, and control wiring diagrams. Reference individual Division 28,
Electronic Safety specification Sections for additional requirements for shop drawings outside of these requirements.

2. Provide Shop Drawings indicating access panel locations, size and elevation for approval prior to installation.

N. Samples: Provide samples when requested by individual Sections.

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

P. Operation and Maintenance Manuals, Owners Instructions:
   1. Reference individual Division 28, Electronic Safety Specification Sections for additional requirements for operations and maintenance manuals.
   2. Submit, at one time, electronic files (PDF format) on CD/DVD of manufacturer's operation and maintenance instruction manuals and parts lists for equipment or items requiring servicing. Submit data when work is substantially complete and in same order format as submittals. Include name and location of source parts and service for each piece of equipment.
      a. Include copy of approved submittal data along with submittal review letters received from Engineer. Data to clearly indicate installed equipment model numbers. Delete or cross out data pertaining to other equipment not specific to this project.
      b. Include copy of manufacturer's standard Operations and Maintenance for equipment. At front of each tab, provide routine maintenance documentation for scheduled equipment. Include manufacturer's recommended maintenance schedule and highlight maintenance required to maintain warranty. Furnish list of routine maintenance parts, including part numbers, sizes and quantities relevant to each piece of equipment.
      c. Include copy of complete parts list for equipment. Include available exploded views of assemblies and sub-assemblies.
      d. Include Warranty per Division 00, Procurement and Contracting Requirements, Division 01, General Requirements, Section 28 00 01, Electronic Safety Basic Requirements and individual Sections.
      e. Include product certificates of warranties and guarantees.
      f. Include copy of start-up and test reports specific to each piece of equipment.
      g. Include commissioning reports.
      h. Engineer will return incomplete documentation without review.
      i. Engineer will provide one set of review comments in Submittal Review format. Arrange for additional reviews; Bear costs for additional reviews at Engineer's hourly rates.
   3. Thoroughly instruct Owner in proper operation of equipment and systems. Where noted in individual Sections, training will include classroom instruction with applicable training aids and systems demonstrations. Field instruction per Section 28 00 01, Electronic Safety Basic Requirements Article titled "Demonstration."
   4. Copies of certificates of code authority inspections, acceptance, code required acceptance tests, letter of conformance and other special guarantees, certificates of warranties, specified elsewhere or indicated on Drawings.

Q. Record Drawings:
   1. Maintain at site at least one set of drawings for recording "as-constructed" conditions. Indicate on drawings changes to original documents by referencing revision document,
and include buried elements and location of concealed items. Include items changed by addenda, field orders, supplemental instructions, and constructed conditions.

2. Record Drawings are to include equipment locations, calculations, and schedules that accurately reflect “as constructed or installed” for project.

3. At completion of project, input changes to original project on Revit Model and make one set of black-line drawings created from Revit Model in version/release equal to contract drawings. Submit Revit disk and drawings upon substantial completion.

4. See Division 28, Electronic Safety individual Sections for additional items to include in Record Drawings.

1.05 QUALITY ASSURANCE

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

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

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

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

E. Provide products that are UL listed.

1.06 WARRANTY

A. Provide written warranty covering the work for a period of one year from date of Substantial Completion in accordance with Division 00, Procurement and Contracting Requirements and Division 01, General Requirements, Section 28 00 01, Electronic Safety Basic Requirements and individual Division 28, Electronic Safety Sections.

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

1.07 COORDINATION DOCUMENTS

A. Prior to construction, coordinate installation and location of HVAC equipment, ductwork, grilles, diffusers, piping, plumbing equipment/fixtures, fire sprinklers, plumbing, cable trays, lights, and electrical services with architectural and structural requirements, and other trades (including ceiling suspension and tile systems), and provide maintenance access requirements. Coordinate with submitted architectural systems (i.e. roofing, ceiling, finishes) and structural systems as submitted, including footings and foundation. Identify zone of influence from footings and ensure systems are not routed within the zone of influence.

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

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

D. Submit final Coordination Drawings with changes as Record Drawings at completion of project.
PART 2 - PRODUCTS

2.01 MANUFACTURERS
   A. Provide like items from one manufacturer, including but not limited to panels, devices and equipment unless otherwise specified in individual Division 28, Electronic Safety Sections.

2.02 MATERIALS
   A. Base contract upon furnishing materials as specified. Materials, equipment, and fixtures used for construction are to be new, latest products as listed in manufacturer's printed catalog data and are to be UL, ETL, or FM approved or have adequate approval or be acceptable by state, county, and city authorities.
   B. Articles, fixtures, and equipment of a kind to be standard product of one manufacturer.
   C. Names and manufacturer's names denote character and quality of equipment desired and are not to be construed as limiting competition.
   D. Hazardous Materials:
      2. Comply with Division 00, Procurement and Contracting Requirements and Division 01, General Requirements for this project relating to hazardous materials.
      3. Do not use any materials containing a hazardous substance. If hazardous materials are encountered, do not disturb; immediately notify Owner and Architect. Hazardous materials will be removed by Owner under separate contract.

2.03 ACCESS PANELS
   A. See Division 01, General Requirements and Division 08, Openings for products and installation requirements.
   B. Confirm Access Panel requirements in Division 01, General Requirements, Division 08, Openings and individual Division 28, Electronic Safety Sections. In absence of specific requirements, comply with the following:
      1. Provide flush mounting access panels for systems and individual components, service of electronic safety systems equipment and junction boxes requiring maintenance, inspection or servicing. Where access panels are located in fire-rated assemblies of building, rate access panels accordingly.
         a. Ceiling access panels to be minimum of 24-inch by 24-inch required and approved size.
         b. Wall access panels to be minimum of 12-inch by 12-inch required and approved size.
         c. Provide screwdriver operated catch.
         d. Manufacturers and Model:
            1) Drywall: Karp KDW.
            2) Plaster: Karp DSC-214PL.
            3) Masonry: Karp DSC-214M.
            4) 2 hour rated: Karp KPF-350FR.
            5) Manufacturers: Karp, Milco, Elmdor, Acudor, or approved equivalent.

PART 3 - EXECUTION

3.01 ACCESSIBILITY AND INSTALLATION
   A. Confirm Accessibility and Installation requirements in Division 00, Procurement and Contracting Requirements, Division 01, General Requirements, Section 28 00 01, Electronic Safety Basic Requirements and individual Division 28, Electronic Safety Sections.
   B. Install equipment having components requiring access (i.e., devices, equipment, electrical boxes, panels, etc.) so that they may be serviced, reset, replaced or recalibrated by service people with normal service tools and equipment. Do not install equipment in obvious passageways, doorways, scuttles or crawlspaces which would impede or block intended usage.
C. Install equipment and products complete as directed by manufacturer’s installation instructions. Obtain installation instructions from manufacturer prior to rough-in of equipment and examine instructions thoroughly. When requirements of installation instructions conflict with Contract Documents, request clarification from Architect prior to proceeding with installation. This includes proper installation methods, sequencing and coordination with other trades and disciplines.

D. Earthwork:
   1. Confirm Earthwork requirements in Contract Documents. In absence of specific requirements, comply with individual Division 28, Electronic Safety Sections and the following:
      a. Perform excavation, dewatering, shoring, bedding, and backfill required for installation of work in this Division in accordance with related earthwork divisions. Contact utilities and locate existing utilities prior to excavation. Repair any work damaged during excavation or backfilling.
      b. Excavation: Do not excavate under footings, foundation bases, or retaining walls.
      c. Provide protection of underground systems. Review the project Geotechnical Report for references to corrosive or deleterious soils which will reduce the performance or service life of underground systems materials.

E. Firestopping:
   1. Confirm Firestopping requirements in Division 07, Thermal and Moisture Protection. In absence of specific requirements, comply with individual Division 28, Electronic Safety Sections and the following:
      a. Coordinate location and protection level of fire and/or smoke rated walls, ceilings, and floors. When these assemblies are penetrated, seal around conduit, raceway and equipment with approved firestopping material. Install firestopping material complete as directed by manufacturer’s installation instructions. Meet requirements of ASTM E814, Standard Test Method for Fire Tests of Through-Penetration Fire Stops.

F. Plenums: In plenums, provide plenum rated materials that meet the requirements to be installed in plenums.

3.02 SEISMIC CONTROL
A. Confirm Seismic Control requirements in Division 01, General Requirements, Structural documents, and individual Division 28 Electronic Safety Sections.
B. Earthquake resistant designs for Electronic Safety (Division 28) systems and equipment to conform to regulations of jurisdiction having authority.
C. Restraints which are used to prevent disruption of function of piece of equipment because of application of horizontal force to be such that forces are carried to frame of structure in such a way that frame will not be deflected when apparatus is attached to a mounting base and equipment pad, or to structure in normal way, utilizing attachments provided. Secure equipment and distribution systems to withstand a force in direction equal to value defined by jurisdiction having authority.
D. Provide means to prohibit excessive motion of safety equipment during earthquake.

3.03 REVIEW AND OBSERVATION
A. Confirm Review and Observation requirements in Division 00, Procurement and Contracting Requirements, Division 01, General Requirements, Section 28 00 01, Electronic Safety Basic Requirements and individual Division 28, Electronic Safety Sections.
B. Notify Architect, in writing, at following stages of construction so that they may, at their option, visit site for review and construction observation:
   1. Underground conduit and wire installation prior to backfilling.
   2. Prior to covering walls when electronic safety systems installation is started.
   3. Prior to ceiling cover/installation.
   4. When main systems, or portions of, are being tested and ready for inspection by AHJ.
C. Final Punch: Costs incurred by additional trips required due to incomplete systems will be the responsibility of the Contractor.

3.04 CONTINUITY OF SERVICE
A. Confirm requirements in Division 00, Procurement and Contracting Requirements and Division 01, General Requirements. In absence of specific requirements in Division 01, General Requirements, comply with individual Division 28, Electronic Safety Sections and the following:
1. During remodeling or addition to existing structures, while existing structure is occupied, current services to remain intact until new construction, facilities or equipment is installed.
2. Prior to changing over to new system, verify that every item is thoroughly prepared. Install new wiring to point of connection.
3. Coordinate transfer time to new service with Owner. If required, perform transfer during off peak hours. Once changeover is started, pursue to its completion to keep interference to a minimum.
   a. If overtime is necessary, there will be no allowance made by Owner for extra expense for such overtime or shift work.
4. Organize work to minimize duration of power interruption.

3.05 CUTTING AND PATCHING
A. Confirm Cutting and Patching Requirements in Division 00, Procurement and Contracting Requirements and Division 01, General Requirements. In absence of specific requirements, comply with individual Division 28, Electronic Safety Sections and the following:
1. Proposed floor cutting/core drilling/sleeve locations to be approved by Project Structural Engineer. Submit proposed locations to Architect/Project Structural Engineer. Where slabs are of post tension construction, perform x-ray scan of proposed penetration locations and submit scan results including proposed penetration locations to Project Structural Engineer/Architect for approval. Where slabs are of waffle type construction, show column cap extent and cell locations relative to proposed penetration(s).
2. Cutting, patching and repairing for work specified in this Division including plastering, masonry work, concrete work, carpentry work, and painting included under this Section will be performed by skilled craftsmen of each respective trade in conformance with appropriate Division of Work.
3. Additional openings required in building construction to be made by drilling or cutting. Use of jack hammer is specifically prohibited. Patch openings in and through concrete and masonry with grout.
4. Restore new or existing work that is cut and/or damaged to original condition. Patch and repair specifically where existing items have been removed. This includes repairing and painting walls, ceilings, etc. where existing conduit and devices are removed as part of this project. Where alterations disturb lawns, paving, and walks, repair, refinish and leave in condition matching existing prior to commencement of work.
5. Additional work required by lack of proper coordination will be provided at no additional cost to the Owner.

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

3.07 DELIVERY, STORAGE AND HANDLING
A. Confirm requirements in Division 00, Procurement and Contracting Requirements and Division 01, General Requirements. In absence of specific requirements, comply with the individual Division 28, Electronic Safety Sections and the following:
1. Handle materials delivered to project site with care to avoid damage. Store materials on site inside building or protected from weather, dirt and construction dust.
2. Protect equipment and pipe to avoid damage. Close conduit openings with caps or plugs. Keep motors and bearings in watertight and dustproof covers during entire course of installation.
3. Protect devices, panels and similar items until in service.
4. Products and/or materials that become damaged due to water, dirt and/or dust as a result of improper storage to be replaced before installation.

3.08 DEMONSTRATION
A. Confirm Demonstration requirements in Division 00, Procurement and Contracting Requirements and Division 01, General Requirements, Section 28 00 01, Electronic Safety Basic Requirements and individual Division 28, Electronic Safety Sections.

B. Upon completion of work and adjustment of equipment, test systems, demonstrate to Owner's Representative, Architect and Engineer that equipment furnished and installed or connected under provisions of these Specifications functions in manner required. Provide field instruction to Owner's Staff as specified in Division 01, General Requirements, Section 28 00 01, Electronic Safety Basic Requirements and individual Division 28, Electronic Safety Sections.

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

3.09 CLEANING
A. Confirm cleaning requirements in Division 00, Procurement and Contracting Requirements, Division 01, General Requirements, Section 28 00 01, Electronic Safety Basic Requirements and individual Division 28 Sections.

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

3.10 INSTALLATION
A. Confirm Installation requirements in Division 00, Procurement and Contracting Requirements, Division 01, General Requirements, Section 28 00 01, Electronic Safety Basic Requirements and individual Division 28, Electronic Safety Sections.

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

C. Start up equipment, in accordance with manufacturer's start-up instructions, and in presence of manufacturer's representative. Test controls and demonstrate compliance with requirements. Replace damaged or malfunctioning controls and equipment.

D. Provide miscellaneous supports required for installation of equipment, conduit and wiring.

3.11 PAINTING
A. Confirm Painting requirements in Division 01, General Requirements and Division 09, Finishes. In absence of specific requirements, comply with individual Division 28, Electronic Safety Sections and the following:
   1. Ferrous Metal: After completion of work, thoroughly clean and paint exposed supports constructed of ferrous metal surfaces, i.e. hangers, hanger rods, equipment stands, with one coat of black asphalt varnish for exterior or black enamel for interior, suitable for hot surfaces.
   2. In electrical and mechanical room, on roof or other exposed areas, equipment not painted with enamel to receive two coats of primer and one coat of rustproof enamel, colors as selected by Architect.
   3. See individual equipment Specifications for other painting.
   4. Structural Steel: Repair damage to structural steel finishes or finishes of other materials damaged by cutting, welding or patching to match original.
   5. Conduit: Clean, primer coat and paint interior conduit exposed in finished areas with two coats paint suitable for metallic surfaces. Color selected by Architect.
3.12 ACCEPTANCE
A. Confirm requirements in Division 00, Procurement and Contracting Requirements and Division 01, General Requirements. In absence of specific requirements, comply with individual Division 28, Electronic Safety Sections and the following:
   1. System cannot be considered for acceptance until work is completed and demonstrated to Architect that installation is in strict compliance with Specifications, Drawings and manufacturer's installation instructions, particularly in reference to following:
      a. Cleaning
      b. Operation and Maintenance Manuals
      c. Training of Operating Personnel
      d. Record Drawings
      e. Warranty and Guaranty Certificates
      f. Start-up/test Documents and Commissioning Reports

3.13 FIELD QUALITY CONTROL
A. Confirm requirements in Division 00, Procurement and Contracting Requirements and Division 01, General Requirements. In absence of specific requirements, comply with individual Division 28, Electronic Safety Sections and the following:
   1. Tests:
      a. Conduct tests of equipment and systems to demonstrate compliance with requirements specified. Reference individual Specification Sections for required tests. Document tests and include in Closeout Documents.
      b. During site evaluations by Architect or Engineer, provide appropriate personnel with tools to remove and replace trims, covers, and devices so that proper evaluation of installation can be performed.

3.14 LETTER OF CONFORMANCE
A. Provide Letter of Conformance, copies of manufacturers' warranties and extended warranties with a statement in letter that electronic safety systems were installed in accordance with manufacturer's recommendations, UL listings and FM Global approvals. Include Letter of Conformance, copies of manufacturers' warranties and extended warranties in operating and maintenance manuals.

END OF SECTION
SECTION 28 3100 - FIRE DETECTION AND ALARM

PART 1 - GENERAL

1.01 SUMMARY

A. Work Included:
   1. Fire Alarm Control Units
   2. Notification Appliance Circuit Panels
   3. Fire Alarm Transmitters
   4. Fire Alarm Annunciators
   5. Fire Alarm Emergency Voice/Alarm Communications System Control Units
   7. Fixed Temperature Heat Detectors
   8. Rate-of-Rise and Fixed Temperature Heat Detectors
   9. Photoelectric Type Detectors
   10. Duct-Mounted Smoke Detectors
   11. Relay Modules
   12. Control Modules
   13. Input Modules
   14. Fault Isolation Modules
   15. Speakers
   16. Combination Speaker/Strobes
   17. Strobes
   18. Miscellaneous Accessories

B. Scope:
   1. Provide a new fire alarm system.
   2. Provide a new fire alarm transmitter communication system.
   3. Provide a new emergency voice alarm communication system.

C. In addition, provide design for the following as required in these Contract Documents:
   1. Fire Alarm System
   2. Fire Alarm Transmitter Communication System
   3. Emergency Voice Alarm Communication System

D. System Design:
   1. Design Criteria: These are Contractor designed systems. Contact AHJ prior to bid to verify systems' requirements. Design systems in compliance with code as interpreted by the AHJ.
   2. Design of Fire Alarm System:
      a. Provide design of the fire alarm system as required by code.
      b. Fire Alarm Sequence of Operation: Activation of manual fire alarm box, automatic fire detector, or fire extinguishing system causes system to enter "alarm" mode including the following operations:
         1) Local English language annunciation of device location, address and condition and audible and visual alarm signal at control panel and remote annunciators.
         2) Manual "acknowledge" function at control panel and remote annunciators to silence audible alarm signal, visual signal remains displayed until initiating alarm is cleared.
         3) Transmit "alarm" signal to off-premises equipment, i.e., to local fire department or Owner's selected vendor. Provide necessary connections to transmitter.
         4) Activate fire alarm notification appliances.
         5) Activate Emergency Control Functions as required by code.
            (a) Transmit signal to fire/smoke dampers.
            (b) Transmit signal to initiate shutdown of air handling equipment.
            (c) Transmit signal to release fire doors.
(d) Transmit signals to elevator control equipment to initiate elevator recall and shunt trip.

c. Supervisory Sequence of Operation: Fire sprinkler tamper or supervisory pressure switch activation, or duct-mounted smoke detector activation causes system to enter “supervisory” mode including the following operations:
   1) Local English language annunciation of device location, address and condition and audible and visual supervisory signal at control panel and remote annunciators.
   2) Manual “acknowledge” function at control panel and remote annunciators to silence audible supervisory signal, visual signal remains displayed until initiating supervisory is cleared.
   3) Transmit “supervisory” signal to off-premises equipment.
   4) Transmit signal to fire/smoke dampers (duct detector only).
   5) Transmit signal to initiate shutdown of air handling equipment (duct detector only).

d. Trouble Sequence of Operation: System trouble, including single ground or open of supervised circuit, or power or system failure, causes system to enter “trouble” mode including the following operations:
   1) Local English language annunciation of device location, address and condition and audible and visual trouble signal at control panel and remote annunciators.
   2) Manual “acknowledge” function at control panel and remote annunciators to silence audible trouble signal, visual signal remains displayed until initiating trouble is cleared.
   3) Transmit “trouble” signal to off-premises equipment.

3. Design of Fire Alarm Transmitter Communication System: Provide design of the fire alarm transmitter communication system as required by code.

4. Design of the Emergency Voice Alarm Communication System: Provide design of the emergency voice alarm communication system as required by code.

1.02 RELATED SECTIONS

A. Contents of Division 28, Electronic Safety and Division 01, General Requirements apply to this Section.

B. Division 26, Electrical requirements apply to this section.

1.03 REFERENCES AND STANDARDS

A. References and Standards as required by Division 28, Electronic Safety and Division 01, General Requirements.

B. In addition, meet the following:

1.04 SUBMITTALS

A. Submittals as required by Division 28, Electronic Safety and Division 01, General Requirements.

B. In addition, provide:
   1. Shop drawings to include the following:
      a. Provide system designer NICET certification number or Engineer's signature and seal on shop drawings.
      b. Identification of system designer and evidence of qualification or certification of designer as required by AHJ.
      c. Floor plans indicating walls, doors, partitions, room descriptions, device/component locations.
      d. Ceiling height and ceiling construction details.
      e. A symbol legend with device catalog number, description, back box size and mounting requirements.
f. Detailed riser diagram.
g. Device address adjacent to each device symbol. Notification appliance circuit and number adjacent to each notification appliance symbol.
h. Point to point wiring indicating the quantity and gauge of the conductors and size of conduit/raceway used.
i. Wiring connection diagrams for control equipment, annunciators, power supplies, chargers, initiating devices, notification appliances, components being connected to the system and interfaces to associated equipment.
j. Battery calculations for each battery backed fire alarm control unit.
k. Voltage drop calculations for each notification appliance circuit, indicating individual appliance current draw, conductor run length and size.
l. Complete sequence of operation.

2. Prior to final acceptance, submit a letter confirming that inspections have been completed and system is installed and functioning in accordance with Specifications. Include manufacturer representative's certification of installation and letter of warranty.

3. Operation and Maintenance Manuals. Provide manuals containing the following:
   a. Catalog Cut Sheets
   b. System Components, Initiating Devices and Notification Appliances' Installation Sheets
   c. Manufacturer's Installation, Operation and Maintenance Manual
   d. Program Data File Printout
   e. Program Data File on Electronic Storage Media
   f. Record Drawings
   g. Record Drawings on Electronic Storage Media
   h. One year warranty agreement including parts and labor. Warranty period begins upon date of completion.
   i. Record of Completion
   j. Test Reports
   k. Instruction Chart

1.05 QUALITY ASSURANCE
   A. Quality assurance as required by Division 28, Electronic Safety and Division 01, General Requirements.
   B. In addition, meet City of Sisters, Oregon requirements, ordinances and amendments.

1.06 WARRANTY
   A. Warranty of materials and workmanship as required by Division 28, Electronic Safety and Division 01, General Requirements.

PART 2 - PRODUCTS
2.01 MANUFACTURERS
   A. Fire Alarm Control Units:
      1. Simplex
      2. Or approved equivalent.
   B. Notification Appliance Circuit Panels:
      1. Same manufacturer as fire alarm control equipment.
      2. Or approved equivalent.
   C. Fire Alarm Transmitters:
      1. Same manufacturer as fire alarm control equipment.
      2. Or approved equivalent.
   D. Fire Alarm Annunciators:
      1. Same manufacturer as fire alarm control equipment.
      2. Or approved equivalent.
E. Fire Alarm Emergency Voice/Alarm Communications System Control Units:
   1. Same manufacturer as fire alarm control equipment.
   2. EVACS
   3. Wheelock
   4. Or approved equivalent.

F. Manual Pull Stations:
   1. Same manufacturer as fire alarm control equipment.
   2. No substitutions permitted.

G. Fixed Temperature Heat Detectors:
   1. Same manufacturer as fire alarm control equipment.
   2. No substitutions permitted.

H. Rate-of-Rise and Fixed Temperature Heat Detectors:
   1. Same manufacturer as fire alarm control equipment.
   2. No substitutions permitted.

I. Photoelectric Type Detectors:
   1. Same manufacturer as fire alarm control equipment.
   2. No substitutions permitted.

J. Duct-Mounted Smoke Detectors:
   1. Same manufacturer as fire alarm control equipment.
   2. No substitutions permitted.

K. Relay Modules:
   1. Same manufacturer as fire alarm control equipment.
   2. No substitutions permitted.

L. Control Modules:
   1. Same manufacturer as fire alarm control equipment.
   2. No substitutions permitted.

M. Input Modules:
   1. Same manufacturer as fire alarm control equipment.
   2. No substitutions permitted.

N. Fault Isolation Modules:
   1. Same manufacturer as fire alarm control equipment.
   2. No substitutions permitted.

O. Speakers:
   1. Must be compatible with control equipment and notification appliance circuit panels.
   2. Same manufacturer as fire alarm control equipment.
   3. Or approved equivalent.

P. Combination Speaker/Strobes:
   1. Must be compatible with fire alarm control equipment and notification appliance circuit panels.
   2. Same manufacturer as fire alarm control equipment.
   3. Or approved equivalent.

Q. Strobes:
   1. Must be compatible with fire alarm control equipment and notification appliance circuit panels.
   2. Same manufacturer as fire alarm control equipment.
   3. Or approved equivalent.

R. Miscellaneous Accessories:
   1. Weatherproof/Surface Backboxes:
      a. Same manufacturer as fire alarm detection devices or notification appliances.
b. Or approved equivalent.

2. Circuit Conductors:
   a. Allied Wire and Cable
   b. Belden
   c. CCI
   d. West Penn Wire
   e. Or approved equivalent.

3. Surge Protection:
   a. Ditek
   b. Transtector
   c. Or approved equivalent.

4. Batteries:
   a. Same manufacturer as fire alarm control equipment.
   b. Power-Sonic
   c. Werker
   d. Or approved equivalent.

5. Locks and Keys:
   a. Same manufacturer as fire alarm control equipment.
   b. Or approved equivalent.

6. Document Storage Cabinet:
   a. Same manufacturer as fire alarm control equipment.
   b. Meir Products
   c. Space Age
   d. Or approved equivalent.

7. Instruction Charts: Confirm make and model with architect prior to ordering.

8. Framed Floor Map: Confirm make and model with architect prior to ordering.

S. Substitutions:
   1. For other acceptable manufacturers of specified control units, submit product data showing equivalent features and compliance with Contract Documents.
   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.

T. Equipment to be supplied by a certified manufacturer representative.

2.02 FIRE ALARM CONTROL UNITS

A. Provide flush mounted units where installed in finished areas; in unfinished areas, surface mounted units are acceptable, unless otherwise noted.

B. Multiprocessor Based: Configurable as an addressable, point identified system.

C. Network Module: Provide system network modules to facilitate peer-to-peer communications between fire alarm control units and network annunciators.

D. Central Processing Unit (CPU):
   1. CPU continuously monitors the communications and data processing cycles of microprocessor. CPU failure generates an audible and visual trouble signal on control panel and remote annunciators.
   2. House the CPU in fire alarm cabinet with sufficient space to allow maximum system expansion and to enclose alphanumeric display.
   3. Retain basic life safety software in field programmable non-volatile memory. Provide CPU with capacity of minimum of 50 addressable points.
   4. Equip CPU with software to provide a control-by-event feature, whereby receipt of an alarm point is programmed to operate control points within system. Provide control-by-event actions for life safety functions in programmable non-volatile memory. CPU software programming for control of systems defined in this Section is installed as part of this Section.
E. System Capabilities:
1. System capable of addressing and operating smoke detectors, manual pull stations, open contact devices and addressable auxiliary control relays on the same communication loop.
2. System capable of displaying value of each smoke detector, address and condition of fire alarm monitoring points.

F. Program Software:
1. Field configuration program provides programmable operating instructions for system. Store resident program in non-volatile memory.
2. Programmed control point activation includes selective control of HVAC, fire door release, elevator recall, elevator shunt trip, and other fire safety and auxiliary functions.
3. Devices meet criterion specified under materials.
4. Verification and display of sensitivity of each addressable smoke detector can be read using the operating software. Replace devices with readings outside of allowed value at time of system check out.

G. Control Panel Display Modules:
1. Provide keyboard display module 80-character backlit LCD. Each alarm/trouble condition appears in English language with description and location of alarm/ supervisory/trouble.
2. Alarm/supervisory/trouble may be acknowledged, silenced and system reset from control panel or remote annunciator(s).

H. Power Supply: Provide power supply(s), adequate to serve control panel modules, remote annunciators, addressable devices, notification appliances and other connected devices.

I. Power Requirements:
1. Loss of 120VAC power automatically causes system to transfer to battery power. Indicate battery power operation by yellow lamp and audible annunciation at control panel and remote annunciator panels. Upon return of 120VAC power, unit recharges batteries to full capacity and maintains battery on float charge. Provide trickle charge adequate capacity to maintain battery fully charged with automatic rate charge.
2. Provide batteries in locking cabinet manufactured for purpose.

J. Auxiliary Relays: Provide sufficient SPDT auxiliary relay contacts for each function in this portion of the Specifications and for equipment interconnections required under electrical and mechanical specifications.

K. Auxiliary Switches: Provide auxiliary equipment control switches with labeled status indicating lights for each switch.

L. System Reset:
1. Key-accessible control function returns system to normal, non-alarm state, if initiating circuits have cleared.
2. Provide reset on both main fire alarm control panel and remote annunciators.

M. Lamp Test: Manual "lamp test" function causes the annunciation lamps to illuminate at fire alarm control and remote annunciator panels. Provide "lamp test" function at each annunciator panel.

N. Addressing: Provide each initiating device with its own discrete address.

2.03 NOTIFICATION APPLIANCE CIRCUIT PANELS
A. Provide power supply(s), adequate to serve modules, remote annunciators, addressable devices, notification appliances and other connected devices or appliances.

B. Loss of normal and emergency power automatically causes system to transfer to battery power. Indicate battery power operation by yellow lamp and audible annunciation at control panel and remote annunciator panels. Upon return of 120VAC power, unit recharges batteries to full capacity and maintains battery on float charge. Provide trickle charge adequate capacity to maintain battery fully charged with automatic rate charge.

C. Provide batteries in locking cabinet manufactured for purpose.
2.04 FIRE ALARM TRANSMITTERS
A. Provide flush mounted units where installed in finished areas; in unfinished areas, surface mounted units are acceptable, unless otherwise noted.
B. Electrically supervised, capable of transmitting alarm, supervisory and trouble signals over RF, GSM, Cellular, or Ethernet lines to off-premises receiver. Signal transmitter interfaces fully with receiver station of local fire department or Owner's selected vendor.
C. Verify requirements and provide call sequence and message as directed by Owner and the AHJ.

2.05 FIRE ALARM ANNUNCIATORS
A. Provide flush mounted units where installed in finished areas; in unfinished areas, surface mounted units are acceptable, unless otherwise noted.
B. Alphanumeric Remote Annunciator with Controls: Back lit LCD alphanumeric annunciator 80 characters long, paging microphone and paging zone selector switches. Provide under locking cover: test switch, alarm and trouble buzzer, buzzer silence switch and buzzer silence message and reset switch, flush mount with finished cover, vandal-resistant UV stabilized Lexan (or approved equivalent) overlay and required modules, control panel, etc., to drive annunciator. Self-contained, suitable for wet location where located exterior. Verify location with AHJ before installation.

2.06 FIRE ALARM EMERGENCY VOICE/ALARM COMMUNICATIONS SYSTEM CONTROL UNITS
A. Provide flush mounted units where installed in finished areas; in unfinished areas, surface mounted units are acceptable, unless otherwise noted.
B. Multi-channeled system. Each channel operates independently. Faults on one channel will not impede operation of other.
C. UL 864 listed.
D. LED indicators for power trouble, ground trouble and signal trouble in each NAC. Also, LED indicators for manual evacuation status, clear status and "ready to talk" status for manual microphone paging.
E. Selectable audio tones (at least four different tone patterns) and voice message generation via digital recorded messages (either Owner supplied, from professionally recorded tapes or manufacturer provided library).
F. Operator controls at panel include manual evacuation (alarm signal from momentary switch activation), manual clear from momentary switch activation, local microphone manual paging, remote microphone manual paging option.
G. Integrated within fire alarm control panel.
H. Include audio amplifiers.
I. Built-in spoken diagnostic system testing program, permitting testing of individual speakers by one unassisted person.

2.07 MANUAL PULL STATIONS
A. Provide flush mounted units where installed in finished areas; in unfinished areas, surface mounted units are acceptable, unless otherwise noted.
B. Semi-flush, red finish, nongrasping operation; maximum pull strength as allowed per ADA criteria.
C. Stations do not allow closure without keyed reset.

2.08 FIXED TEMPERATURE HEAT DETECTORS
A. Provide flush mounted units where installed in finished areas; in unfinished areas, surface mounted units are acceptable, unless otherwise noted.
B. Rated 135 degrees F or 190 degrees F as required by space use.
C. Provide off-white, low-profile detectors.

2.09 RATE-OF-RISE AND FIXED TEMPERATURE HEAT DETECTORS
A. Provide flush mounted units where installed in finished areas; in unfinished areas, surface mounted units are acceptable, unless otherwise noted.
B. Responding to 15 degrees F temperature rise per minute and to 135 degrees F fixed temperature as required by space use.
C. Provide off-white, low-profile detectors.

2.10 PHOTOELECTRIC TYPE DETECTORS
A. Provide flush mounted units where installed in finished areas; in unfinished areas, surface mounted units are acceptable, unless otherwise noted.
B. Panel adjustable sensitivity, LED source, multiple cell, 360 degree smoke entry, visual latching operation indicator, insect screen, functional test switch, two-wire operation and vandal-resistant locking feature.

2.11 DUCT-MOUNTED SMOKE DETECTORS
A. Photoelectric type. Duct sampling tubes extending width of duct, visual indication of detector actuation, direct housing mount. Detector powered from control panel, power on indicator light. Detector rated for air velocity, humidity and temperature of duct and environment where installed.

2.12 RELAY MODULES
A. Signaling line circuit interface module that connects to other building systems for control of fire/life safety functions, e.g., air-handler shutdown, fire/smoke damper closure, elevator recall.
B. Module powered from control panel.

2.13 CONTROL MODULES
A. Signaling line circuit interface module that provides notification appliance circuits or system control outputs.
B. Module powered from control panel.

2.14 INPUT MODULES
A. Signaling line circuit interface module that provides initiating device circuits for connection to contact closure initiating devices.
B. Module powered from control panel.

2.15 FAULT ISOLATION MODULES
A. Signaling line circuit interface modules that provide isolation of wire-to-wire shorts on a signaling line circuit with automatic reconnection upon correction of short circuit.
B. Provide module with status indicator LED.

2.16 SPEAKERS
A. Flush wall and ceiling mount, white finish. Insect-proof, 4-inch multitap to 1/4, 1/2, 1 and 2 watts with back box and trim grill.
B. Provide speaker capable of transmitting tone or voice.

2.17 COMBINATION SPEAKER/STROBES
A. Multi-candela, flush wall and ceiling mount, white finish. Insect-proof, 4-inch multitap to 1/4, 1/2, 1 and 2 watts with backbox and trim grill. Provide speaker capable of transmitting tone or voice.
B. Provide with integral ANSI 117.1 and UL 1971 approved strobe light. Provide strobos that meet the latest requirements of NFPA 72, ANSI 117.1 and UL 1971. Candela rating as required by NFPA 72.
2.18 STROBES
A. Multi-candela, flush wall and ceiling mount, white finish, insect-proof.
B. Provide strobes that meet the latest requirements of NFPA 72, ANSI 117.1 and UL 1971. Candela rating as required by NFPA 72.

2.19 MISCELLANEOUS ACCESSORIES
A. Circuit Conductors: Copper or optical fiber; color code and label. Type FPL, FPLR and FPLP as required by NEC. Minimum signaling line circuit and initiating device circuit wire size: AWG18. Minimum notification appliance circuit wire size: AWG14, or as approved by Engineer. Fiber optic cable as required by manufacturer.
B. Surge Protection: In accordance with IEEE C62.41 B3 combination waveform and NFPA 70; except for optical fiber conductors.
C. Batteries: Sealed lead acid type. Provide additional cabinet, if required due to space limitations in control panels.
D. Locks and Keys:
   1. Deliver keys to Owner.
   2. Provide same standard lock and key for each key operated switch and lockable panel and cabinet; provide five keys of each type.
E. Document Storage Cabinet:
   1. Suitable for as-built drawings, operation and maintenance manual, system data file disk and tools.
   2. Constructed from steel with baked enamel finish; size adequate for full size drawings, operation and maintenance manual, spare parts and tools.
F. Instruction Charts:
   1. Printed instruction chart for operators, showing steps to be taken when signal is received (normal, alarm, supervisory and trouble); easily readable from normal operator’s station.
   2. Frame: Stainless steel or aluminum with polycarbonate or glass cover.
G. Framed Floor Map:
   1. Provide framed floor plan of facility.
   2. Frame: Stainless steel or aluminum with polycarbonate or glass cover.

PART 3 - EXECUTION
3.01 GENERAL INSTALLATION REQUIREMENTS
A. Obtain Architect’s approval of locations of devices, appliances and annunciators before installation.
B. Circuits:
   1. Signaling Line Circuits (SLC): Class B
   2. Notification Appliance Circuits (NAC): Class B.
C. Spare Capacity:
D. Power Sources:
   1. Primary: Dedicated branch circuits of facility power distribution system.
   2. Secondary: Storage batteries.
   3. Capacity: Sufficient to operate fire alarm system under normal supervisory condition for 24 hours and operate alarm signals for 15 minutes at end of standby period.
E. Obtain approval of system design from AHJ prior to installation. Do not begin installation without approval from AHJ and submittal review comments from Engineer.
F. Install in accordance with applicable codes, NFPA 72, NFPA 70 and the Contract Documents.

G. In accordance with manufacturer's instructions, provide wiring, conduit and outlet boxes required for the erection of a complete system as described in these specifications, as shown on Drawings and as required by AHJ.

H. Conceal wiring, conduit, boxes and supports where installed in finished areas.

I. Provide raceway system for cabling concealed in walls and hard ceilings and in locations where cabling is exposed. Where exposed, provide surface raceway in finished areas and surface mounted EMT in non-finished areas.

J. Provide cabling and conduits system suitable for wet locations for below grade systems.

K. At junction boxes and termination points, provide identification tags on wires and cables.

L. Route wiring to avoid blocking access to equipment requiring service, access, or adjustment.

M. Fire Safety Systems Interfaces:
   1. Provide conduit, wiring, boxes and terminations from fire alarm system to monitored components.
      a. Alarm Inputs: Provide connection in accordance with NFPA 72 for the following systems and components:
         1) Other alarm inputs.
      b. Supervisory Inputs: Provide connection in accordance with NFPA 72 for the following systems and components:
         1) Other supervisory inputs.
      c. Trouble Inputs: Provide connection in accordance with NFPA 72 for the following systems and components:
         1) Other trouble inputs.
   2. Fire Safety Functions: Provide power and control conduit, wiring, boxes and terminations to power devices and interface to fire alarm system.
      a. Doors:
         1) Provide smoke detectors and addressable control relays to release magnetic hold open devices and roll-down fire doors and door locks. Verify requirements and quantities prior to bidding.
         2) Smoke Barrier Door Magnetic Holders: Release upon activation of smoke detectors in smoke zone on either side of door.
         3) Electronic Locks or Electromagnetic Door Locks on Egress Doors: Unlock smoke zone egress doors upon activation of any alarm initiating device or suppression system in smoke zone.
         4) Overhead Coiling Fire Doors: Release upon activation of smoke detectors on either side of door.
      b. HVAC Systems:
         1) Fire/Smoke Dampers and Smoke Dampers:
            (a) Provide required smoke detectors, relays, wiring and the like.
            (b) Connect control and power wiring to dampers per manufacturer's instructions.
            (c) Verify quantities, location and requirements of dampers with Division 23, HVAC Drawings and Specifications and mechanical system installer.
         2) Air Moving Systems:
            (a) Provide duct-mounted smoke detectors on air systems with air flow rates exceeding 2000 CFM. Coordinate with Division 23, HVAC.
            (b) Install duct-mounted smoke detector(s) on return side of air system.
            (c) Provide control wiring from addressable relay contacts to air handling equipment controller. Connect to controller so that when duct-mounted smoke detector is activated, the air handling equipment is shut down.
(d) Provide duct-mounted smoke detectors rated for air velocity, temperature and humidity of duct. Verify quantities, locations and requirements with Division 23, HVAC Drawings and mechanical system installer.

(e) Where duct-mounted smoke detectors are mounted in inaccessible building void spaces provide access hatch. Provide access hatch with fire rating equivalent to rating of wall, ceiling, or shaft being penetrated.

N. Inspection and Testing for Completion:
1. System testing and commissioning to be performed by a certified manufacturer representative.
2. Perform inspection and testing in accordance with NFPA 72 and requirements of local authorities; document each inspection and test.
3. Document audibility measurements and verify intelligibility for each space on record drawings.
4. Provide the services of the installer’s supervisor or person with equivalent qualifications to supervise inspection and testing, correction and adjustments.
5. Provide tools, software and supplies required to accomplish inspection and testing.
6. Prepare for testing by ensuring that work is complete and correct; perform preliminary tests as required to test system.
7. Correct defective work, adjust for proper operation and retest until entire system complies with Contract Documents.
8. Notify Owner seven days prior to beginning completion inspections and tests.
9. Notify authorities having jurisdiction and comply with their requirements for scheduling inspections and tests and for observation by their personnel.
10. 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.
   a. Record all system operations and malfunctions.
   b. If a malfunction occurs, start diagnostic period over after correction of malfunction.
   c. Owner will provide attendant operator personnel during diagnostic period; schedule training to allow Owner personnel to perform normal duties.
   d. At end of successful diagnostic period, complete and submit NFPA 72 "Inspection and Testing Form."

O. Owner Personnel Instruction:
1. Provide the following instruction to designated Owner personnel:
   a. Hands-On Instruction: On-site, using operational system.
   b. Classroom Instruction: Owner furnished classroom, on-site or at other local facility.
2. Basic Operation: One-hour sessions for attendant personnel, security officers and engineering staff; combination of classroom and hands-on:
   a. Initial Training: One session pre-closeout.
   b. Refresher Training: One session post-occupancy.
3. Detailed Operation: Two-hour sessions for engineering and maintenance staff; combination of classroom and hands-on:
   a. Initial Training: One session pre-closeout.
   b. Refresher Training: One session post-occupancy.
4. Furnish the services of instructors and teaching aids; have copies of operation and maintenance data and record drawings available during instruction.
5. Provide means of evaluation of trainees suitable to type of training given; report results to Owner.

P. Closeout:
1. Closeout Demonstration:
   a. Demonstrate proper operation of functions to Owner.
   b. Be prepared to conduct any of the required tests.
c. Have at least one copy of operation and maintenance data, copy of project record drawings, input/output matrix and operator instruction chart(s) available during demonstration.
d. Have authorized technical representative of control unit manufacturer present during demonstration.
e. Demonstration may be combined with inspection and testing required by AHJ. Notify AHJ in time to schedule demonstration.
f. Repeat demonstration until successful.

2. 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 Architect.
   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.

3. Perform post-occupancy instruction within three months after date of occupancy.

### 3.02 FIRE ALARM CONTROL UNITS

A. Reference 3.01, General Installation Requirements.
B. Install per manufacturer's instructions and recommendations.
C. Provide control units with 120VAC dedicated circuit per NFPA requirements.
D. Do not install cabinets or equipment below the battery cabinet. Do not locate battery and charging system cabinets in ceiling space.
E. Provide instruction charts at each control unit where system operations are performed. Obtain approval from the Architect prior to mounting.
F. Perform system programming at the fire alarm control panel. Program the system without shutting the system down. Programming is done off line. Update and maintain hard copy and CD-ROM copy of program at the site.
G. Room Name Labeling: Control unit schedules, programming and labeling for electrical equipment, to use the room names and room numbers that the Architect adopts at the date of substantial completion of construction. This work is to be done at no added cost to the Owner.
H. Programmable Function Keys: Provide control panel accessible function keys for the notification bypass, fire drill, fire door bypass, elevator control bypass, and supervising station bypass.

### 3.03 NOTIFICATION APPLIANCE CIRCUIT PANELS

A. Reference 3.01, General Installation Requirements.
B. Install per manufacturer's instructions and recommendations.
C. Provide notification appliance circuit panel power supplies with 120VAC dedicated circuit per NFPA requirements.
D. Do not install cabinets or equipment below the battery cabinet. Do not locate battery and charging system cabinets in ceiling space.

### 3.04 FIRE ALARM TRANSMITTERS

A. Reference 3.01, General Installation Requirements.
B. Install per manufacturer's instructions and recommendations.
C. Provide conduit and wiring for connections to the transmitter as required for fire alarm system off site supervision.
3.05 FIRE ALARM ANNUNCIATORS
   A. Reference 3.01, General Installation Requirements.
   B. Install per manufacturer's instructions and recommendations.

3.06 FIRE ALARM EMERGENCY VOICE/ALARM COMMUNICATIONS SYSTEM CONTROL UNITS
   A. Install instruction cards in or adjacent to control units.
   B. Reference 3.01, General Installation Requirements.
   C. Install per manufacturer's instructions and recommendations.

3.07 MANUAL PULL STATIONS
   A. Reference 3.01, General Installation Requirements.
   B. Install per manufacturer's instructions and recommendations.
   C. Provide machine printed address labels on addressable devices. Labels to be visible from the floor without magnification.
   D. Provide protective guard where device is subject to abuse and where required by AHJ.

3.08 FIXED TEMPERATURE HEAT DETECTORS
   A. Reference 3.01, General Installation Requirements.
   B. Install per manufacturer's instructions and recommendations.
   C. Provide machine printed address labels on addressable devices. Labels to be visible from the floor without magnification.
   D. Provide protective guard where device is subject to abuse and where required by AHJ.

3.09 RATE-OF-RISE AND FIXED TEMPERATURE HEAT DETECTORS
   A. Reference 3.01, General Installation Requirements.
   B. Install per manufacturer's instructions and recommendations.
   C. Provide machine printed address labels on addressable devices. Labels to be visible from the floor without magnification.
   D. Provide protective guard where device is subject to abuse and where required by AHJ.

3.10 PHOTOELECTRIC TYPE DETECTORS
   A. Reference 3.01, General Installation Requirements.
   B. Install per manufacturer's instructions and recommendations.
   C. Provide machine printed address labels on addressable devices. Labels to be visible from the floor without magnification.
   D. Provide protective guard where device is subject to abuse and where required by AHJ.

3.11 DUCT-MOUNTED SMOKE DETECTORS
   A. Reference 3.01, General Installation Requirements.
   B. Install per manufacturer's instructions and recommendations.
   C. Provide machine printed address labels on addressable devices. Labels to be visible from the floor without magnification.

3.12 RELAY MODULES
   A. Reference 3.01, General Installation Requirements.
   B. Install per manufacturer's instructions and recommendations.
   C. Provide machine printed address labels on addressable devices. Labels to be visible from the floor without magnification.
3.13 CONTROL MODULES
   A. Reference 3.01, General Installation Requirements.
   B. Install per manufacturer's instructions and recommendations.
   C. Provide machine printed address labels on addressable devices. Labels to be visible from the floor without magnification.

3.14 INPUT MODULES
   A. Reference 3.01, General Installation Requirements.
   B. Install per manufacturer's instructions and recommendations.
   C. Provide machine printed address labels on addressable devices. Labels to be visible from the floor without magnification.

3.15 FAULT ISOLATION MODULES
   A. Reference 3.01, General Installation Requirements.
   B. Install per manufacturer's instructions and recommendations.
   C. Provide machine printed address labels on addressable devices. Labels to be visible from the floor without magnification.
   D. Provide Fault Isolator Modules for signaling line circuit per code requirements and manufacturer instructions.

3.16 SPEAKERS
   A. Reference 3.01, General Installation Requirements.
   B. Install per manufacturer's instructions and recommendations.
   C. Provide machine printed labels on notification appliances with appliance circuit number and sequence. Labels to be visible from the floor without magnification.
   D. Provide protective guard where device is subject to abuse and where required by AHJ.

3.17 COMBINATION SPEAKER/STROBES
   A. Reference 3.01, General Installation Requirements.
   B. Install per manufacturer's instructions and recommendations.
   C. Provide machine printed labels on notification appliances with appliance circuit number and sequence. Labels to be visible from the floor without magnification.
   D. Provide protective guard where device is subject to abuse and where required by AHJ.

3.18 STROBES
   A. Reference 3.01, General Installation Requirements.
   B. Install per manufacturer's instructions and recommendations.
   C. Provide machine printed labels on notification appliances with appliance circuit number and sequence. Labels to be visible from the floor without magnification.
   D. Provide wire guards or protective covers where device is subject to abuse and where required by AHJ.

3.19 MISCELLANEOUS ACCESSORIES
   A. Reference 3.01, General Installation Requirements.
   B. Install per manufacturer's instructions and recommendations.
   C. Weatherproof/Surface Backboxes: Provide manufacturer's weatherproof backbox listed for use in areas where the device or appliance is subject to humidity in excess of listed rating. Provide manufacturer surface backboxes where devices cannot be installed recessed.
   D. Circuit Conductors: Provide wiring to meet the requirements of national, state and local electrical codes. Provide color coded wiring as recommended and specified by the fire alarm
and detection system manufacturer. Provide Type FPLR cable when in a riser application or FPLP cable when installed in plenums.

E. Surge Protection; 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.

F. Document Storage Cabinet: Provide document storage cabinet adjacent to fire alarm control panel.

G. Instruction Charts: Install chart adjacent to fire control unit.

H. Framed Floor Map: Provide framed floor plan of facility adjacent to the annunciator panel identifying room names/numbers, device/addresses or fire zone number and description as utilized on the annunciator panel, as required by local AHJ. Check with the local fire department for size and approved mounting location.

END OF SECTION
PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Subsoil materials.
   2. Topsoil materials.

B. Related Sections:
   1. Section 31 0516 - Aggregates for Earthwork.
   2. Section 31 2213 - Rough Grading.
   3. Section 31 2317 - Trenching.
   4. Section 31 2323 - Fill.

1.2 REFERENCES

A. ASTM International:
   2. ASTM D2487 - Standard Classification of Soils for Engineering Purposes (Unified Soil Classification System).

1.3 SUBMITTALS

A. Section 01 3000 – Administrative Requirements: Requirements for submittals.

B. Material Source: Submit name of imported materials source.

C. Manufacturer’s Certificate: Certify Products meet or exceed specified requirements.

1.4 QUALITY ASSURANCE

A. Furnish each material from single source throughout the Work.

B. Perform Work in accordance with Section 00330 of the 2015 Oregon Standard Specifications for Construction.

C. Maintain one copy of Standard Specifications document on site.

PART 2 PRODUCTS

2.1 SUBSOIL MATERIALS

A. Selected General Backfill: Conforming to Section 00330 of the 2015 Oregon Standard Specifications for Construction.

2.2 TOPSOIL MATERIALS


B. Imported or Select Material meeting the following gradation.
### 2.3 SOURCE QUALITY CONTROL

A. Section 01 4000 – Quality Requirements: Quality Assurance.

B. Testing and Analysis of Subsoil Material: Perform in accordance with ASTM D1557.

C. Testing and Analysis of Topsoil Material: Perform in accordance with ASTM D1557.

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 EXCAVATION

A. Excavate subsoil and topsoil from areas designated within the Work. Strip topsoil to 6" depth of topsoil in designated areas.

B. Stockpile excavated material meeting requirements for subsoil materials and topsoil materials.

C. Remove excess excavated materials not intended for reuse, from site.

D. Remove excavated materials not meeting requirements for subsoil materials and topsoil materials from site.

#### 3.2 STOCKPILING

A. Stockpile materials on site at locations designated by Architect/Engineer.

B. Stockpile in sufficient quantities to meet Project schedule and requirements.

C. Separate differing materials with dividers, or stockpile apart to prevent mixing.

D. Prevent intermixing of soil types or contamination.

E. Direct surface water away from stockpile site to prevent erosion or deterioration of materials.

<table>
<thead>
<tr>
<th>Particle Size Range</th>
<th>Percent Retained (by Weight)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Larger than 2&quot;</td>
<td>0</td>
</tr>
<tr>
<td>2&quot;-3/4&quot;</td>
<td>0-5</td>
</tr>
<tr>
<td>3/4&quot;-No. 4</td>
<td>0-20</td>
</tr>
<tr>
<td>No. 4 or Less</td>
<td>0-100</td>
</tr>
</tbody>
</table>
3.3 STOCKPILE CLEANUP

A. Remove stockpile, leave area in clean and neat condition. Grade site surface to prevent free standing surface water.

END OF SECTION
PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   2. Fine aggregate materials.

B. Related Sections:
   2. Section 31 2213 - Rough Grading.
   3. Section 31 2317 - Trenching.
   4. Section 31 2323 - Fill.
   5. Section 32 1123 - Aggregate Base Courses.
   6. Section 33 1116 - Site Water Utility Distribution Piping.
   7. Section 33 3100 - Sanitary Utility Sewerage Piping.

1.2 REFERENCES

A. ASTM International:
   2. ASTM D1557 - Standard Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort (6,000 ft.lbf/ft³ (2,700 kN-m/m³)).
   3. ASTM D2487 - Standard Classification of Soils for Engineering Purposes (Unified Soil Classification System).

1.3 SUBMITTALS

A. Section 01 3000 - Administrative Requirements: Requirements for submittals.

B. Material Source: Submit name of imported materials suppliers.

C. 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 Sections 00330, 02360, and 02690 of the 2015 Oregon Standard Specifications for Construction.

PART 2 PRODUCTS

2.1 COARSE AGGREGATE MATERIALS


B. (Drain Rock): Natural stone; free of clay, shale, organic matter; graded in accordance with ASTM C136; to the following limits:

2.2 FINE AGGREGATE MATERIALS


B. (No. 10-0 Sand): Natural river or bank sand; free of silt, clay, loam, friable or soluble materials, and organic matter; graded in accordance with ASTM D2487 Group Symbol SP; within the following limits:

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2.3 SOURCE QUALITY CONTROL

A. Section 01 4000 - Quality Requirements: Quality Assurance.


D. When tests indicate materials do not meet specified requirements, change material and retest.

PART 3 EXECUTION

3.1 EXCAVATION

A. Excavate materials from onsite locations designated by Architect/Engineer as specified in Section 31 2213. Onsite crushing may require a separate permit.

B. Stockpile excavated material meeting requirements for coarse aggregate materials.

C. Remove excess excavated materials no intended for reuse, from site.

D. Remove excavated materials not meeting requirements for coarse aggregate materials and fine aggregate materials from site.
3.2 STOCKPILING

A. Stockpile materials on site at locations designated by Architect/Engineer.
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.

3.3 STOCKPILE CLEANUP

A. Remove stockpile, leave area in clean and neat condition. Grade site surface to prevent free standing surface water.

END OF SECTION
SECTION 31 1000
SITE CLEARING

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Removing surface debris.
   2. Removing designated paving and curbs.
   3. Removing designated trees, shrubs, and other plant life.
   4. Removing abandoned utilities.
   5. Excavating topsoil.

B. Related Sections:
   1. Section 02 4119 – Selective Demolition.
   2. Section 31 2213 - Rough Grading.

1.2 SUBMITTALS

A. Section 01 3000 - Administrative Requirements: Requirements for submittals.

B. Product Date: submit data for herbicide. Indicate compliance with applicable codes for environmental protection.

1.3 QUALITY ASSURANCE

A. Perform Work in accordance with Sections 00310 and 00320 of the 2015 Oregon Standard Specifications for Construction.

B. Maintain one copy of the Standards Specifications on site.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

3.1 EXAMINATION

A. Section 01 3000 - Administrative requirements: Verification of existing conditions before starting work.

B. Verify existing plant life designated to remain is tagged or identified.

3.2 PREPARATION

A. Call Local Utility Line Information service at 1-800-322-2344 not less than three working days before performing Work.
   1. Request underground utilities to be located and marked within and surrounding construction areas.
SECTION 31 1000
SITE CLEARING

3.3 PROTECTION
   A. Locate, identify, and protect utilities indicated to remain, from damage.
   B. Protect trees, plant growth, and features designated to remain, as final landscaping as specified in Section 01 5000 - Temporary Facilities and Controls.
   C. Protect bench marks, survey control points, and existing structures from damage or displacement.

3.4 CLEARING
   A. Clear areas required for access to site and execution of Work per Section 00320 of the 2015 Oregon Standard Specifications for Construction.

3.5 REMOVAL
   A. Remove debris, rock, and extracted plant life from site.
   B. Remove paving, curbs, etc. as shown on the drawings.
   C. Remove abandoned utilities. Indicate removal termination point for underground utilities on Record Documents.
   D. Continuously clean-up and remove waste materials from site. Do not allow materials to accumulate on site.
   E. Do not burn or bury materials on site. Leave Site in clean condition.

3.6 TOPSOIL EXCAVATION
   A. Excavate topsoil from areas to be further excavated, re-landscaped, or re-graded, marked areas, entire site, without mixing with foreign materials for use in finish grading.
   B. Do not excavate wet topsoil.
   C. Stockpile in area designated on site to depth not exceeding 8 feet and protect from erosion. Stockpile material on impervious material and cover over with same material, until disposal.
   D. Remove excess topsoil not intended for reuse, from site.

3.7 SCHEDULES
   Not Used

END OF SECTION
ROUGH GRADING

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Excavating topsoil.
   2. Excavating subsoil.
   3. Cutting, grading, filling, rough contouring, compacting, site for site structures, building pads, and roadways.

B. Related Sections:
   3. Section 31 1000 - Site Clearing: Excavating topsoil.
   4. Section 31 2316 - Excavation: Building excavation.
   5. Section 31 2317 - Trenching: Trenching and backfilling for utilities.

1.2 REFERENCES

A. American Association of State Highway and Transportation Officials:

B. ASTM International:
   2. ASTM D698 - Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft³ (600 kN-m/m³)).
   4. ASTM D1557 - Standard Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort (6,000 ft-lbf/ft³ (2,700 kN-m/m³)).
   5. ASTM D2167 - Standard Test Method for Density and Unit Weight of Soil in Place by the Rubber Balloon Method.

1.3 SUBMITTALS

A. Section 01 3000 - Administrative Requirements: Requirements for submittals.

1.4 CLOSEOUT SUBMITTALS

A. Section 01 7700 - Execution and Closeout Requirements: Requirements for submittals.

B. Project Record Documents: Accurately record actual locations of utilities remaining by horizontal dimensions, elevations or inverts, and slope gradients.
1.5 QUALITY ASSURANCE
A. Perform Work in accordance with Section 00330 of the 2015 Oregon Standard Specifications for Construction.

PART 2 PRODUCTS
2.1 MATERIALS
1. Topsoil: As specified in Section 31 0513.
2. Subsoil Fill: As specified in Section 31 0513.
3. Coarse Aggregate Materials: As specified in Section 31 0516.

PART 3 EXECUTION
3.1 EXAMINATION
A. Section 01 3300 - Administrative Requirements: Verification of existing conditions before starting Work.
B. Verify survey bench mark and intended elevations for the Work are as indicated on Drawings.

3.2 PREPARATION
A. Call “One Call” Utility Notification Center at 1-800-322-2344 prior to performing Work. Request underground utilities to be located and marked within and surrounding construction areas.
B. Identify required lines, levels, contours, and datum.
C. Notify utility companies if conflicts are found.
D. Protect utilities indicated to remain from damage.
E. Protect plant life, lawns, rock outcropping and other features remaining as portion of final landscaping.
F. Protect bench marks, survey control point, existing structures, fences, sidewalks, paving, and curbs from excavating equipment and vehicular traffic.

3.3 TOPSOIL EXCAVATION
A. Excavate topsoil from areas to be further excavated, re-landscaped, or re-graded without mixing with foreign materials for use in finish grading; refer to landscape specification and drawings for requirements.
B. Do not excavate wet topsoil.
C. Stockpile in area designated on site to depth not exceeding 8 feet and protect from erosion. Stockpile material on impervious material and cover over with tarps, or keep moist, until disposal.
3.4 SUBSOIL EXCAVATION

A. Excavate subsoil from areas to be further excavated, re-landscaped, or re-grade marked areas.

B. Do not excavate wet subsoil or excavate and process wet material to obtain optimum moisture content.

C. When excavating through roots, perform Work by hand and cut roots with sharp axe.

D. Remove excess subsoil not intended for reuse from site.

3.5 FILLING

A. Refer to Document 00 3300 for Site Preparation and Earthwork recommendations.

B. Install Work in accordance with Section 00330 of the 2015 Oregon Standard Specifications for Construction.

3.6 TOLERANCES

A. Section 01 4000 - Quality Requirements: Tolerances.

B. Top Surface of Subgrade: Plus or minus 0.1 foot from required elevation.

3.7 FIELD QUALITY CONTROL

A. Section 01 4000 - Quality Requirements 01 7800 - Execution and Closeout Requirements: Field inspecting, testing, adjusting, and balancing.

B. Perform laboratory material tests in accordance with Section 00330 of the 2015 Oregon Standard Specifications for Construction.

C. When tests indicate Work does not meet specified requirements, remove Work, replace and retest.

END OF SECTION
PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Excavating for building foundations.
   2. Excavating for paving, roads, and parking areas.
   3. Excavating for site structures.
   4. Excavating for landscaping.
   5. Embankments and fill for prepared subgrade.

B. Related Sections:
   2. Section 33 1116 - Site Water Utility Distribution Piping.

1.2 REFERENCES

A. ASTM International:
   1. ASTM D1557 - Standard Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 lbf/ft3 (2,700 kN-m/m3)).
   2. ASTM D2922 - Standard Test Method for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).

B. Local utility standards when working within 24 inches of utility lines.

1.3 SUBMITTALS

A. Section 01 3000 - Administrative Requirements: Requirements for submittals.

B. 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.

C. Shop Drawings: Indicate soil densification grid for each size and configuration footing requiring soils densification.

1.4 QUALITY ASSURANCE

A. Perform Work in accordance with Section 00330 of the 2015 Oregon Standard Specifications for Construction.

B. Maintain one copy of Standard Specifications document on site.

PART 2 PRODUCTS

Not Used.
PART 3 EXECUTION

3.1 PREPARATION

A. Call Oregon Utility Location Center Information service at 1-800-322-2344 not less than three working days before performing Work.
   1. Request underground utilities to be located and marked within and surrounding construction areas.

B. Identify required lines, levels, contours, and datum.

C. Notify utility company to remove and relocate utilities.

D. Protect utilities indicated to remain from damage.

E. Protect plant life, lawns, and other features remaining as portion of final landscaping.

F. Protect bench marks, survey control points, existing structures, sidewalks, paving, and curbs from excavating equipment and vehicular traffic.

3.2 EXCAVATION

A. Underpin adjacent structures which may be damaged by excavation work.

B. Excavate subsoil to accommodate building foundations, paving and site structures, and construction operations. All material shall be defined as "Unclassified Excavation". Unclassified excavation shall consist of the excavation and disposal of all material, regardless of its nature. No attempt will be made to quantify or classify rock excavation. No separate measurement or payment for rock excavation will be made. There is no additional compensation for rock encountered during work.

C. Compact disturbed load bearing soil in direct contact with foundations to original bearing capacity; perform compaction in accordance with paragraph.

D. Slope banks with machine to angle of repose or less until shored.

E. Do not interfere with 45 degree bearing splay of foundations.

F. Grade top perimeter of excavation to prevent surface water from draining into excavation.

G. Trim excavation. Remove loose matter.

H. Notify Architect/Engineer of unexpected subsurface conditions.

I. Correct areas over excavated with select granular structural fill as directed by Architect/Engineer.

J. Stockpile subsoil in area designated on site and protect from erosion.

K. Repair or replace items indicated to remain damaged by excavation.

3.3 FIELD QUALITY CONTROL

A. Section 01 4000 - Quality Requirements: Quality Assurance.
B. Request visual inspection of bearing surfaces by Architect/Geotechnical Engineer before installing subsequent work.

3.4 PROTECTION

A. Prevent displacement or loose soil from falling into excavation; maintain soil stability.

B. Protect bottom of excavations and soil adjacent to and beneath foundation from freezing.

C. Protect structures, utilities and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earth operations.

END OF SECTION
PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Excavating trenches for utilities from 5 feet outside building to utility service.
   2. Compacted fill from top of utility bedding to subgrade elevations and/or original elevations.
   3. Backfilling and compaction.

B. Related Sections:
   1. Section 31 2316 - Excavation: General building excavation.
   2. Section 31 2323 - Fill: General Backfilling.
   3. Section 33 1116 - Site Water Utility Distribution Piping: Water piping and bedding from building to utility service.
   4. Section 33 3100 - Sanitary Utility Sewerage Piping: Sanitary sewer piping and bedding from building to utility service.

1.2 REFERENCES

A. ASTM International:
   2. ASTM D1557 - Standard Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort (6,000 ft-lbf/ft³ (2,700 kN-m/m³)).

1.3 DEFINITIONS

A. Utility: Any buried pipe, duct, conduit, or cable.

1.4 SUBMITTALS

A. Section 01 3300 - Administrative Requirements: Requirements for submittals.


C. Materials Source: Submit name of imported fill materials suppliers.

D. Manufacturer’s Certificate: Certify Products meet or exceed specified requirements.

E. Traffic Control Plan for all trenching operation in public streets. Plan shall be approved by Architect/Engineer prior to starting any work.

1.5 QUALITY ASSURANCE

A. Perform Work in accordance with Section 00405 of the 2015 Oregon Standard Specifications for Construction.
1.6 FIELD MEASUREMENTS
   A. Verify field measurements prior to fabrication.

1.7 COORDINATION
   A. Section 01 3100 - Field Engineering: Coordination and project conditions.
   B. Verify Work associated with lower elevation utilities is complete before placing higher
      elevation utilities.

PART 2 PRODUCTS

2.1 PIPE ZONE, PIPE BEDDING, AND TRENCH BACKFILL MATERIALS
   A. Provide and install granular material (Class B Backfill) 3/4"-0 meeting the requirements of
      Section 00405 of the 2015 Oregon Standard Specifications for Construction for Pipe
      Zone, Pipe Bedding and Trench Backfill for all trenches located in hardscape areas
      (roads, drives, walk, patio areas, etc.).
   B. Trench backfill material in landscape/softscape areas may be Class A Backfill as defined
      in Section 00405 of the 2015 Oregon Standard Specifications for Construction, as
      modified herein to contain no particle with any dimension greater than 3 inches, or other
      unsuitable material. Pipe Bedding and Pipe Zone material in landscape/softscape areas
      shall be granular material (Class B Backfill).

2.2 ACCESSORIES
   A. Geotextile Fabric: Non-biodegradable, non-woven.
      1. Alkzo Nobel Geosynthetic Co.
      2. Huesker, Inc.
      3. TC Mirafi.
      4. Tenax Corp.
      5. Tensar Earth Technologies, Inc.
      6. Substitutions: Section 01 6000 – Product Requirements.

PART 3 EXECUTION

3.1 LINES AND GRADES
   A. Lay pipes to lines and grades indicated on Drawings.
      1. Architect/Engineer reserves right to make changes in lines, grades, and depths
         of utilities when changes are required for Project conditions.
   B. Use laser-beam instrument with qualified operator to establish lines and grades.

3.2 PREPARATION
   A. Call Oregon Utility Line Information service at 1-800-322-2344 not less than three
      working days before performing Work.
      1. Request underground utilities to be located and marked within and surrounding
         construction areas.
B. Identify required lines, levels, contours, and datum locations.

C. Protect plant life, lawns, and other features remaining as portion of final landscaping.

D. Protect bench marks, existing structures, sidewalks, paving, and curbs from excavating equipment and vehicular traffic.

E. Maintain and protect above and below grade utilities indicated to remain.

F. Establish temporary traffic control when trenching is performed in public right-of-way. Relocate controls and reroute traffic as required during progress of Work. Maintain at least, one-way traffic utilizing flaggers in accordance with Standard and Specifications. Provide a Traffic Control Plan at least 10 days prior to the start or work and/or prior to pre-construction meeting with City.

3.3 TRENCHING

A. Excavate subsoil required for utilities to utility service. Sawcut pavement in those areas where utility is being installed under pavement. Sawcut wide enough to account for sloping of trenching operation.

B. Perform excavation within 24 inches of existing utility service in accordance with utility’s requirements.

C. Do not advance open trench more than 200 feet ahead of installed pipe. No open trenches shall be left uncovered at the end of shift.

D. Cut trenches sufficiently wide to enable installation and allow inspection. Remove water or materials that interfere with Work.

E. Excavate bottom of trenches maximum 2 feet wider than outside diameter of pipe.

F. Excavate trenches to depth indicated on Drawings. Provide uniform and continuous bearing and support for bedding material and pipe utilities.

G. Do not interfere with 45 degree bearing splay of foundations.

H. When Project conditions permit, slope side walls of excavation starting 4 feet above top of pipe. When side walls can not be sloped, provide sheeting and shoring to protect excavation as specified in this section. Conduct sheet/shoring in accordance with OSHA Standards for Trenching.

I. When subsurface materials at bottom of trench are loose or soft, excavate to greater depth as directed by Architect/Engineer until suitable material is encountered.

J. Cut out soft areas of subgrade not capable of compaction in place. Backfill with granular material and compact to density equal to or greater than requirements for subsequent backfill material.


L. All excavation including trench excavation shall be defined as unclassified.

M. Correct areas over excavated areas with compacted backfill as specified for authorized excavation or replace with fill concrete as directed by Architect/Engineer.
N. Remove excess subsoil not intended for reuse, from site.
O. Remove pavement (roadway and sidewalk) materials from site.

3.4 SHEETING AND SHORING
A. Sheet, shore, and brace excavations to prevent danger to persons, structures and adjacent properties and to prevent caving, erosion, and loss of surrounding subsoil.
B. Support trenches more than 5 feet deep excavated through unstable, loose, or soft material. Provide sheeting, shoring, bracing, or other protection to maintain stability of excavation.
C. Design sheeting and shoring to be removed at completion of excavation work.
D. Repair damage caused by failure of the sheeting, shoring, or bracing and for settlement of filled excavations or adjacent soil.
E. Repair damage to new and existing Work from settlement, water or earth pressure, or other causes resulting from inadequate sheeting, shoring, or bracing.

3.5 BACKFILLING
A. Backfill trenches in accordance with Section 00405 of the 2015 Oregon Standard Specifications for Construction.
B. Systematically backfill to allow maximum time for natural settlement. Do not backfill over porous, wet, frozen, or spongy subgrade surfaces.
C. Place material in continuous layers as follows:
D. Employ placement method that does not disturb or damage foundation perimeter drainage, utilities in trench, and adjacent existing pavements.
E. Maintain optimum moisture content of fill materials to attain required compaction density.
F. Do not leave trench open at end of working day. Place temporary pavement in those under traffic and within public right-of-way.
G. Protect open trench to prevent danger to Owner using temporary fencing outside public right-of-way.

3.6 TOLERANCES
A. Top Surface of Backfilling under Paved Areas: Plus or minus 1 inch from required elevations.
B. Top Surface of General Backfilling: Plus or minus 1 inch from required elevations.

3.7 FIELD QUALITY CONTROL
A. Section 01 4000 - Quality Requirements: Field inspecting.
B. Perform laboratory material tests in accordance with ASTM D1557.
C. Perform in place compaction tests in accordance with Subsection 00330.43 of the 2015 Oregon Standard Specifications for Construction.

D. When tests indicate Work does not meet specified requirements, remove Work, replace, compact, and retest.

E. Frequency of Tests: 1 per 100 linear feet of trench. Additional testing shall be conducted when depth of trench exceeds 3 feet. Testing within public right-of-way shall be in accordance with Section 00445 of the 2015 Oregon Standard Specifications for Construction.

3.8 PROTECTION OF FINISHED WORK

A. Section 01 7000 - Execution: Protecting finished work.

B. Reshape and re-compact fills subjected to vehicular traffic during construction.

END OF SECTION
PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Backfilling site structures to subgrade elevations.
   2. Fill under paving.
   3. Fill for over-excavation.

B. Related Sections:
   3. Section 31 2213 - Rough Grading: Site filling.
   4. Section 31 2316 - Excavation.
   5. Section 31 2317 - Trenching: Backfilling of utility trenches.
   6. Section 33 1116 - Site Water Utility Distribution Piping.

1.2 REFERENCES

A. ASTM International:
   1. ASTM D1557 - Standard Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort (6,000 ft-lbf/ft³ (2,700 kN-m/m³)).
   2. ASTM D2922 - Standard Test Method for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).

1.3 SUBMITTALS

A. Section 01 33 00 - Administrative Requirements: Requirements for submittals.


1.4 QUALITY ASSURANCE

A. Perform Work in accordance with Section 00330 of the 2015 Oregon Standard Specifications for Construction.

B. Maintain one copy of Standard Specifications document on site.

PART 2 PRODUCTS

2.1 FILL MATERIALS

A. Subsoil Fill: Per Section 00330 (General Backfill) of the 2015 Oregon Standard Specifications for Construction.

B. Granular Fill: Class B Backfill as specified in Section 00405 of the 2015 Oregon Standard Specifications for Construction, as modified herein to contain no particle with any dimension greater than 3 inches, or other unsuitable material.
2.2 ACCESSORIES
A. Geotextile Fabric: Non-biodegradable, non-woven.
   1. TC Mirafi.
   2. Tensar Earth Technologies, Inc.
   3. Substitutions: Section 01 6000 - Product Requirements.

PART 3 EXECUTION

3.1 EXAMINATION
A. Section 01 4505 - Field Engineering: Coordination and project conditions.
B. Verify structural ability of unsupported walls to support loads imposed by fill.

3.2 PREPARATION
A. Compact subgrade to density requirements for subsequent backfill materials.
B. 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.
C. Scarify subgrade surface to depth of 12 inch.
D. Proof roll to identify soft spots; fill and compact to density equal to or greater than requirements for subsequent fill material.

3.3 BACKFILLING
A. Backfill areas to contours and elevations with unfrozen materials.
B. Systematically backfill to allow maximum time for natural settlement. Do not backfill over porous, wet, frozen or spongy subgrade surfaces.
C. Employ placement method that does not disturb or damage other work.
D. Maintain optimum moisture content of backfill materials to attain required compaction density.
E. Backfill against supported foundation walls. Do not backfill against unsupported foundation walls.
F. Backfill simultaneously on each side of unsupported foundation walls until supports are in place.
G. Slope grade away from building minimum 2 percent slope for minimum distance of 10 ft., unless noted otherwise.
H. Make gradual grade changes. Blend slope into level areas.
I. Remove surplus backfill materials from site.
J. Leave fill material stockpile areas free of excess fill materials.
3.4 TOLERANCES

A. Top Surface of Backfilling within Building Areas Landscaping: Plus or minus 1 inch from required elevations.

B. Top Surface of Backfilling under Paved Areas: Plus or minus 1 inch from required elevations.

C. Top Surface of General Backfilling: Plus or minus 1 inch from required elevations.

3.5 FIELD QUALITY CONTROL

A. Section 01 4000 - Quality Requirements: Field inspecting, testing, adjusting, and balancing.

B. Perform laboratory material tests in accordance with ASTM D1557.

C. Perform in place compaction tests in accordance with Section 00330 of the 2015 Oregon Standard Specifications for Construction.

D. When tests indicate Work does not meet specified requirements, remove Work, replace, compact, and retest.

E. Frequency of Tests: 1 per 500 cyd placed or at least one per day when embanking materials.

F. Proof roll compacted fill surfaces under slabs-on-grade, paving, and landscaping, as directed by Architect/Engineer.

3.6 PROTECTION OF FINISHED WORK

A. Section 01 7000 - Execution: Protecting finished work.

B. Reshape and re-compact fills subjected to vehicular traffic during construction.

END OF SECTION
PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Diversions Channels.
   2. Rock Barriers.

B. Related Sections:
   1. Section 31 0513 - Soils for Earthwork.
   2. Section 31 0516 - Aggregates for Earthwork.
   3. Section 31 2316 - Excavation.
   4. Section 31 2323 - Fill.
   5. Section 31 3700 - Riprap.
   6. Section 32 9119 - Landscape Grading.
   7. Section 32 9219 - Seeding and Soil Supplements.
   8. Section 33 4213 - Pipe Culverts.

1.2 REFERENCES

A. American Association of State Highway and Transportation Officials:

B. ASTM International:
   1. ASTM C127 - Standard Test Method for Density, Relative Density (Specific Gravity), and Absorption of Coarse Aggregate.
   2. ASTM D698 - Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft³ (600 kN-m/m³)).
   3. ASTM D1557 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft³ (2,700 kN-m/m³)).
   5. ASTM D3017 - Standard Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth).

1.3 SUBMITTALS

A. Section 01 3300 - Submittal Procedures: Requirements for submittals.

B. Manufacture’s Certificate: Certify Products meet or exceed specified requirements.

1.4 CLOSEOUT SUBMITTALS

A. Section 01 7000 - Execution and Closeout Requirements: Requirements for submittals.

1.5 QUALITY ASSURANCE

A. Perform Work in accordance with requirements of Section 00280 of the 2015 Oregon Standard Specifications and Oregon Department of Environment Quality (DEQ).
B. Maintain one copy of the Standard Specifications on site.

C. Contractor shall be responsible for providing erosion control and stormwater management during construction. Stormwater shall not be allowed to run off project area. Contractor shall provide necessary means, methods, and materials to retain run off in the project area. Construction plans show storm facilities needed for full build out and are not meant to capture and dispose of run off generated during construction.

PART 2 PRODUCTS

2.1 ROCK AND GEOTEXTILE MATERIALS
A. Furnish materials in accordance with Section 00280 of the 2015 Oregon Standard Specifications for Construction.

2.2 AGGREGATE AND SOIL MATERIALS
A. Coarse Aggregate: As specified in Section 31 0516.
B. Soil Backfill: As specified in Section 31 0513. Subsoil with no rocks over 6 inches in diameter, frozen earth or foreign matter.

2.3 PLANTING MATERIALS
A. Seeding and Soil Supplements: as specified in Section 32 9219. Furnish in accordance with Section 01030 of the 2015 Standard Specifications for Construction.

2.4 PIPE MATERIALS
A. Pipe: PVC C900 Pipe, as specified in Section 33 4213. Furnish in accordance with AWWA and Section 00445 of the 2015 Oregon Standard Specifications for Construction as modified by the City of Sisters Standards and Specifications.

2.5 MIXES
A. Concrete: As specified in Section 03 3000. Furnish in accordance with Section 00440 of the 2015 Standard Specifications for Construction.

2.6 SOURCE QUALITY CONTROL (AND TESTS)
A. Section 01 4000 - Quality Requirements: Testing, inspection and analysis requirements.
B. Perform tests on cement, aggregates, and mixes to ensure conformance with specified requirements.
C. Test samples in accordance with ACI 301.
D. Make rock available for inspection at producer’s quarry prior to shipment. Notify Architect/Engineer Owner at least seven days before inspection is allowed.
E. Allow witnessing of inspections and test at manufacturer’s test facility. Notify Architect/Engineer Owner at least seven days before inspections and tests are scheduled.

PART 3 EXECUTION

3.1 DIVERSION CHANNELS

A. Windrow excavated material on low side of channel.

B. Compact to 95 percent maximum density.

C. On entire channel area, apply soil supplements and sow seed as specified in Section 32 9219.

D. Install Work in accordance with Section 00280 of the 2015 Oregon Standard Specifications for Construction.

3.2 ROCK BASIN

A. Construct generally in accordance with rock energy dissipater requirements to indicated shape and depth. Rock courses may be placed in several operations but minimum depth of initial course must be 3 feet or greater.

3.3 ROCK BARRIER

A. Install Work in accordance with Section 00280 of the 2015 Oregon Standard Specifications for Construction.

3.4 SEDIMENT TRAPS

A. Install Work in accordance with Section 00280 of the 2015 Oregon Standard Specifications for Construction.

3.5 SITE STABILIZATION

A. Incorporate erosion control devices, best management practices or intermediate measures as needed to contain drainage (stormwater) onsite into the Project at the earliest practicable time as to prevent runoff from impacting areas outside of Project Area.

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 35 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 9219 at percent of permanent application rate with no topsoil.
3. Stabilize disturbed areas which are either at finished grade or will not be disturbed within one year in accordance with Section 32 9219 permanent seeding specifications.

E. Stabilize diversion channels, sediment traps, and stockpiles immediately.

3.6 FIELD QUALITY CONTROL

A. Section 01 4000 - Quality Requirements 01 7000 - Execution and Closeout Requirements: Field inspecting, testing, adjusting, and Balancing.

B. Inspect erosion control devices on a weekly basis and after each runoff event. Make necessary repairs to ensure erosion and sediment controls are in good working order.

C. Field test concrete in accordance with Section 03 3000.


E. When tests indicate Work does not meet specified requirements, remove Work, replace and retest.

F. Frequency of Compaction Testing: One for each lift.

3.7 CLEANING

A. Section 01 7000 - Execution and Closeout Requirements: Requirements for cleaning.

B. When sediment accumulation in sedimentation structures has reached a point one-third depth of sediment structure or devise, 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.

3.8 PROTECTION

A. Section 01 7000 - Execution and Closeout Requirements: Requirements for protecting finished Work.

END OF SECTION
PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Aggregate subbase.
   2. Aggregate base course.

B. Related Sections:
   1. Section 31 2317 - Trenching: Compacted fill under base course.
   2. Section 31 2323 - Fill: Compacted fill under base course.
   4. Section 32 1313 - Concrete Paving: Finish concrete surface course.

1.2 REFERENCES

A. ASTM International:
   2. ASTM D2922 - Standard Test Method for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).

1.3 SUBMITTALS

A. Section 01 3300 - Administrative Requirements: Requirements for submittals.

B. Materials Source: Submit name of aggregate materials suppliers.

C. Manufacturer's Certificate: Certify Products meet or exceed specified requirements.

1.4 SUSTAINABLE DESIGN SUBMITTALS - not used

1.5 QUALITY ASSURANCE

A. Furnish each aggregate material from single source throughout the Work.

B. Perform Work in accordance with Section 00641 of the 2015 Oregon Standard Specifications for Construction.

C. Maintain one copy of the Standard Specifications document on site.

PART 2 PRODUCTS

2.1 AGGREGATE MATERIALS

A. Coarse Aggregate: As specified in Section 31 0516.
PART 3 EXECUTION

3.1 EXAMINATION

A. Section 01 4000 - Field Engineering: Verification of existing conditions before starting Work.

B. Verify compacted substrate is dry and ready to support paving and imposed loads.
   1. Proof roll substrate.
   2. Remove soft substrate and replace with compacted fill as specified in Section 31 2323.

C. Verify substrate has been inspected, gradients and elevations are correct.

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 as indicated on Drawings.

B. Roller compact aggregate to 95 percent maximum density.

C. Level and contour surfaces to elevations and gradients indicated.

D. Maintain optimum moisture content of fill materials to attain specified compaction density.

E. Use mechanical tamping equipment in areas inaccessible to compaction equipment.

3.4 TOLERANCES

A. Maximum Variation from Flat Surface: 1/4 inch measured with 10 foot straight edge.

B. Maximum Variation From Thickness: 1/4 inch.

C. Maximum Variation From Elevation: 1/2 inch.

3.5 FIELD QUALITY CONTROL

A. Section 01 4000 - Quality Requirements: Field inspecting.

B. Compaction testing and frequency of testing shall be performed in accordance with Section 00641 of the 2015 Oregon Standard Specifications for Construction. Begin compaction of each layer of dense-graded aggregate immediately after the material is spread and continue until a density of not less than 95% of the maximum density has been achieved.

C. When tests indicate Work does not meet specified requirements, remove Work, replace and retest.
END OF SECTION
PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Asphalt paving base course, binder course, and wearing course.

B. Related Sections:
   1. Section 31 2213 - Rough Grading: Preparation of site for paving.
   2. Section 32 1123 - Aggregate Base Courses: Compacted subbase for paving.
   3. Section 32 1723 - Pavement Markings: Painted pavement markings, lines, and legends.

1.2 REFERENCES

A. Asphalt Institute:
   1. AI MS-2 - Mix Design Methods for Asphalt Concrete and Other Hot-Mix Types.

B. ASTM International:

1.3 SUBMITTALS

A. Section 01 3300 - Administrative Requirements: Requirements for submittals.

B. Product Data:
   1. Submit product information for asphalt and aggregate materials.
   2. Submit mix design with laboratory test results supporting design.

C. Manufacturer's Certificate: Certify Products meet or exceed specified requirements.

1.4 QUALITY ASSURANCE

A. Obtain materials from same source throughout.

B. Perform Work in accordance with Section 00744 of the 2015 Oregon Standard Specifications for Construction. Refer to Section 3.7 for compaction requirements.
1.5 ENVIRONMENTAL REQUIREMENTS

A. Install Asphalt Concrete in accordance with Sections 00290 and 00744 of the 2015 Oregon Standard Specifications for Construction.

PART 2 PRODUCTS

2.1 MATERIALS


B. Reclaimed Asphalt Pavement (RAP): Processed material obtained by milling or full depth removal of existing asphalt paving, no more than 30% RAP material will be allowed in the new HMAC pavement.

2.2 AGGREGATE MATERIALS

A. Coarse Aggregate: In accordance with Section 00744 of the 2015 Oregon Standard Specifications for Construction.


C. Mineral Filler: ASTM D242; finely ground mineral particles, free of foreign matter.

2.3 MIXES

A. Use dry material to avoid foaming. Mix uniformly.

B. Asphalt Paving Mixtures: Designed in accordance with Section 00744 of the 2015 Oregon Standard Specifications for Construction.
   1. Wearing Course: Level 2: 1/2” Dense, PG 64-28.

2.4 SOURCE QUALITY CONTROL

A. Section 01 4000 - Quality requirements: Testing, inspection and analysis requirements.

B. Submit proposed mix design for review prior to beginning of Work.

C. Test samples in accordance with Section 00744 of the 2015 Oregon Standard Specifications for Construction.

PART 3 EXECUTION

3.1 EXAMINATION

A. Section 01 3100 - Field Engineering: Verification of existing conditions before starting Work.

B. Verify utilities indicated under paving are installed with excavations and trenches backfilled and compacted.
C. Verify compacted subgrade subbase is dry and ready to support paving and imposed loads.
   1. Proof roll subbase with 12,000 lb. steel wheel vibratory roller, or equivalent, in minimum two perpendicular passes to identify soft spots.
   2. Remove soft subbase and replace with compacted fill as specified in Section 31 2323.

D. Verify gradients and elevations of base are correct.

E. Verify manhole frames and inlets are installed in correct position and elevation.

3.2 SUBBASE

A. Aggregate Subbase: Install as specified in Section 32 1123.

3.3 EXISTING WORK

A. Saw cut and notch existing paving as indicated on Drawings.
B. Clean existing paving to remove foreign material, excess joint sealant, and crack filler from paving surface.
C. Repair surface defects in existing paving to provide uniform surface to receive new paving.

3.4 TACK COAT

A. Apply tack coat in accordance with 00730 of the 2015 Oregon Standard Specifications for Construction.

3.5 SINGLE COURSE ASPHALT PAVING

A. Install Work in accordance with 00744 of the 2015 Oregon Standard Specifications for Construction.
B. Place asphalt within 24 hours of applying primer or tack coat.
C. Place asphalt wearing course to thickness indicated on Drawing.
D. Compact paving by rolling to specified density. Do not displace or extrude paving from position. Hand compact in areas inaccessible to rolling equipment.
E. Perform rolling with consecutive passes to achieve even and smooth finish without roller marks.

3.6 PLACEMENT TOLERANCES

A. Flatness: Maximum variation of 1/4 inch measured with 10 foot straight edge.
B. Scheduled Compacted Thickness: Within 1/4 inch.
C. Variation from Indicated Elevation: Within 1/2 inch.
3.7 FIELD QUALITY CONTROL

A. Section 01 4000 - Quality Requirements: Field inspecting, testing.

B. The HMAC should be compacted to a minimum of 92 percent of the Rice theoretical maximum density. Density test frequency shall be one test per every 5,000 square feet, or a minimum of five density test per date per material when placed.

3.8 PROTECTION OF FINISHED WORK

A. Section 01 7700 - Execution: Requirements for protecting finished Work.

B. Immediately after placement, protect paving from mechanical injury for 48 hours or until surface temperature is less than 140 degrees F.

C. Route pedestrian traffic away from work during placement and for 24 hours after placement.

END OF SECTION
PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Precast concrete parking bumpers.
   2. Parking bumper anchors.

B. Related Sections:
   1. Section 32 1216 - Asphalt Paving.
   2. Section 32 1313 - Concrete Paving.

1.2 REFERENCES

A. ASTM International:
   1. ASTM A615/A615M - Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement.

1.3 SUBMITTALS

A. Section 01 3300 - Submittal Procedures: Requirements for submittals.

B. Product Data: Submit unit configuration, dimensions.

C. Samples: Submit two concrete bumper units, illustrating surface finish.

1.4 QUALITY ASSURANCE

A. Perform Work in accordance with manufacturer’s recommendations.

B. Maintain one copy of each document on site.

1.5 COORDINATION

A. Section 01 4000 - Administrative Requirements: Requirements for coordination.

B. Coordinate the Work with pavement placement and parking striping.

PART 2 PRODUCTS

2.1 CONCRETE BUMPERS

A. Cement: ANSI/ASTM C150, Portland Type – Normal III – High Early Strength II – Sulfate Resisting white gray or buff color.
SECTION 32 1713  32 1713-2
PARKING BUMPERS

B. Concrete Materials: ASTM C33 ASTM C330; water and sand.

C. Reinforcing Steel: ASTM A615/A615M, 60 ksi yield grade, deformed bars, uncoated finish, strength and size commensurate with precast unit design.


E. Concrete Mix: Minimum 5000 psi, 28 day strength, air entrained to 5 to 7 percent.

F. Use rigid molds, constructed to maintain precast units uniform in shape, size and finish. Maintain consistent quality during manufacture.

G. Embed reinforcing steel, and drill or sleeve for two dowels.

H. Cure units to develop concrete quality, and to minimize appearance blemishes including non-uniformity, staining, or surface cracking.

I. Minor patching in plant is acceptable, providing appearance of units is not impaired.

2.2 RECYCLED PLASTIC/COMPOSITE

A. Color to be blue.

B. Recycled Plastic: Recycled plastic, solid wheel stops.

C. Recycled Composite: As manufactured by Xpotential Products, or equal.

D. Provide minimum five-year product warranty.

E. Products shall be chemical and weather resistant.

2.3 CONFIGURATION

A. Nominal Size: See Plan Details.

B. Profile: Manufacturer’s standard. Rectangular cross section with sloped vertical faces, square ends, with drainage slots.

2.4 ACCESSORIES

A. Dowels: Cut reinforcing steel, 1/2 inch diameter, inch long, pointed tip.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install units without damage to shape or finish. Replace or repair damaged units.

B. Install units in alignment with adjacent work.
C. Fasten units in place with 2 dowels for each unit bumper.

END OF SECTION
PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Traffic lines and markings.
   2. Legends.
   3. Paint.
   4. Glass beads.

B. Related Sections:
   1. Section 32 1216 - Asphalt Paving.
   2. Section 32 1313 - Concrete Paving.

1.2 REFERENCES

A. American Association of State Highway and Transportation Officials:

B. ASTM International:
   2. ASTM D126 - Standard Test Methods for Analysis of Yellow, Orange, and Green
      Pigments Containing Lead Chromate and Chromium Oxide Green.
      Unit (KU) Viscosity Using a Stormer - Type Viscometer.
   5. ASTM D713 - Standard Practice for Conducting Road Service Tests on Fluid Traffic
      Marking Materials.
   6. ASTM D969 - Standard Test Method for Laboratory Determination of Degree of
      Bleeding of Traffic Paint.
   7. ASTM D1301 - Standard Test Methods for Chemical Analysis of White Lead
      Pigments.
   8. ASTM D1394 - Standard Test Methods for Chemical Analysis of White Titanium
      Pigments.
   9. ASTM D1475 - Standard Test Method for Density of Liquid Coatings, Inks, and
      Related Products.
   10. ASTM D1640 - Standard Test Methods for Drying, Curing, or Film Formation of
       Organic Coatings at Room Temperature.
   12. ASTM D2371 - Standard Test Method for Pigment Content of Solvent-Reducible
       Paints.
       from Solvent-Reducible Paints.
       Spectroscopy and Gas Chromatography.

1.3 PERFORMANCE REQUIREMENTS

A. Paint Adhesion: Adhere to road surface forming smooth continuous film one minute after
   application.

B. Paint Drying: Tack free by touch so as not to require coning or other traffic control devices to
   prevent transfer by vehicle tires within two minutes after application.
1.4 SUBMITTALS

A. Section 01 3300 - Submittal Procedures: Requirements for submittals.

B. Product Data: Submit paint formulation for each type of paint.

C. Samples:
   1. Submit eight sample plates of each color of material. Prepare four plates without glass beads and four with glass beads for each different batch of material. After approval, Owner will retain these plates for field comparisons of applied paint.
   2. Submit two gallons and four one quart paint samples accompanied by properly executed test reports.
   3. Submit samples of glass bead in compliance with AASHTO M247.

D. Test Reports: Submit source and acceptance test results in accordance with AASHTO M247.

E. Manufacturer's Installation Instructions: Submit instructions for application temperatures, eradication requirements, application rate, line thickness, type of glass beads, bead embedment and bead application rate, and any other data on proper installation.

F. Manufacturer's Certificate: Certify Products meet or exceed specified requirements.

1.5 QUALITY ASSURANCE

A. Perform Work in accordance with Sections 00850 and 00860 of the 2015 Oregon Standard Specifications for Construction.

B. Maintain one copy of the standard specifications on site.

1.6 QUALIFICATIONS

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

B. Applicator: Company specializing in performing work of this section with minimum 2 years documented experience approved by manufacturer.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Section 01 6000 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.

B. Invert containers several days prior to use when paint has been stored more than 2 months. Minimize exposure to air when transferring paint. Seal drums and tanks when not in use.

C. Glass Beads. Store glass beads in cool, dry place. Protect from contamination by foreign substances.

1.8 ENVIRONMENTAL REQUIREMENTS

A. Section 01 6000 - Product Requirements: Environmental conditions affecting products on site.
B. Do not apply materials when surface and ambient temperatures are outside temperature ranges required by paint product manufacturer.

C. Do not apply exterior coatings during rain or snow when relative humidity is outside humidity ranges, or moisture content of surfaces exceed those required by paint product manufacturer.

D. Do not apply paint when temperatures are expected to fall below 50 degrees F for 24 hours after application.

E. Volatile Organic Content (VOC). Do not exceed State or Environmental Protection Agency maximum VOC on traffic paint.

1.9 WARRANTY

A. Section 01 7000 - Execution and Closeout Requirements: Requirements for warranties.

B. Furnish three year manufacturer's warranty for traffic paints.

1.10 MAINTENANCE SERVICE

A. Section 01 7000 - Execution and Closeout Requirements: Requirements for maintenance service.

B. Furnish service and maintenance of traffic paints for three years from Date of Substantial Completion.

PART 2 PRODUCTS

2.1 PAINTED PAVEMENT MARKINGS

A. Furnish materials in accordance with Sections 00850 and 00860 of the 2015 Oregon Standard Specifications for Construction.

B. Glass Beads: AASHTO M247, Type 1, coated to enhance embedment and adherence with paint.

2.2 EQUIPMENT

A. Continuous Longitudinal Line Application Machine: Use application equipment with following capabilities.
   1. Dual nozzle paint gun to simultaneously apply parallel lines of indicated width in solid or broken patterns or various combinations of those patterns.
   2. Pressurized bead-gun to automatically dispense glass beads onto painted surface, at required application rate.
   3. Measuring device to automatically and continuously measure length of each line placed, to nearest foot.
   4. Device to heat paint to 125 degrees F for fast dry applications.

B. Machine Calibration:
   1. Paint Line Measuring Device: Calibrate automatic line length gauges to maintain tolerance of plus or minus 25 feet per mile.
2. Cycle Length/Paint Line Length Timer: Calibrate cycle length to maintain tolerance of plus or minus 6 inches per 40 feet; calibrate paint line length to maintain tolerance to plus or minus 3 inches per 10 feet.

3. Paint Guns: Calibrate to simultaneously apply paint binder at uniform rates as specified with an allowable tolerance of plus or minus 1 mil.

4. Bead Guns: Calibrate to dispense glass beads simultaneously at specified rate. Check guns by dispensing glass beads into gallon container for predetermined fixed period of time. Verify weight of glass beads.

C. Other Equipment:
   1. For application of crosswalks, intersections, stop lines, legends and other miscellaneous items by walk behind stripers, hand spray or stencil trucks, apply with equipment meeting requirements of this section. Do not use hand brushes or rollers. Optionally apply glass beads by hand.

2.3 SOURCE QUALITY CONTROL

A. Section 01 4000 - Quality Requirements: Testing, inspection and analysis requirements.

B. Test and analyze traffic paints in accordance with Sections 00850 and 00860 of the 2015 Oregon Standard Specifications for Construction.

C. Make points and glass beads available for inspection at manufacturer’s factory prior to packaging for shipment. Notify Engineer/Owner at least seven days before inspection is allowed.

D. Make paints and glass beads available for inspection at manufacturer’s factory prior to packaging for shipment. Notify Engineer/Owner at least seven days before inspection is allowed.

E. Allow witnessing of factory inspections and test at manufacturer’s test facility. Notify Engineer/Owner at least seven days before inspections and tests are scheduled.

PART 3 EXECUTION

3.1 EXAMINATION

A. Section 01 3000 - Administrative Requirements: Verification of existing conditions before starting work.

B. Do not apply paint to concrete surfaces until concrete has cured for 28 days.

3.2 PREPARATION

A. Maintenance and Protection of Traffic:
   1. Provide short term traffic control in accordance with Section 01 5000 - Temporary Facilities and Controls.
   2. Prevent interference with marking operations and to prevent traffic on newly applied markings before markings dry.
   3. Maintain travel lanes between 7:00 AM to 9:00 AM, and between 4:00 PM and 6:00 PM.
   4. Maintain access to existing businesses, and other properties requiring access.
B. Surface Preparation.
   1. Clean and dry paved surface prior to painting.
   2. Blow or sweep surface free of dirt, debris, oil, grease or gasoline.
   3. Spot location of final pavement markings as specified and as indicated on Drawings by applying pavement spots 25 feet on center.
   4. Notify Architect/Engineer after placing pavement spots and minimum 3 days prior to applying traffic lines.

3.3 EXISTING WORK

A. Remove existing markings in an acceptable manner. Do not remove existing pavement markings by painting over with blank paint. Remove by methods that will cause least damage to pavement structure or pavement surface. Satisfactorily repair any pavement or surface damage caused by removal methods.

B. Clean and repair existing remaining or reinstalled lines and legends.

3.4 APPLICATION

A. Install Work in accordance with Sections 00850 and 00860 of the 2015 Oregon Standard Specifications for Construction.

3.5 APPLICATION TOLERANCES

A. Section 01 40 00 - Quality Requirements: Tolerances.

B. Maximum Variation from Wet Film Thickness: 1 mil.

C. Maximum Variation from Wet Paint Line Width: Plus or minus 1/8 inch.

D. Maximum Variation from Specified Application Temperature: Plus or minus 5 degrees F.

3.6 FIELD QUALITY CONTROL

A. Section 01 4000 - Quality Requirements 01 7000 - Execution and Closeout Requirements: Field inspecting, testing, adjusting, and balancing.

B. Inspect for incorrect location, insufficient thickness, line width, coverage, retention, uncured or discolored material, and insufficient bonding.

C. Repair lines and markings, which after application and curing do not meet following criteria:
   1. Incorrect Location: Remove and replace incorrectly placed patterns.
   2. Insufficient Thickness, Line Width, Paint Coverage, Glass Bead Coverage or Retention: Prepare defective material by acceptably grinding or blast cleaning to remove substantial amount of beads and to roughen marking surface. Remove loose particles and debris. Apply new markings on cleaned surface in accordance with this Section.
   3. Uncured or Discolored Material, Insufficient Bonding: Remove defective markings in accordance with this Section and clean pavement surface one foot beyond affected area. Apply new markings on cleaned surface in accordance with this Section.

D. Replace defective pavement markings as specified throughout 3 year warranted period. Replace markings damaged by anti-skid materials, studded tires, tire chains, chemical
deicers, and snow plowing or other loss of marking material regardless of cause. When markings are damaged by pavement failure or by Owner's painting, crack sealing, or pavement repair operations, Contractor is released from warranty requirements for damaged work.

E. A three member team will evaluate warranty provisions. Team will consist of one member from Owner, one member from Contractor, and third person who is mutually acceptable to Owner and Contractor. Any costs for third person will be equally shared between Owner and Contractor. At least once each year, beginning with year after acceptance, team shall:

1. Observe Owner taking readings by retro reflectometer, or review Owner records of such evaluation. The number of readings will be as large as necessary to ensure that minimum criteria are satisfied. Readings will be during period from March 15 through October, when pavement is clean and dry.

2. Determine color fade, discoloration or pigment loss based on visual color comparison between original sample plates with glass beads and in-place pavement markings.

3. Determine magnitude of material loss.

F. Prepare list of defective areas and areas requiring additional inspection and evaluation to decide where material may need replaced. Provide traffic control as necessary if markings require more detailed evaluation.

G. Replace failed or defective markings in entire section of defective markings within 30 days after notification when any of the following exists during warranty period:

1. Average retro reflectivity within any 528 foot section is less than 1225 mcd/m²/1x for white pavement markings and 100 mcd/m²/1x for yellow pavement markings.

2. Marking is discolored or exhibits pigment loss, and is determined to be unacceptable by three member team based on visual comparison with beaded color plates.

3. More than 15 percent of area of continuous line, or more than 15 percent of combined area of skip lines, within any 528 foot section of roadway is missing.

H. Replace pavement marking material under warranty using original or better type material. Continue warranty to end of original 3 year period even when replacement materials have been installed as specified.

I. When eradication of existing paint lines is necessary, eradicate by shot blast or water blast method. Do not gouge or groove pavement more than 1/16 inch during removal. Limit area of removal to area of marking plus 1 inch on all sides. Prevent damage to transverse and longitudinal joint sealers, and repair any damage according to requirements in Section 32 1313 or Section 32 1216.

J. Maintain daily log showing work completed, results of above inspections or tests, pavement and air temperatures, relative humidity, presence of any moisture on pavement, and any material or equipment problems. Make legible entries in log in ink, sign and submit by end of each work day. Enter environmental data into log prior to starting work each day and at two additional times during day.

3.7 PROTECTION OF FINISHED WORK

A. Section 01 7000 - Execution and Closeout Requirements: Requirements for protecting finished Work.
B. Protect painted pavement markings from vehicular and pedestrian traffic until paint is dry and track free. Follow manufacturer's recommendations or use minimum of 30 minutes. Consider barrier cones as satisfactory protection for materials requiring more than 2 minutes dry time.

END OF SECTION
PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Fence framework, fabric, and accessories.
   2. Excavation for post bases.
   3. Concrete foundation for posts and center drop for gates.
   5. Privacy slats.

B. Related Sections:
   1. Section 32 1313 - Concrete Paving: Concrete anchorage for posts.

1.2 REFERENCES

A. ASTM International:
   1. ASTM A121 - Standard Specification for Zinc-Coated (Galvanized) Steel Barbed Wire.
   12. ASTM F668 - Standard Specification for Polyvinyl Chloride (PVC) and Other Organic Polymer-Coated Steel Chain-Link Fence Fabric.

B. Chain Link Fence Manufacturers Institute:
   1. CLFMI - Product Manual
1.3 SYSTEM DESCRIPTION

A. Fence Height: As indicated on Drawings.

B. Line Post Spacing: At intervals not exceeding 10 feet.

C. Fence Post and Rail Strength: Conform to ASTM F1043 Heavy Industrial Fence Light Industrial Fence quality.

D. Chain link fence fabric shall be minimum 9 gauge steel wire, prior to any coatings, zinc-coated or aluminum-coated (aluminized). All chain link fabric is to be closed loop at the top. Include top rail.

E. Confirm material requirements for post, rails, gates, and attaching hardware with School District maintenance staff to confirm materials meet or exceed the in-house standards.

F. All fence posts shall be schedule 40. Fences under 6-feet in height shall use 2 3/8” OD terminal posts and 1 7/8” OD line posts. All fencing over 6-feet and up to 12-feet shall use 2 7/8” OD terminal posts and 2 3/8” line posts. On fences over 12-feet in height, larger diameter post should be considered.

G. Where vinyl coated fencing is specified, all posts and hardware shall be powder coated, conforming to ASTM D7803. Color to match fabric.

H. All fence hardware shall be pressed steel.

I. All fence ties shall be steel ties.

J. Poles and footings shall be structurally designed to withstand wind pressure on tall fences for tennis courts, backstops, and other sports field fencing.

K. Confirm layout and design for baseball backstops and other sports field areas with the School District prior to manufacturing and installation.

L. Chain link cantilever slide gates with enclosed aluminum track and hardware manufactured to comply with ASTM F-1184.

1.4 SUBMITTALS

A. Section 01 3300 - Submittal Procedures: Requirements for submittals.

B. Shop Drawings: Indicate plan layout, spacing of components, post foundation dimensions, hardware anchorage, gates, and schedule of components.

C. Product Date: Submit data on fabric, posts, accessories, fittings, and hardware.

D. Samples: Submit two inch samples of fence fabric, slat infill, inch in size illustrating construction and colored finish.

E. Manufacturer’s Installation Instructions: Submit installation requirements, post foundation, and anchor bolt templates.

1.5 CLOSE OUT SUBMITTALS

A. Section 01 7700 - Execution and Closeout Requirements: Close out procedures.
B. Project Record Documents: Accurately record actual locations of property perimeter posts relative to property lines and easements.

C. Operation and Maintenance Data: Procedures for submittals.

1.6 QUALITY ASSURANCE

A. Supply material in accordance with CLFMI - Product Manual.

B. Perform installation in accordance with ASTM F567.

C. Perform Work in accordance with Section 01050 of the 2015 Oregon Standard Specifications for Construction.

D. Maintain one copy of the Standards Specifications on site.

1.7 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 years documented experience approved by manufacturer.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Section 01 6150 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.

B. Deliver fence fabric and accessories in packed cartons or firmly tied rolls.

C. Identify each package with manufacturer’s name.

D. Store fence fabric and accessories in secure and dry place.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers:
   1. Anchor Fence Inc.
   2. Cyclone Inc.
   3. Page Aluminized Steel Corp.
   5. Substitutions: Section 01 2500 - Substitutions.

2.2 MATERIALS AND COMPONENTS

2.3 ACCESSORIES

A. Caps: Galvanized pressed steel; sized to post diameter, set screw retainer

B. Fittings: Sleeves, bands, clips, rail ends, tension bars, fasteners and fittings; galvanized steel.

2.4 GATES

A. General:
   1. Gate Types, Opening Widths and directions of Operation: As indicated on Drawings.
   2. Factory assembled gates.
   3. Conform to requirements specified for PVC coated steel chain link fence except that PVC coated aluminum alloy framing conforming to ASTM B429/B429M may be used.
   4. Design gates for operation by one person.

B. Swing Gates:
   1. Fabricate gates to permit 180 degree swing.
   2. Gates Construction: ASTM F900 with welded corners. Use of corner fittings is not permitted.

C. Sliding Gates:
   1. Framing and Posts: ASTM F1184, Class 2 for internal rollers.
   2. Rollers for overhead and cantilever sliding gates: Bearing type. Furnish non-sealed bearings with grease fitting for periodic maintenance.
   3. Secure rollers to post or frame without welding.

D. Cantilever Sliding Gates:
   1. Gate frames: Fabricate chain link cantilever slide gates in accordance with ASTM F-1184, Type II, Class 2, using aluminum members conforming to ASTM B 221, alloy and temper 6061-T6. Vertical members shall be 2 inch (50mm) square aluminum, weighing 1.13 lb./ft., 2 inch x 4 inch aluminum bottom frame member weighing 1.73 lb./ft., and a one-piece aluminum track/frame member weighing a minimum of 4.621 lb./ft. for Single Track and 7.95 lb./ft. for Dual Track. The 2 inch square frame member of said track/frame shall have a wall thickness of not less than .250 inches on all four sides. Aluminum alloy used shall be 6061-T6 only. Internal uprights shall be 2-inch square aluminum spaced equally at no more than 6 feet on center subdividing the gate frame into panels. Weld all members together forming a rigid one-piece frame integral with top track. Provide 2 truck assemblies for each gate leaf, except as indicated for gates larger than 30’ (9144mm).
   2. Gate Frame Finish: Natural Aluminum. Chain Link Filler Finish: To match specification of existing fence
      a. All Operated Chain-Link Cantilever slide gates will be filled across the entire length of the panel (including the back frame counterbalance) to satisfy UL325 and ASTM F-2200 safe gate design guidelines.
      b. Chain Link mesh size, and wire gauge to match that of existing fence. Fabric shall be attached between each internal upright with hook bolts spaced no more than 15 inches (380 mm) on center as recommended by the manufacturer.
   3. Trussing: Each bay shall be cross-trussed by means of 1/4” cable with adjustable turnbuckles. Trusses will maintain the structural integrity of the gate while
allowing for expansion and contraction of aluminum in varying weather conditions.

4. Top track/rail: Enclosed combination one-piece track and rail, aluminum extrusion with weight of:
   a. Openings up to 30’; 4.62 lbs./ft. Top track/rail to be a single formed profile with integrated center stabilizing web without welding. All wall thicknesses to be 0.25”.
   b. Openings up to 31’ to 50’; 7.95 lbs./ft. Top track/rail to be a single formed profile with integrated center stabilizing web without welding. All wall thicknesses to be 0.25”.

5. Truck assembly: Swivel type, zinc die coated steel, with 6 sealed lubricant ball bearing rollers, 2 inches (50 mm) in diameter by 9/16” (14 mm) in width, and 2 side rolling wheels to ensure truck alignment in track. Mount trucks on post brackets using 7/8” (22 mm) diameter ball bolts with 5/8” (16 mm) shank. Truck assembly shall withstand same reaction load as track 2,000 # (907.2 kg.).

6. Gate hangers, brackets, guide assemblies, receivers, and latches: Malleable iron or steel, galvanized after fabrication. Operated cantilever gates are shipped without standard latching/locking hardware per ASTM F-2200. If positive locking is required, a suitable electronic locking device should be employed (See Section 02829 if applicable).

7. Bottom guide wheel assemblies: Each assembly shall consist of two, 3” (75 mm) diameter wheels, straddling bottom horizontal gate rail, allowing adjustment to maintain gate frame plumb and in proper alignment. Attach one assembly to each support post.

8. End Plug: After gate has been installed, both ends of the combination track/frame member shall be closed off with a shock absorbing plastic block that shall also serve as a stop bracket.

9. Gate posts:
   a. For gates under 31’-0” (9449 mm): galvanized steel 4” (101.6 mm) OD schedule 40 pipe, ASTM F 1083, weighing 9.1 lb./ft. (13.6 kg/m). Provide 1 latch post and 2 support posts for single slide gates and 4 support posts for double slide gates.
   b. For gates 31’-0” (9449 mm) or larger: 2 pairs of support posts for each leaf (dual) 4” (100 mm) OD schedule 40 pipe, ASTM F 1083, weighing 9.1 lb./ft. (13.6 kg/m) each. Posts connected by welding 6 inch x 3/8 inch (12.7 x 9.5 mm) plate between posts as shown on drawings. Also one 4” (100 mm) latch post.

10. Match chain link fabric to that of the fence system.

11. Install fabric securely stretched and held in center of tubing.

12. Provide minimum overhang for each leaf opening size as follows:

<table>
<thead>
<tr>
<th>Opening</th>
<th>Overhang</th>
</tr>
</thead>
<tbody>
<tr>
<td>Up to 10’-0”</td>
<td>6’-6”</td>
</tr>
<tr>
<td>Up to 14’-0”</td>
<td>7’-6”</td>
</tr>
<tr>
<td>14’-1” – 22’-0”</td>
<td>10’-0”</td>
</tr>
<tr>
<td>22’-1” – 30’-0”</td>
<td>12’-0”</td>
</tr>
</tbody>
</table>

13. Gates are to be designed to open or close by applying an initial pull force of no greater than 40 lbs.

14. Electrically operated gates and accessories must be manufactured and installed to comply with the safety requirement of ASTM F2200 and UL 325.
2.5 FINISHES

A. Components and Fabric: In accordance with School District Standards.

B. Hardware: In accordance with School District Standards.

C. Accessories: Same finish as framing.

PART 3 EXECUTION

3.1 INSTALLATION


B. MANUAL OR OPERATED CHAIN LINK CANTILEVER SLIDE GATE FRAMING INSTALLATION

1. Install gate posts in accordance with manufacturers' instructions, and in accordance with ASTM F-567.

2. Install “Fall-over” posts per ASTM F-1184 and ASTM F-2200 (Section 4.2) to prevent fall of more than 45 degrees from the vertical plane if gate should disengage from mounting hardware.

3. Concrete set gate posts: Drill holes in firm, undisturbed or compacted soil. Holes shall have diameter 4 times greater than outside dimension of post with a minimum diameter of 12" (304 mm), and depths approximately 6" (152 mm) inches deeper than post bottom with a minimum depth of 42" (1066 mm) per ASTM F-567 (Section 5.13.1). Excavate deeper as required for adequate support in soft and loose soils, and for posts with heavy lateral loads. Set post bottom 42" (1066 mm) below surface when in firm, undisturbed soil. Place concrete around posts in a continuous pour, tamp for consolidation. Trowel finish around post and slope to direct water away from posts. Check each post for vertical and top alignment, and maintain in position during placement and finishing operations.

C. MANUAL GATE INSTALLATION

1. Install gates plumb, level, and secure for full opening without interference. Gate movement shall not be initiated by gravity when in an automated gate operator is disengaged/disconnected per ASTM F-1184.

2. Attach hardware by means which will prevent unauthorized removal.

3. Adjust gate and hardware for smooth operation.

4. All gate installations to conform to all applicable federal, state, and local codes as well as: ASTM F-567 and ASTM F-1184.

D. OPERATED GATE INSTALLATION

1. Install gates plumb, level, and secure for full opening without interference. Gate movement shall not be initiated by gravity when an automated gate operator is disengaged / disconnected per ASTM F-2220 (Section 4.9)

2. There shall be a maximum gap of 2 ¼" (57 mm) between the horizontal plane of the moving gate panel and any fixed obstacle (support posts, “fall-over” posts, hardware, pilaster, etc.) Except that said obstacle be more than 16" from the moving horizontal plane of the gate panel per ASTM F-2200 (Section 6.1.4.).

3. Gate Receiver Guides shall be recessed behind the leading edge of the receiver post or any other fixed object per ASTM F-2200 (Section 6.1.6).
4. No device designed to provide activation for the automated gate operator is to be installed within 6’ of the horizontal plane of the gate panel per UL-325.

5. All Operated Chain-Link Cantilever slide gates are required to have Gate Warning Placards fully visible to the approach on both sides of the gate per UL-325.

6. Attached hardware by means which will prevent unauthorized removal.

7. Adjust hardware for smooth operation.

8. All operated gate installations to conform to all applicable federal, state, and local codes as well as: ASTM F-567, ASTM F-1184, ASTM F-2200, and Underwriters Laboratory UL-325 safety standards.

3.2 ERECTION TOLERANCES

1. Section 01 4000 – Quality Requirements: Tolerances.


PART 1 GENERAL

1.1 SUMMARY
A. Related Sections

1.2 DESCRIPTION
A. Furnish all labor, materials and equipment, and perform all operations to protect existing trees to remain from construction activities.

1.3 PERFORMANCE STANDARDS
A. Protection of trees or woody shrubs identified to remain means maintenance of the trees in good health and vitality, as well as protection from physical damage and disease.

1.4 GUARANTEE
A. Definitions:
   1. Replaceable: Trees of size and species available from commercial nurseries within the climate zone. In general, trees 10 inches or less in diameter at chest height are considered replaceable.
   2. Non replaceable: In general, trees 10 inches or greater in diameter at chest height. Smaller specimens of certain species may be considered nonreplaceable.
B. Appraisal: The value of nonreplaceable trees lost due to construction activities will be established by a qualified tree appraiser utilizing the International Society of Arboriculture’s “Guide to the Methods and Procedures for Appraising Amenity Plants.” In establishing value, the tree condition prior to construction shall be assumed to be in an above average condition.
C. Completely remove stump and replace replaceable trees, or credit Owner appraised value of nonreplaceable trees lost during construction and construction guarantee period.

PART 2 PRODUCTS

2.1 BARRIER
A. Six feet high, continuous fence, with woven 1-1/2 x 1-1/2 inch fabric with posts as required preventing adjustment of fencing during construction.

PART 3 EXECUTION

3.1 GENERAL
A. Protected Zone: Install and maintain barrier at edge of leaf canopy (drip line). Do not provide gates or means of access.
B. Control: Avoid activities that would cause compaction or contamination of soil within barrier. Do not permit parking, storage, or construction traffic within barrier. Do not store
or dump liquids or powders in locations where spills would flow into root area (root area extends up to 40 feet from trunk of major trees).

3.2 LIMBING AND PRUNING

A. Landscape Contractor shall coordinate with School District Staff for all limbing of dead branches up to a height of 12 feet and within 1 inch of face or bark for all existing conifer trees to be saved on the project site.

B. Pruning shall be done by qualified tree surgeon.

3.3 CONSTRUCTION WITHIN PROTECTED ZONE

A. Total impact to the root zone of a tree shall not exceed 30% of the overall area defined by the drip line of the tree.

B. Clearing and Grubbing: Clearing and grubbing under drip line of protected trees will be with hand tools.

C. Cutting Roots: Cut roots with method that will not vibrate or displace remaining roots within the soil mass. Cutting with axe will satisfy this requirement. Do not pound roots with shovel or backhoe bucket.

D. Grading: Use methods that will not result in tire or track pressure in protected area for existing trees. If fills exceed 12 inches or cuts exceed 6 inches, contact Owner’s Representative for interpretation of Grading Plan.

E. Trenching: Where drawings show trenched utility through protected area for existing trees, stockpile away from tree and hold tree side of trench to vertical face; shore if necessary. Where Contractor designs utility routes, contact Owner’s Representative for approval prior to trenching in protected areas.

F. Pavements: While some plant growth inhibitors may be used under pavements, soil sterilants shall not be used where roots may possibly extend or where sterilant may be washed or leached into root area. If chemical control of subgrade weed growth is necessary, utilize the following method:

1. Remove weeds by mechanical means or by application of Roundup by Monsanto.
NOTES:
1. REMOVE ALL BARRIERS UPON COMPLETION OF PROJECT.

FOR PRUNING SEE NATIONAL ARBORIST ASSOCIATION SPECS.

DEAD TREES AND SCRUB OR UNDERGROWTH SHALL BE CUT FLUSH WITH ADJACENT GRADE. NO GRUBBING ALLOWED UNDER DRIP LINE.
PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Monolithic concrete manholes and structures with transition to cover frame, covers, anchorage, and accessories.
   3. Monolithic FRP manholes and structures with transition to cover frame, covers, anchorage, and accessories.
   4. Masonry manholes and structures with masonry transition to cover frame, covers, anchorage, and accessories.
   5. Bedding and cover materials.

B. Related Sections:
   1. Section 03 3000 - Cast-In-Place Concrete: Concrete type for manhole base pad construction.
   2. Section 31 0513 - Soils for Earthwork: Soil for backfill in trenches.
   4. Section 31 2316 - Excavation: Excavating for manholes and structures.
   5. Section 31 2323 - Fill: Backfilling after manhole and structure installation.

1.2 REFERENCES

A. American Concrete Institute:
   1. ACI 318 - Building Code Requirements for Structural Concrete.
   2. ACI 530/530.1 - Building Code Requirements for Masonry Structures and Specifications for Masonry Structures.

B. ASTM International:
   10. ASTM C497M - Standard Test Methods for Concrete Pipe, Manhole Sections, or Tile (Metric).
1.3 DESIGN REQUIREMENTS
   A. Equivalent strength: Based on structural design of reinforced concrete as outlined in ACI 318.

1.4 SUBMITTALS
   A. Section 01 3300 - Administrative Requirements: Requirements for submittals.
   B. Shop Drawings: Indicate manhole and structure locations, elevations, piping, conduit, and sizes and elevations of penetrations.
   C. Product Data: Submit cover and frame construction, features, configuration, dimensions.
      1. Materials Resources Certificates:
         a. Certify source and origin for products.
         b. Certify recycled material content for recycled content products.
         c. Certify source for local and regional materials and distance from Project site.

1.5 QUALITY ASSURANCE
   B. Maintain one copy of each document on site.

1.6 QUALIFICATIONS
   A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum three years documented experience.

1.7 DELIVERY, STORAGE AND HANDLING
   A. Section 01 6150 - Delivery, Storage, and Handling: Product storage and handling requirements.
   B. Comply with precast concrete manufacturer’s instructions for unloading, storing and moving precast manholes and structures.
   C. 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.
   D. 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.

PART 2 PRODUCTS

2.1 MANHOLES AND STRUCTURES INCLUDING PROTECTIVE COATINGS
   A. Furnish materials in accordance with Section 00470 of the 2015 Oregon Standard Specifications for Construction.
B. Manhole and Structure Sections: Reinforced precast concrete in accordance with ASTM C478 (ASTM C478M) with gaskets in accordance with ASTM C923 (ASTM C923M).

C. All reinforced manholes must be lined with an approved sulfide resistant material with a 50 year life.

2.2 FRAMES AND COVERS

A. Furnish materials in accordance with Section of the 2015 Oregon Standard Specifications for Construction.

2.3 CONFIGURATION

A. Furnish materials in accordance with Section 00470 of the 2015 Oregon Standard Specifications for Construction.

2.4 BEDDING AND COVER MATERIALS

A. Bedding: Base Aggregate as specified in Section 31 0516

B. Cover: Base Aggregate as specified in Section 31 0516

C. Soil Backfill from Above Pipe to Finish Grade: Base Aggregate as specified in Section 31 0516

2.5 FINISHING - STEEL

A. Furnish materials in accordance with Section 00470 of the 2015 Oregon Standard Specifications for Construction.

PART 3 EXECUTION

3.1 EXAMINATION

A. Section 01 4000 - Quality Control: 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.

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 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 veering firmly and fully on crushed stone bedding, compacted in accordance with provisions of Section 31 2316 and 31 2323 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 services.

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 flush with interior of structure.

J. Shape inverts through manhole and structures as shown on Drawings.

3.4 FRAME AND COVER INSTALLATION

A. Set frame and cover 2 inches (50.8 mm) above finished grade for manholes and structures with covers located within unpaved areas to allow to be graded away from cover beginning 1 inch (25.4 mm) below top surface of frame.

3.5 FIELD QUALITY CONTROL

A. Section 01 4000 - Quality Control 01 7000 - Contract Closeout Requirements: Field inspecting, testing, adjusting, and balancing.

B. Test cast-in-place concrete in accordance with Section 03 3000.

C. 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.
   3. Remove concrete without damaging existing vertical reinforcing bars when removal of existing concrete wall is required. Clean vertical bars of concrete and bend into new concrete top slab or splice to required vertical reinforcement, as indicated Drawings.
   4. Clean and apply sand-cement bonding compound on existing concrete surfaces to receive cast-in-place concrete in accordance with Section 03 3000.
3.6 SCHEDULES

A. NOT USED.

END OF SECTION
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. Valves.
   3. Hydrants.
   4. Positive displacement meters.
   5. Backflow preventers.
   7. Precast concrete vault.
   8. Bedding and cover materials.

B. Related Sections:
   1. Section 03 3000 - Cast-In-Place Concrete: Concrete for thrust restraints.
   2. Section 31 0513 - Soils for Earthwork: Soils for backfill in trenches.
   4. Section 31 2316 - Excavation: Product and execution requirements for excavation and backfill required by this section.
   5. Section 31 2317 - Trenching: Execution requirements for trenching required by this section.
   6. Section 31 2323 - Fill: Requirements for backfill to be placed by this section.
   7. Section 33 1300 - Disinfecting of Water Utility Distribution: Disinfection of site service utility water piping.

1.2 REFERENCES

A. American Association of State Highway and Transportation Officials:

B. 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.

C. American Society of Sanitary Engineering:
   1. ASSE 1012 - Backflow Preventer with Intermediate Atmospheric Vent.
   2. ASSE 1013 - Reduced Pressure Principle Backflow Preventers.

D. ASTM International:
   5. ASTM D698 - Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft3 (600 kN-m/m3)).
   6. ASTM D1557 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3 (2,700 kN-m/m3)).

E. American Welding Society:
1. AWS A5.8 - Specification for Filler Metals for Brazing and Braze Welding.

F. American Water Works Association:
5. AWWA C500 - Metal-Seated Gate Valves for Water Supply Service.
6. AWWA C502 - Dry-Barrel Fire Hydrants.
7. AWWA C504 - Rubber-Sealed Butterfly Valves.
8. AWWA C508 - Swing-Check Valves for Waterworks Service, 2 in. (50 mm) Through 24 in. (600 mm) NPS.
9. AWWA C509 - Resilient-Seated Gate Valves for Water-Supply Service.
10. AWWA C600 - Installation of Ductile-Iron Water Mains and Their Appurtenances.
11. AWWA C606 - Grooved and Shouldered Joints.
12. AWWA C700 - Cold-Water Meters - Displacement Type, Bronze Main Case.
13. AWWA C701 - Cold-Water Meters - Turbine Type, for Customer Service.
14. AWWA C702 - Cold-Water Meters - Compound Type.
15. AWWA C706 - Direct-Reading, Remote-Registration Systems for Cold-Water Meters.
16. AWWA C900 - Polyvinyl Chloride (PVC) Pressure Pipe, 4 in. through 12 in., for Water Distribution.
17. AWWA C901 - Polyethylene (PE) Pressure Pipe and Tubing, 1/2 in. through 3 in., for Water Service.

G. Underwriters Laboratories Inc.:
1. UL 246 - Hydrants for Fire - Protection Service.

1.3 SUBMITTALS

A. Section 01 3300 - Submittal Procedures: Requirements for submittals.

B. Product Data: Submit data on pipe materials, pipe fittings, valves and accessories.

C. Manufacturer's Certificate: Certify Products meet or exceed specified requirements.
1.4 CLOSEOUT SUBMITTALS

A. Section 01 7000 - Execution and Closeout Requirements: Requirements for submittals.
B. 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.

1.5 QUALITY ASSURANCE

A. Valves: Manufacturer's name and pressure rating marked on valve body.
B. Perform Work in accordance with Section 01140 of the 2015 Oregon Standard Specifications for Construction.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Section 01 6150 - Product Requirements: 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 WATER PIPING


2.2 GATE VALVES

A. Furnish materials in accordance with Section 01150 of the 2015 Oregon Standard Specifications for Construction.
B. 3 Inches (75 mm) and larger: AWWA C509, Iron body, bronze trim, non-rising stem with square nut, single wedge, resilient seat, flanged ends, control rod, 4 post indicator, extension box, and valve key.

2.3 UNDERGROUND PIPE MARKERS

A. Manufacturers: Furnish and install in accordance with Section 01140 of the 2015 Oregon Standard Specifications for Construction.
2.4 BEDDING AND COVER MATERIALS

A. Bedding: Base Aggregate as specified in Section 31 0516.

B. Cover: Base Aggregate as specified in Section 31 0516.

C. Soil Backfill from Above Pipe to Finish Grade: in hardscape areas, use Base Aggregate for Trench Backfill. In areas of soft scape, use Class A (screened native).

2.5 ACCESSORIES


PART 3 EXECUTION

3.1 EXAMINATION

A. Section 01 3100 - Administrative Requirements: 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.

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 2317 for Work of this Section.

B. Backfill around sides and to top of pipe in accordance with Section 31 2323.

C. Maintain optimum moisture content of fill material to attain required compaction density.

3.4 INSTALLATION - PIPE

A. Maintain separation of water main from sewer piping in accordance with Section 61 050 of Chapter 333 of the Oregon Administrative Rules.

B. Maintain separation of water service piping from sewer or drainage piping in accordance with Section 609.2 of the 2014 Oregon Plumbing Specialty Code.

C. Install trace wire continuous over top of pipe coordinate with Sections 31 2323 and 31 2317. Install delectable marking tape 12 inches above top at pipe.
D. Backfill trench in accordance with Section 31 2323.

3.5 DISINFECTION OF DOMESTIC WATER PIPING SYSTEM

A. Flush and disinfect system in accordance with Section 33 1300.

3.6 FIELD QUALITY CONTROL

A. Section 01 4000 - Quality requirements, 01 7700 - Execution and Closeout Requirements: Field inspecting, testing, adjusting, and balancing.

B. Perform hydrostatic testing and disinfection in accordance with Section 01140 of the 2015 Oregon Standard Specifications for Construction, as modified by the City of Sisters Standards and Specifications, and Section 33 1300.


D. When tests indicate Work does not meet specified requirements, remove Work, replace and retest.

END OF SECTION
PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Pipe and fittings for domestic water service connections to buildings.
   2. Corporation stops assembly.
   3. Curb stop assembly.
   4. Meter setting equipment.
   5. Water meters.
   8. Bedding and cover materials.

B. Related Sections:
   1. Section 03 3000 - Cast-In-Place Concrete.
   2. Section 22 0523 - General-Duty Valves for Plumbing Piping.
   3. Section 22 1100 - Facility Water Distribution.
   4. Section 31 0513 - Soils for Earthwork.
   5. Section 31 0516 - Aggregates for Earthwork.
   6. Section 31 2316 - Excavation.
   7. Section 31 2317 - Trenching.
   8. Section 31 2323 - Fill.
  10. Section 33 1300 - Disinfecting of Water Utility Distribution

1.2 REFERENCES

A. American Association of State Highway and Transportation Officials:

B. 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.

C. American Society of Sanitary Engineering:
   1. ASSE 1012 - Backflow Preventer with Intermediate Atmospheric Vent.
   2. ASSE 1013 - Reduced Pressure Principle Backflow Preventers.

D. ASTM International:
   2. ASTM B62 - Standard Specification for Composition Bronze or Ounce Metal Castings.
   6. ASTM D698 - Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft3 (600 kN-m/m3)).
   7. ASTM D1557 - Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (56,000 ft.lbf/ft3 (2,700 kN-m/m3)).

E. American Welding Society:
1. AWS A5.8 – Specification for Filler Metals for Brazing and Braze Welding.

F. American Water Works Association:
1. AWWA C600 - Installation of Ductile-Iron Water Mains and Their Appurtenances.
2. AWWA C700 - Cold-Water Meters - Displacement Type, Bronze Main Case.
3. AWWA C701 - Cold-Water Meters - Turbine Type, for Customer Service.
4. AWWA C702 - Cold-Water Meters - Compound Type.
5. AWWA C706 - Direct-Reading, Remote-Registration Systems for Cold-Water meters.
6. AWWA C800 - Underground Service Line Valves and Fittings.
7. AWWA C901 - Polyethylene (PS) Pressure Pipe and Tubing 1/2 in. through 3 in., for Water Service.

1.3 SUBMITTALS

A. Section 01 3300 – Submittal Procedures Requirements for submittals.

B. Shop Drawings: Provide shop drawings for precast concrete vaults to include detail drawings showing the vault and accessories.

C. Product Data: Submit data on pipe materials, pipe fittings, corporation stop assemblies, curb stop assemblies, meters, meter setting equipment, service saddles, backflow preventer, and accessories.

D. Manufacturer’s Certificate: Certify Product meet or exceed specified requirements.

1.4 CLOSEOUT SUBMITTALS

A. Section 01 7700 - Execution and Closeout Requirements: Requirements for submittals.

B. Project Record Documents: Record actual locations of piping mains, curb stops, connections, thrust restraints, and invert elevations.

C. Identify and describe unexpected variations to subsoil conditions or discovery of uncharted utilities.
1.5 QUALITY ASSURANCE

A. Perform Work in accordance with Sections 01140 and 01170 of the 2015 Oregon Standard Specifications for Construction.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Section 01 6150 – Produce Requirements: Requirements for transporting, handling, storing, and protecting products.

B. During loading, transporting, and unloading of materials and products, exercise care to prevent any damage.

C. Store products and materials off ground and under protective coverings and custody, away from walls and in manner to keep these clean and in good condition until used.

D. Exercise care in handling precast concrete products to avoid chipping, cracking, and breakage.

PART 2 PRODUCTS

2.1 WATER PIPING AND FITTINGS

A. Furnish materials in accordance with Section 01170 of the 2015 Oregon Standard Specifications for Construction, as modified by the City of Sisters Standards and Specifications.

B. PVC Pipe: Schedule 40, ASTM D2241:
   1. Fittings: Schedule 40, ASTM D2241.

C. Polyethylene Pipe: AWWA C901 with high molecular mass with a 200 psi pressure rating:
   1. Fittings: Compression

2.2 CORPORATION STOP ASSEMBLY

A. Furnish materials in accordance Section 01170 of the 2015 Oregon Standard Specifications for Construction, as modified by the City of Sisters Standards and Specifications.

B. Corporation Stops:
   1. Brass or red brass alloy body conforming to ASTM B62.
   2. Inlet end threaded for tapping according to AWWA C800.
   3. Outlet end suitable for service pipe specified.

C. Service Saddles:
   1. Double strap type, designed to hold pressures in excess pipe working pressure.

2.3 PREPARATION CURB STOP ASSEMBLY

A. Furnish materials in accordance Section 01170 of the 2015 Oregon Standard Specifications for Construction, as modified by the City of Sisters Standards and Specifications.
B. **Curb Stops:**
   1. Brass or red brass alloy body conforming to ASTM B62.
   2. Plug type valve.
   3. Positive pressure sealing.

C. **Curb Boxes and Covers:**
   1. Cast iron body, Extension Type or Buffalo Type.
   2. Minneapolis or Arch Pattern Base.
   3. Lid with inscription WATER, with Pentagon Plug.

### 2.4 METER SETTING EQUIPMENT

A. Furnish materials in accordance Section 01170 of the 2015 Oregon Standard Specifications for Construction, as modified by the City of Sisters Standards and Specifications.

B. **Outside Meter Setting:**
   1. Meter Yokes: Copper or iron, riser type assembly with bronze inlet inverted key angle valve expansion type outlet connection and Ell fitting; flared copper tubing connections both ends.
   2. Meter Yokes: Copper or iron, inlet and outlet horizontal or vertical setting with matching couplings, fittings and stops.

### 2.5 WATER METERS

A. Furnish materials in accordance Section 01170 of the 2015 Oregon Standard Specifications for Construction, as modified by the City of Sisters Standards and Specifications.

### 2.6 BACKFLOW PREVENTERS

A. Furnish materials in accordance Section 02480 of the 2015 Oregon Standard Specifications for Construction, as modified by the City of Sisters Standards and Specifications.

### 2.7 UNDERGROUND PIPE MARKERS

A. Furnish materials in accordance Section 02470 of the 2015 Oregon Standard Specifications for Construction, as modified by the City of Sisters Standards and Specifications.

### 2.8 BEDDING, PIPE COVER, AND TRENCH BACKFILL MATERIALS

A. Bedding: Base Aggregate as specified in Section 31 0516.

B. Pipe Cover: Base Aggregate as specified in Section 31 0516.

C. Trench Backfill: in hardscape areas, use Base Aggregate for Trench Backfill. In areas of soft scape, use Class A (screened native).

### 2.9 ACCESSORIES

A. Concrete for Thrust Restraints: Concrete type specified in Section 03 3000.
PART 3 EXECUTION

3.1 EXAMINATION

A. Section 01 3100 – Administrative Requirements: 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.

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 FIELD QUALITY CONTROL

A. Perform hydrostatic testing and disinfection in accordance with Section 01140 of the 2015 Oregon Standard Specifications for Construction, as modified by the City of Sisters Standards and Specifications, and Section 33 1300.
PART 1 GENERAL

1.1 SUMMARY

A. Section includes disinfection of potable water distribution system; and testing and reporting results.

B. Related Sections:
   1. Section 33 1116 - Site Water Utility Distribution Piping Product and Execution requirements for installation, testing, or site domestic water distribution piping.

1.2 REFERENCES

A. American Water Works Association:
   1. AWWA B300 - Hypochlorites.
   2. AWWA B301 - Liquid Chlorine
   3. AWWA B302 - Ammonium Sulfate.
   4. AWWA B303 - Sodium Chlorite.
   5. AWWA C600 - Installation of Ductile-Iron Water Mains and Their Appurtenances.
   6. AWWA C651 - Disinfecting Water Mains.

1.3 SUBMITTALS

A. Section 01 3300 - Submittal Procedures: Requirements for submittals.

B. Product Data: Submit procedures, proposed chemicals, and treatment levels for review.

C. Test Reports: Indicate results comparative to specified requirements.

D. Certificate: Certify cleanliness of water distribution system meets or exceeds specified requirements.

1.4 CLOSEOUT SUBMITTALS

A. Section 01 7700 - Execution and Closeout Requirements: Requirements for submittals.

B. 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.

C. 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.
SECTION 33 1300
DISINFECTION OF WATER UTILITY DISTRIBUTION

7. Certify water conforms, or fails to conform, to bacterial standards of State of Oregon.

D. Water Quality Certificate: Certify water conforms to quality standards of the City of Sisters, suitable for human consumption.

1.5 QUALITY ASSURANCE

A. Perform Work in accordance with Section 01140 of the 2015 Oregon Standard Specifications for Construction, as modified by the City of Sisters Standards and Specifications.

1.6 QUALIFICATIONS

A. Water Treatment Firm: Company specializing in disinfecting potable water systems specified in this section with minimum three years documented experience.


C. Submit bacteriologist’s signature and authority associated with testing.

PART 2 PRODUCTS

2.1 MATERIALS

A. Furnish disinfection chemicals in accordance with Section 01140 of the 2015 Oregon Standard Specifications for Construction, as modified by the City of Sisters Standards and Specifications.

PART 3 EXECUTION

3.1 EXAMINATION

A. Section 01 3300 - Administrative Requirements: Verification of existing conditions before starting work.

B. Verify piping system has been cleaned, inspected, and pressure tested.

C. Perform scheduling and disinfecting activity with start-up, water pressure testing, adjusting and balancing, demonstration procedures, including coordination with related systems.

3.2 INSTALLATION

A. Coordinate all testing with City of Sisters 48 hours in advance of testing.

B. Provide and attach required equipment to perform the Work of this section.

C. Perform disinfection of water distribution system and installation of system and pressure testing. Refer to Section 33 1116.

D. Inject treatment disinfectant into piping system.
E. Maintain disinfectant in system for 24 hours.

F. Flush, circulate, and clean until required cleanliness is achieved.

G. Replace permanent system devices removed for disinfection.

3.3 FIELD QUALITY CONTROL

A. Section 01 4000 - Quality Requirements and 01 7700 - Execution and Closeout Requirements: Field inspecting, testing, adjusting, and balancing.

B. 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
PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Sanitary sewage pipe.
   2. Underground pipe markers.
   4. Bedding and cover materials.

B. Related Sections:
   1. Section 03 3000 - Cast-In-Place Concrete: Concrete type for manhole base pad construction.
   2. Section 31 0513 - Soils for Earthwork: Soils for backfill in trenches.
   4. Section 31 2316 - Excavation: Product and execution requirements for excavation and backfill required by this section.
   5. Section 31 2317 - Trenching: Execution requirements for trenching required by this section.
   6. Section 31 2323 - Fill: Requirements for backfill to be placed by this section.

1.2 REFERENCES

A. American Association of State Highway and Transportation Officials:

B. ASTM International:
   2. ASTM C14 - Standard Specification for Concrete Sewer, Storm Drain, and Culvert Pipe.
   9. ASTM D698 - Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft.lbf/ft³ (600 kN·m/m³)).
  10. ASTM D1557 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft.lbf/ft³ (2,700 kN·m/m³)).

1.3 DEFINITIONS

A. Bedding: Fill placed under, beside and directly over pipe, prior to subsequent backfill operations.

1.4 SUBMITTALS

A. Section 01 3300 - Submittal Procedures: Requirements for submittals.
B. Product Data: Submit data indicating pipe material used, pipe accessories, etc.
C. Manufacturer's Installation Instructions: Indicate 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 7000 - Execution and Closeout Requirements: Requirements for submittals.
B. Project Record Documents: Record location of pipe runs, connections, manholes, cleanouts, and invert elevations.
C. Identify and describe unexpected variations to subsoil conditions or discovery of uncharted utilities.

1.6 QUALITY ASSURANCE

A. Perform Work in accordance with Section 00445 of the 2015 Oregon Standard Specifications for Construction, as modified by the City of Sisters Standards and Specifications.

1.7 FIELD MEASUREMENTS

A. Verify field measurements and elevations are as indicated.
1.8 COORDINATION

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

B. Coordinate the Work with termination of sanitary sewer connection outside building, connection to existing sewer facilities.

PART 2 PRODUCTS

2.1 SANITARY SEWAGE PIPE

A. Plastic Pipe: ASTM D3034, SDR 35 (Minimum), Poly Vinyl Chloride (PVC) material; inside nominal diameter as indicated on Drawings bell and spigot style rubber ring sealed gasket joint.
   1. Fittings: PVC.

2.2 UNDERGROUND PIPE MARKERS

A. Furnish in accordance with Section 00445 of the 2015 Oregon Standard Specifications for Construction, as modified by the City of Sisters Standards and Specifications.

   B. Plastic Ribbon Tape: Bright colored, continuously printed, minimum 6 inches (150 mm) wide by 4 mil (0.10 mm) thick, manufactured for direct burial service.

   C. Trace Wire: Magnetic detectable conductor, brightly colored plastic covering, imprinted with "Sewer Service" in large letters.

2.3 BEDDING AND COVER MATERIALS

A. Bedding: Base Aggregate as specified in Section 31 0516.

B. Cover: Base Aggregate as specified in Section 31 0516.

C. Soil Backfill from Above Pipe to Finish Grade: Per Section 31 2317 – Trenching.

PART 3 EXECUTION

3.1 EXAMINATION

A. Section 01 3000 - Administrative Requirements: Verification of existing conditions before starting work.

B. Verify site subgrade is ready to receive work and excavations, dimensions, and elevations are as indicated on drawings.

3.2 PREPARATION

A. Correct over excavation with base course.
B. Remove large stones or other hard matter which could damage pipe or impede consistent backfilling or compaction.

3.3 BEDDING

A. Excavate pipe trench in accordance with Section 31 2317.

B. Place bedding material at trench bottom, level materials in continuous layer not exceeding 6 inches.

C. Maintain optimum moisture content of bedding material to attain required compaction density.

3.4 INSTALLATION - PIPE

A. Install pipe in accordance with Section 00445 of the 2015 Oregon Standard Specifications for Construction, as modified by the City of Sisters Standards and Specifications.

3.5 FIELD QUALITY CONTROL

A. Section 01 4000 - Quality Requirements and 01 7700 - Execution and Closeout Requirements: Field inspecting, testing, adjusting, and balancing.

B. Perform test on site sanitary sewage system in accordance with Section 00445 of the 2015 Oregon Standard Specifications for Construction, as modified by the City of Sisters Standards and Specifications.

3.6 PROTECTION OF FINISHED WORK

A. Section 01 7000 - Execution and Closeout Requirements: Requirements for protecting finished Work.

B. Protect pipe and aggregate cover from damage or displacement until backfilling operation is in progress.

END OF SECTION
PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Storm drainage piping.
   2. Accessories.
   4. Catch basins and plant area drains.
   5. Cleanouts.

B. Related Sections:
   1. Section 00 3132 - Geotechnical Report
   2. Section 03 3000 - Cast-In-Place Concrete: Concrete type for [catch basin] [cleanout] base pad construction.
   4. Section 22 1400 - Facility Storm Drainage: Product and execution requirements for storm drainage piping within 5 feet (1500 mm) of building.
   5. Section 31 0513 - Soils for Earthwork: Soils for backfill in trenches.
   7. Section 31 2316 - Excavation: Product and execution requirements for excavation and backfill required by this section.
   8. Section 31 2317 - Trenching: Execution requirements for trenching required by this section.
   9. Section 31 2323 - Fill: Requirements for backfill to be placed by this section.
  10. Section 33 0513 - Manholes and Structures.
  11. Section 33 4600 - Subdrainage: Termination of subdrainage tile system for connection to Work of this Section.

1.2 REFERENCES

A. American Association of State Highway and Transportation Officials:

B. ASTM International:
   2. ASTM C14 - Standard Specification for Concrete Sewer, Storm Drain, and Culvert Pipe.
   6. ASTM C924 - Standard Practice for Testing Concrete Pipe Sewer Lines by Low-Pressure Air Test Method.
   7. ASTM C969 - Standard Practice for Infiltration and Exfiltration Acceptance Testing of Installed Precast Concrete Pipe Sewer Lines.
   8. ASTM C969M - Standard Practice for Infiltration and Exfiltration Acceptance Testing of Installed Precast Concrete Pipe Sewer Lines (Metric).
  10. ASTM D698 - Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft.lbf/ft3 (600 kN-m/m3)).
11. ASTM D1557 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft.lbf/ft³ (2,700 kN-m/m³)).


1.3 SUBMITTALS

A. Section 01 3300 - Submittal Procedures: Requirements for submittals.

B. Product Data: Submit data indicating pipe, pipe accessories, etc.

C. Manufacturer's Installation Instructions: Submit special procedures required to install Products specified.

D. Manufacturer's Certificate: Certify Products meet or exceed specified requirements.

1.4 CLOSEOUT SUBMITTALS

A. Section 01 7000 - Execution and Closeout Requirements: Requirements for submittals.

B. Project Record Documents:
   1. Accurately record actual locations of pipe runs, connections, catch basins, cleanouts, and invert elevations.
   2. Identify and describe unexpected variations to subsoil conditions or discovery of uncharted utilities.

1.5 QUALITY ASSURANCE

A. Perform Work in accordance with Section 00445 of the 2015 Oregon Standard Specifications for Construction.

B. Maintain one copy of each document on site.
1.6 PRE-INSTALLATION MEETINGS
   A. Section 01 3000 - Administrative Requirements: Pre-installation meeting.
   B. Convene minimum one week prior to commencing work of this section.

1.7 COORDINATION
   A. Section 01 3000 - Administrative Requirements: Coordination and project conditions.
   B. Coordinate the Work with termination of storm sewer connection outside building to building drainage systems.

PART 2 PRODUCTS

2.1 STORM DRAINAGE PIPING
   A. Furnish materials in accordance with Section 00445 of the 2015 Oregon Standard Specifications for Construction.

2.2 ACCESSORIES
   A. Filter Fabric: Non-biodegradable, non-woven.
   B. Grout: Specified in Section 03 3000 and 04 0503.

2.3 UNDERGROUND PIPE MARKERS
   A. Plastic Ribbon Tape: Bright colored, continuously printed, minimum 6 inches wide by 4 mil thick, manufactured for direct burial service.
   B. Trace Wire: Magnetic detectable conductor, clear brightly colored plastic covering, imprinted with "Storm Sewer Service" in large letters.

2.4 CATCH BASINS AND PLANT AREA DRAINS
   A. Catch Basin Lid and Frame Manufacturers: As indicated on the drawings, or approved equal.
   B. Furnish materials in accordance with Section 00470 of the 2015 Oregon Standard Specifications for Construction.
   C. Base Pad: Cast-in-place concrete of type specified in Section 03 3000.

2.5 BEDDING AND COVER MATERIALS
   A. Bedding: Base Aggregate as specified in Section 31 0516.
   B. Cover: Aggregate as specified in Section 31 0516.
C. Soil Backfill from Above Pipe to Finish Grade: Class A backfill as defined in Section 00405 of the 2015 Oregon Standard Specifications for Construction. In areas where piping is below hardscape such as roads, walks, slabs, etc., trench backfill shall be Base Aggregate as specified in Section 31 0516.

PART 3 EXECUTION

3.1 EXAMINATION

A. Section 01 3000 - Administrative Requirements: 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 layout drawings.

3.2 PREPARATION

A. Hand trim excavations to required elevations. Correct over excavation with fine coarse aggregate lean concrete.

B. Remove large stones or other hard matter which could damage piping or impede consistent backfilling or compaction.

3.3 BEDDING

A. Excavate pipe trench in accordance with Section 31 2317 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 6 inches compacted depth.

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. Place pipe on minimum 6 inch deep bed of base aggregate as specified in Section 31 0516.

C. Lay pipe to slope gradients noted on drawings with maximum variation from indicated slope of 1/8 inch in 10 feet.

D. Install aggregate at sides and over top of pipe. Install top cover to minimum compacted thickness of 12 inches, compact to 95 percent.

E. Refer to Section 31 2323 for backfilling and compacting requirements. Do not displace or damage pipe when compacting.

F. Refer to Section 33 0513 for manhole requirements.

G. Connect to drywell/infiltration ponds.
H. Install trace wire continuous over top of pipe buried 6 inches below finish grade, coordinate with Sections 31 2323 and 31 2317.

I. Connect to subdrainage tile system piping. Refer to Section 33 46 00.

J. Install site storm drainage system piping to 5 feet of building. Connect to building storm drainage system. Refer to Section 22 14 00.

3.5 INSTALLATION - CATCH BASINS AND CLEANOUTS

A. Form bottom of excavation clean and smooth to correct elevation.

B. Form and place Cast-In-Place Concrete base pad, with provision for storm sewer pipe end sections.

C. Level top surface of base pad; sleeve concrete shaft sections to receive storm sewer pipe sections.

D. Establish elevations and pipe inverts for inlets and outlets as indicated on Drawings.

E. Mount lid and frame level in grout, secured to top cone section to elevation indicated.

3.6 FIELD QUALITY CONTROL

A. Section 01 4000 - Quality Requirements 01 400 - Execution and Closeout Requirements 01 700: Field inspecting, testing, adjusting, and balancing.

B. Request inspection prior to and immediately after placing aggregate cover over pipe.

C. Compaction Testing: Refer to Document 00 3300 for density requirements.

D. When tests indicate work does not meet specified requirements, remove work, replace and retest.

E. Frequency of Compaction Tests: One compaction test per 100 feet of trench and three foot of depth.

F. Infiltration Test: Test in accordance with ASTM 969.

G. Deflection Test: Test in accordance with Section 00445 of the 2015 Oregon Standard Specifications for Construction.

H. Pressure Test: Test in accordance with ASTM C924 and ASTM C1103 depending on size of pipe.

3.7 PROTECTION OF FINISHED WORK

A. Section 01 7000 - Execution and Closeout Requirements: 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.
3.8 SCHEDULE

A. NOT USED

END OF SECTION
COMcheck Software Version 4.0.6.1

Interior Lighting Compliance Certificate

Section 1: Project Information

Project Title:
Project Type: New Construction
Construction Site: Owner/Agent: Designer/Contractor:
525 E Cascade Avenue
Deschutes County
Sisters, OR 97759

Section 2: Interior Lighting and Power Calculation

<table>
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<tr>
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<th>B Floor Area</th>
<th>C Allowed Watts / ft²</th>
<th>D Allowed Watts</th>
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<td>8103</td>
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Total Allowed Watts = 8103

Section 3: Interior Lighting Fixture Schedule

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<th>Fixture ID</th>
<th>Description / Lamp / Wattage Per Lamp / Ballast</th>
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<th>B Lamps/Fixture</th>
<th>C # of Fixtures</th>
<th>D Fixture Watt.</th>
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Total Proposed Watts = 3348

Section 4: Requirements Checklist

In the following requirements, blank checkboxes identify requirements that the applicant has not acknowledged as being met. Checkmarks identify requirements that the applicant acknowledges are met or excepted from compliance. ‘Plans reference page/section’ identifies where in the plans/specs the requirement can be verified as being satisfied.

**Lighting Wattage:**

✔ 1. Total proposed watts must be less than or equal to total allowed watts.
   Allowed Wattage: 8103  Proposed Wattage: 3348
   Complies: YES

**Mandatory Requirements:**

✔ 2. Exit signs. Internally illuminated exit signs shall not exceed 5 watts per side.

   Plans reference page/section: \**E0.02**

✔ 3. Daylight zone control. All daylight zones are provided with individual controls that control the lights independent of general area lighting in the non-daylight zone. In all individual daylight zones larger than 350 sq.ft., automatic daylight controls is provided. Automatic daylight sensing controls reduce the light output of the controlled luminaires at least 50 percent, and provide an automatic OFF control, while maintaining a uniform level of illumination. Contiguous daylight zones adjacent to vertical fenestration may be controlled by a single controlling device provided that they do not include zones facing more than two adjacent cardinal orientations (i.e., north, east, south, west). Daylight zones under skylights shall be controlled separately from daylight zones adjacent to vertical fenestration.

   Plans reference page/section: \**E2.01**

✔ 4. Interior lighting controls. At least one local shutoff lighting control has been provided for every 2,000 square feet of lit floor area and each area enclosed by walls or floor-to-ceiling partitions. The required controls are located within the area served by the controls or are a remote switch that identifies the lights served and indicates their status.
| **5.** Sleeping unit controls. Master switch at entry to hotel/motel guest room. | ✔ |
| Plans reference page/section: | E2.01 |
| **6.** Egress lighting. Egress illumination is controlled by a combination of listed emergency relay and occupancy sensors to shut off during periods that the building space served by the means of egress is unoccupied. | ✔ |
| Plans reference page/section: | E2.01 |
| **7.** Additional controls. Each area that is required to have a manual control shall have additional controls that meet the requirements of Sections 505.2.2.1 and 505.2.2.2. | ✔ |
| Plans reference page/section: | E2.01 |
| **8.** Light reduction controls. Each space required to have a manual control also allows for reducing the connected lighting load by at least 50 percent by either 1) controlling (dimming or multi-level switching) all luminaires; or 2) dual switching of alternate rows of luminaires, alternate luminaires, or alternate lamps; or 3) switching the middle lamp luminaires independently of other lamps; or 4) switching each luminaire or each lamp. | ✔ |
| Plans reference page/section: | E2.01 |
| **9.** Buildings larger than 2,000 square feet are equipped with an automatic control device to shut off lighting in those areas. This automatic control device shall function on either: 1) a scheduled basis, using time-of-day, with an independent program schedule that controls the interior lighting in areas that do not exceed 10,000 square feet and are not more than one floor; or 2) an occupant sensor that shall turn lighting off within 30 minutes of an occupant leaving a space; or 3) a signal from another control or alarm system that indicates the area is unoccupied. | ✔ |
| Plans reference page/section: | E2.01 |
| **10.** Occupancy sensors in rooms that include daylight zones are required to have Manual ON activation. | ✔ |
| Plans reference page/section: | E2.01 |
| **11.** An occupant sensor control device is installed that automatically turns lighting off within 30 minutes of all occupants leaving a space. | ✔ |
| Plans reference page/section: | E2.01 |
| **12.** Additional controls. An occupant sensor control device that automatically turns lighting off within 30 minutes of all occupants leaving a space or a locally activated switch that automatically turns lighting off within 30 minutes of being activated is installed in all storage and supply rooms up to 1000 square feet. | ✔ |
| Plans reference page/section: | E2.01 |
| **13.** Occupant override. Automatic lighting shutoff operating on a time-of-day scheduled basis incorporates an override switching device that: 1) is readily accessible, 2) is located so that a person using the device can see the lights or the area controlled by that switch, or so that the area being lit is annunciated, 3) is manually operated, 4) allows the lighting to remain on for no more than 2 hours when an override is initiated, and 5) controls an area not exceeding 2,000 square feet. | ✔ |
| Plans reference page/section: | E2.01 |
| **14.** Holiday scheduling. Automatic lighting shutoff operating on a time-of-day scheduled basis has an automatic holiday scheduling feature that turns off all loads for at least 24 hours, then resumes the normally scheduled operation. | ✔ |
| Plans reference page/section: | NA |
| **15.** Exterior lighting controls. Lighting not designated for dusk-to-dawn operation shall be controlled by either a combination of a photosensor and a time switch, or an astronomical time switch. Lighting designated for dusk-to-dawn operation shall be controlled by an astronomical time switch or photosensor. | ✔ |
| Plans reference page/section: | E2.01 |
| **16.** Tandem wiring. The following luminaires located within the same area shall be tandem wired: 1. Fluorescent luminaires equipped with one, three or odd-numbered lamp configurations, that are recess-mounted within 10 feet center-to-center of each other. 2. Fluorescent luminaires equipped with one, three or any odd-numbered lamp configuration, that are pendant- or surface-mounted within 1 foot edge-to-edge of each other. | ✔ |
| Plans reference page/section: | NA |
| **17.** Medical task lighting or art/history display lighting claimed to be exempt from compliance has a control device independent of the control of the nonexempt lighting. | ✔ |
| Plans reference page/section: | NA |
Section 5: Compliance Statement

Compliance Statement: The proposed lighting design represented in this document is consistent with the building plans, specifications and other calculations submitted with this permit application. The proposed lighting system has been designed to meet the 2014 Oregon Energy Efficiency Specialty Code requirements in COMcheck Version 4.0.6.1 and to comply with the mandatory requirements in the Requirements Checklist.

Robert Rutherford Designer  
Signature  
9/8/17
Section 1: Project Information

Project Title: Project Type: New Construction
Exterior Lighting Zone: 2 (Residential mixed use area)

Construction Site: Owner/Agent: Designer/Contractor:
525 E Cascade Avenue
Deschutes County
Sisters, OR 97759

Section 2: Exterior Lighting Area/Surface Power Calculation

<table>
<thead>
<tr>
<th>A Exterior Area/Surface</th>
<th>B Quantity</th>
<th>C Allowed Watts / Unit</th>
<th>D Tradable Wattage</th>
<th>E Allowed Watts (B x C)</th>
<th>F Proposed Watts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Walkway &lt; 10 feet wide</td>
<td>4000 ft of walkway length</td>
<td>0.7</td>
<td>Yes</td>
<td>2800</td>
<td>493</td>
</tr>
<tr>
<td>Parking area</td>
<td>30000 ft2</td>
<td>0.06</td>
<td>Yes</td>
<td>1800</td>
<td>648</td>
</tr>
</tbody>
</table>

Total Tradable Watts* = 4600
Total Allowed Watts = 4600
Total Allowed Supplemental Watts** = 600

* Wattage tradeoffs are only allowed between tradable areas/surfaces.
** A supplemental allowance equal to 600 watts may be applied toward compliance of both non-tradable and tradable areas/surfaces.

Section 3: Exterior Lighting Fixture Schedule

<table>
<thead>
<tr>
<th>A Fixture ID : Description / Lamp / Wattage Per Lamp / Ballast</th>
<th>B Lamps/Fixture</th>
<th>C # of Fixtures</th>
<th>D Fixture Watt.</th>
<th>E (C X D)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Walkway &lt; 10 feet wide (4000 ft of walkway length): Tradable Wattage</td>
<td></td>
<td></td>
<td></td>
<td>1141</td>
</tr>
<tr>
<td>SA: SA: ARCHITECTURAL WALL MOUNT LED: Other:</td>
<td></td>
<td></td>
<td></td>
<td>104</td>
</tr>
<tr>
<td>SB: SB: LED LINEAR INDUSTRIAL INDUSTRIA: Other:</td>
<td></td>
<td></td>
<td></td>
<td>341</td>
</tr>
<tr>
<td>SB2: SB2: LED LINEAR INDUSTRIAL INDUSTRIA: Other:</td>
<td></td>
<td></td>
<td></td>
<td>48</td>
</tr>
<tr>
<td>Parking area (30000 ft2): Tradable Wattage</td>
<td></td>
<td></td>
<td></td>
<td>648</td>
</tr>
<tr>
<td>SC: SC: LED LINEAR INDUSTRIAL INDUSTRIA: Other:</td>
<td></td>
<td></td>
<td></td>
<td>648</td>
</tr>
</tbody>
</table>

Total Tradable Proposed Watts = 1141

Section 4: Requirements Checklist

In the following requirements, blank checkboxes identify requirements that the applicant has not acknowledged as being met. Checkmarks identify requirements that the applicant acknowledges are met or excepted from compliance. ‘Plans reference page/section’ identifies where in the plans/specs the requirement can be verified as being satisfied.

Controls, Switching, and Wiring:

✔ 1. Lighting designated to operate more than 2000 hours per year for Uncovered Parking Areas shall be equipped with motion sensors that will reduce the luminaire power by thirty-three percent or turn off one-third the luminaires when no activity is detected.

Plans reference page/section: E2.01

 Exterior Lighting Restrictions and Exceptions:

✔ 2. Mercury vapor and incandescent lighting is not permitted for use as exterior lighting.
✔ 3. Exempt lighting fixtures are equipped with a control device independent of the control of the nonexempt lighting and are identified in Section 3 table above.
Section 5: Compliance Statement

Compliance Statement: The proposed exterior lighting design represented in this document is consistent with the building plans, specifications and other calculations submitted with this permit application. The proposed lighting system has been designed to meet the 2014 Oregon Energy Efficiency Specialty Code requirements in COMcheck Version 4.0.6.1 and to comply with the mandatory requirements in the Requirements Checklist.

Robert Rutherford
Designer

Signature

Date 9/8/17
Section 1: Project Information

Project Title: Sisters Transportation Center
Project Type: New Construction

Section 2: General Information

Building Location (for weather data): Sisters, Oregon
Climate Zone: 5b

Section 3: Mechanical Systems List

<table>
<thead>
<tr>
<th>Quantity</th>
<th>System Type &amp; Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>RTU-1 (Single Zone) :</td>
</tr>
<tr>
<td></td>
<td>Heating: 1 each - Central Furnace, Propane, Capacity = 74 kBtu/h</td>
</tr>
<tr>
<td></td>
<td>No minimum efficiency requirement applies</td>
</tr>
<tr>
<td></td>
<td>Cooling: 1 each - Single Package DX Unit, Capacity = 49 kBtu/h, Air-Cooled Condenser, Air Economizer</td>
</tr>
<tr>
<td></td>
<td>Proposed Efficiency = 15.00 SEER, Required Efficiency: 13.00 SEER</td>
</tr>
<tr>
<td></td>
<td>Fan System: FAN SYSTEM 1</td>
</tr>
<tr>
<td></td>
<td>Fans:</td>
</tr>
<tr>
<td></td>
<td>FAN 1 Supply, Constant Volume, 1400 CFM, 0.5 motor nameplate hp</td>
</tr>
<tr>
<td></td>
<td>FAN 2 Relief, Constant Volume, 1400 CFM, 0.3 motor nameplate hp</td>
</tr>
<tr>
<td>1</td>
<td>RTU-2 (Single Zone) :</td>
</tr>
<tr>
<td></td>
<td>Heating: 1 each - Central Furnace, Propane, Capacity = 59 kBtu/h</td>
</tr>
<tr>
<td></td>
<td>No minimum efficiency requirement applies</td>
</tr>
<tr>
<td></td>
<td>Cooling: 1 each - Single Package DX Unit, Capacity = 31 kBtu/h, Air-Cooled Condenser, Air Economizer</td>
</tr>
<tr>
<td></td>
<td>Proposed Efficiency = 15.00 SEER, Required Efficiency: 13.00 SEER</td>
</tr>
<tr>
<td></td>
<td>Fan System: FAN SYSTEM 2</td>
</tr>
<tr>
<td></td>
<td>Fans:</td>
</tr>
<tr>
<td></td>
<td>FAN 3 Supply, Constant Volume, 1100 CFM, 0.5 motor nameplate hp</td>
</tr>
<tr>
<td></td>
<td>FAN 4 Relief, Constant Volume, 1100 CFM, 0.3 motor nameplate hp</td>
</tr>
<tr>
<td>1</td>
<td>RTU-3 (Single Zone) :</td>
</tr>
<tr>
<td></td>
<td>Heating: 1 each - Central Furnace, Propane, Capacity = 59 kBtu/h</td>
</tr>
<tr>
<td></td>
<td>No minimum efficiency requirement applies</td>
</tr>
<tr>
<td></td>
<td>Cooling: 1 each - Single Package DX Unit, Capacity = 31 kBtu/h, Air-Cooled Condenser, Air Economizer</td>
</tr>
<tr>
<td></td>
<td>Proposed Efficiency = 15.00 SEER, Required Efficiency: 13.00 SEER</td>
</tr>
<tr>
<td></td>
<td>Fan System: FAN SYSTEM 3</td>
</tr>
<tr>
<td></td>
<td>Fans:</td>
</tr>
<tr>
<td></td>
<td>FAN 5 Supply, Constant Volume, 1100 CFM, 0.5 motor nameplate hp</td>
</tr>
<tr>
<td></td>
<td>FAN 6 Relief, Constant Volume, 1100 CFM, 0.3 motor nameplate hp</td>
</tr>
<tr>
<td>1</td>
<td>RTU-4 (Single Zone) :</td>
</tr>
<tr>
<td></td>
<td>Heating: 1 each - Central Furnace, Propane, Capacity = 59 kBtu/h</td>
</tr>
<tr>
<td></td>
<td>No minimum efficiency requirement applies</td>
</tr>
<tr>
<td></td>
<td>Cooling: 1 each - Single Package DX Unit, Capacity = 31 kBtu/h, Air-Cooled Condenser, Air Economizer</td>
</tr>
<tr>
<td></td>
<td>Proposed Efficiency = 15.00 SEER, Required Efficiency: 13.00 SEER</td>
</tr>
<tr>
<td></td>
<td>Fan System: FAN SYSTEM 3</td>
</tr>
<tr>
<td></td>
<td>Fans:</td>
</tr>
</tbody>
</table>
FAN 5 Supply, Constant Volume, 1100 CFM, 0.5 motor nameplate hp
FAN 6 Relief, Constant Volume, 1100 CFM, 0.3 motor nameplate hp

1 EWH-1 (Unknown):
   Heating: 1 each - Unit Heater, Electric, Capacity = 5120 kBtu/h
   No minimum efficiency requirement applies
   Fan System: None

1 EWH-2 (Unknown):
   Heating: 1 each - Unit Heater, Electric, Capacity = 5120 kBtu/h
   No minimum efficiency requirement applies
   Fan System: None

1 EWH-3 (Unknown):
   Heating: 1 each - Unit Heater, Electric, Capacity = 5120 kBtu/h
   No minimum efficiency requirement applies
   Fan System: None

1 EWH-4 (Unknown):
   Heating: 1 each - Unit Heater, Electric, Capacity = 5120 kBtu/h
   No minimum efficiency requirement applies
   Fan System: None

1 EWH-5 (Unknown):
   Heating: 1 each - Unit Heater, Electric, Capacity = 5120 kBtu/h
   No minimum efficiency requirement applies
   Fan System: None

1 EWH-6 (Unknown):
   Heating: 1 each - Unit Heater, Electric, Capacity = 5120 kBtu/h
   No minimum efficiency requirement applies
   Fan System: None

Section 4: Requirements Checklist

In the following requirements, blank checkboxes identify requirements that the applicant has not acknowledged as being met. Checkmarks identify requirements that the applicant acknowledges are met or excepted from compliance. 'Plans reference page/section' identifies where in the plans/specs the requirement can be verified as being satisfied.

**Requirements Specific To: RTU-1**:

✔ 1. Equipment meets minimum efficiency: Single Package Unit: 13.00 SEER
✔ 2. Newly purchased equipment meets the efficiency requirements.
✔ 3. Energy recovery ventilation systems. Individual fan systems that have both a design supply air capacity of 5,000 cfm or greater and a minimum outside air supply of 70 percent or greater of the design supply air quantity have an energy recovery system.

 Plans reference page/section: N/A, less than 5,000 CFM

**Requirements Specific To: RTU-2**:

✔ 1. Equipment meets minimum efficiency: Single Package Unit: 13.00 SEER
✔ 2. Newly purchased equipment meets the efficiency requirements.
✔ 3. Energy recovery ventilation systems. Individual fan systems that have both a design supply air capacity of 5,000 cfm or greater and a minimum outside air supply of 70 percent or greater of the design supply air quantity have an energy recovery system.

 Plans reference page/section: N/A, less than 5,000 CFM

**Requirements Specific To: RTU-3**:

✔ 1. Equipment meets minimum efficiency: Single Package Unit: 13.00 SEER
✔ 2. Newly purchased equipment meets the efficiency requirements.
✔ 3. Energy recovery ventilation systems. Individual fan systems that have both a design supply air capacity of 5,000 cfm or greater and a minimum outside air supply of 70 percent or greater of the design supply air quantity have an energy recovery system.

 Plans reference page/section: N/A, less than 5,000 CFM

**Requirements Specific To: RTU-4**:

✔ 1. Equipment meets minimum efficiency: Single Package Unit: 13.00 SEER
✔ 2. Newly purchased equipment meets the efficiency requirements.
✔ 3. Energy recovery ventilation systems. Individual fan systems that have both a design supply air capacity of 5,000 cfm or greater and a minimum outside air supply of 70 percent or greater of the design supply air quantity have an energy recovery system.

 Plans reference page/section: N/A, less than 5,000 CFM

**Requirements Specific To: EWH-1**:


1. Energy recovery ventilation systems. Individual fan systems that have both a design supply air capacity of 5,000 cfm or greater and a minimum outside air supply of 70 percent or greater of the design supply air quantity have an energy recovery system.

Requirements Specific To: EWH-2:

1. Energy recovery ventilation systems. Individual fan systems that have both a design supply air capacity of 5,000 cfm or greater and a minimum outside air supply of 70 percent or greater of the design supply air quantity have an energy recovery system.

Requirements Specific To: EWH-3:

1. Energy recovery ventilation systems. Individual fan systems that have both a design supply air capacity of 5,000 cfm or greater and a minimum outside air supply of 70 percent or greater of the design supply air quantity have an energy recovery system.

Requirements Specific To: EWH-4:

1. Energy recovery ventilation systems. Individual fan systems that have both a design supply air capacity of 5,000 cfm or greater and a minimum outside air supply of 70 percent or greater of the design supply air quantity have an energy recovery system.

Requirements Specific To: EWH-5:

1. Energy recovery ventilation systems. Individual fan systems that have both a design supply air capacity of 5,000 cfm or greater and a minimum outside air supply of 70 percent or greater of the design supply air quantity have an energy recovery system.

Requirements Specific To: EWH-6:

1. Energy recovery ventilation systems. Individual fan systems that have both a design supply air capacity of 5,000 cfm or greater and a minimum outside air supply of 70 percent or greater of the design supply air quantity have an energy recovery system.

Generic Requirements: Must be met by all systems to which the requirement is applicable:

1. Calculation of heating and cooling loads. Design loads are determined in accordance with the procedures described in the ASHRAE/ACCA Standard 183. Alternatively, design loads have been determined by an approved equivalent computation procedure.

2. Packaged Electric Equipment. Specified packaged electrical equipment has a heat pump as the primary heating source.

   Requirement is not applicable.

3. Equipment and system sizing. Heating and cooling equipment and systems capacity do not exceed the loads calculated in accordance with Section 503.2.1.

4. HVAC Equipment Performance Requirements. Reported efficiencies have been tested and rated in accordance with the applicable test procedure. The efficiency has been verified through certification under an approved certification program or, if no certification program exists, the equipment efficiency ratings are supported by data furnished by the manufacturer.

5. Thermostatic Controls. The supply of heating and cooling energy to each zone is controlled by individual thermostatic controls that respond to temperature within the zone.

6. Heat pump supplementary heat. Heat pumps having supplementary electric resistance heat have controls that, except during defrost, prevent supplementary heat operation when the heat pump can meet the heating load.

7. Set point overlap restriction. Where used to control both heating and cooling, zone thermostatic controls provide a temperature range or deadband of at least 5°F (2.8°C) within which the supply of heating and cooling energy to the zone is capable of being shut off or reduced to a minimum.

8. Optimum Start Controls. Each HVAC system has controls that vary the start-up time of the system to just meet the temperature set point at time of occupancy.
9. Off-hour controls. Each zone is provided with thermostatic setback controls that are controlled by either an automatic time clock or programmable control system.

Plans reference page/section: Specifications

10. Shutoff damper controls. Both outdoor air supply and exhaust are equipped with not less than Class I motorized dampers.

Plans reference page/section: Specifications

11. Freeze Protection and Snow melt system controls. Freeze protection systems, such as heat tracing of outdoor piping and heat exchangers, including self-regulating heat tracing, include automatic controls capable of shutting off the systems when outdoor air temperatures meet code criteria.

Plans reference page/section: N/A

12. Separate air distribution systems. Zones with special process temperature requirements and/or humidity requirements are served by separate air distribution systems from those serving zones requiring only comfort conditions; or shall include supplementary control provisions so that the primary systems may be specifically controlled for comfort purposes only.

Plans reference page/section: N/A

13. Humidity control. If a system is equipped with a means to add or remove moisture to maintain specific humidity levels in a zone or zones, a humidity control device is provided.

Plans reference page/section: N/A

14. Humidity control. Where a humidity control device exists it is set to prevent the use of fossil fuel or electricity to produce relative humidity in excess of 30 percent. Where a humidity control device is used for dehumidification, it is set to prevent the use of fossil fuel or electricity to reduce relative humidity below 60 percent.

Plans reference page/section: N/A

15. Humidity control. Where a humidity control device exists it is set to maintain a deadband of at least 10% relative humidity where no active humidification or dehumidification takes place.

Plans reference page/section: N/A

16. Ventilation. Ventilation, either natural or mechanical, is provided in accordance with Chapter 4 of the International Mechanical Code. Where mechanical ventilation is provided, the system has the capability to reduce the outdoor air supply to the minimum required by Chapter 4 of the International Mechanical Code.

Plans reference page/section: M0.02

17. Demand controlled ventilation (DCV). DCV is required for spaces larger than 500 ft² for simple systems and spaces larger than 150 ft² for multiple zone systems.

Plans reference page/section: M2.01, specifications

18. Kitchen hoods. Kitchen makeup is provided as required by the Oregon Mechanical Specialty Code.

Plans reference page/section: N/A

19. Enclosed parking garage ventilation controls. In Group S-2, enclosed parking garages used for storing or handling automobiles employ automatic carbon monoxide sensing devices.

Plans reference page/section: n/a

20. Duct and plenum insulation and sealing. All supply and return air ducts and plenums are insulated with the specified insulation. When located within a building envelope assembly, the duct or plenum is separated from the building exterior or unconditioned or exempt spaces by a minimum of R-8 insulation. All ducts, air handlers and filter boxes are sealed. Joints and seams comply with Section 603.9 of the International Mechanical Code.

21. Low-pressure duct systems. All longitudinal and transverse joints, seams and connections of low-pressure supply and return ducts are securely fastened and sealed with welds, gaskets, mastics (adhesives), mastic-plus-embedded-fabric systems or tapes installed in accordance with the manufacturer’s installation instructions.

Plans reference page/section: Specifications

22. Medium-pressure duct systems. All ducts and plenums designed to operate medium-pressure are insulated and sealed in accordance with Section 503.2.7. Pressure classifications specific to the duct system are clearly indicated on the construction documents.

Plans reference page/section: N/A

23. High-pressure duct systems. Ducts designed to operate at high-pressure are insulated and sealed in accordance with Section 503.2.7. In addition, ducts and plenums are leak-tested in accordance with the SMACNA HVAC Air Duct Leakage Test Manual.

Plans reference page/section: N/A

24. Piping Insulation. All pipes serving space-conditioning systems (hot water piping for heat systems, chilled water, refrigerant, and brine piping systems, and steam piping) are insulated as specified by this section.
✔ 25. Air system balancing. Each supply air outlet and zone terminal device is equipped with means for air balancing in accordance with the requirements of IMC 603.17. Discharge dampers intended to modulate airflow are prohibited on constant volume fans and variable volume fans with motors 10 horsepower.

Plans reference page/section: Specifications

26. Hydronic system balancing. Individual hydronic heating and cooling coils are equipped with means for balancing and pressure test connections.

Plans reference page/section: N/A

27. Manuals. The construction documents require that an operating and maintenance manual be provided to the building owner by the mechanical contractor. See long description for specifications.

Plans reference page/section: Specifications

28. Air System Design and Control. Each HVAC system having a total fan system motor nameplate hp exceeding 5 hp meets the provisions of Sections 503.2.10.1 through 503.2.10.2.

Plans reference page/section: N/A, fans are less than 5 HP

29. Allowable fan floor horsepower. Each HVAC system at fan system design conditions does not exceed the allowable fan system motor nameplate hp (Option 1) or fan system bhp (Option 2) as shown and calculated in requirement details.

Plans reference page/section: M0.02

30. Motor nameplate horsepower. For each fan, the selected fan motor is no larger than the first available motor size greater than the brake horsepower (bhp).

Plans reference page/section: M0.02

31. Large Volume Fan Systems. Fan systems over 8,000 (7 m3/s) cfm without direct expansion cooling coils that serve single zones reduce airflow based on space thermostat heating and cooling demand. A two-speed motor or variable frequency drive reduces airflow to a maximum 60 percent of peak airflow or minimum ventilation air requirement as required by Chapter 4 of the International Mechanical Code, whichever is greater.

Plans reference page/section: N/A, no fans are over 8,000 CFM

32. All air-conditioning equipment and air-handling units with direct expansion cooling and a cooling capacity at ARI conditions greater than or equal to 110,000 Btu/h that serve single zones have their supply fan operation controlled according to code specific requirements.

Plans reference page/section: N/A, all cooling capacities are less th 110,000 BTU/H

33. Series fan-powered terminal unit fan motors. Fan motors for series fan-powered terminal units are electronically-commutated motors and have a minimum motor efficiency of 70 percent when rated in accordance with NEMA Standard MG 1-2006 at full load rating conditions.

Plans reference page/section: N/A

34. Heating outside a building. Systems installed to provide heat outside a building are radiant systems. Such heating systems are controlled by an occupancy sensing device or a timer switch, so that the system is automatically deenergized when no occupants are present.

Plans reference page/section: N/A

35. Hot Gas Bypass Limitation. For cooling systems <= 240 kBTU/h, maximum hot gas bypass capacity is no more than 50% total cooling capacity.

Plans reference page/section: N/A, there will be no hot gas bypass

Section 5: Compliance Statement

Compliance Statement: The proposed mechanical design represented in this document is consistent with the building plans, specifications and other calculations submitted with this permit application. The proposed mechanical systems have been designed to meet the 2014 Oregon Energy Efficiency Specialty Code requirements in COMcheck Version 4.0.7.0 and to comply with the mandatory requirements in the Requirements Checklist.

Name - Title                     Signature                     Date

Section 6: Post Construction Compliance Statement

☐ HVAC record drawings of the actual installation, system capacities, calibration information, and performance data for each equipment provided to the owner.
❑ HVAC O&M documents for all mechanical equipment and system provided to the owner by the mechanical contractor.
❑ Written HVAC balancing and operations report provided to the owner.

The above post construction requirements have been completed.

Principal Mechanical Designer-Name  Signature  Date