CLACKAMAS COMMUNITY COLLEGE ROOK HALL TI

PROJECT MANUAL - VOLUME 2 OF 2 SPECIFICATIONS DIVISIONS 21 - 33

PERMIT SET PERMIT & BID SET MAY 7, 2021 APRIL 22, 2021

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MAY 7, 2021 PERMIT & BID SET

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Not used

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Not used

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Not used

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SECTION 21 00 00 - FIRE SUPPRESSION BASIC REQUIREMENTS

PART 1 - GENERAL

- 1.1 DESIGN-BUILD SUMMARY OF WORK
 - A. Work included in 21 00 00 applies to Division 21, Fire Suppression work to provide materials, labor, tools, permits and incidentals to make fire suppression systems ready for Owner's use for proposed project.
- 1.2 DESIGN-BUILD INSTRUCTIONS
 - A. This document is issued to give Bidders a basis for preparing a proposal to design and install a complete Fire Suppression system for this project.
 - B. Alternates to this Document may be offered as a separate proposal.

1.3 DESIGN-BUILD DESIGN APPROACH

- A. Use this Specification as a guide for design/engineering requirements, workmanship and materials or construction. Utilize design-build concept throughout construction phase of project.
- B. Investigate and be apprised of applicable codes, rules, and regulations as enforced by AHJ.
- C. Visit the Site of the proposed construction. Verify and inspect the existing site to determine conditions that affect this work.

1.4 DESIGN-BUILD DESIGN CRITERIA/CALCULATIONS

- A. Related Work Specified Elsewhere:
 - 1. Contents of Section apply to Division 21, Fire Suppression Specifications.
 - 2. Requirements of Section are a minimum for Division 21, Fire Suppression Sections, unless otherwise stated in each Section, in which case that Section's requirements take precedence.
- B. Fire Suppression Design Criteria: Refer to individual Division 21, Fire Suppression Sections for fire suppression system design criteria.
- C. Fire Suppression Equipment: Refer to individual Division 21, Fire Suppression Sections for fire suppression equipment requirements.

1.5 SECTION INCLUDES

- A. Work included in 21 00 00, Fire Suppression Basic Requirements applies to Division 21, Fire Suppression work to provide materials, labor, tools, permits, incidentals, and other services to provide and make ready for Owner's use of fire protection 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 Item 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 Item.

5. Authority Having Jurisdiction (AHJ): Indicates reviewing authorities, including local fire marshal, Owner's insurance underwriter, Owner's Authorized Representative, and other reviewing entity whose approval is required to obtain systems acceptance.

1.6 RELATED SECTIONS

- A. Content of Section applies to Division 21, Fire Suppression 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

1.7 REFERENCES AND STANDARDS

- A. References and Standards per Division 00, Procurement and Contracting Requirements and Division 01, General Requirements, individual Division 21, Fire Suppression 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. OZERCC Oregon Zero Energy Ready Commercial 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. ASCE-7 Minimum Design Loads for Buildings and Other Structures
 - 7. ASHRAE American Society of Heating, Refrigerating and Air-Conditioning Engineers
 - 8. ASHRAE Guideline 0, the Commissioning Process
 - 9. ASME American Society of Mechanical Engineers
 - 10. ASPE American Society of Plumbing Engineers
 - 11. ASSE American Society of Sanitary Engineering
 - 12. ASTM ASTM International
 - 13. AWWA American Water Works Association
 - 14. CFR Code of Federal Regulations
 - 15. EPA Environmental Protection Agency
 - 16. ETL Electrical Testing Laboratories
 - 17. FCC Federal Communications Commission

- 18. FM FM Global
- 19. FM Global FM Global Approval Guide
- 20. IAPMO International Association of Plumbing and Mechanical Official
- 21. ICC International Code Council
- 22. IEC International Electrotechnical Commission
- 23. ICC-ESR International Code Council Evaluation Service Reports
- 24. HI Hydraulic Institute Standards
- 25. ISO International Organization for Standardization
- 26. MSS Manufacturers Standardization Society
- 27. NEC National Electric Code
- 28. NEMA National Electrical Manufacturers Association
- 29. NFPA National Fire Protection Association:
 - a. NFPA 13 Standard for the Installation of Sprinkler Systems
 - b. NFPA 25 Standard for Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems
 - c. NFPA 70 National Electrical Code
 - d. NFPA 72 National Fire Alarm and Signaling Code
- 30. NRCA National Roofing Contractors Association
- 31. NSF National Sanitation Foundation
- 32. OSHA Occupational Safety and Health Administration
- 33. SMACNA Sheet Metal and Air Conditioning Contractors' National Association, Inc.
- 34. TIMA Thermal Insulation Manufacturers Association
- 35. UL Underwriters Laboratories Inc.
- D. See Division 21, Fire Suppression individual Sections for additional references.

1.8 SUBMITTALS

- A. See Division 01, General Requirements for Submittal Procedures as well as specific individual Division 21, Fire Suppression 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. "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 posted to ftp site. For electronic format, provide one file per division containing one bookmarked PDF file with each bookmark corresponding to each Specification Section. Arrange bookmarks in ascending order of Specification Section number. Individual submittals sent piecemeal in a per Specification Section method will be returned without review or comment. Copy Architect on all transmissions/submissions.
- E. Submit shop drawings, calculations and product data sheets as one complete stand-alone package to AHJ, Owner's insurance underwriter and Engineer.
- F. Product Data: Provide Manufacturer's descriptive literature for products specified in Division 21, Fire Suppression Sections.
- G. 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 Item. 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 Division 21, Fire Suppression specification Sections for specific Item required in product data submittal outside of these requirements.
- 3. Provide pump curves, operation characteristics, capacities, ambient noise criteria, etc. for equipment.
- 4. For vibration isolation of equipment, list make and model selected with operating load and deflection. Indicate frame type where required. Submit manufacturer's product data.
- 5. See Division 21, Fire Suppression Sections for additional submittal requirements outside of these requirements.
- H. Maximum of two reviews provided of complete submittal package. Arrange for additional reviews and/or early review of long-lead Item; Bear costs of additional reviews at Engineer's hourly rates. Incomplete submittal packages/submittals will be returned to contractor without review.
- I. 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.
- J. 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.
- K. Trade Coordination: Include physical characteristics, electrical characteristics, device layout plans, wiring diagrams, and connections as required per Division 21, Fire Suppression coordination documents. For equipment with electrical connections, furnish copy of approved submittal for inclusion in Division 26, Electrical and Division 28, Electronic Safety submittals.
- L. Make provisions for openings in building for admittance of equipment prior to start of construction or ordering of equipment.
- M. 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.
- N. Shop Drawings:

- Provide coordinated Shop Drawings which include physical characteristics of all systems, equipment and piping layout, pipe layout, hanger layout, sway brace layout, seismic restraints, sway brace calculations, drains, location of drain discharge, risers, valves, details, water test information, physical device layout plans, and control wiring diagrams. Reference individual Division 21, Fire Suppression Sections for additional requirements for shop drawings outside of these requirements.
- 2. Shop Drawings and hydraulics calculations, sway brace calculations, trapeze hanger calculations, and the like, to be prepared under the direct supervision and control of a Professional Engineer competent to do such work and licensed in the state of Oregon. Drawings and calculations to bear the seal and wet signature of the professional Engineer.
- 3. Provide Shop Drawings which indicate information required by NFPA 13. Include room names and fire sprinkler occupancy hazard classifications.
- 4. Provide Shop Drawings illustrating information for Hydraulic Information Sign for each hydraulic remote area calculated.
- 5. Utilizing the Reflected Ceiling backgrounds, provide Shop Drawings illustrating locations of fire sprinklers and piping.
- 6. Utilizing the Structural backgrounds, provide Shop Drawings illustrating locations and types of hangers and sway braces.
- 7. Provide Shop Drawings illustrating each type of hanger, including fasteners to structure.
- 8. Provide Shop Drawings illustrating each type of branchline restraint and sway brace, including length of sway brace member, sway brace fittings, minimum and maximum angles from vertical of sway brace member, method of attachment to structure, size, length and embedment of attachment to structure and size and type of structural member to which sway brace will be attached. Number each type of restraint and sway brace. Indicate on Drawings locations of each type of numbered restraint and sway brace.
- 9. Provide details for any hanger, attachment, or sway brace to be attached to any I-joist, structural insulated panels (SIPs), cross laminated timber, and similar engineered structural products according to the specifications of the engineered product manufacturer.
- 10. Provide Shop Drawings illustrating information for Sprinkler System General Information Sign.
- 11. Shop Drawings to include a cross-sectional view that shows the sprinkler heads and piping in relation to the building's architectural and structural information. View to be chosen based on a location that will display the most information.
- 12. When required, provide Coordination Drawings.
- 13. Provide Shop Drawings indicating access panel locations, size and elevation for approval prior to installation.
- 14. Provide details of hanger, sway bracing and branch line restraint attachments to structure and to piping. Include details on the size and load capacities of fasteners. Provide verification of the structural capacity to withstand seismic load.
- 15. Provide sway bracing calculations on drawings showing horizontal seismic design load and requirements, with indication of zone of influence for each bracing location.
- 16. Provide a schedule of sway bracing type, size, and design criteria, including length, angle from vertical, and load capacities.
- 17. Clearly indicate the elevation of the highest sprinkler in relation to the elevation of the flow test pressure gauge monitor hydrant.
- Provide details of flexible sprinkler hose fitting per manufacturer's schedule of equivalent feet used in hydraulic calculations, showing device length, maximum number of 90-degree bends and expected radius of bends.
- 19. Provide a schedule of signage to be installed at each flexible sprinkler hose fitting.
- 20. On the drawings, provide a list of number, model, temperature, sprinkler Identification number, manufacturer, orifice, deflector type, thermal sensitivity and pressure rating, quantity of each type to be contained in the spare sprinkler cabinet and the issue date or revision date of the list."

- 21. Spare sprinkler head cabinet size indicating the number of spare sprinkler head to be contained therein.
- O. Samples: Provide samples when requested by individual Sections.
- P. Resubmission Requirements:
 - 1. Make any corrections or change in submittals when required. Provide submittals as specified. The Engineer will not be required to edit and/or interpret the Contractor's submittals. Indicate changes for the resubmittal in a cover letter with reference to page(s) changed and reference response to comment. Clearly indicate changes on Drawings and cloud changes in the submittals.
 - 2. Resubmit for review until review indicates no exceptions taken or make "corrections as noted".
- Q. Operation and Maintenance Manuals/Owner's Instructions:
 - . Submit, at one time, electronic files (PDF format) of manufacturer's operation and maintenance instruction manuals and parts lists for equipment or Item requiring servicing. Include valve charts. Submit data when work is substantially complete and in same order format as submittals. Include name and location of source parts and service for each piece of equipment.
 - a. Include copies of certificates of code authority acceptance, code-required acceptance tests; test reports and certificates.
 - b. Include Warranty per Division 00, Procurement and Contracting Requirements and Division 01, General Requirements, Section 21 00 00, Fire Suppression Basic Requirements and individual Sections.
 - c. Catalog description of each Item of equipment actually installed on job.
 - d. Instructions for operation and maintenance of fire suppression systems composed of operating instructions, maintenance instructions and manufacturer's literature as follows:
 - Testing and Maintenance Schedule Chart: Provide an 8-1/2- by 11-inch typewritten list of each item of installed equipment requiring testing inspection, lubrication or service, describing and scheduling performance of maintenance.
 - 2) Manufacturer's Literature: Provide copies of manufacturer's instructions for operation and maintenance of fire suppression equipment, including replacement parts list with name and address of nearest distributor. Mark each copy with equipment identification label as listed in equipment schedule, i.e. F-5 etc.
 - e. Include product certificates of warranties and guarantees.
 - f. Include Record Drawings,
 - g. Include copy of water supply flow test used as basis for hydraulic calculations.
 - h. Include hydraulic calculations and sway brace calculations.
 - i. Include Contractor's Material and Test Certificates for Aboveground Piping/Underground Piping.
 - j. Include a copy of NFPA 25.
 - k. Include a copy of valve charts and whether normally open or normally closed.
 - I. Include a copy of drain, auxiliary, and low point drains charts.
 - m. Include a copy of the list to be included in the spare sprinkler head box.
 - n. 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.
 - o. 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: i.e. belts, motors, lubricants, and filters.

- p. Include copy of complete parts list for equipment. Include available exploded views of assemblies and sub-assemblies.
- q. Include copy of startup and test reports specific to each piece of equipment.
- r. Engineer will return incomplete documentation without review. Engineer will provide one set of review comments in Submittal Review format. Contractor must arrange for additional reviews; Contractor to bear costs for additional reviews at Engineer's hourly rates.
- 2. Thoroughly instruct Owner in proper operation of equipment and systems. Where noted in individual Sections, training will include classroom instruction with applicable training aids and systems demonstrations. Field instruction per Section 21 00 00, Fire Suppression Basic Requirements, Article titled "Demonstration".
- 3. Copies of certificates of code authority inspections, acceptance, code required acceptance tests, letter of conformance and other special guarantees, certificates of warranties, specified elsewhere or indicated on Drawings.
- R. Record Drawings:
 - 1. Maintain at site at least one set of Drawings for recording "As-constructed" conditions. Indicate on Drawings changes to original documents by referencing revision document, and include buried elements, location of cleanouts, and location of concealed mechanical Item. Include items changed by field orders, supplemental instructions, and constructed conditions.
 - 2. Record Drawings are to include equipment and fixture/connection schedules that accurately reflect "as constructed or installed" for project.
 - 3. At completion of project, input changes to original project on CAD Drawings and make one set of black-line drawings created from CAD Files in version/release equal to contract drawings. Submit CAD disk and drawings upon substantial completion.
 - 4. At completion of project, show changes and deviations from the Drawings in red on one set of black-line drawings. Include written Addendums, RFIs, and change order items. Make changes to Drawings in a neat, clean, and legible manner.
 - 5. Invert elevations and dimensioned locations for water services and drainage piping below grade extending to 5-feet outside building line.
 - 6. Record Drawings to include site information or reference site information for complete understanding of the fire protection system between the building and the point of connection to the water supply and location of flow test pressure hydrants.
 - 7. See Division 21, Fire Suppression individual Sections for additional items to include in Record Drawings.

1.9 QUALITY ASSURANCE

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

- D. Manufacturer's Instructions: Follow manufacturer's written instructions. If in conflict with Contract Documents, obtain clarification. Notify Engineer/Architect, in writing, before starting work.
- E. Items shown on Drawings are not necessarily included in Specifications or vice versa. Confirm requirements in all Contract Documents.
- F. Provide products that are UL listed.
- G. Piping Insulation products to contain less than 0.1 percent by weight PBDE in all insulating materials.
- 1.10 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 21 00 00, Fire Suppression Basic Requirements and individual Division 21, Fire Suppression 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.
- 1.11 COORDINATION DOCUMENTS
 - A. Prior to construction, coordinate installation and location of HVAC equipment, ductwork, grilles, diffusers, piping, plumbing equipment/fixtures, fire sprinklers, fire alarm, plumbing, cable trays, lights, and electrical services with architectural and structural requirements, and other trades (including fire alarm ceiling suspension and tile systems), and provide maintenance access requirements. Coordinate with submitted architectural systems (i.e. roofing, ceiling, and 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.
 - D. Submit final Coordination Drawings with changes as Record Drawings at completion of project.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Articles, fixtures, and equipment of a kind to be standard product of one manufacturer, including but not limited to sprinkler heads, pipe, fittings, hangers and bracing materials.
- 2.2 STANDARDS OF MATERIALS AND WORKMANSHIP
 - 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, FM, and ICC-ES approved for their intended fire protection function or have adequate approval or be acceptable by State, County, and City authorities.
 - B. Names and manufacturer's names denote character and quality of equipment desired and are not to be construed as limiting competition.
 - C. Hazardous Materials:

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

2.3 ACCESS PANELS

- A. See Division 01, General Requirements and Division 08, Openings for products and installation requirements.
- B. Confirm Access Panel requirements in Division 01, General Requirements, Division 08, Openings and individual Division 21, Fire Suppression Sections. In 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 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.
 - 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: Karp, Milcor, Elmdor, Acudor or approved equivalent.

PART 3 - EXECUTION

d.

3.1 ACCESSIBILITY AND INSTALLATION

- A. Confirm Accessibility and Installation requirements in Division 00, Procurement and Contracting Requirements, Division 01, General Requirements, Section 21 00 00, Fire Suppression Basic Requirements and individual Division 21, Fire Suppression Sections.
- B. Install equipment requiring access (i.e. drains, control operators, valves, motors, engines, pumps, controllers, air compressors, gauges, fill cups, tanks, cleanouts and the like) 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 and Engineer prior to proceeding with installation. This includes proper installation methods, sequencing, and coordination with other trades and disciplines.
- D. Firestopping:
 - 1. Confirm Firestopping requirements in Division 07, Thermal and Moisture Protection.
 - 2. In absence of specific requirements, comply with individual Division 21, Fire Suppression Sections and 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 International E814, Standard Test Method for Fire Tests of Through-Penetration Fire Stops.

- E. 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 coordinating installation of piping systems.
 - 2. Include provisions for servicing and removal of equipment without dismantling piping.
- F. Plenums: Provide plenum rated materials that meet the requirements to be installed in plenums. Immediately notify Architect/Engineer of discrepancy.

3.2 SEISMIC CONTROL

- A. Confirm Seismic Control requirements in Division 01, General Requirements, Structural documents, and individual Division 21, Fire Suppression Sections.
- B. Provide fire suppression equipment and piping, both hanging and base mounted, with mounting connection points of sufficient strength to resist lateral seismic forces equal to lateral seismic forces as determined by building code and NFPA 13 calculations, whichever is more demanding.
- C. See Structural Drawings for seismic design criteria for sway bracing and seismic restraint.
- D. Earthquake resistant designs for Fire Protection (Division 21) equipment and distribution, i.e. fire sprinkler systems, fire standpipe systems, fire pumps, fire pump controllers, fire tanks, clean agent fire suppression systems, etc. to conform to regulations of jurisdiction having authority.
- E. 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.
- F. Provide stamped Shop Drawings from licensed Engineer of seismic bracing and seismic movement assemblies for piping, equipment, tanks, pumps controllers and the like. Submit shop drawings along with equipment submittals.
- G. Provide stamped Shop Drawings from licensed Engineer of seismic flexible joints for piping and crossing building expansion or seismic joints. Submit Shop Drawings along with seismic bracing details.
- H. Provide details of flexible drops for sprinklers in conformance with Building Code and ASCE 7 requirements of ceilings. Coordinate with Architectural and Structural Drawings and Specifications.
- I. Piping: Per NFPA 13, ASCE-7 and local requirements.
- J. Equipment:
 - 1. Per "Seismic Restraints Manual Guidelines for Mechanical Systems" latest edition published by SMACNA, ASCE 7 and local requirements.

2. Provide means to prohibit excessive motion of fire protection equipment during an earthquake.

3.3 REVIEW AND OBSERVATION

- A. Confirm Review and Observation requirements in Division 00, Procurement and Contracting Requirements and Division 01, General Requirements, Section 21 00 00, Fire Suppression Basic Requirements and individual Division 21, Fire Suppression Sections.
- B. Notify Architect or Engineer, 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.
 - 5. When mains or branchlines are to be permanently concealed by construction or insulation systems.
 - 6. When fire suppression 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: Costs incurred by additional trips required due to incomplete systems will be the responsibility of the Contractor.

3.4 CONTINUITY OF SERVICE

- A. Confirm requirements in Division 00, Procurement and Contracting Requirements and Division 01, General Requirements. In absence of specific requirements, comply with individual Division 21. Fire Supression Sections and the following:
 - 21, Fire Suppression 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 at a minimum. If overtime is required, there will be no allowance made by Owner for extra expense for such overtime or shift work.
 - 4. During entire time system, or part thereof, is not operational, provide a firewatch per Fire Code, including a watchperson whose sole duty is to watch for and report fires.
 - 5. Organize work to minimize duration of power interruption.

3.5 CUTTING AND PATCHING

- A. Confirm Cutting and Patching requirements in Division 01, General Requirements. In absence of specific requirements, comply with individual Division 21, Fire Suppression Sections and the following:
 - 1. Cutting and patching performed under Division 21, Fire Suppression includes, but is not limited to:
 - a. Cutting and patching of plaster or partitions.
 - b. Cutting and patching of finished ceilings.
 - 2. Perform cutting and patching by skilled craftsmen in trade of work to be performed. Fill holes which are cut oversized for completed work. Match refinished areas with existing adjacent finish in a manner acceptable to Architect.

- 3. When masonry to concrete construction must be penetrated, provide a steel pipe sleeve in opening and grout in place in a neat manner. Leave grout surface to match existing finish. Provide escutcheons. If sleeves are not provided, core drill penetrations.
- 4. Locate concealed utilities to eliminate possible service interruption or damage.
- 5. Additional work required by lack of proper coordination will be provided at no additional cost to the Owner.
- 6. 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).
- 7. 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.
- 8. 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.
- 9. 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, landscaping, paving, and walks, surfaces to be repaired, refinished and left in condition matching existing prior to commencement of work.
- 10. Repair mutilation of building around pipes, equipment, hangers, and braces.

3.6 EQUIPMENT SELECTION AND SERVICEABILITY

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

3.7 DELIVERY, STORAGE AND HANDLING

- Confirm requirements in Division 00, Procurement and Contracting Requirements and Division 01, General Requirements. In absence of specific requirements, comply with individual Division 21, Fire Suppression Sections and the following:
 - 1. Handle materials delivered to project site with care to avoid damage and deterioration. Store materials in original containers which identify manufacturer, name, brand and model numbers on site inside building or protected from weather, sun, 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 Item until in service.

3.8 DEMONSTRATION

- A. Confirm Demonstration requirements in Division 00, Procurement and Contracting Requirements and Division 01, General Requirements, Section 21 00 00, Fire Suppression Basic Requirements and individual Division 21, Fire Suppression Sections.
- B. Upon completion of work and adjustment of equipment and test systems, demonstrate to Owner's Authorized 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 21 00 00, Fire Suppression Basic Requirements and individual Division 21, Fire Suppression 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.
- D. Training and Demonstration per Section 01 91 13, General Commissioning Requirements.
- E. Prior to acceptance of work and during time designated by Architect, provide necessary qualified personnel to operate system for a period of two hours.
- F. Instruct the Owner in the operation of the sprinkler system, including main valve position (open or closed) recognition, system drainage, system testing, dry pipe valve reset and the relation to the fire alarm system.
- G. Upon completion of work and adjustment of equipment, test systems to demonstrate to Owner's Authorized Representative and Architect that equipment is furnished and installed or connected under provisions of these Specifications.

3.9 CLEANING

- A. Confirm Cleaning requirements in Division 00, Procurement and Contracting Requirements and Division 01, General Requirements, Section 21 00 00, Fire Suppression Basic Requirements and individual Division 21, Fire Suppression Sections.
- B. Upon completion of installation, except for sprinklers, 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.
- C. Sprinklers may not be cleaned except for vacuuming in a manner in which no part of the sprinkler is touched by the vacuuming equipment. Replace sprinklers which bear traces of foreign substances with sprinklers of same model, temperature, K-factor, orifice, finish, style, orientation, and the like.

3.10 INSTALLATION

- A. Confirm Installation requirements in Division 00, Procurement and Contracting Requirements and Division 01, General Requirements, Section 21 00 00, Fire Suppression Basic Requirements and individual Division 21, Fire Suppression Sections.
- B. Install equipment 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, in the presence of manufacturer's representative. Test controls and demonstrate compliance with requirements. Replace damaged or malfunctioning controls and equipment. 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 21, Fire Suppression Sections and the following:
 - 1. Ferrous Metal: After completion of fire protection 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. After acceptance by 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. Structural Steel: Repair damage to structural steel finishes or finishes of other materials damaged by cutting, welding or patching to match original.
- 4. 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.
- 5. Covers: Covers such as vault covers 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 21, Fire Suppression 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 21, Fire Suppression and the following:
 - 1. Scope:
 - a. It is the intent of these documents to provide necessary information and adjustments to fire protection 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 Item with new material to match existing. Promptly notify Owner if utilities are found which are not shown on Drawings.
 - 2. Equipment and Piping: Unless otherwise directed, equipment, piping, or fittings being removed as part of demolition process are Owner's property. Remove other Item 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, fittings, rough-ins, and connectors. Removal is to be to a point behind finished surfaces (floors, walls, and ceilings).
 - 5. Coordinate demolition of existing fire suppression systems with Contractor. Where applicable or possible, portions of fire suppression demolition work may be performed by Contractor. Verify with local AHJ as to limitations of demolition by others and not fire suppression trades. Coordinate extent of demolition of fire suppression work to be done by others and supervise this work. No extra costs will be approved by replacement of systems due to improper or excessive demolition.

3.14 ACCEPTANCE

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 21, Fire Suppression 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 including Contractor's Material and Test Certificate for Underground Piping, Contractor's Material and Test Certificate for Aboveground Piping, Contractor's Material and Test Certificate for Private Fire Service Mains, Fire pump acceptance test data report, and the like.
 - 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
 - h. Letter of Conformance

3.15 FIELD QUALITY CONTROL

- A. Confirm Field Quality Control requirements in Division 00, Procurement and Contracting Requirements and Division 01, General Requirements, Section 21 00 00, Fire Suppression Basic Requirements and individual Division 21, Fire Suppression Sections.
- B. Upon completion of installation of equipment, sprinklers, hose valves and piping and after units are water pressurized, test system to demonstrate capability and compliance with requirements. When possible, correct malfunctioning Item at site, then retest to demonstrate compliance; otherwise remove and replace with new Item and proceed with retesting.
- C. Inspect each installed Item for damage to finish. If feasible, restore and match finish to original, except fire sprinklers, at site; otherwise, remove Item and replace with new Item. Feasibility and match to be judged by Architect. Remove cracked or dented Item and replace with new Item.
- D. Fire sprinklers may not be reused, or cleaned, except for dusting. Replace damaged, field painted, oversprayed, overcoated or field coated sprinklers with new sprinklers of same manufacturer, model, finish, K-factor and performance characteristics. Where identical replacement sprinklers are not available, provide sprinklers of similar finish, style, K-factor and performance characteristics.

3.16 LETTER OF CONFORMANCE

A. Provide Letter of Conformance and copies of manufacturers' warranties and extended warranties with a statement that fire suppression items were installed in accordance with manufacturer's recommendations, UL listings and FM Global approvals. Include Letter of Conformance, 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 fire protection equipment wiring diagrams to coordinate with electrical systems so that proper wiring of equipment involved is affected.
- 3.18 CONNECTIONS TO EXISTING
 - A. Prior to connection of piping to existing piping or utilities, field verify existing conditions and exact sizes and locations of existing piping. Provide additional offsets, transitions, joints, cut-ins, and replace portions of existing as required to facilitate connections of new.

END OF SECTION

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SECTION 21 05 00 - COMMON WORK RESULTS FOR FIRE SUPPRESSION

PART 1 - GENERAL

1.1 SUMMARY

- A. Work Included:
 - 1. Aboveground Black Steel Pipe and Fittings
 - 2. Wall and Floor Penetrations and Sleeves
 - 3. Hangers and Supports
 - 4. Sway Braces and Restraints
 - 5. Anchors and Attachments
 - 6. Gauges
 - 7. Valves
 - 8. Pipe, Valve, and Fire Protection Equipment Identification
 - 9. Signs
 - 10. Drains

1.2 RELATED SECTIONS

- A. Contents of Division 21, Fire Suppression and Division 01, General Requirements apply to this Section.
- B. In addition, reference the following:
 - 1. Division 22, Plumbing
 - 2. Division 23, Heating, Ventilating and Air Conditioning
 - 3. Division 26, Electrical
 - 4. Division 28, Electronic Safety
 - 5. Section 21 00 00, Fire Suppression Basic Requirements
 - 6. Section 21 13 00, Fire Suppression Sprinkler Systems

1.3 REFERENCES AND STANDARDS

- A. References and Standards as required by Section 21 00 00, Fire Suppression Basic Requirements and Division 01, General Requirements.
- B. Meet requirements of ASCE 7, Minimum Design Loads for Buildings and Other Structures, by American Society of Civil Engineers, latest adopted edition.

1.4 SUBMITTALS

A. Submittals as required by Section 21 00 00, Fire Suppression Basic Requirements and Division 01, General Requirements.

1.5 QUALITY ASSURANCE

- A. Quality assurance as required by Section 21 00 00, Fire Suppression Basic Requirements and Division 01, General Requirements.
- B. In addition, meet the following:
 - 1. Material and Equipment: Listed for its intended fire protection use in current UL Fire Protection Equipment Directory, or UL Online Certifications Directory for Fire Protection, International Code Council Evaluation Service Reports and FM Global Approval Guide. All material and equipment to be new and from a current manufacturer.
 - 2. Provide per AHJ requirements.
 - 3. References to product Specifications for materials are listed according to accepted ANSI, ASTM, ASME, AWWA and other base standards. Materials to meet latest approved versions of these standards.

- 4. Fire Suppression Screw-Thread Connections: Comply with local fire department/fire marshal regulations for sizes, threading and arrangement of connections for fire department equipment to fire department connections.
- 5. Manufacturers: Unless an item is marked "No substitutions", submit substitution request for materials of other than named manufacturers.
- 6. Noise and Vibration:
 - a. Install vibration isolators and measures required to prevent noise and vibration from being transmitted to occupied areas. Select equipment to operate within noise coefficient (NC) design level for particular type of installation in relation to its location.
 - b. After installation, make proper adjustments to reduce noise and vibration to acceptable levels as defined by Architect.
 - c. In acoustically sensitive areas, design system in a manner that minimizes the number of wall penetrations.

1.6 WARRANTY

A. Warranty of materials and workmanship as required by Section 21 00 00, Fire Suppression Basic Requirements and Division 01, General Requirements.

1.7 FLOW TEST

A. If flow test information provided below has been conducted greater than 12 months prior to working plan submittal, the information provided is advisory only and not to be used for design. Provide materials and labor for a new water supply test on the closest nearby fire hydrants per NFPA 13 and NFPA 291. Utilize new flow test results for design of NFPA 13 fire sprinkler and NFPA 14 standpipe systems.

1.8 SYSTEM IMPAIRMENT

A. When returning a water-based fire protection system to service after impairment or control valve closure, verify the system is in working order by performing a main drain test per NFPA 25.

PART 2 - PRODUCTS

- 2.1 MANUFACTURERS
 - A. Aboveground Black Steel Pipe and Fittings:
 - 1. Pipe:
 - a. Bull Moose Tube
 - b. Wheatland Tube Co.
 - c. Youngstown Tube Co.
 - d. Tex-Tube Co.
 - e. State Pipe and Supply, Inc.
 - f. Or approved equivalent
 - 2. Fittings, Mechanical and Grooved Couplings:
 - a. Victaulic
 - b. Gruvlok
 - c. Shurjoint Piping Products Inc.
 - d. Smith-Cooper International
 - e. Tyco Fire & Building Products
 - f. Viking Corp.
 - g. Allied Rubber and Gasket Co. Inc., dba ARGCO
 - h. Anvil International
 - i. Dixon Valve & Coupling
 - j. Or approved equivalent.
 - Fittings, Threaded:
 - a. Ward Mfg.

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- b. Anvil International
- c. Smith-Cooper International
- d. Aegis Technologies
- e. Or approved equivalent.
- 4. Fittings, Rubber Gasketed:
 - a. Victaulic
 - b. Anvil International
 - c. AnvilStar
 - d. EBAA Iron, Inc.
 - e. Shurjoint Piping Products, Inc.
 - f. Smith-Cooper International
 - g. Tyco Fire & Building Products
 - h. Viking Corp.
 - i. Ward Mfg.
 - j. Allied Rubber and Gasket Co. Inc., dba ARGCO
 - k. Dixon Valve & Coupling
 - I. Or approved equivalent.
- 5. Fittings, Welded:
 - a. Anvil International
 - b. Shurjoint Piping Products Inc.
 - c. Smith-Cooper International
 - d. State Pipe & Supply, Inc.
 - e. Or approved equivalent.
- 6. Fittings, Flanged:
 - a. Victaulic
 - b. United Brand Fittings
 - c. U.S. Pipe
 - d. Anvil S.P.F.
 - e. Iowa Fittings Co.
 - f. Tyco Fire Products
 - g. Or approved equivalent.
- B. Wall and Floor Penetrations and Sleeves:
 - 1. Allied Rubber and Gasket Co., Inc., dba ARGCO
 - 2. Fire Protection Products Inc. (FPPI)
 - 3. Or approved equivalent.
- C. Hangers and Supports:
 - 1. Cooper B-Line Tolco
 - 2. Anvil International
 - 3. ITW Buildex Sammys
 - 4. Erico International
 - 5. PHD Mfg. Inc.
 - 6. Or approved equivalent.
- D. Sway Braces and Restraints:
 - 1. Cooper B-Line Tolco
 - 2. Anvil International
 - 3. Erico International
 - 4. PHD Mfg. Inc.
 - 5. Or approved equivalent.
- E. Anchors and Attachments:
 - 1. Concrete:
 - a. Cast-In Place Anchors for Hangers:
 - 1) Cooper B-Line Tolco
 - 2) Erico International

- 3) Or approved equivalent.
- b. Cast-In Place Anchors for Braces:
 - 1) Cooper B-Line Tolco
 - 2) Anvil International
 - 3) Erico International
 - 4) Or approved equivalent.
- c. Attachments as specified or described by structural. If not specified or described by structural, then as follows:
 - 1) Hilti
 - 2) Powers
 - 3) Simpson Strong-Tie
 - 4) DeWalt
 - 5) Or approved equivalent.
- 2. Wood:
 - a. Cooper B-Line Tolco
 - b. Anvil International
 - c. Elco Construction Products
 - d. Erico International
 - e. ITW Buildex Sammys
 - f. Or approved equivalent.
- 3. Steel:
 - a. Cooper B-Line Tolco
 - b. Anvil International
 - c. Elco Construction Products
 - d. Erico International
 - e. ITW Buildex Sammys
 - f. Or approved equivalent.
- F. Gauges:
 - 1. Ashcroft
 - 2. US Gauge
 - 3. Brecco
 - 4. Reliable Automatic Sprinkler Co.
 - 5. Fire Protection Products, Inc. (FPPI)
 - 6. Allied Rubber and Gasket Co. Inc., dba ARGCO
 - 7. Wika Instrument Corp.
 - 8. Or approved equivalent.
- G. Valves:
 - 1. OS&Y Gate:
 - a. Victaulic
 - b. Nibco
 - c. Mueller
 - d. Or approved equivalent.
 - 2. NRS Gate:
 - a. Nibco
 - b. Mueller
 - c. Victaulic
 - d. Or approved equivalent.
 - 3. Swing Check:
 - a. Victaulic
 - b. Nibco
 - c. Mueller
 - d. Viking
 - e. Tyco
 - f. AnvilStar
 - g. Reliable

- h. Or approved equivalent.
- 4. Wafer Check:
 - a. Nibco
 - b. Mueller
 - c. Viking
 - d. Tyco
 - e. Or approved equivalent.
- 5. Butterfly Valves:
 - a. Victaulic
 - b. Nibco
 - с. Тусо
 - d. Use lug body next to pumps; Nibco.
 - e. Reliable
 - f. Or approved equivalent.
- 6. Pressure Relief:
 - a. Watts
 - b. United Brass Works
 - c. AGF
 - d. Or approved equivalent.
 - Automatic Ball Drip Drain Valve:
 - a. Tyco

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- b. Reliable Automatic Sprinkler Co.
- c. Or approved equivalent.
- 8. Three-Way Gauge Valve:
 - a. Fire Protection Products Inc. (FPPI)
 - b. AGF Mfg. Inc.
 - c. Nibco
 - d. Or approved equivalent.
- 9. Automatic Air Release Valve:
 - a. Potter Electric Signal Co.
 - b. Or approved equivalent.
- 10. Ball Valve:
 - a. Victaulic
 - b. Apollo Valves
 - c. Fire Protection Products Inc. (FPPI)
 - d. Nibco
 - e. Or approved equivalent.
- H. Pipe, Valve, and Fire Protection Equipment Identification:
 - 1. Fire Protection Products, Inc. (FPPI)
 - 2. Allied Rubber and Gasket Co., Inc., dba ARGCO
 - 3. Or approved equivalent.
- I. Signs:
 - 1. Tyco Fire Products
 - 2. Reliable Automatic Sprinkler
 - 3. Viking Corp.
 - 4. Allied Rubber and Gasket Co., Inc., dba ARGCO
 - 5. Or approved equivalent.
- J. Drains:
 - 1. Reference Aboveground Black Steel Pipe and Fittings.
 - 2. AGF
 - 3. Victaulic
 - 4. Or approved equivalent.

2.2 ABOVEGROUND BLACK STEEL PIPE AND FITTINGS

- A. Wet Pipe Systems:
 - 1. Pipe Size 2-inch Diameter and Smaller: ASTM A53, ASTM A135, or ASTM A795; minimum of Schedule 40.
 - 2. Pipe Size 2-1/2-inch Diameter and Larger: ASTM A53, ASTM A135, or ASTM A795; minimum of Schedule 10.
 - 3. Exposed pipe 8-feet or less above finished floor: A minimum of Schedule 40.
- B. Dry Pipe Systems:
 - 1. Pipe Size 2-inch Diameter and Smaller: ASTM A53, ASTM A135, or ASTM A795; Schedule 40 only, shop welded, or threaded or cut grooved.
 - 2. Pipe Size 2-1/2-inch Diameter and Larger: ASTM A53, ASTM A135, or ASTM A795; minimum of Schedule 10.
 - 3. Exposed pipe 8-feet or less above finished floor: Minimum of Schedule 40.
- C. Joints:
 - 1. Threaded, flanged or bevel welded.
 - 2. Piping installed in plenums or shafts to have welded joints.
- D. Fittings:
 - 1. Threaded:
 - a. Malleable Iron: Class 150 and Class 300, ANSI B16.3.
 - b. Cast Iron: Class 125 and 250, ANSI B16.3.
 - 2. Flanged:
 - a. Cast iron; Class 125 and 250, ASME B16.1.
 - b. Raised ground face, bolt holes spot faced.
 - 3. Welded:
 - a. Carbon Steel: Long radius, standard weight or extra strong.
 - b. Factory Wrought Steel Buttweld Fittings: ASME B16.9.
 - c. Buttwelding Ends for Pipe, Valves, Flanges and Fittings: ASME B16.25.
 - d. Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures: ASTM A234.
 - e. Steel Pipe Flanges and Flanged Fittings: ASME B16.5.
 - f. Forged Steel Fittings, Socket Welded and Threaded: ASME B16.11.
 - 4. Mechanical Fittings and Grooved Couplings:
 - a. Couplings: UL 213, AWWA C606, ASTM A536 ductile iron or ASTM A47 malleable iron, with enamel finish and grooves or shoulders designed to accept grooved couplings. Synthetic-rubber gasket with central-cavity, pressure-responsive design and ASTM A183 carbon-steel bolts and nuts.
 - b. FM Global approved.
- E. Anti-Microbial Coating: Factory-applied coating to inhibit corrosion from microbiological organisms.

2.3 WALL AND FLOOR PENETRATIONS AND SLEEVES

A. Below Grade and High Water Table Areas: Waterproof elastomeric compound.

2.4 HANGERS AND SUPPORTS

- A. General: Select size of hangers and supports to exactly fit pipe size for bare piping.
- B. Hangers: Ferrous.
- C. Hanger Rods: Zinc electroplated carbon steel.

- D. Finishes: Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finish.
- E. Materials:
 - 1. Use carbon steel pipe hangers and supports, metal trapeze pipe hangers and attachments for general service applications.
 - 2. Use stainless steel hangers, rods and attachments for corrosive environment applications. Examples of corrosive environment applications include, but are not limited to: swimming pools and spas, pool and spa equipment rooms and adjacent areas, chemical rooms, kidney dialysis areas, marine and beach environments, commercial laundries and the like.
- F. Anti-Scratch Padding: Use padded hangers for piping subject to scratching.

2.5 SWAY BRACES AND RESTRAINTS

- A. Sway Bracing: From a single manufacturer and compatible with sway brace calculation program.
- B. Stainless steel for corrosive environment applications. Examples of corrosive environment applications include, but are not limited to: swimming pools and spas, pool and spa equipment rooms and adjacent areas, chemical rooms, kidney dialysis areas, marine and beach environments, commercial laundries, and the like.

2.6 ANCHORS AND ATTACHMENTS

- A. General: Anchor supports to masonry, concrete and block walls per anchoring system manufacturer's recommendations, or as modified by project Structural Engineer.
- B. Materials:
 - 1. Ferrous.
 - 2. Stainless steel for corrosive environment applications. Examples of corrosive environment applications include, but are not limited to: swimming pools and spas, pool and spa equipment rooms and adjacent areas, chemical rooms, kidney dialysis areas, marine and beach environments, commercial laundries, and the like.
- C. Cast in Place Anchors for Hangers: Verify listing is for hangers, braces, or both.
- D. Attachments in Concrete:
 - 1. Suitable for hanging and bracing fire protection systems in concrete which is subject to cracking in a seismic event.
 - 2. Seismic Design Areas C, D, E and F:
 - Compatible with International Code Council Evaluation Service Acceptance Criteria AC-193 and AC308 for expansion, screw and adhesive anchors. Meet requirements of ACI 355.2, Qualification of Post-Installed Mechanical Anchors in Concrete and Commentary.
 - b. All models of Hilti HDI and ITW Red Head Multi-Set II anchors are not approved for attaching fire protection systems in Seismic Design Areas C, D, E and F. No Exceptions.
- E. ITW Buildex Sammys with FM Approval only are not allowed in certain seismic zones. Verify with FM that FM Approval is effective in project's seismic zone.

2.7 GAUGES

A. Pressure Gauges: 3.5-inch, dial type, bronze bourdon tube or spring type, stainless steel case. 0 to 300 PSI.

2.8 VALVES

- A. OS&Y Gate:
 - 1. 2-1/2-inches and Larger: Iron body.
 - 2. 2-inches and Smaller: Bronze body.
- B. NRS Gate:
 - 1. Iron body. Non-rising stem with indicator post.
 - 2. Underground Butterfly Valves: Telescopic barrel type.
- C. Swing Check: Iron body, rubber and bronze faced checks.
- D. Wafer Check: Iron body, rubber seat, spring actuated.
- E. Butterfly Valves: Ductile iron body with factory-installed tamper switches. Use lug body next to pumps.
- F. Pressure Relief: Bronze body, stainless steel spring.
- G. Automatic Ball Drip Drain Valve: Bronze, spring-type.
- H. Three-Way Gauge Valve: Brass; rated to 300 psi.
- I. Automatic Air-Release Valve for Wet Systems:
 - 1. Rated to 175 psi.
 - 2. Automatic float-type with shutoff mounted in a water retention pan.
 - 3. Single set 24VAC@2A for electronic supervision.
 - 4. Ball valve switch with cover tamper.
- J. Ball Valves: Brass body, brass stem; forged brass ball disc.
- 2.9 PIPE, VALVE, AND FIRE PROTECTION EQUIPMENT IDENTIFICATION
 - A. Engraved plastic laminate or corrosion resistant metal sign or plastic equipment marker.
 - B. Corrosion-resistant chain or permanent adhesive.
- 2.10 SIGNS
 - A. Engraved plastic laminate or corrosion resistant metal sign or plastic equipment marker.
 - B. Corrosion-resistant chain or permanent adhesive.
- 2.11 DRAINS
 - A. Reference Aboveground Black Steel Pipe and Fittings.
- PART 3 EXECUTION
- 3.1 GENERAL INSTALLATION REQUIREMENTS
 - A. Install in conformance with UL Listing, FM Approval or ICC-ES requirements and restrictions.
- 3.2 ABOVEGROUND BLACK STEEL PIPE AND FITTINGS
 - A. Piping Routing:
 - 1. Route piping, except as otherwise indicated, vertically and horizontally (sloped to drain). Avoid diagonal runs wherever possible. Orient horizontal routes parallel with walls and beam lines.

- 2. Install piping as shown or described by diagrams, details and notations on Drawings or, if not indicated, install piping to provide the shortest route which does not obstruct usable space or block access for servicing the building and its equipment.
- 3. Install piping in concealed spaces above finished ceilings. Prior to design and installation. obtain pre-approval by Architect for exposed piping.
- 4. In open-to-structure areas which are open to public view, route exposed piping to minimize visual impact. Obtain Architect's and Engineer's approval of exposed piping installation.
- 5. Coordinate installation with other trades. Route piping as required to avoid building structure, equipment, plumbing piping, HVAC piping, ductwork, lighting fixtures, electrical conduits and bus ducts and similar work. Final location of lighting will have priority over final sprinkler locations. Provide drains to trapped sections of system which result from such routing. Other trades take precedence for installation space.
- 6. Support piping adjacent to walls, overhead construction, columns and other structural and permanent enclosure elements of the building. Limit clearance to 2-inches wherever furring is indicated for concealment of piping. Allow for insulation thickness. Locate insulated piping to provide minimum 1-inch clearance outside insulation.
- 7. Wherever possible in finished and occupied spaces, conceal piping from view by locating within column or beam enclosures, hollow wall construction, or above suspended ceilings. Do not encase horizontal routes in solid partitions, except where approved.
- 8. General Electrical Equipment Clearances: Do not route piping through electrical rooms, transformer vaults, elevator equipment rooms and other electrical or electronic equipment spaces and enclosures. Do not route piping above electric power or lighting panel, switchgear, low voltage panel, or similar electric device.
- 9. Rooms Protected by Alternative Systems: Route water filled and dry system piping around rooms protected by pre-action systems, clean agent systems, gaseous suppression systems and other alternative fire suppression systems.
- 10. Install pipe runs to minimize obstruction to other work.
- 11. Pitch all dry and pre-action system piping 1/4-inch per 10-feet for mains and 1/2-inch per 10-feet for branch lines, including pipe passing through both warm and cold areas.
- B. Couplings:
 - 1. Install where indicated on Drawings and on each side of pieces of equipment to permit easy removal of equipment.
 - 2. Deburr cut edges.
- C. Pipe Penetrations: Wire pipe cutout coupon at point of pipe penetration.
- D. Pipe and Pipe Fittings:
 - 1. Expansion and Flexibility: Install work with due regard for expansion and contraction to prevent damage to the piping, equipment, building and its contents. Provide piping offsets, loops, approved type expansion joints, sway bracing, wire restraints, vertical restraints, flexible couplings or other means to control pipe movement and to minimize pipe forces.
 - 2. Coordinate support of pipe 4-inches and larger with Structural Engineer.
 - 3. Provide clearances around piping per NFPA 13.
 - 4. Install dry and pre-action welded pipe with welds facing vertically up, or where this is not possible, as close as possible to vertical between 46 degrees and 234 degrees. Intent is to minimize corrosion caused by moisture in the bottom of pipes.

3.3 WALL AND FLOOR PENETRATIONS AND SLEEVES

- A. Escutcheons: Install on exposed pipes passing through walls or floors.
 - 1. Pipe Sleeves: Lay out work in advance of pouring concrete and furnish and set sleeves necessary to complete work.
 - 2. Floor Sleeves: Provide sleeves on pipes passing through concrete or masonry construction. Extend sleeve 1-inch above finished floor. Caulk pipes passing through floor with nonshrinking fire and water resistant grout or approved equivalent caulking

compound. Caulk/seal piping passing through fire rated building assembly with UL rated assemblies. Provide fire-rated assemblies per local AHJ requirements.

- 3. Wall Sleeves: Provide sleeves on pipes passing through concrete or masonry construction. Provide sleeve flush with finished face of wall. Caulk pipes passing through walls with non-shrinking caulking compound. Caulk/seal piping passing through fire-rated building assemblies with UL Listed or FM Approved fire-rated firestopping compound. Provide fire-rated assemblies per local AHJ requirements.
- 4. Beam Sleeves:
 - a. Coordinate with trades for locations of pipe sleeves in reinforced concrete and steel beams. Penetrations must be indicated on structural shop drawings. See Drawings and Specifications for specific sleeve location limitations. Pipe sleeve locations must be indicated on reinforced concrete and steel beam shop drawings.
 - b. 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.
- 5. Penetrations in Fire-Rated Wall/Floor Assemblies:
 - a. Reference Division 07, Thermal and Moisture Protection.
 - b. Coordinate with Drawings location of fire rated walls, ceilings and floors. When these assemblies are penetrated, seal around piping and equipment with approved firestopping material.
 - c. 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 and NFPA.
 - d. Install firestopping material complete as directed by manufacturer's installation instructions. Meet requirements of ASTM E814.

3.4 HANGERS AND SUPPORTS

A. Installation of pipe hangers, inserts and supports to conform to NFPA 13. Provide adjustable hangers, inserts, brackets, clamps, supplementary steel and other accessory materials required for proper support of pipe lines and equipment. Provide supplementary materials for proper support and attachment of hangers.

3.5 SWAY BRACES AND RESTRAINTS

- A. Locate per orientation and spacing as required by sway brace calculations.
- B. Attach sway bracing directly to pipe or equipment being braced.
- C. Do not attach sway bracing to bottom of truss members.
- 3.6 ANCHORS AND ATTACHMENTS
 - A. In post-tension construction, determine location of post-tension cables and install anchors to avoid contact or interference with post-tension cables. Coordinate with Structural.
 - B. Do not use powder-driven attachments.
 - C. Building Attachments and Inserts: Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves and flanges, for sizes NPS 2-1/2 and larger. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.
 - D. Hanger and Support Attachments:
 - 1. Concrete:
 - a. Before Pouring: Prior to installation, coordinate locations of cast in place concrete inserts with other trades. Install in accordance with manufacturer's instructions.
 - b. After Pouring:

- 1) Where supports in slabs are required after concrete has been poured, provide drilled-in threaded inserts (mechanical-expansion anchors), installed in accordance with manufacturer's recommendations.
- 2) Install mechanical-expansion anchors after concrete is completely cured and in accordance with manufacturer's installation instructions.
- 3) Where anchors are to be installed in post-tension construction, determine and avoid locations of post-tension cables prior to drilling.
- 2. Metal Floor Deck: Support hangers per UL Listing or FM Approval for selected concrete insert before pouring of concrete topping, or from beam clamps fastened to structural steel.
- 3. Steel Joists: Support hangers from beam clamps fastened to bar joists or to auxiliary steel between bar joists as required.
- 4. C-Clamp Hangers: Do not attach to one side of double-angle bottom members.
- 5. Locate and install hangers, supports and attachments connecting to I-joists, structural insulated panels (SIPs), cross laminated timber and similar engineered structural products according to the structural product manufacturer specifications.
- E. Make available to the Architect information required to verify the anchorage, sway bracing and restraint of fire protection systems.

3.7 GAUGES

- A. Install gauges conveniently and accessibly located with reference to finished building for repairs, removal and service.
- B. Install with dial positioned for maximum visibility.

3.8 VALVES

- A. General:
 - 1. Provide post indicator on buried control valves.
 - 2. Inspect valves for leaks. Adjust or replace packing to stop leaks. Replace valve if leak persists.
- B. Installation:
 - 1. Install valves where required for proper operation, testing and drainage. Locate valves so as to be accessible and so that separate support can be provided when necessary. Install conveniently and accessibly located with reference to finished building for repairs, removal and service.
 - 2. Swing Check Valves: Install in horizontal position with hinge pin horizontally perpendicular to centerline of pipe. Install for proper direction of flow.
 - 3. Wafer Check Valves: Install between two flanges in horizontal or vertical position, position for proper direction of flow.
- C. Pressure Relief Valves: Provide piping to permanent drain.
- 3.9 PIPE, VALVE, AND FIRE PROTECTION EQUIPMENT IDENTIFICATION
 - A. Install engraved plastic laminate or corrosion resistant metal sign or plastic equipment marker, secured with corrosion-resistant chain or permanent adhesive on or near each Item of fire suppression equipment and each operational device, as specified in this specification if not otherwise specified for each Item or device.
 - B. Provide signs for the following general categories of equipment and operational devices: Valves, drains, pumps, standpipes, tanks and similar equipment.
 - C. Each new piece of equipment to bear a permanently attached identification plate, listing manufacturer's name, capacities, sizes and characteristics.

- D. Piping to bear the manufacturer's name, schedule of thickness, size and ASTM identification number
- E. Provide valve tag on every valve, control device, main drain, auxiliary drain, and drum drip in each system. Exclude check valves and valves within factory fabricated equipment units. List each tagged valve in valve schedule for each piping system.
- F. List each tagged item and its location in valve schedule; identify on fire suppression drawings.
- G. Install framed, glass or rigid transparent plastic covered, mounted valve schedule and valve location drawing in main riser or fire pump room.
- H. Provide identification sign on ceiling tile below valve location.
- I. Provide permanent identification sign at pressure regulating valves stating required setting of pressure regulator.
- J. Adjusting: Relocate fire suppression identification device which has become visually blocked.
- K. Cleaning: Clean face of identification devices and glass frames of valve charts.

3.10 SIGNS

- A. General Information Signs: Provide a general information sign used to determine system design basis and information relevant to the inspection, testing and maintenance requirements required by NFPA 25, Standard for the Inspection, Testing and Maintenance of Water-Based Fire Protection Systems. Such general information is to be provided with a permanently marked weatherproof metal or rigid plastic sign, secured with corrosion-resistant wire, chain, or other acceptable means. Such signs are to be placed at each system control rise loop and auxiliary system control valve. The sign is to include the following information:
 - 1. Name and Location of the Facility Protected
 - 2. Presence of High-Piled and/or Rack Storage
 - 3. Maximum Height of Storage Planned
 - 4. Flow Test Data
 - 5. Location of Auxiliary Drains and Low Point Drains
 - 6. Original Results of Main Drain Flow Test
 - 7. Name of Installing Contractor or Designer
 - 8. Indication of presence and location of other auxiliary systems.
- B. Dry Signs: At system riser supplying dry systems, provide the following information: volume in gallons contained in each system.

3.11 DRAINS

- A. Locate drain connections within 7-feet of floor. Provide piping capable of being fully drained.
- B. Provide a drain vent at top of vertical drains. Coordinate with Division 22, Plumbing.
- C. Coordinate location of auxiliary drains with Architect. Architect to approve location before drain is installed.
- D. Protect drains from tampering and accidental operation.
- E. Protect drain discharge at the exterior with a turned-down 45 degree elbow.

END OF SECTION
SECTION 21 13 00 - FIRE SUPPRESSION SPRINKLER SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. Work Included:
 - 1. Sprinklers
 - 2. Flexible Sprinkler Hose Fitting Assembly For fire sprinklers in suspended ceilings which are supplied by a wet pipe system.
 - 3. Inspector's Test Connection
 - 4. Wet System Air Vent
 - 5. Spare Sprinkler Cabinet
 - 6. Sprinkler Guards
- B. This is a contractor designed system. Contact AHJ prior to bid to verify fire system requirements. Provide design compliant with codes as interpreted by AHJ.
- C. Scope:
 - 1. Wet-Pipe Sprinkler System.
 - 2. Revision and extension of existing system to new and remodeled areas.
- D. Coordinate location and type of tamper, flow and pressure switches and fire alarm system.
- E. Provide electrical connections and wiring as required for a complete and operable system. Includes but is not limited to bells, air compressors, sump pumps, fire pumps, jockey pumps and pump controllers.

1.2 RELATED SECTIONS

- A. Contents of Division 21, Fire Suppression and Division 01, General Requirements apply to this Section.
- B. In addition, reference the following:
 - 1. Division 22, Plumbing
 - 2. Division 23, Heating, Ventilating and Air-Conditioning
 - 3. Division 26, Electrical
 - 4. Division 28, Electronic Safety
 - 5. Section 21 00 00, Fire Suppression Basic Requirements
 - 6. Section 21 05 00, Common Work Results for Fire Suppression
- 1.3 REFERENCES AND STANDARDS
 - A. References and Standards as required by Section 21 00 00, Fire Suppression Basic Requirements and Division 01, General Requirements.
- 1.4 SUBMITTALS
 - A. Submittals as required by Section 21 00 00, Fire Suppression Basic Requirements and Division 01, General Requirements.
- 1.5 QUALITY ASSURANCE
 - A. Quality assurance as required by Section 21 00 00, Fire Suppression Basic Requirements and Division 01, General Requirements.

1.6 WARRANTY

A. Warranty of materials and workmanship as required by Section 21 00 00, Fire Suppression Basic Requirements and Division 01, General Requirements.

1.7 SYSTEM DESCRIPTION

- A. Provide coverage for remodeled building areas as required. Field verify field conditions prior to submittal of bid. Adjust bid to provide protection features in accordance with applicable codes and interpretations by AHJ. Provide design and installation based on more stringent requirements if this specification and AHJ requirements differ from Code.
- B. Sprinkler system design to include a 10 percent pressure and flow cushion between system demand point and available water supplies.
- C. Extend hydraulic calculations from hydraulically most remote design area back to location of pressure hydrant of flow test or effective point of water supply where characteristics of water supply are known.

1.8 EXTRA STOCK

- A. Provide extra sprinklers per code.
- B. Provide suitable wrenches for each sprinkler type and metal storage cabinet in riser room.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Sprinklers:
 - 1. Finished Areas:
 - a. Victaulic
 - b. Viking
 - с. Тусо
 - d. Reliable
 - e. Globe
 - f. Senju
 - g. Or approved equivalent.
 - 2. Nonfinished Areas:
 - a. Victaulic
 - b. Viking
 - c. Tyco
 - d. Reliable
 - e. Globe
 - f. Or approved equivalent.
 - 3. Dry Sprinklers:
 - a. Victaulic
 - b. Viking
 - c. Tyco
 - d. Reliable
 - e. Or approved equivalent.

B. Flexible Sprinkler Hose Fitting Assembly:

- 1. Victaulic; VicFlex.
- 2. Flexhead Industries
- 3. SprinkFLEX
- 4. Allied Rubber and Gasket Company, Incorporated, dba ARGCO
- 5. Reliable Automatic Sprinkler Company
- 6. Tyco Fire and Building Products
- 7. Viking Corporation
- 8. Or approved equivalent.
- C. Inspector's Test Connection:

- 1. Combination Test and Drain:
 - a. Victaulic; Series 720 TestMaster II Alarm Test Module with pressure relief valve.
 - b. AGF; Model 1011, 2511, 3011, with pressure relief valve.
 - c. Or approved equivalent.
- 2. Dry System Inspector's Test Connection:
 - a. AGF; Model 3011.
 - b. Or approved equivalent.
- D. Wet System Air Vent:
 - 1. Potter Electric Signal Company; Model PAV
 - 2. Or approved equivalent.
- E. Spare Sprinkler Cabinet:
 - 1. Victaulic
 - 2. Fire Protection Products, Inc. (FPPI).
 - 3. Tyco Fire & Building Products
 - 4. Allied Rubber and Gasket Co.
 - 5. Potter Roemer Fire Pro.
 - 6. Or approved equivalent.
- F. Sprinkler Guards:
 - 1. Victaulic
 - 2. Viking
 - 3. Тусо
 - 4. Reliable
 - 5. Globe
 - 6. Senju
 - 7. Or approved equivalent.
- 2.2 SPRINKLERS
 - A. Finished Areas:
 - 1. Type: Glass-Bulb
 - 2. Style: Recessed
 - 3. Response: Quick-Response
 - 4. Finish: Match existing sprinkler types.
 - 5. Escutcheon: Match existing sprinkler types.
 - B. Nonfinished Areas:
 - 1. Type: Glass-Bulb
 - 2. Response: Quick-Response
 - 3. Finish: Brass
 - C. Pendent sprinklers supplied by dry or preaction piping: Dry pendent type.
- 2.3 FLEXIBLE SPRINKLER HOSE FITTING ASSEMBLY
 - A. Fully welded non-mechanical fittings, stainless steel, braided, leak-tested with minimum 1-inch true-bore internal corrugated hose diameter. 175 psi.
 - B. Ceiling Bracket: Galvanized steel, direct attachment type, with integrated snap-on clip ends and removable flexible hose attachment with set screw. FM1637, UL 2443.
 - C. Affix permanent sign, label or decal at each flexible sprinkler hose fitting assembly anchoring component limiting the relocation of the sprinkler.

2.4 INSPECTOR'S TEST CONNECTION

- A. Combination Test and Drain: Bronze body, brass stem, impregnated Teflon seat, chrome coated brass ball, steel handle with positive stops, tamper resistant test orifice, integral tamper resistant sight glasses, tapped and plugged port for system access, steel identification plate. Provide with pressure relief valve and drainage piping with bronze body and stainless steel spring.
- B. Dry System Inspector's Test Connection: Bronze, brass stem, steel handle, chrome-plated bronze ball, Teflon valve seat, tamper and corrosion resistant orifice equivalent to smallest sprinkler orifice, sight flow connection.
- 2.5 WET SYSTEM AIR VENT
 - A. Brass, UL 2573 with ball valve supervisory switch.

2.6 SPARE SPRINKLER CABINET

- A. NFPA 13 Systems: Sized to accommodate a minimum of two spare sprinklers of each Sprinkler Identification Number (SIN), manufacturer, model, orifice, deflector type, temperature and thermal sensitivity, or a minimum of six sprinklers for facilities having under 300 sprinklers, or a minimum of 12 sprinklers for facilities having 300 to 1000 sprinklers, or a minimum of 24 sprinklers for facilities having over 1000 sprinklers, whichever is more.
- B. Welded steel with hinged steel cover.
- C. Red enamel or polyester coated finish inside and out.

2.7 SPRINKLER GUARDS

- A. Metal.
- B. Listed for use with sprinkler model to which it is attached.

PART 3 - EXECUTION

- 3.1 GENERAL INSTALLATION REQUIREMENTS
 - A. Install per manufacturer's requirements and recommendations.

3.2 SPRINKLERS

- A. Center sprinklers in center or quarter points of suspended ceiling tile.
- B. Align sprinklers with architectural column lines, lighting, diffusers and other ceiling features. In unfinished ceilings, route piping to minimize visual impact. Sprinklers and piping not so aligned are to be removed and replaced at no additional cost to Owner.
- C. Install dry sprinklers in a manner which does not trap water.
- 3.3 FLEXIBLE SPRINKLER HOSE FITTING ASSEMBLY
 - A. Install flexible sprinkler hose fitting assemblies where pendent sprinkler heads are located in acoustic ceiling tiles.
 - B. Install with no more bends than are included in equivalent footage used in hydraulic calculations.
 - C. Maintain manufacturer's recommended bending radius as included in equivalent footage used in hydraulic calculations.
 - D. Affix permanent sign, label or decal at each flexible sprinkler hose fitting assembly anchoring component limiting the relocation of the sprinkler.

3.4 INSPECTOR'S TEST CONNECTION

- A. Locate where full flow discharge or pressure relief valve discharge will not do damage, including damage to landscaping and will not cause dangerous conditions to walking surfaces or discoloration to building surfaces.
- B. Locate within 5-feet of finished floor.

3.5 WET SYSTEM AIR VENT

- A. Locate at a point in the system that will vent the most air.
- B. Connect at top of pipe.
- C. Locate so as not to interfere with sprinkler spray pattern.
- D. Locate where it can be easily accessed for inspection and cleaning.
- E. Pipe output of air vent to drain with an indirect connector or to exterior where it will not cause damage.
- 3.6 SPARE SPRINKLER CABINET
 - A. Attach to wall at the main sprinkler system riser.
 - B. Locate so cover is easy to open and readily accessible.
 - C. Locate in an area with a temperature between 40 and 100 degrees Fahrenheit (4 and 38 degrees Celsius).
 - D. Locate sprinkler wrenches inside cabinet.
 - E. Inside the cabinet, provide a list of sprinklers installed in the property, including sprinkler identification number, manufacturer, model, orifice, deflector type, thermal sensitivity and pressure rating, quantity of each type to be contained in the cabinet and issue or revision date of the list.
- 3.7 SPRINKLER GUARDS
 - A. Install per manufacturer's instructions and recommendations.

END OF SECTION

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SECTION 22 00 00 - PLUMBING BASIC REQUIREMENTS

PART 1 - GENERAL

1.1 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 Authorized Representative, and other reviewing entity whose approval is required to obtain systems acceptance.

1.2 RELATED SECTIONS

- A. Contents of Section applies to Division 22, 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

1.3 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. OZERCC Oregon Zero Energy Ready Commercial 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. CGA Compressed Gas Association
 - 15. CISPI Cast Iron Soil Pipe Institute
 - 16. ETL Electrical Testing Laboratories
 - 17. EPA Environmental Protection Agency
 - 18. FM FM Global
 - 19. IAPMO International Association of Plumbing and Mechanical Officials
 - 20. GAMA Gas Appliance Manufacturers Association
 - 21. HI Hydraulic Institute Standards
 - 22. ISO International Organization for Standardization
 - 23. MSS Manufacturers Standardization Society
 - 24. NEC National Electric Code
 - 25. NEMA National Electrical Manufacturers Association
 - 26. NFGC National Fuel Gas Code
 - 27. NFPA National Fire Protection Association
 - 28. NRCA National Roofing Contractors Association
 - 29. NSF National Sanitation Foundation
 - 30. OSHA Occupational Safety and Health Administration
 - 31. SMACNA Sheet Metal and Air Conditioning Contractors' National Association, Inc.
 - 32. TEMA Tubular Exchanger Manufacturers Association
 - 33. TIMA Thermal Insulation Manufacturers Association
 - 34. UL Underwriters Laboratories Inc.
- D. See Division 22, Plumbing individual Sections for additional references.

1.4 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 posted to ftp site. For electronic format, provide one file per division containing one bookmarked PDF file with each bookmark corresponding to each Specification Section. Arrange bookmarks in ascending order of Specification Section number. 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.
 - 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 Section 22 05 48, Vibration and Seismic Controls for Plumbing Piping and Equipment. 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, Owner's Instructions:
 - a. Submit, at one time, electronic files (PDF format) 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.
 - 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 pressure, flow, leakage and purity test data and air and water systems test data, as applicable. Include copy of third-party and state and local jurisdiction inspection reports.
- 8) Include copy of valve charts/schedules.
- 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.
- 10) Include product certificates of warranties and guarantees.
- 11) 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 CAD Drawings and make one set of black-line drawings created from CAD Files in version/release equal to contract drawings. Submit CAD disk and drawings upon substantial completion.
 - d. At completion of project, show changes and deviations from the Drawings in red on one set of black-line drawings. Include written Addendums, RFIs, and change order items. Make changes to Drawings in a neat, clean, and legible manner.
 - e. Provide Invert elevations and dimensioned locations for water services, building waste, and storm drainage piping below grade extending to 5-feet outside building line.
 - f. See Division 22, Plumbing individual Sections for additional items to include in record drawings.

1.5 QUALITY ASSURANCE

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

- D. Manufacturer's Instructions: Follow manufacturer's written instructions. If in conflict with Contract Documents, obtain clarification. Notify Engineer/Architect, in writing, before starting work.
- E. Items shown on Drawings are not necessarily included in Specifications or vice versa. Confirm requirements in all Contract Documents.
- F. Provide products that are UL listed.
- 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.
- I. 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.
- J. Provide safety controls required by National Boiler Code (ASME CSD 1) for boilers and water heaters with an input of 400,000 BTUH and higher.

1.6 WARRANTY

- A. Provide written warranty covering the work for a period of one year from date of Substantial Completion in accordance with Division 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.

1.7 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.

1.8 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

2.1 MANUFACTURERS

A. Articles, fixtures, and equipment of a kind to be standard product of one manufacturer, including but not limited to fixtures, pumps, drains and equipment.

2.2 STANDARDS OF MATERIALS AND WORKMANSHIP

- 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. Names and manufacturer's names denote character and quality of equipment desired and are not to be construed as limiting competition.
- C. Hazardous Materials:
 - 1. Comply with local, State of Oregon, and Federal regulations relating to hazardous materials.
 - 2. Comply with Division 00, Procurement and Contracting Requirements and Division 01, General Requirements for this project relating to hazardous materials.
 - 3. Do not use any materials containing a hazardous substance. If hazardous materials are encountered, do not disturb; immediately notify Owner and Architect. Hazardous materials will be removed by Owner under separate contract.

2.3 ACCESS PANELS

- A. See Division 01, General Requirements and Division 08, 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.
 - Manufacturers and Models:
 - 1) Drywall: Karp KDW.
 - 2) Plaster: Karp DSC-214PL.

d.

- 3) Masonry: Karp DSC-214M.
- 4) 2 hour rated: Karp KPF-350FR.
- 5) Milcor, Elmdor, Acudor, or approved equivalent.

PART 3 - EXECUTION

3.1 ACCESSIBILITY AND INSTALLATION

- A. Confirm Accessibility and Installation requirements in Division 00, 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 and Engineer 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:
 - 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.

3.2 SEISMIC CONTROL

- A. Confirm Seismic Control requirements in Division 01, General Requirements, Structural documents, Section 22 05 48, Vibration and Seismic Controls for Plumbing Piping and Equipment, 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.
- C. Piping:
 - 1. Per "Seismic Restraints Manual Guidelines for Mechanical Systems" latest edition published by SMACNA or local requirements.
- D. Provide means to prohibit excessive motion of plumbing equipment during earthquake.

3.3 REVIEW AND OBSERVATION

- A. Confirm Review and Observation requirements in Division 00, Procurement and Contracting Requirements, Division 01, General Requirements, Section 22 00 00, Plumbing Basic Requirements and individual Division 22, Plumbing Sections.
- B. Notify Architect or Engineer, 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.

3.4 CONTINUITY OF SERVICE

- 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.

3.5 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.

3.6 EQUIPMENT SELECTION AND SERVICEABILITY

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

3.7 DELIVERY, STORAGE AND HANDLING

- 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.

3.8 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 Authorized 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.
- D. Training and Demonstration per Section 01 91 13, General Commissioning Requirements and 22 08 00, Commissioning of Plumbing.

3.9 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

- 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.

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SECTION 22 05 19 - PLUMBING DEVICES

PART 1 - GENERAL

1.1 SUMMARY

- A. Work Included:
 - 1. Water Hammer Arrestors
 - 2. Trap Primers

1.2 RELATED SECTIONS

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

1.3 REFERENCES AND STANDARDS

- A. References and Standards as required by Section 22 00 00, Plumbing Basic Requirements and Division 01, General Requirements.
- 1.4 SUBMITTALS
 - A. Submittals as required by Section 22 00 00, Plumbing Basic Requirements and Division 01, General Requirements.
- 1.5 QUALITY ASSURANCE
 - A. Quality assurance as required by Section 22 00 00, Plumbing Basic Requirements and Division 01, General Requirements apply to this Section.

1.6 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

1

2.1 MANUFACTURERS

- A. Water Hammer Arrestors:
 - Piston Type:
 - a. PPP
 - b. Sioux Chief
 - c. Or approved equivalent.
- B. Trap Primers:
 - 1. Wade
 - 2. Zurn
 - 3. J.R. Smith
 - 4. PPP
 - 5. Or approved equivalent.

2.2 WATER HAMMER ARRESTORS

- A. Bellows-type, stainless steel casing and bellows, pressure rated, tested and certified in accordance with PDI WH-201 or ASSE 1010.
- B. Piston-type, copper, brass or stainless steel with O-ring piston, pressure rated, tested and certified in accordance with PDI WH-201 or ASSE 1010.

2.3 TRAP PRIMERS

A. Electronic trap seal automatic primer valve with integral anti siphon protection and timer. Coordinate quantity, locations and voltage characteristics for control points.

PART 3 - EXECUTION

3.1 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, Plumbing Basic Requirements for additional requirements.
- B. Provide instruments with scale ranges selected according to service with largest appropriate scale.
- C. Install per manufacturer recommendations.

3.2 WATER HAMMER ARRESTORS

- A. Install in upright position, in locations and of sizes in accordance with PDI WH-201 or ASSE 1010, and elsewhere as indicated.
- B. Locate water hammer arrestors in supply pipe in accordance with recommendations of Plumbing and Drainage Institute PDI-WH201 or ASSE 1010. Install ahead of solenoid operated valves. Determine size of arrestor by fixture unit value of fixture supplied, using PDI symbols to designate sizes. Provide access panel for each water hammer arrestor.
- C. Install per manufacturer recommendations.

3.3 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.
- E. Locate trap primers such that the maximum allowable distance from the primer to the drain does not exceed the manufacturer's allowable distance.
- F. Install trap primers concealed behind walls with an access panel. Coordinate final location with architect prior to installation.

END OF SECTION

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

PART 1 - GENERAL

1.1 SUMMARY

- A. Work Included:
 - 1. Valves, General
 - 2. Ball Valves
 - 3. Thermostatic Point-of-Use Mixing Valves (ASSE 1070 Rated)

1.2 RELATED SECTIONS

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

1.3 REFERENCES AND STANDARDS

- A. References and Standards as required by Section 22 00 00, Plumbing Basic Requirements and Division 01, General Requirements.
- 1.4 SUBMITTALS
 - A. Submittals as required by Section 22 00 00, Plumbing Basic Requirements and Division 01, General Requirements.
- 1.5 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.

1.6 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

2.1 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. Havs
- Jenkins 11.
- Josam 12.
- Kennedy 13.
- Milwaukee 14.
- 15. Mueller
- 16. Nibco
- **Red-White Valve** 17.
- 18. Smith
- 19. Stockham
- 20. **Tour Anderson**
- 21. Wade
- 22. Watts
- 23. Wilkins
- 24 Zurn
- 25. Or approved equivalent.
- C. Ball Valves:
 - 1. See Valves General above. 2.
 - NSF Valves:
 - a. Clow
 - Kennedv b.
 - Nibco C.
 - Or approved equivalent. d.
- D. Thermostatic Point-of-Use Mixing Valves (ASSE 1070 Rated):
 - Lawler 1.
 - 2. Leonard
 - 3. Powers Hydroguard
 - Or approved equivalent. 4.

2.2 **VALVES - GENERAL**

- Α. General:
 - Sizes: Unless otherwise indicated, provide valves of same size as upstream pipe size. 1.
 - Operators: Provide handwheels, fastened to valve stem, for valves other than 2. 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.
 - Valve Identification: Manufacturer's name (or trademark) and pressure rating clearly 3. marked on valve body.
- Β. Valves in Insulated Piping: With 2-inch stem extension and following features:
 - Ball Valves: With extended operating handle of non-thermal-conductive material, and 1. 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:
 - Flanged: With flanges according to ASME B16.1 for iron valves. 1.
 - 2. Solder Joint: With sockets according to ASME B16.18.
 - Threaded: With thread according to ASME B1.20.1. 3.
- D. Valve Bypass and Drain Connections: MSS SP-45.

2.3 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, lead-free brass or stainless steel ball, lead-free brass stem, Teflon seat, extended steel handle. Apollo 77CLF 100 Series two-piece.
- 2.4 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

3.1 GENERAL INSTALLATION REQUIREMENTS

- A. Prepare valves for shipping as follows:
 - 1. Protect internal parts against rust and corrosion.
 - 2. Protect threads, flange faces, grooves, and weld ends.
 - 3. Set ball valves open to minimize exposure of functional surfaces.
 - 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. Do not attempt to repair defective valves; replace with new valves.
- I. 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.
- J. 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.

- K. Insulation: Where insulation is indicated, install extended stem valves, arranged in proper manner to receive insulation.
- L. Seats: Renewable seats, except where otherwise indicated.
- M. When soldering, use paste flux that are approved by the manufacturer for use with lead free alloys.
- N. If valve applications are not indicated on Drawings, use the following:
 1. Shutoff Service: Ball valves.
- O. 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.
- P. 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.
- Q. 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.
- 3.2 BALL VALVES
 - A. See General Installation Requirements above.
- 3.3 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 05 29 - HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT

- PART 1 GENERAL
- 1.1 SUMMARY
 - A. Work Included:
 - 1. Pipe Hangers and Supports for Plumbing Piping and Equipment
 - 2. Wall and Floor Sleeves
 - 3. Building Attachments
 - 4. Miscellaneous Metal and Materials
- 1.2 RELATED SECTIONS
 - A. Contents of Division 22, Plumbing and Division 01, General Requirements apply to this Section.
- 1.3 REFERENCES AND STANDARDS
 - A. References and Standards as required by Section 22 00 00, Plumbing Basic Requirements and Division 01, General Requirements.
 - B. In addition, meet the following:
 - 1. ASCE 7-16, Minimum Design Loads for Buildings and Other Structures.
 - 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.

1.4 SUBMITTALS

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

1.6 WARRANTY

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

1.7 PERFORMANCE REQUIREMENTS

- A. General Provide pipe and equipment hangers and supports in accordance with the following:
 - 1. When supports, anchorages, and seismic restraints for equipment, and supports, anchorages, and seismic restraints for 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

2.1 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.
 - h. Or approved equivalent.
 - 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
 - f. Or approved equivalent.
 - 3. Thermal-Hanger Shield Inserts:
 - a. Erico Hanger Co., Inc.
 - b. Pipe Shields, Inc.
 - c. Rilco Manufacturing Co., Inc.
 - d. HOLDRITE Insulation Couplings
 - e. Or approved equivalent.
 - Freestanding Roof Supports:
 - a. Erico Hanger Co., Inc.
 - b. Nelson-Olsen Inc.
 - c. B-Line
 - d. M. Fab
 - e. Or approved equivalent.
 - Pipe Alignment and Secondary Supports:
 - a. HOLDRITE
 - b. Starquick
 - c. Or approved equivalent.
- B. Wall and Floor Sleeves:

4.

5.

- 1. Below Grade and High Water Table Areas:
 - a. Modular Link Sealing System at Pipe Sleeves:
 - 1) Thunderline Corporation
 - 2) Or approved equivalent.
- 2. Pre-Engineered Firestop Pipe Penetration Systems:
 - a. HOLDRITE HydroFlame
 - b. Proset
 - c. Or approved equivalent.
- C. Building Attachments:

- 1. Anchor-It
- 2. Gunnebo Fastening Corp.
- 3. ITW Ramset/Red Head
- 4. Masterset Fastening Systems, Inc.
- 5. Or approved equivalent.
- D. 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.
 - e. Or approved equivalent.

2.2 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 A1011 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. Concrete Inserts:
 - 1. Malleable iron body, hot dipped galvanized finish. Lateral adjustment. MSS Type 18.
- F. Continuous Concrete Insert:
 - 1. Steel construction, minimum 12 gauge. Electrogalvanized finish. Pipe clamps and insert nuts to match.
- G. Beam Clamps:
 - 1. MSS Type 19 and 23, wide throat, with retaining clip.
 - 2. Universal Side Beam Clamp: MSS Type 20.
- H. Hangers for Pipe Size 2-inches and Smaller:
 - 1. Adjustable swivel ring hanger, UL listed, Type 6 or Type 10.
- I. Riser Clamps:
 - 1. Steel, UL listed. MSS Type 8.
- J. Plumbers Tape:

1.

- 1. Not permitted as pipe hangers or pipe straps.
- K. Pipe Alignment and Secondary Support Systems:
 - 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.
 - 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.

2.3 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. 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:
 - 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.
 - 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.

2.4 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:

- Anchor Bolts (Cast-In-Place): Steel bolts, ASTM A307. Nuts to conform to ASTM A194. Design values for shear and tension not more than 80 percent of the allowable listed loads.
- 2. Anchor (Expansion) Bolts: Carbon steel to ASTM A307; nut to conform to ASTM A194; drilled-in type. Design values for shear and tension not more than 80 percent of the allowable listed loads.
- 3. Anchor (Adhesive) Bolts: Consisting of two-part adhesive cartridge and zinc-plated Type A307 steel anchor bolt rod assembly with ASTM A194 nut.
- 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, non-shrink and nonmetallic, dry, hydraulic-cement grout.
 - 1. Characteristics: Post hardening and volume adjusting; recommended for both interior and exterior applications.
 - 2. Properties: Non-staining, noncorrosive, and non-gaseous.
 - 3. Design Mix: 5000-PSI (34.5-MPa), 28-day compressive strength.

2.5 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, non-shrink and nonmetallic, dry, hydraulic-cement grout.
 - 1. Characteristics: Post hardening and volume adjusting; recommended for both interior and exterior applications.
 - 2. Properties: Non-staining, noncorrosive, and non-gaseous.
 - 3. Design Mix: 5000-PSI (34.5-MPa), 28-day compressive strength.
- PART 3 EXECUTION

3.1 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:
 - 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.

3.2 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.
 - 4. Pipe Support Brackets: Support pipe with pipe slides.
 - 5. Steel Backing in Walls: Provide steel backing in walls to support fixtures and piping hung from steel stud walls.
 - 6. Channel Support System Installation: Arrange for grouping of parallel runs of piping and support together on field-assembled channel systems.
 - a. Field assemble and install according to manufacturer's written instructions.
 - 7. Pipe Guides:
 - a. Install on continuous runs where pipe alignment must be maintained. 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.
 - 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.
 - 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 piping through electrical rooms, transformer vaults, elevator equipment rooms, IT rooms, MPOE 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 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. Vertical Piping:
 - 1. Support with U-clamps fastened to wall to hold piping away from wall unless otherwise approved.
 - 2. Riser clamps to be directly under fitting or welded to pipe. Provide neoprene pads for all systems except natural gas.
 - 3. Riser to be supported at each floor penetration.
 - 4. Provide structural steel supports at the base of pipe risers. Size supports to carry forces exerted by piping system when in operation.
- C. 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.

3.3 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.

3.4 BUILDING ATTACHMENTS

- A. Install within concrete slabs or attach to structural steel or wood. 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.
- B. Attachment to Wood Structure: Provide MSS Type 34 for attachment to wooden beam or approved attachment for a wood structure.
- C. Install mechanical-anchor fasteners in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.
- D. 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.
- E. 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. Test powder-actuated insert attachments with a minimum load of 100 pounds.

- F. 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.
- G. Anchor Bolts:
 - 1. 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.
- H. Pipe Anchors: Provide anchors to fasten piping which is subject to expansion and contraction, and adjacent to equipment to prevent loading high forces onto the equipment.
- I. 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.
- J. 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.
- K. 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.
- L. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers and other accessories.

3.5 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.
- E. Setting Loose Plates: Clean concrete and masonry bearing surfaces of any bond reducing materials, and roughen to improve bond to surfaces. Clean bottom surface of bearing plates.
 - 1. Set loose leveling and bearing plates on wedges or other adjustable devices. After the bearing members have been positioned and plumbed, tighten the anchor bolts. Do not remove wedges or shims, but if protruding, cut-off flush with edge of the bearing plate before packing with grout. Use metallic non-shrink grout in concealed locations where not exposed to moisture; use non-metallic non-shrink grout in exposed locations, unless otherwise indicated.
 - 2. Pack grout solidly between bearing surfaces and plates to ensure that no voids remain.
- 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:
 - 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.

- Finish welds at exposed connections so no roughness shows after finishing and d. contours of welded surfaces match adjacent contours. Provide hot dipped galvanized components for items exposed to weather.
- 4.

END OF SECTION

SECTION 22 05 53 - IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

- A. Work Included:
 - 1. Tags
 - 2. Plastic Pipe Markers

1.2 RELATED SECTIONS

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

1.3 REFERENCES AND STANDARDS

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

1.4 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:

1.5 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.

1.6 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

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

2.2 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.
 - 4. Color: Yellow background with black lettering.

2.3 PLASTIC PIPE MARKERS

- A. Color: Conform to ASME A13.1 and ANSI Z535.1.
- 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

3.1 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 markers on each access door and housings, indicating purpose of access (to what equipment) and other maintenance and operating instructions.
- 3.2 TAGS
 - A. Small devices, such as in-line pumps, may be identified with tags. Use metal tags on piping 3/4-inch diameter and smaller.
 - B. Identify valves in main and branch piping with metal tags. Indicate valve function and the normally open or closed positions on the valve tag.
 - C. Coordinate with the facility maintenance personnel to ensure consistency with the existing tagging system.
 - D. Tag balancing valves with balanced GPM or CFM indicated after balancing is completed and accepted.
 - E. Install tags with corrosion resistant chain.
- 3.3 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. 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 07 00 - PLUMBING INSULATION

PART 1 - GENERAL

1.1 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

1.2 RELATED SECTIONS

- A. Contents of Division 22, Plumbing and Division 01, General Requirements apply to this Section.
- 1.3 REFERENCES AND STANDARDS
 - A. References and Standards as required by Section 22 00 00, 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.

1.4 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.

1.5 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.

1.6 WARRANTY

- A. Warranty of materials and workmanship as required by Section 22 00 00, Plumbing Basic Requirements and Division 01, General Requirements.
- 1.7 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.

2.1 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. Insulation:
 - a. Armacell LLC Armaflex
 - b. K-Flex
 - c. Or approved equivalent.
 - Glue:
 - a. Armacell LLC Armaflex Low VOC Adhesive
 - b. K-Flex
 - c. Or approved equivalent.
 - 3. Paint:
 - a. Armacell LLC Armaflex
 - b. K-Flex
 - 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
 - 5. Or approved equivalent.
- 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.

2.2 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*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.

2.3 TYPE 2, FLEXIBLE ELASTOMERIC INSULATION

- A. Elastomeric Foam: ASTM C534; flexible, cellular elastomeric, molded or sheet.
 - 1. Thermal Conductivity Value: 0.25 BTU*in/(hr*sf*F) at 75 degrees F.
 - 2. Maximum Service Temperature of 220 degrees F.
 - 3. Maximum Flame Spread: 25.
 - 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.

2.4 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.

2.5 TYPE 7, ADA ACCESSIBLE LAVATORY/SINK INSULATION KIT

A. P-traps, trap arms, tail pieces, hot water and cold water insulating guards meeting ASTM C1822. Molded closed cell insulation with vinyl cover and nylon fasteners, paintable. Provide accessories as required for complete installation covering all exposed waste piping, water piping, stops and supplies. Color white.

2.6 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.

2.7 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

3.1 GENERAL INSTALLATION INFORMATION

- A. Verification of Conditions:
 - 1. Do not apply insulation until pressure testing and inspection of piping has been completed.
 - 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.
- 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. 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).</p>
- H. Piping Surfaces to be Insulated:

Item to be Insulated	System Insulation Type	Pipe Size	Insulation Thickness
Hot Water Piping Above Grade (105F to 140F)	1	Runouts up to 1-1/2-inch (uncirculated branches)	1-inch
		Mains =<1-1/4-inch	1-inch
		Mains > 1- 1/4-Inch	1-1/2-Inch
Hot Water Circulation Piping Above Grade	1	Runouts up to 1-1/2-inch	1-inch
(105F to 140F)		Mains =<1-1/4-inch	1-inch
		Mains >1-1/4-inch	1-1/2-inch

Item to be Insulated	System Insulation Type	Pipe Size	Insulation Thickness
Cold Water Piping Above Grade	1	=<1-1/2-inch	1/2-inch
		>1-1/2-inch	1-inch
ADA Accessible Lavatory/Sink	7	All	As Listed
Condensate Drain Piping	1, 2	All	1/2-inch

3.2 TYPE 1, GLASS WOOL PIPE INSULATION

- A. See General Installation Requirements above.
- B. Install in accordance with manufacturer's instructions for below grade installation.
- C. 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.
- D. 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.
- E. Above Grade Roof Drain/Overflow Drain Piping: Cover all roof drain piping and overflow drain piping with sectional pipe covering.

3.3 TYPE 2, FLEXIBLE ELASTOMERIC INSULATION

- A. See General Installation Requirements above.
- B. Install in accordance with manufacturer's instructions for below grade installation.
- C. 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.
- D. Above Grade Roof Drain/Overflow Drain Piping: Cover all roof drain piping and overflow drain piping with sectional pipe covering.
- E. 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.
- 3.4 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.

3.5 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.
- 3.6 ACCESSORIES
 - A. See General Installation Requirements above.
 - B. Install in accordance with manufacturer's instructions.
 - C. Furnish and install accessories for all insulation types listed in this Section.

3.7 PIPE FITTING INSULATION COVERS

- A. See General Installation Requirements above.
- B. Install in accordance with manufacturer's instructions.

END OF SECTION

SECTION 22 10 00 - PLUMBING PIPING

PART 1 - GENERAL

1.1 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. Hot and Cold Domestic Water Above Grade
 - 4. Condensate Piping
 - 5. Primer Piping
 - 6. Cleanouts

1.2 RELATED SECTIONS

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

1.3 REFERENCES AND STANDARDS

- A. References and Standards as required by Section 22 00 00, 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).
 - 4. Cast Iron Piping to conform to standards of ASTM A-74, CISPI 301 and FM 1680.
 - 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.
 - 9. NFPA Standard 51B "Fire Prevention in Use of Cutting and Welding Processes".
 - 10. Crosslinked polyethylene (PEX) pipe conforming to ASTM F876, F877 and CSA B1375, or DIN 16892 and 16893.

1.4 SUBMITTALS

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

1.5 QUALITY ASSURANCE

- A. Quality assurance as required by Section 22 00 00, Plumbing Basic Requirements and Division 01, General Requirements.
- 1.6 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

- 2.1 MANUFACTURERS
 - A. See component manufacturers listed in individual articles below.
 - B. ADS
 - C. American-USA

- D. Cerro
- E. Charlotte
- F. Clamp-All
- G. Conbraco/Apollo Press
- H. Elkhart
- I. Enfield
- J. Fuseseal
- K. Gruvlok
- L. Husky
- M. Ideal
- N. Mission
- O. Mueller
- P. Nibco
- Q. Orion
- R. Shurjoint Mechanical Couplings
- S. Sioux Chief
- T. Spears
- U. Tyler
- V. Uponor
- W. Viega
- X. Zurn
- Y. Or approved equivalent.
- Z. Cleanouts:
 - 1. J.R. Smith
 - 2. Mifab
 - 3. Sioux Chief
 - 4. Wade
 - 5. Watts
 - 6. Zurn
 - 7. Or approved equivalent.
- AA. Firestopping Penetrations in Fire Rated Wall Floor Assemblies:
 - 1. Hilti
 - 2. Proset
 - 3. Or approved equivalent.
- 2.2 GENERAL
 - A. Provide pipe, tube and fittings of the same type, fitting requirements, grade, class and the size and weight indicated or required for each service, as indicated in other Division 22, 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: Furnish each item with legible markings indicating name brand and manufacturer, manufacturing process, heat number and markings as required per ASTM and UL/FM Standards.
- 2.3 SANITARY, DRAINAGE (RAIN/STORMWATER) DWV PIPING, BURIED WITHIN 5-FEET OF BUILDING
 - A. Cast Iron Pipe: ASTM A888/CISPI 301 hubless.
 - 1. Fittings: Cast iron.
 - 2. Coupling Assembly:
 - a. Heavy Duty: ASTM C1540, Clamp-All Hi-Torq 125, Husky SD 4000, Mission HeavyWeight couplings.
- 2.4 SANITARY, DRAINAGE (RAIN/STORMWATER) DWV PIPING, ABOVE GRADE
 - A. Cast Iron Pipe: ASTM A888/CISPI 301 hubless.
 - 1. Fittings: Cast iron.
 - 2. Coupling Assembly:
 - a. Standard Duty: ASTM C1277 or CISPI 310.
 - B. Copper Tube: ASTM B 306, DWV
 - 1. Fittings: ASME B16.29, wrought copper.
 - 2. Joints: ASTM B32, alloy Sn50 solder.
- 2.5 HOT AND COLD DOMESTIC WATER ABOVE GRADE
 - A. Copper Tube: 2-1/2-inches and smaller. ASTM B88 (ASTM B88M), Type L (B), Drawn.
 - 1. Fittings: ASME B16.18 copper.
 - 2. Joints: ASTM B32, alloy Sn95 solder.
 - B. Copper Tube: ASTM B88 (ASTM B88M), Type L (B) for 2-1/2-inches and smaller, Type K (A) for 3-inches and larger, Drawn.
 - 1. Fittings: Fittings are to be manufactured to copper tubing sizes, with grooves designed to accept grooved end couplings of the same manufacturer. Fittings are to be wrought copper, conforming to ASTM B75 alloy C12200 or ASTM B-152 alloy C11000 and ANSI B16.22.
 - 2. Coupling: 2-inches to 8-inches for copper tubing consisting of ductile iron cast housings meeting ASTM A536, complete with a synthetic rubber gasket of a pressure-responsive design, with plated nuts and bolts to secure unit together. Couplings to be manufactured to connect copper tubing sized tube and fittings.

2.6 CONDENSATE PIPING

- A. Copper Tube: ASTM B 88 (ASTM B898M), Type K (A), L (B), or M (C).
 - 1. Fittings: ASME B16.29, wrought copper.
 - 2. Joints: ASTM B32, alloy Sn50 solder.
- B. Use chemical resistant piping for drainage of condensate from combustion fuel sources (such as condensing boilers and water heaters), as noted in this Section for area of application.
- C. CPVC (Chlorinated Polyvinyl Chloride) Pipe and Fittings Except Exterior of the Building and in Plenums and Rated Assemblies:
 - 1. Pipe and Fittings: Schedule 40, NSF-14, ASTM 439, IAPMO IS20-96, socket fittings, solvent weld.

2.7 PRIMER PIPING

- A. Above Ground: Type L hard-drawn copper tubing with wrought sweat fittings and soldered joints.
- B. Below Ground: Type L soft annealed copper tubing with wrought sweat fittings and brazed joints.
- C. Below Ground: Cross-linked polyethylene (PEX) and engineered plastic fittings.
 - 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.
 - c. Provide blue colored PEX for cold water systems and red colored PEX for hot water systems for tube sizes 1/2-inch thru 1-inch.
 - 2. Fittings:
 - a. Fittings: Engineered Plastic Fittings for above grade applications. Engineered plastic fittings for below grade applications. Serrated type with reinforcement rings.
 - b. Reinforcement Rings: Manufactured using "Engel Method" to ensure that viscoelastic stress regenerative properties are sufficient to produce pressure tight seal.
 - c. Fitting Insert: Of such dimension in that tubing must be expanded in order to facilitate insertion of fitting into tube.
 - d. Accomplish expansion of tubing and ring by an expansion tool designed expressly for that purpose.
 - e. Fittings complies with requirements of ASTM F877.

2.8 CLEANOUTS

- A. 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:
 - 1. Tile Floor Cleanouts: J. R. Smith 4020 with round heavy-duty nickel bronze top, taper thread, ABS plug and standard screws.
 - 2. Carpeted Floor Cleanout: J. R. Smith 4020-X with carpet clamping frame, round heavy-duty nickel bronze top, taper thread, ABS plug, carpet clamping device and standard screws.
 - 3. Concrete Floor Cleanout (General): J. R. Smith 4020 with round heavy-duty nickel bronze top, taper thread and ABS plug with standard 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 standard screws.
 - 5. Wall Cleanout: J. R. Smith 4472-U, countersunk bronze taper thread plug, stainless steel shallow cover and vandalproof screws.

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION REQUIREMENTS

- A. Underground Piping Systems:
 - 1. Examination: Verify that excavations are to required grade, dry, and not over-excavated.
 - 2. Perform necessary excavation and backfill required for installation of plumbing work. Repair piping or other work at no expense to Owner.
 - 3. Water: Keep excavations free of standing water. Re-excavate 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.

- 4. Tests: During progress of work for compacted fill, Owner reserves right to request compaction tests made under direction of testing laboratory.
- 5. 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.
- 6. 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 Specification Sections 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.

	Class A		Class B	
Material Passing	Min.	Max.	Min.	Max.
3/4-inch Square Opening	27	47	0	1

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.

7. Backfilling:

- a. Following installation and successful completion of required tests, backfill piping in lifts.
 - 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) Črushed rock, fill sand or other backfill material approved elsewhere in Specifications may be used above "Pipe Zone."
- 8. 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, or
 - 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.

B. 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.
- 4. Align piping accurately at connections, within 3/32-inch misalignment tolerance. Comply with ANSI B31 Code for Pressure Piping.
- 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. Install mating flange faces true and parallel to each other and not requiring 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.

C. 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.
- D. Corrosive Soil Conditions:
 - 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.
- E. 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.
- F. 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.
- G. Cut piping squarely, free of rough edges and reamed to full bore. Insert piping fully into fittings.
- H. Provide joints of type indicated in each piping system.

I. 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.

J. 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.
- 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.
- 3.2 SANITARY, DRAINAGE (RAIN/STORMWATER) DWV PIPING, BURIED WITHIN 5-FEET OF BUILDING
 - A. Excavation and Backfill:
 - 1. See 3.01 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:

- 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. Grade piping 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 indirect 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, Plumbing Fixtures.
 - 4. Drains:
 - a. Install drains to suit finished floor. Install drains and components per manufacturer's instructions. Slope flooring 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: Coat the piping terminus of any cut piping with an applied epoxy per manufacturer's instructions. Denso Protal 7200 fast-cure epoxy repair coating.
- 3.3 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. Clean joints 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 meeting CDA standard test method 1.0 and ASTM B813-91. Apply solder until a full fillet is present around the joint. Do not apply solder and flux 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. Grade piping 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 indirect 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, Plumbing Fixtures.
 - 4. Drains:
 - a. Install drains to suit finished floor or roof surface. Install drains and components per manufacturer's instructions. Slope flooring 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.

3.4 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. Clean joints 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 meeting CDA standard test method 1.0 and ASTM B813-91. Apply solder until a full fillet is present around the joint. Do not apply solder and flux 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. Use listed brazing flux for joining of copper tube to brass or bronze fittings, meeting AWS FB3A or FB3C. "Shock" cooling is prohibited. A continuous fillet is to be visible around the completed joint. After cooling, thoroughly remove flux residue with warm water and a brush prior to testing. Do not use BCuP filler on copper alloys containing over 10 percent nickel. Cap or plug piping 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. Use unions for piping connections to equipment.
- 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. Install exposed connections to equipment with special care, showing no tool marks or threads at fittings and piping. No bowed or bent piping permitted.
- 10. Make ferrous to non-ferrous connections with 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.
- 14. Backflow Preventers: Pipe relief to nearest drain. Slope at 2 percent.
- 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, reflush and return system to service.
 - 3. Certification: Provide copy of domestic water chlorination certificate in each operations and maintenance manual.
 - 4. Provide water line disinfections performed by a licensed contractor with training in potable water line disinfections.

3.5 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.

3.6 PRIMER PIPING

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

3.7 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.

END OF SECTION

SECTION 22 40 00 - PLUMBING FIXTURES

PART 1 - GENERAL

1.1 SUMMARY

- A. Work Included:
 - 1. General Plumbing Fixtures:
 - a. China Fixtures, White Only
 - b. Enameled Steel Fixtures, White Only
 - c. Faucet Fittings
 - d. Stainless Steel Fixtures
 - 2. Carriers
 - 3. Fixture Trim
 - 4. Floor Drains
 - 5. Floor Sinks
 - 6. Flushometers Water Closet/Urinal
 - 7. Water Closet Seats
 - 8. Water Supply Boxes

1.2 RELATED SECTIONS

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

1.3 REFERENCES AND STANDARDS

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

1.4 SUBMITTALS

- A. Submittals as required by Section 22 00 00, Plumbing Basic Requirements and Division 01, General Requirements.
- 1.5 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.
 - 2. NSF 61, Annex G, Drinking Water System Components, Compliant.
 - 3. ISO 9001, Quality Management Standard Certified.
 - 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.
 - 6. Items approved for use by State of Oregon.

1.6 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

- 2.1 MANUFACTURERS
 - A. "Or approved equivalent" as defined in 22 00 00, Plumbing Basic 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. 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. Stainless Steel Fixtures:
 - a. Elkay
 - b. Haws
 - c. Just
 - d. Or approved equivalent.
- C. Carriers:
 - 1. JR Smith
 - 2. Zurn
 - 3. Or approved equivalent.
- D. Fixture Trim:
 - 1. McGuire
 - 2. Dearborn Brass
 - 3. Oatey
 - 4. Or approved equivalent.
- E. Floor Drains:
 - 1. Smith
 - 2. Wade
 - 3. Watts
 - 4. Zurn
- F. Floor Sinks:
 - 1. Smith
 - 2. Wade
 - 3. Watts
 - 4. Zurn
 - 5. Or approved equivalent.

- G. Flushometers Water Closet/Urinal:
 - 1. Sloan
 - 2. Zurn
 - 3. Or approved equivalent.
- H. Water Closet Seats:
 - 1. Bemis
 - 2. Or approved equivalent.
- I. Water Supply Boxes:
 - 1. Sioux Chief
 - 2. Or approved equivalent.
- 2.2 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 Thermostatic Mixing Valves:
 - 1. Lavatories provide ASSE 1070 compliant mixing valves or multiple lavatories served by a single ASSE 1070 compliant 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.

2.3 CARRIERS

- A. Wall Hung Water Closets:
 - 1. Vertical: Zurn Z-1204-N4-X-50 or Z-1204-ND4-X-50 (JR Smith 230y-M54-M12 or 230DY-M54-M12). Adjustable vertical load siphon jet with 500 lb. capacity.
 - Horizontal: Zurn ZE-1203-N4-X-50 or ZE-1203-ND4-X-50 (JR Smith 220 R or L-Y-M54-M12 or 220DY-M54-M12). Adjustable horizontal siphon jet with 500 lb. load capacity.
- B. Wall Hung Lavatory: Zurn Z-1231 (D). (JR Smith 700). Concealed arm or Plate type, 250 lb. capacity.

2.4 FIXTURE TRIM

- A. Traps: Provide heavy duty commercial grade traps on fixtures except fixtures with integral traps. Exposed traps will be chromium plated cast brass or 17 gauge chromium plated brass tubing.
 1. Sink: McGuire 8912-C-DF.
 - Sink. McGuire 8912-C-DF.
 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.
- E. Sink Basket Strainer: McGuire 151.
- F. Trim barrier-free wrap for P-traps and supplies by McGuire, Pro-Wrap, Plumberex or True-bro.
- G. Escutcheons: McGuire wrought brass deep bell.
- H. Wax Rings and Toilet Bolts: WM Harvey No Seep No. 1 053065-N.
- 2.5 FLOOR DRAINS
 - A. See Schedule on Drawings for types.
- 2.6 FLOOR SINKS
 - A. See Schedule on Drawings for types.
 - B. Plastic components are not allowed.
- 2.7 FLUSHOMETERS WATER CLOSET/URINAL
 - A. See Schedule on Drawings for types.
- 2.8 WATER CLOSET SEATS
 - A. See Schedule on Drawings for type.
- 2.9 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

3.1 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.

3.2 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.

3.3 FIXTURE TRIM INSTALLATION

- A. Install components in accordance with manufacturer's instructions and approved product data submittals.
- B. Set plumb, level and rigid.
- 3.4 FLOOR DRAINS INSTALLATION
 - A. Install components in accordance with manufacturer's instructions and approved product data submittals.
 - B. Set plumb, level and rigid.
- 3.5 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.
- 3.6 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.
- 3.7 WATER CLOSET SEAT INSTALLATION
 - A. Install components in accordance with manufacturer's instructions and approved product data submittals.
 - B. Set plumb, level and rigid.
- 3.8 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

SECTION 23 00 00 - HEATING, VENTILATING AND AIR CONDITIONING (HVAC) BASIC REQUIREMENTS

PART 1 - GENERAL

1.1 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 Authorized Representative, and other reviewing entity whose approval is required to obtain systems acceptance.

1.2 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

1.3 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, 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. 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. CGA Compressed Gas Association
 - 17. CISPI Cast Iron Soil Pipe Institute
 - 18. EPA Environmental Protection Agency
 - 19. ETL Electrical Testing Laboratories
 - 20. FM FM Global
 - 21. GAMA Gas Appliance Manufacturers Association
 - 22. HI Hydraulic Institute Standards
 - 23. IAPMO International Association of Plumbing & Mechanical Officials
 - 24. IFGC International Fuel Gas Code
 - 25. ISO International Organization for Standardization
 - 26. MSS Manufacturers Standardization Society
 - 27. NEC National Electric Code
 - 28. NEMA National Electrical Manufactures Association
 - 29. NFPA National Fire Protection Association
 - 30. NFGC National Fuel Gas Code
 - 31. NRCA National Roofing Contractors Association
 - 32. NSF National Sanitation Foundation
 - 33. OSHA Occupational Safety and Health Administration
 - 34. SMACNA Sheet Metal and Air Conditioning Contractors' National Association, Inc.
 - 35. TEMA Tubular Exchanger Manufactures Association
 - 36. TIMA Thermal Insulation Manufactures Association
 - 37. UL Underwriters Laboratories, Inc.
- D. See Division 23, HVAC individual Sections for additional references.

1.4 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 posted to ftp site. For electronic format, provide one file per division containing one bookmarked PDF file with each bookmark corresponding to each Specification Section. Arrange bookmarks in ascending order of Specification Section number. 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.
 - 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 Section 23 05 48, Vibration and Seismic Controls for HVAC Equipment. 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".
 - When submitting drawings for Engineers re-review, clearly indicate changes on drawings and "cloud" any revisions. Submit a list describing each change.
 tion and Maintenance Manuals. Owner's Instructions:
- 14. Operation and Maintenance Manuals, Owner's Instructions:
 - a. Submit, at one time, electronic files (PDF format) 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.
 - 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.
 - 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 CAD Drawings and make one set of black-line drawings created from CAD Files in version/release equal to contract drawings. Submit CAD disk and drawings upon substantial completion.
 - d. At completion of project, show changes and deviations from the Drawings in red on one set of black-line drawings. Include written Addendums, RFIs, and change order items. Make changes to Drawings in a neat, clean, and legible manner.
 - e. See Division 23, HVAC individual Sections for additional items to include in record drawings.

1.5 QUALITY ASSURANCE

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

- D. Manufacturer's Instructions: Follow manufacturer's written instructions. If in conflict with Contract Documents, obtain clarification. Notify Engineer/Architect, in writing, before starting work.
- E. Items shown on Drawings are not necessarily included in Specifications or vice versa. Confirm requirements in all Contract Documents.
- F. Provide products that are UL listed.
- G. Piping and duct insulation products to contain less than 0.1 percent by weight PBDE in all insulating materials.

1.6 WARRANTY

- A. Provide written warranty covering the work for a period of one year from date of Substantial Completion in accordance with Division 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.

1.7 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. 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

2.1 MANUFACTURERS

A. Articles, fixtures, and equipment of a kind to be standard product of one manufacturer, including but not limited to pumps, fans, valves, control devices, air handlers, vibration isolation devices, etc.

2.2 STANDARDS OF MATERIALS AND WORKMANSHIP

- 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. Names and manufacturer's names denote character and quality of equipment desired and are not to be construed as limiting competition.
- C. Hazardous Materials:
- 1. Comply with local, State of Oregon, and Federal regulations relating to hazardous materials.
- 2. Comply with Division 00. Procurement and Contracting Requirements and Division 01. General Requirements for this project relating to hazardous materials.
- 3. Do not use any materials containing a hazardous substance. If hazardous materials are encountered, do not disturb: immediately notify Owner and Architect, Hazardous materials will be removed by Owner under separate contract.

2.3 ACCESS PANELS

- See Division 01, General Requirements and Division 08, Openings for products and installation Α. requirements.
- Confirm Access Panel requirements in Division 01, General Requirements, Division 08, Β. Openings and individual Division 23, HVAC Sections. In absence of specific requirements in Division 01, General Requirements, comply with the following:
 - Provide flush mounting access panels for service of systems and individual components 1 requiring maintenance or inspection. Where access panels are located in fire-rated assemblies of building, rate access panels accordingly.
 - Ceiling access panels to be minimum 24-inch by 24-inch required and approved a. size.
 - b. Wall access panels to be minimum of 12-inch by 12-inch required and approved size.
 - Provide screwdriver operated catch. C. d.
 - Manufacturers and Models:
 - Drywall: Karp KDW. 1)
 - 2) Plaster: Karp DSC-214PL.
 - 3) Masonry: Karp DSC-214M.
 - 2 hour rated: Karp KPF-350FR. 4)
 - Manufacturers: Milcor, Elmdor, Acudor or approved equivalent. 5)

PART 3 - EXECUTION

3.1 ACCESSIBILITY AND INSTALLATION

- Α. 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.
- Β. 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 and Engineer prior to proceeding with installation. This includes proper installation methods, sequencing and coordination with other trades and disciplines.
- D. Firestopping:
 - Confirm Firestopping requirements in Division 07, Thermal and Moisture Protection. In 1 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.
- E. 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.
- F. 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.

3.2 SEISMIC CONTROL

- A. Confirm Seismic Control requirements in Division 01, General Requirements, Structural documents, Section 23 05 48, Vibration and Seismic Controls for HVAC Equipment, 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:
 - 1. Per "Seismic Restraints Manual Guidelines for Mechanical Systems" latest edition published by SMACNA or local requirements.
- D. Provide means to prohibit excessive motion of mechanical equipment during earthquake.

3.3 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 and Engineer, 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.

3.4 CONTINUITY OF SERVICE

- 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.

3.5 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.

3.6 EQUIPMENT SELECTION AND SERVICEABILITY

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

3.7 DELIVERY, STORAGE AND HANDLING

- 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.

3.8 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 Authorized 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.
- D. Training and Demonstration per Section 01 91 13, General Commissioning Requirements and Section 23 08 00, Commissioning of HVAC.

3.9 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

- 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
 - Α. 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

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SECTION 23 05 13 - COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

- A. Work Included:
 - 1. Starters
 - 2. Shaft Grounding
 - 3. Motors

1.2 RELATED SECTIONS

- A. Contents of Division 23, HVAC and Division 01, General Requirements apply to this Section.
- 1.3 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. NEMA Premium Efficiency
 - 2. Energy Policy Act (EPACT), latest applicable version(s) for minimum motor efficiencies.

1.4 SUBMITTALS

- A. Submittals as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.
- 1.5 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. 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.

1.6 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

2.1 MANUFACTURERS

- A. Starters:
 - 1. Cerus
 - 2. Eaton Electrical
 - 3. General Electric
 - 4. Siemens
 - 5. Schneider Electric/Square D
 - 6. Or approved equivalent.
- B. Shaft Grounding:
 - 1. Shaft Grounding Inc.
 - 2. Aegis SGR Bearing Protection Ring
 - 3. Or approved equivalent.

C. Motors:

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

2.2 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.
 - 3. Single-phase motors with automatic controls. Provide motor-rated relay with coils rated for control voltage.
- 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.

2.3 SHAFT GROUNDING

- A. Variable Speed Motor Shaft Grounding: Shaft grounding ring; solid ring type.
- B. Provide shaft grounding assembly on motors controlled by variable frequency drive. Shaft grounding device to be in the form of brush that resides on the motor shaft. Brush assembly shall be capable of tolerating misalignment and maintaining rotating contact throughout the motors life.
- C. Material: Material used in the grounding assembly shall be stable material commonly used within industry that is not believed to constitute a hazardous material under Occupational Safety & Health Administration (OSHA) regulations.
- D. Brushes: Specifically developed carbon compounds of sustained performance with wear life expectancy of 3 years minimum.
- E. Seals: Sealed type to keep contaminants from entering the shaft grounding system in wet or severe environment applications.
- F. Shaft Grounding Assembly: For clean room air handling systems, use the type that contains the wear products within a special enclosure within the shaft grounding system.

2.4 MOTORS

- A. Construction:
 - 1. Open drip-proof type except where specifically noted otherwise.
 - 2. Design for continuous operation in 40 degrees C 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 except 1.25 for motors associated with shaft pressurization system fans and 1.35 for single phase motors.
- 6. Efficiency: Provide NEMA Premium Efficiency motors.
- 7. 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
- B. 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.
- C. 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.
- D. Single Phase Power, Split Phase Motors:
 - 1. Starting Torque: Less than 150 percent of full load torque.
 - 2. Starting Current: Up to seven times full load current.
 - 3. Breakdown Torque: Approximately 200 percent of full load torque.
 - 4. Drip-proof Enclosure: Class A (50 degrees C temperature rise) insulation, NEMA Service Factor, prelubricated sleeve or ball bearings.
 - 5. Enclosed Motors: Class A (50 degrees C temperature rise) insulation, 1.0 Service Factor, prelubricated ball bearings.
- E. Single Phase Power, Permanent-Split Capacitor Motors:
 - 1. Starting Torque: Exceeding one fourth of full load torque.
 - 2. Starting Current: Up to six times full load current.
 - 3. Multiple Speed: Through tapped windings.
 - 4. Open Drip-proof or Enclosed Air Over Enclosure: Class A (50 degrees C temperature rise) insulation, minimum 1.0 Service Factor, prelubricated sleeve or ball bearings, automatic reset overload protector.
- F. Single Phase Power, Capacitor Start Motors:
 - 1. Starting Torque: Three times full load torque.
 - 2. Starting Current: Less than five times full load current.
 - 3. Pull-up Torque: Up to 350 percent of full load torque.
 - 4. Breakdown Torque: Approximately 250 percent of full load torque.
 - 5. Motors: Capacitor in series with starting winding; provide capacitor-start/capacitor-run motors with two capacitors in parallel with run capacitor remaining in circuit at operating speeds.
 - 6. Drip-proof Enclosure: Class A (50 degrees C temperature rise) insulation, NEMA Service Factor, prelubricated sleeve bearings.
 - 7. Enclosed Motors: Class A (50 degrees C temperature rise) insulation, 1.0 Service Factor, prelubricated ball bearings.

PART 3 - EXECUTION

- 3.1 GENERAL INSTALLATION
 - A. Coordinate location of disconnect and starter or motor controller. Combination starter/disconnects may be used in lieu of separate items.
 - B. Explosion-Proof Motors: UL approved and labeled for hazard classification, with over temperature protection.

- C. 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.
- D. Unless otherwise indicated, motors 1-HP and larger to meet/exceed NEMA Premium Efficiency.
- E. Exception: Motors less than 250 watts, for intermittent service, motors furnished with equipment manufacturer's standard package equipment need not conform to these specifications.
- F. Motors located in exterior locations or wet air streams are to be of totally enclosed type.
- G. Disconnects: Provided by Division 26, Electrical unless specified otherwise.
- H. After completing equipment installation, inspect unit components. Remove paint splatters and other spots, dirt, and debris. Repair damaged finish to match original finish.

3.2 STARTER INSTALLATION

- 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.

3.3 SHAFT GROUNDING INSTALLATION

- A. Shaft grounding assembly installation not to affect the motor manufacturer warranty. Where the severe environment conditions require application of the shaft grounding types that are screwed into the motor shaft, the installation of the shaft grounding system performed either by the motor manufacturer or by the motor manufacturer authorized facility.
- B. Bond the brush to the closest ground point using code sized green insulated stranded copper conductor per manufacturer instructions.
- C. Test and verify the performance of the assembly to ensure that under no conditions the shaft exceeds 3 volts.
- D. Install securely on firm foundation. Mount ball bearing motors with shaft in any position.
- E. Check line voltage and phase and ensure agreement with nameplate.
- F. Verify motor rotation.
- 3.4 MOTOR INSTALLATION
 - A. Electrical Service: Power wiring from source to motor termination under Division 26, Electrical.

- Β. Install in accordance with manufacturer's instructions. Coordinate with starter or variable speed controller with control sequence to provide necessary starter accessories.
- C. Install securely on firm foundation. Mount ball bearing motors with shaft in any position.
- D. Check line voltage and phase and ensure agreement with nameplate.
- E. Verify motor rotation.
- F. Field Quality Control:

1.

- Prepare for acceptance tests as follows:
 - Run each motor with its controller. Demonstrate correct rotation, alignment, and а speed at motor design load.
 - Test interlocks and control features for proper operation. b.
 - Verify that current in each phase is within nameplate rating. C.
- 2. Testing: Perform the following field quality-control testing:
 - Perform each electrical test and visual and mechanical inspection stated in NETA a. ATS, Section 7.15.1. Certify compliance with test parameters.
 - Correct malfunctioning units on-site, where possible, and retest to demonstrate b. compliance; otherwise, replace with new units and retest.
- 3. Manufacturer's Field Service: Engage a factory-authorized service representative to perform the following:
 - Inspect field-assembled components, equipment installation, and piping and a. electrical connections for compliance with requirements.
 - Test and adjust controls and safeties. Replace damaged and malfunctioning b. controls and equipment.
 - Verify bearing lubrication. C.
 - Verify proper motor rotation. d.
 - Test Reports: Prepare a written report to record the following test procedures used: e. Test results that comply with requirements.
 - 1)
 - 2) Test results that do not comply with requirements and corrective action taken to achieve compliance.
- G. Align motors, bases, shafts, pulleys and belts. Tension belts according to manufacturer's written instructions.
- Clean motors, on completion of installation, according to manufacturer's written instructions. Η.

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SECTION 23 05 29 - HANGERS AND SUPPORTS FOR HVAC PIPING, DUCTWORK AND EQUIPMENT

PART 1 - GENERAL

- 1.1 SUMMARY
 - A. Work Included:
 - 1. Hangers and Supports for HVAC Piping, Ductwork and Equipment
 - 2. Wall and Floor Sleeves
 - 3. Building Attachments
 - 4. Flashing
 - 5. Miscellaneous Metal and Materials

1.2 RELATED SECTIONS

- A. Contents of Division 23, HVAC and Division 01, General Requirements apply to this Section.
- 1.3 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. ASCE 7-10, Minimum Design Loads for Buildings and Other Structures.
 - 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.

1.4 SUBMITTALS

- A. Submittals as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.
- 1.5 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.
 - 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.

1.6 WARRANTY

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

1.7 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. Engineered Support Systems:
 - 1. Support frames such as pipe racks or stanchions for piping, ductwork, and equipment which provide support from below.
 - 2. Equipment, ductwork and piping support frame anchorage to supporting slab or structure.
- C. Provide channel support systems, for piping to support multiple pipes capable of supporting combined weight of supported systems, system contents, and test water.
- D. Provide heavy-duty steel trapezes for piping to support multiple pipes capable of supporting combined weight of supported systems, system contents, and test water.
- E. Provide seismic restraint hangers and supports for piping, ductwork and equipment. See Section 23 05 48, Vibration and Seismic Controls for HVAC Equipment.
- F. Obtain approval from AHJ for seismic restraint hanger and support system to be installed for piping and equipment. See Section 23 05 48, Vibration and Seismic Controls for HVAC Equipment.

PART 2 - PRODUCTS

2.1 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
- B. Wall and Floor Sleeves:
 - 1. Thunderline Corporation "Link Seal".
 - 2. Or approved equivalent.
- C. Building Attachments:
 - 1. Anchor-It
 - 2. Gunnebo Fastening Corporation
 - 3. Hilti Corporation
 - 4. ITW Ramset/Red Head
 - 5. Masterset Fastening Systems, Incorporated

2.2 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 A1011 Grade 33, 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.
- 2.3 WALL AND FLOOR SLEEVES
 - A. Pre-Engineered Firestop Pipe Penetration Systems: UL listed assemblies for maintaining fire rating of piping penetrations through fire-rated assemblies. Comply with ASTM E814.
 - B. Fabricated Accessories:
 - 1. Steel Pipe Sleeves: Fabricate from Schedule 40 black or galvanized steel pipe. Remove end burrs by grinding.
 - 2. Sheet Metal Pipe Sleeves: Fabricate from G-90 galvanized sheets closed with lock-seam joints. Provide the following minimum gauges for the sizes indicated:
 - a. Sleeve Size 4-inches in Diameter and Smaller: 18 gauge.
 - b. Sleeve Sizes 5-6-inches: 16 gauge.
 - c. Sleeve Sizes 7-inches and Larger: 14 gauge.
 - d. Fire-Rated Safing Material.
 - Rockwool Insulation: Complying with FS-HH-I-558, Form A, Class IV, 6 pounds per cubic foot density with melting point of 1985 degrees F and K value of 0.24 at 75 degrees F.
 - 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.

2.4 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. Anchor Bolts:
 - 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.

- 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.
- 4. Anchor (Adhesive) Bolts: Consisting of two-part adhesive cartridge and zinc-plated Type A307 steel anchor bolt rod assembly with ASTM A194 nut.

2.5 FLASHING

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

2.6 MISCELLANEOUS METAL 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. Cold galvanize field-welded joints and components. 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

- 3.1 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, transformer vaults, elevator equipment rooms, IT rooms, MPOE 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.

3.2 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. Design hangers and supports to allow for expansion and contraction.
- D. Provide aluminum supports for aluminum ductwork.
- E. Provide stainless steel supports for stainless steel ductwork.
- F. Support vertical ducts at maximum intervals of 16-feet and at each floor.
- G. Install upper attachments to structures with an allowable load not exceeding one-fourth of failure (proof-test) load.
- H. Install flexible ductwork per the more stringent of SMACNA HVAC Duct Construction Standards or the following:
 - 1. Support horizontal duct runs at not more than 4 feet intervals.
 - 2. Support vertical risers at not more than 6 feet intervals.
 - 3. Limit sag between support hangers to 1/2-inch per foot of spacing support.
 - 4. Supports shall be rigid and shall be not less than 1.5-inches wide at point of contact with the duct surface.
 - 5. Duct bends shall be not less than 1.5 duct diameter bend radius.
- I. Use double nuts and lock washers on threaded rod supports.
- J. Floor supports in mechanical rooms to be elevated 1-inch above finish floor and void space filled with masonry grout.

- K. Anchor ducts securely to building in such a manner as to prevent transmission of vibration to structure. Do not connect duct hanger straps directly to roof deck. Do not support ducts from other ducts, piping or equipment.
- L. Attach strap hangers installed flush with end of sheet-metal duct run to duct with sheet-metal screws.
- M. Construct exterior ductwork or ductwork which is otherwise exposed to weather watertight and slope 1/4-inch per foot to avoid standing water.
- N. Exposed ductwork hung in clean areas such as sanitary areas, pharmaceutical areas, wash down areas or food process areas to be installed using double end, food grade trapeze hanger rods suitable for use with food grade strut.
- O. 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.
- P. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers, and other accessories.
- Q. 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.
- R. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.
- S. 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.
- T. Prime paint ferrous nongalvanized hangers, accessories, and supplementary steel which are not factory painted.
- U. Do not support piping from other piping.
- V. Fire protection piping will be supported independently of other piping.

3.3 WALL AND FLOOR SLEEVES

- A. Fabricated Pipe Sleeves:
 - 1. Provide either steel or sheet metal pipe sleeves accurately centered around pipe routes. Size such that piping and insulation, if any, will have free movement within the sleeve, including allowance for thermal expansion. Sleeve diameter to be determined by local seismic clearance requirements, and by waterproofing requirements.
 - 2. Length: Equal to thickness of construction penetrated, except extend floor sleeves 1-inch above floor finish.
 - 3. Provide temporary support of sleeves during placement in concrete and other work around sleeves. Provide temporary end closures to prevent concrete and other materials from entering pipe sleeves.
 - 4. Seal each end airtight with a resilient nonhardening sealer, UL listed, fire rated ASTM 814.
- B. Installation of metallic or plastic piping penetrations through non fire-rated walls and partitions and through smoke-rated walls and partitions:
 - 1. Install fabricated pipe sleeve.
 - 2. After installation of sleeve and piping, tightly pack entire annular void between piping or piping insulation and sleeve identification with specified material.

3. Seal each end airtight with a resilient nonhardening UL listed fire resistant ASTM 814.

3.4 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. Space attachments within maximum piping span length indicated in MSS SP-58.
- D. Install building attachments within concrete slabs or attach to structural steel or wood. 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.
- E. Attachment to Wood Structure: Anvil side beam bracket Figure 202 for attachment to wooden beam or approved attachment for a wood structure.
- F. Install mechanical-anchor fasteners in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.
- G. Install concrete inserts before concrete is placed; fasten inserts to forms. Where concrete with compressive strength less than 2500 PSI is indicated, install reinforcing bars through openings at top in inserts.
- H. Do not use powder-actuated concrete fasteners for lightweight aggregate concretes or for slabs less than 4-inches thick.
- I. 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.
- J. 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.

3.5 FLASHING

- A. Flash and counterflash where piping, ductwork and equipment passes through weather or waterproofed walls, floors, and roofs.
- B. Provide 12-inch minimum height curbs for roof-mounted mechanical equipment. Flash and counter flash with galvanized steel, soldered and waterproofed.

3.6 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:
 - 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.
- G. Setting Loose Plates: Clean concrete and masonry bearing surfaces of any bond reducing materials, and roughen to improve bond to surfaces. Clean bottom surface of bearing plates.
- 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.
- 3.7 FIRE RATED SUPPORTS
 - A. Provide fire rated support as required by Codes.

END OF SECTION

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SECTION 23 05 48 - VIBRATION AND SEISMIC CONTROLS FOR HVAC EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

- A. Work Included:
 - 1. Vibration Isolation
 - 2. Seismic Restraint Devices
 - 3. Factory Finishes
 - 4. 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.
- C. Scope of Work:
 - 1. Vibration isolation and seismic restraint of new equipment and systems within project boundary defined in architectural drawings.
 - 2. Vibration isolation and seismic restraint of new equipment and systems in existing buildings to points of connection with existing systems.
 - 3. Seismic restraint of existing systems and equipment shown on drawings, within project boundary defined in architectural drawings.
 - 4. Provide supplementary structural steel for seismic restraint systems. No hanging from roof deck is permitted on this project, unless specifically allowed by Structural Engineer of Record in writing prior to bid.

1.2 RELATED SECTIONS

- A. Contents of Division 23, HVAC and Division 01, General Requirements apply to this Section.
- 1.3 REFERENCES AND STANDARDS
 - A. References and Standards as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.
- 1.4 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:
 - 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:
 - 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.
- 6. Welding certificates.
- 7. Equipment Certification: Provide seismic certification for equipment as noted in Seismic Design Summary or schedules on Drawings.

1.5 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 defection.
 - 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 7-16.
 - b. Confirm Seismic Control requirements in Division 01, General Requirements and Structural documents.
 - c. Equipment Importance Factor: 1.0.
 - d. Seismic Design Category: C or D.
 - e. Building Occupancy Category: II.

- f. 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 7-16. 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.
- g. 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.
- h. Where required, seismic sway bracing of suspended duct and piping meet following:
 - 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.
 - 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.
- i. Seismic restraints may be omitted from suspended piping and duct if following conditions are satisfied:
 - 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.

1.6 WARRANTY

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

1.7 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

2.1 MANUFACTURERS

- A. Vibration Isolation:
 - 1. The VMC Group
 - 2. B-Line Systems, Inc.
 - 3. Kinetics Noise Control, Inc.
 - 4. Mason Industries, Inc.
 - 5. M.W. Saussé Vibrex
 - 6. Where Mason numbers are specified, equivalent products by listed manufacturers are acceptable.
- B. Seismic Restraint Devices:
 - 1. The VMC Group
 - 2. B-Line Systems, Inc.
 - 3. Kinetics Noise Control, Inc.
 - 4. Mason Industries, Inc.
 - 5. M.W. Saussé Vibrex
 - 6. California Dynamics Corporation
 - 7. Cooper B-Line Tolco
 - 8. Unistrut Diversified Products Co.; Wayne Manufacturing Division.
 - 9. Hilti, Inc.
- C. Factory Finishes:
 - 1. Kynar 500 Fluoropolymer Coating
 - 2. Or approved equivalent.
- D. Seismic-Bracing/Restraint Devices/Systems for Equipment, Piping and Ductwork:
 - 1. The VMC Group
 - 2. Kinetics Noise Control, Inc.
 - 3. Mason Industries, Inc.
 - 4. Hilti, Inc.
 - 5. Cooper B-Line, Inc.
 - 6. California Dynamics Corporation
 - 7. Unistrut
 - 8. ISAT, Inc.
 - 9. Where Mason numbers are specified, equivalent products by listed manufacturers are acceptable.
- 2.2 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 1/2-inch centers; 50 durometer hardness; maximum loading 60 PSI. Minimum 1/4-inch thick steel load distribution plate and 1/16-inch shim plates between layers, 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 0.30-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 or SLF.
- 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 5c Spring Hangers with Vertical-Limit Stop: Combination coil-spring and elastomeric-insert hanger with spring and insert in compression and with a vertical-limit stop.
 - 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.
 - 7. Adjustable Vertical Stop: Steel washer with neoprene washer "up-stop" on lower threaded rod.
 - 8. Mason Type: RW30.
- I. Type 6 Horizontal Thrust Restraints: Combination coil spring and elastomeric insert with spring and insert in compression and with a load stop. Include rod and angle-iron brackets for attaching to equipment.
 - 1. Frame: Steel, fabricated for connection to threaded rods and to allow for a maximum of 30 degrees of angular rod misalignment 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.
 - 7. Coil Spring: Factory set and field adjustable for a maximum of 1/4-inch movement at start and stop.
 - 8. Mason Type: WBI or WBD.
- J. Type FC-1, Flexible duct connectors. See Specification Section 23 33 00 Air Duct Accessories.

2.3 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.

2.4 FACTORY FINISHES

- 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.
- 2.5 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

- 3.1 GENERAL INSTALLATION REQUIREMENTS
 - A. Provide mounts for equipment installed outdoors for wind loads of 30 lbs. psf applied to any exposed surface of isolated equipment.

- B. Do not install equipment or pipe which makes rigid contact with building slabs, beams, studs, walls, etc.
- C. Anchor baseplate to floor or structure. Provide rubber grommets and washers to isolate bolt from base plate. Under no circumstances is isolation efficiency to be destroyed when bolting isolators to floor.
- D. Building Penetrations: Isolate water piping and ductwork penetrating wall, ceilings, floors or shafts from structure by piping isolator or by 3/8-inch thick foamed rubber insulation. Install units flush with finished structure face, using one for each side as required. Cut units to length if longer than structure thickness. Caulk around pipe or duct at equipment room wall.
- E. Provide roof curbs, equipment supports and roof penetrations. Work to maintain roof warranty. Coordinate location, size, structural connections/requirements and flashing prior to installation.
- F. Install Type 6 horizontal thrust restraints at centerline of thrust, symmetrical on either side of equipment.
- G. 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.
- H. 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.
- I. Testing: Perform following field quality-control testing:
 - 1. Isolator seismic-restraint clearance.
 - 2. Isolator deflection.
 - 3. Snubber minimum clearances.
- J. 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.
- K. Cleaning: After completing equipment installation, inspect vibration isolation and seismic-control devices. Remove paint splatters and other spots, dirt and debris.
- L. 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.
- 3.2 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:

Equipment	Size	Vibration Isolator Type	Minimum Deflection (in)
Fan-coils, Unit Heaters,	All	Type 5B, or 5C, FC-1,2	0.75
	01.45	T 1 0	
Condensing Units	0 to 4.5 tons	Type 1 or 2	0.3
Condensing Units	5+ tons	Type 4A	2.5
Axial, Cabinet, Centrifugal Inline Fans	0 to 23.5-inch diameter	Type 3, 4A, 4B, 5B, or 5C, FC-1	0.75

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.

3.3 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.
- 3.4 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.
- 3.5 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 05 53 - IDENTIFICATION FOR HVAC PIPING, DUCTWORK AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

- A. Work Included:
 - 1. Plastic Nameplates
 - 2. Tags
 - 3. Ceiling Tags

1.2 RELATED SECTIONS

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

1.3 REFERENCES AND STANDARDS

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

1.4 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.

1.5 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.

1.6 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

2.1 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:
 - 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.

2.2 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.
 - 1. Letter Color: White.
 - 2. Letter Height: 1/2-inch.
 - 3. Background Color: Black.
 - 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.

2.3 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. 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. 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.
 - 4. Color: Yellow background with black lettering.
2.4 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.
 - 3. Blue Heating/cooling valves.
 - 4. Ceiling tile labels, machine generated, adhesive backed tape labels with black letters, clear tape.
- PART 3 EXECUTION
- 3.1 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.

3.2 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.

3.3 TAGS

- A. Use metal tags on piping 3/4-inch diameter and smaller.
- B. Tag balancing valves and major dampers with balanced GPM or CFM indicated after balancing is completed and accepted.
- C. Install tags with corrosion resistant chain.

- D. Small devices, such as in-line pumps, may be identified with tags.
- E. Identify valves in main and branch piping with metal tags. Indicate valve function and the normally open or closed positions on the valve tag.
- F. Identify air terminal units and radiator valves with numbered plastic tags.
- G. Tag automatic controls, instruments, and relays. Key to control schematic.
- H. Install valve schedule at each mechanical room.

3.4 CEILING TAGS

A. 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 05 93 - TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 - GENERAL

1.1 SUMMARY

- A. Work Included:
 - 1. General Requirements and Procedures
 - 2. Pre-Construction Balance (Existing Systems)
 - 3. Ductwork Pressure Testing
 - 4. Fundamental Air Systems Balancing Procedures
 - 5. Temperature Control Verification
 - 6. Constant Volume Air Systems Balancing Procedures
 - 7. Pre-Balance Reporting
 - 8. Final Reports:
 - a. Report Requirements
 - b. General Report Data
 - c. System Diagrams
 - d. Air Handling Units
 - e. Fans
 - f. Duct Traverses
 - g. Diffusers/Registers/Grilles
 - h. Instrument Calibration
 - 9. Additional Tests

1.2 RELATED SECTIONS

- A. Contents of Division 23, HVAC and Division 01, General Requirements apply to this Section.
- 1.3 REFERENCES AND STANDARDS
 - A. References and Standards as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.
- 1.4 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.
 - 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.

- 4. Strategies and Procedures Plan: Submit two copies of the TAB strategies and step-by-step procedures as specified in Part 3 below. Include a complete set of report forms intended for use on this Project.
- 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.
- 9. Final Report.
- 10. Provide additional submittals to commissioning authority as dictated in commissioning specifications.

1.5 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 TAB Agencies:
 - a. Oregon:
 - 1) Air Introduction and Regulations Inc.
 - 2) Accurate Air Balance, Inc.
 - 3) Neudorfer Engineers
 - 4) Northwest Engineering Services
 - 5) Air Balancing Specialty Inc.
 - 6) Precision Test & Balance, Inc.
 - 7) Testcomm
 - 8) Pacific Coast Air Balance
 - 2. Balance Firm Qualifications:
 - a. General:
 - 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.
 - 2) Provide proof of testing agency having successfully completed at least five projects of similar size and scope.
 - b. Testing and Balancing firm is certified by NEBB or AABC and has a NEBB Certified Professional (CP) or a AABC Test and Balancer Engineer (TBE) on staff.
 - c. Industry Standards: Testing and Balancing will conform to NEBB or AABC, and American National Standards Institute (ANSI) as follows:
 - 1) NEBB: Comply with Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems.
 - 2) AABC: Comply with National Standards for Total System Balance.
 - 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.
 - d. Test Observation: If requested, conduct tests in the presence of the Commissioning Authority, AHJ, Architect or the Architect's representative.
 - 3. Noise Criteria:
 - a. Noise levels in all 8 octave bands due to equipment and duct systems are not to exceed the following NC levels:

TYPE OF ROOM	NC LEVEL
Bathrooms and Toilet Rooms	35-40
Conference Room	30-35

Corridors (Public)	35-40
Lobbies, Waiting Areas	35-40
Offices, Large Open (3 or more	35-40
occupants)	
Offices, Small Private (2 or fewer	30-35
occupants)	
Kitchens	40-45
Classrooms (Small, Medium, Large)	30-35
Cafeteria/Dining	35-40
All Others	35-40

- b. An allowance, not to exceed 5db, may be added to the measured value to compensate for the variation of the room attenuating effect between room test condition prior to occupancy and design condition after occupancy which may include the addition of sound absorbing material, such as furniture. This allowance may not be taken after occupancy. The room attenuating effect is defined as the difference between sound power level emitted to room and sound pressure level in room.
- c. In absence of specified measurement requirements, measure equipment noise levels three feet from equipment and at an elevation of maximum noise generation.
- 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 Commissioning Authority, Architect, Architect's Representative, or Owner's 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 Authorized 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. TAB Conference: Meet with the Commissioning Authority, 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.
- 11. 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.
- 12. TAB Reports: Use standard forms from NEBB or AABC.
- 13. Instrumentation Type, Quantity, and Accuracy: As described in NEBB or AABC.
- 14. Instrumentation Calibration: Calibrate instruments at least every 6 months or more frequently if required by the instrument manufacturer.

1.6 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 NEBB or AABC 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.

1.7 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.
- N. AABC: Associated Air Balance Council.
- O. NEBB: National Environmental Balancing Bureau.

- P. AMCA: Air Movement and Control Association.
- Q. CTI: Cooling Tower Institute.
- R. SMACNA: Sheet Metal and Air Conditioning Contractors' National Association.
- 1.8 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. Witness leakage and pressure tests carried out by Section 233100.
 - D. 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

3.1 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.
- 12. Report deficiencies discovered before and during performance of TAB procedures.
- 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 NEBB or AABC and this Section.
 - 2. Coordinate location of test probes prior to start of TAB procedures and make test probes available for Owner's tests after start of occupancy. Where required, 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. Hydronic Systems: Adjust to within plus or minus 10 percent of design at coils and plus or minus 5 percent at system pumps and equipment.
 - 4. 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.
 - 7. At final inspection, recheck random selections of data recorded in report. Recheck points or areas as selected and witnessed by Owner's Authorized Representative, or Commissioning Agent.

3.2 PRE-CONSTRUCTION BALANCE (EXISTING SYSTEMS)

- A. Pre-Construction Balance Air Systems
 - 1. Prior to start of construction or demolition; read and record airflow to establish "as-found" conditions. Provide pitot traverse of supply, return and exhaust ductwork at locations indicated on drawings and, as minimum, at central air handlers, main branch ductwork and at each floor.
 - 2. Read and record static pressure conditions across existing filters, coils and fans.
 - 3. Read and record amp draw and motor data from each existing air handler and fan that will be modified during project.
- B. Pre-Construction Balance Hydronic Systems
 - 1. Prior to start of construction or demolition; read and record flow of hydronic systems to establish "as-found" conditions.
 - 2. Read and record head loss and flow at existing coils, heat exchangers, air control devices, and pumps.
 - 3. Read and record amp draw and motor data from each existing pump.
- C. Pre-Construction Balance Steam Systems
 - 1. Prior to start of construction or demolition; read and record flow of existing steam and condensate system devices to establish "as-found" conditions.

- 2. Read and record at existing coils, heat exchangers, sterilizers, and boilers where manufacturers data is not available. Measure steam flow via ultrasonic meter.
- 3. Read and record name plate data for the existing condensate receivers and boilers.
- D. Pre-Construction Balance Plumbing
 - 1. Prior to start of construction or demolition; read and record flow of existing plumbing hot water heaters, hot water recirculation pump and recirculation branch lines.
 - 2. Read and record name plate data for existing water heaters, domestic hot water heat exchangers, and hot water recirculation pump.
- E. Report data and observations to Architect.

3.3 DUCTWORK PRESSURE TESTING

- A. Test ductwork prior to connection to fan equipment. Repair leaks and retest until stipulated results are achieved.
- B. Provide air pressure testing of ductwork as noted below for various project types and systems:
 - 1. Supply and return ductwork located inside shafts and outside building envelope.
 - 2. Exhaust ductwork located inside shafts.
 - 3. Exhaust ductwork located outside building envelope, when used in a heat recovery system.
 - 4. For low-rise and high-rise multi-family, and single-residence Dwelling Units: not required.
 - 5. Exhaust systems serving compounding pharmacies, laboratories, laboratory support spaces, fume hoods, bio-safety cabinets, or hazardous exhausts: pressure test all ductwork.
 - 6. For other project types or systems: pressure test ductwork in accordance with SMACNA HVAC Air Duct Leakage Test Manual, of representative sections of installed ductwork totaling not less than the total installed duct areas noted below:
 - a. For variable air volume supply, return, or exhaust air systems' ductwork of higher than 2-inches pressure class: pressure test 40 percent of the total installed duct area.
 - b. For variable air volume supply, return, or exhaust air systems' ductwork of 2-inches or less pressure class: pressure test ductwork connected to 10-percent of the total installed duct area of such ductwork, but not less than ductwork connected to two terminal units. Where the tested 10-percent fails to comply, then pressure test 40-percent of the total installed duct area.
 - c. For constant air volume supply, return, or exhaust systems: pressure test 40-percent of the total installed duct area.
 - 7. Where tests are required, provide separate tests for each of supply, return and exhaust air systems.
 - 8. Where the tested 40-percent fails to comply with the requirements of this section, then pressure test 100-percent of the total installed duct area. Sections shall be selected by the building owner or the Architect and shall include sections of ductwork upstream and downstream of terminal units. Positive pressure leakage testing may be utilized for negative pressure ductwork.
 - 9. Area requirement of 40-percent of the total installed duct area is inclusive of ductwork located in shafts or outside building envelope.
- C. Test ductwork prior to connection to fan equipment. Repair leaks and retest until stipulated results are achieved. Pressure testing to meet the following leakage classifications below as a minimum (2012 SMACNA HVAC Air Duct Leakage Manual, Table 4-1):
 - 1. Leakage class to be as defined below as a minimum.
 - a. Minimum Duct Leakage Classification

Duct Type	Leakage Class
Metal (Flexible excluded)	

Round and flat oval	3
Rectangular	6

- 2. Testing machine: Meet requirements of SMACNA standards. Pacific Air Products "Port-O-Lab", Rolok, or United Sheet Metal
- 3. Test supply systems prior to connecting terminal units.
- 4. Perform tests in presence of Owner's Authorized Representative. Give 48 hours advance notice before commencement of each test.
- 5. Test ductwork systems in sections as large as possible and record test results accordingly.
- 6. Coordinate testing with ceiling installation.
 - a. Provide sheet-metal plates and install between each duct test section (applies to main-to-main fittings, branch-to-branch fittings and main-to-branch fittings). At each plate location, fabricate joint with Ductmate. Insert 14 gauge sheet metal between Ductmate using a neoprene gasket on both sides of metal plate.
 - b. Leave plates in place until isolated section has been tested and approved by Owner's Authorized Representative.
 - c. Once sections have passed test, remove plates and reattach Ductmate joints. After fan unit is running, test joint for leakage by using a mixture of soap and water. If any noise or bubbling occurs, reseal joint. Owner's Authorized Representative to witness this procedure.
- 7. Test duct at 1.5 times the design air pressure, up to pressure class of the duct. Seal any audible leaks.

3.4 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. Examine heat-transfer coils for correct piping connections and for clean and straight fins.
- D. 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.
- E. Prepare schematic diagrams of systems' "as-built" duct layouts.
- F. Determine the best locations in main and branch ducts for accurate duct airflow measurements.
- G. 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.
- H. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.
- I. Verify that motor starters are equipped with thermal protection, sized for the connected load.
- J. Check dampers for proper position to achieve desired airflow path.
- K. Check for airflow blockages.
- L. Check that condensate drains are installed, trapped and primed and routed to drain.
- M. Check for readily observable leaks in air-handling unit components and ductwork.
- N. 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.

3.5 **TEMPERATURE CONTROL VERIFICATION**

- Α. Examine automatic temperature system components to verify the following:
 - Dampers, valves, and other controlled devices operate by the intended controller. 1.
 - Dampers and valves are in the position indicated by the controller. 2.
 - Integrity of valves and dampers for free and full operation and for tightness of fully closed 3. 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.
 - Thermostats and humidistats are located to avoid adverse effects of sunlight, equipment, 5. drafts, and cold walls.
 - 6. Sensors are located to sense only the intended conditions.
 - Sequence of operation for control modes is according to the Contract Documents. 7.
 - 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.
- Β. 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.
- Η. Confirm interaction of electrically operated switch transducers.
- Ι. 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.
- 3.6 CONSTANT VOLUME AIR SYSTEMS BALANCING PROCEDURES
 - Adjust fans to deliver total design airflows within the maximum allowable rpm listed by the fan Α. manufacturer. Adjust fans to deliver design airflow at the lowest possible speed. 1.
 - Measure fan static pressures to determine actual static pressure as follows:
 - Measure outlet static pressure as far downstream from the fan as practicable and а upstream from restrictions in ducts such as elbows and transitions.
 - Measure static pressure directly at the fan outlet or through the flexible connection. b.
 - Measure inlet static pressure of single-inlet fans in the inlet duct as near the fan as C. possible, upstream from flexible connection and downstream from duct restrictions.
 - Measure inlet static pressure of double-inlet fans through the wall of the plenum d. 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.

3.7 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.

3.8 FINAL REPORTS

- A. Report Requirements:
 - 1. General:
 - a. Computer generated in PDF format and tabulated, divided, and bookmarked 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
 - I. 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) Inlet Vane Settings for Variable-Air-Volume Systems
 - 7) Settings for Supply-air, Static-pressure Controller
 - 8) 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. Water and Steam Flow Rates
 - c. Duct, Outlet, and Inlet Sizes
 - d. Pipe and Valve Sizes and Locations
 - e. Terminal Units
 - f. 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
- c. 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) Preheat Coil Static-pressure Differential in Inches wg (Pa)
 - 7) Cooling Coil Static-pressure Differential in Inches wg (Pa)
 - 8) Heating Coil Static-pressure Differential in Inches wg (Pa)
 - 9) Outside Airflow in cfm (L/s)
 - 10) Return Airflow in cfm (L/s)
 - 11) Outside-air Damper Position
 - 12) Return-air Damper Position
 - 13) Vortex Damper Position
- E. Fans:

1.

a.

- Fan Test Reports: For supply, return, and exhaust fans, include the following:
 - 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
- F. 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) Duct Static Pressure in Inches wg
 - 4) Duct Size in Inches
 - 5) Duct Area in SF
 - 6) Design Airflow Rate in cfm

- 7) Design Velocity in fpm
- 8) Actual Airflow Rate in cfm
- 9) Actual Average Velocity in fpm
- G. Diffusers/Registers/Grilles:

a.

- 1. For diffusers, registers and grilles, include the following:
 - 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) Final Airflow Rate in cfm
 - 4) Final Velocity in fpm
 - 5) Space Temperature in Degrees F
- H. Instrument Calibration:

a.

- 1. For instrument calibration, include the following:
 - Report Data: Include the following:
 - 1) Instrument Type and Make
 - 2) Serial Number
 - 3) Application.
 - 4) Dates of Use
 - b. Dates of Calibration.

3.9 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 07 00 - HVAC INSULATION

PART 1 - GENERAL

1.1 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

1.2 RELATED SECTIONS

- A. Contents of Division 23, HVAC and Division 01, General Requirements apply to this Section.
- 1.3 REFERENCES AND STANDARDS
 - A. References and Standards as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.
- 1.4 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.

1.5 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.

1.6 WARRANTY

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

1.7 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

2.1 MANUFACTURERS

- A. Type A, Flexible Glass Wool Blanket:
 - 1. Certainteed
 - 2. Johns Manville
 - 3. Knauf
 - 4. Owens-Corning
- B. Type B, Duct Liner:
 - 1. Certainteed
 - 2. Johns Manville
 - 3. Knauf
 - 4. Owens-Corning
- C. Jacketing:
 - 1. ITW Insulation Systems
 - 2. General Insulation Company
 - 3. 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
- F. Duct Insulation Compounds:
 - 1. Certainteed
 - 2. Johns Manville
 - 3. Owens-Corning
- 2.2 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. DBDE-free. UL/E validated to be formaldehyde-free.

- E. 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.
- 2.3 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.
 - G. Erosion-Resistant Surfaces: UL 181.
 - 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.
- 2.4 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.
 - E. Insulated Jacketing Tape: Venture Tape VentureClad Plus 1579CW Insulation Cladding, or approved equal.

2.5 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.

2.6 DUCT INSULATION ACCESSORIES

- A. Staples, bands, wires, tape, anchors, corner angles and similar accessories as recommended by insulation manufacturer for applications indicated.
- 2.7 DUCT INSULATION COMPOUNDS
 - A. Cements, adhesives, coatings, sealers, protective finishes and similar accessories as recommended by insulation manufacturer for applications indicated.

PART 3 - EXECUTION

3.1 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.
 - b. Cover insulation on pipes above ground, outside of building, with aluminum jacketing. Position seam on bottom of pipe.
- 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. 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.
- G. 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.
- H. 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.
- I. 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 (hot and cold) piping.

Item to be Insulated	System Insulation Type	Duct Size	Insulation Thickness
Supply ductwork where duct is not specified to be lined.	A	All	1.5-inch
Return ductwork where duct is not specified to be lined.		All	None
HVAC plenums and unit housings not preinsulated	В	All	1.5-inch
Exhaust ducts within 10-feet of exterior	A	All	3-inch
Exposed insulation in mechanical rooms or areas subject to damage	C, D	All	1.5-inch

J. Ductwork Surfaces to be Insulated:

- 1. Note: Insulation thickness shown is a minimum. If state codes require additional thickness, then provide insulation thickness per code requirements.
- K. Piping Surfaces to be Insulated:

Item to be System Insulated Insulation Type	Conductivity Range (Btu-inch per hour per SF per degrees F)	Pipe Size (Inches)	Insulation Thickness (Inches)
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Refrigerant	2	0.21-0.27 at a	<1	0.5
Liquid Piping		temperature of	1 to <1.5	0.5
(40F to 60F)		75 degrees F	1.5 to <4	1.0
			4 to <8	1.0
			>= 8	1.0

1. Note: Insulation thickness shown is a minimum. If state code requires additional thickness, then provide insulation thickness per code requirements.

3.2 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.

3.3 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.

3.4 JACKETING

- A. See General Installation Requirements above.
- B. Install in accordance with manufacturer's instructions.
- 3.5 ACCESSORIES
 - A. Install insulation in conformance with manufacturer's instructions, recommendations and requirements.
 - B. See General Installation Requirements above.
 - C. Furnish and install accessories for all insulation types listed in this Section.
- 3.6 DUCT INSULATION ACCESSORIES
 - A. Install insulation in conformance with manufacturer's recommendations and requirements.

3.7 DUCT INSULATION COMPOUNDS

A. Install insulation in conformance with manufacturer's recommendations and requirements.

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SECTION 23 09 00 - INSTRUMENTATION AND CONTROL PERFORMANCE SPECIFICATIONS

PART 1 - GENERAL

1.1 SUMMARY

- A. Work Included:
 - 1. Communications
 - 2. BAS Graphics
 - 3. Building Controllers
 - 4. Application Specific Controllers
 - 5. Application Specific Controller Terminal Unit Controllers
 - 6. Input/Output Interface
 - 7. Power Supplies and Line Filtering
 - 8. Control Panels
 - 9. Auxiliary Control Devices
 - 10. Wiring and Raceways
- B. This is a performance specification and Contractor is responsible for design tasks and engineering.
- 1.2 RELATED SECTIONS
 - A. Contents of Division 23, HVAC and Division 01, General Requirements apply to this Section.

1.3 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. Current edition of ANSI/ASHRAE Standard 135 and addendum, BACnet.
 - 2. Current edition of UL 916 Underwriters Laboratories Standard for Energy Management Equipment, Canada and the US.
 - 3. Current edition of FCC Part 15, Subpart J, Class A.
 - 4. Current edition of BACnet Testing Laboratories (BTL).

1.4 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 Authorized 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's Authorized 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:
 - 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.
 - 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.

1.5 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.
- 1.6 WARRANTY
 - A. Warranty of materials and workmanship as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

1.7 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.
- B. The existing building has an existing BACnet controls system. Intent is for the new controls components to be fully integrated into the existing building controls system. New controls components are to be compatible with existing controls system. Coordinate controls work with CCC facilities personnel.
- 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, furnish, 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.

1.8 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:

Measure Variable	Reported Accuracy	
Space Temperature	Plus or Minus 1 degree F	
Ducted Air	Plus or Minus 1 degrees F	
Outside Air	Plus or Minus 2 degrees F	
Dew Point	Plus or Minus 3 degrees F	
Delta-T	Plus or Minus 0.25 degree F	
Relative Humidity	Plus or Minus 5 percent RH	

- 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:

Controlled Variable	Control Accuracy	Range of Medium
Air Pressure	Plus or minus 0.2 inch wg	0-6 inch wg
	Plus or minus 0.01 inch wg	-0.1 to 0.1 inch wg

Airflow	Plus or minus 10 percent of full scale	
Space Temperature	Plus or minus 2.00 degrees F	
Duct Temperature	Plus or minus 3.0 degrees F	
Humidity	Plus or minus 5 percent RH	
Fluid Pressure	Plus or minus 1.5 PSI	1-150 PSI
	Plus or minus 1.0 inch wg	0-50 inch wg differential

PART 2 - PRODUCTS

2.1 OREGON/WASHINGTON MANUFACTURERS

- A. Automated Logic (ALC)
- B. Or appoved equivalent.

2.2 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. 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.

2.3 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 fan coils, packaged equipment, zone terminal units, and combination fire and smoke damper status. 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.

2.4 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. 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.
- E. Memory: Building controller maintains BIOS and programming information in event of power loss for at least 72 hours.
- F. 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.

- G. 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.
- 2.5 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.
- 2.6 APPLICATION SPECIFIC CONTROLLER TERMINAL UNIT CONTROLLERS
 - A. Provide one application controller for each terminal unit that adequately covers objects listed in object list for unit. Controllers to interface to building controller via LAN using specified protocol. Controllers to include on board flow sensor, inputs, outputs and programmable, self-contained logic program as needed for control of units.

- B. Application controllers to include universal inputs with 10-bit resolution that can accept thermistors, 0-5 VDC, and dry contact signals. Inputs on controller may be either analog or digital. Controller to also include support and modifiable programming for interface to intelligent room sensor with digital display (digital display to indicate setpoint only). Controller to also include binary outputs on board. For applications using variable speed parallel fans, provide a single analog output selectable for 0-10 V or 0-20 mA control signals. Application controller to include microprocessor driven, self calibrating flow sensor for use in pressure independent control logic. Terminal units controlled using pressure independent control algorithms and flow readings to be in CFM. Flow sensor and controller to have control range of 0.004 in.wc. to 1.5 in.wc. with an accuracy of +5% at 1 in.wc.
- C. 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 loops for control of multiple devices. Provide programming of application controller completely modifiable in the field over installed specified protocol LANs or remotely via modem interface. Operator to program logic sequences by graphically moving function blocks on screen and tying blocks together on screen. Application controller programmed using the same programming tool as Building Controller and as described in Operator Workstation article.
- D. Application controller to include support for intelligent room sensor. Display on room sensor programmable at application controller and include an operating mode and a field service mode. 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 for specific display requirements for intelligent room sensor.
- E. Provide duct temperature sensor at discharge of each terminal unit that is connected to controller for reporting back to operator workstation. Provide analog inputs for the duct temperatures.

2.7 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.

2.8 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.

2.9 CONTROL PANELS

- A. Control Panels:
 - 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.

2.10 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.
- 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.
- 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.
 - 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.
- 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.
 - 6. Bearings: Self-lubricating stainless steel sleeve or Celcon bearing.
 - 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. 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.
- E. Air Flow Meters:
 - 1. Fan Inlet Type: Self-supporting aluminum traverse probes housing thermal dispersion sensors. Probe spacing and sensor quantity as recommended by manufacturer. Provide factory calibrated electronic flow transmitter with CFM readout display and capability of providing 4 to 20 milliamp output for interface with direct digital controls. Ebtron GTx116-PC.
 - Fan Inlet Type: Self-supporting traverse probe type velocity pressure averaging station; stainless steel construction for exhaust fans; aluminum construction for air handler units. Provide factory calibrated electronic flow transmitter; CFM readout display; capable of providing 4 to 20 milliamp output. Air Monitor Volu-probe/FI; Paragon; Accutrol.
 - 3. Duct Mounted Air Flow Station: Self-supporting aluminum alloy tube with stainless steel mounting brackets. Probe and sensor density quantity as recommended by manufacturer. Sensor use thermal dispersion technology with two "bead in glass," hermetically sealed thermistor probes at each measuring point. Provide electronic flow transmitter with CFM readout display and capable of 4-20 mA output signal. Ebtron GTA116-PC.
- 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. Duct Mounted Carbon Dioxide Sensor:
 - 1. Duct mounted CO2 sensor consists of infrared sensing element with heated stannic dioxide semiconductor. Operating range 0-2000 ppm plus 50 ppm plus 2 percent of measured value; maximum duct velocity of 1500 fpm; duct mounting kit.
- H. Wall Mounted Space Carbon Dioxide Sensor:
 - 1. Sensor to employ non-dispersive infrared technology. (N.D.I.R.)
 - 2. Sensor Repeatability: Plus or minus 20 ppm. 0-2000.
 - 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.
- I. 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).

- J. Occupancy Sensor: Dual technology infrared and ultrasonic sensing device, ceiling or wall mounted, built-in self-adjusting settings, timer settings of 30 seconds to 30 minutes, with manual and automatic modes. Provide multiple devices in parallel when area served is greater than a single device sensing capability. Provide integral power pack, 120 VAC input, 24 VDC output, with manual override switch. Leviton OSC-MOW series.
- K. Paddle Type Flow Switches: Paddle type switches (water service only) UL listed, SPDT snap-acting with pilot duty rating (125 VA minimum) and have adjustable sensitivity with NEMA 1 enclosure.
- L. 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.
- M. 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.
- N. 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.
- O. 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.
- P. 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, with plus or minus 1 percent full-scale accuracy with 500 ohm maximum burden.
- Q. 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.
- R. Overflow Switch: Insertion flow sensor, brass, impeller flow design with analog transmitter unit. Data Industrial Model 220BR.

2.11 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.
- 3. Concealed in Building Walls and Ceilings: Plenum rated cable.
- 4. Concealed in Building Ceilings: Plenum rated cable in cable tray.
- 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.

PART 3 - EXECUTION

3.1 DEMOLITION

- A. Terminal Devices: Remove terminal sensors, actuators and controls as indicated on drawings and as required to accommodate scope of mechanical work shown on drawings and described in specifications. Remove pneumatic piping and cap with hardware as appropriate. Remove wiring and conduit associated with devices. Do not leave any unused abandoned piping or wiring in space.
- B. Graphics and Programming: Remove symbols from control system graphics associated with deleted terminal elements. Modify programming code to delete alarms, control loops, etc., associated with deleted terminal devices.

3.2 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 Owner's Authorized 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.

3.3 CONTROL SYSTEM CHECKOUT AND TESTING

- A. Testing completed before Owner's Authorized 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.

3.4 ACCEPTANCE TESTING AND TRAINING

- A. Site Testing:
 - 1. Contractor provides personnel, equipment, instrumentation, and supplies necessary to perform testing. Owner or Owner's Authorized 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:
 - 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 and excluding lunch time, Monday through Friday, during normal first shift in effect at training facility. Notification of any planned training given to Owner's Authorized Representative at least 15 days prior to training.
 - 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.

3.5 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."
- 3.6 WIRING AND RACEWAYS
 - 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, AO, DO, and function (i.e. pump start, OM Sensor).

3.7 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.

B. 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.
- C. 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.

D. Air Flow Station: Install where indicated in ductwork and/or equipment with manufacturer's recommended straight ductwork upstream and downstream of air flow station or as shown on drawings, whichever is greater. Where equipment manufacturer's standard airflow measuring station cannot read airflows at required design velocities, provide appropriate air flow measuring station to provide accurate reading throughout system design operations range.

3.8 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:
 - 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 a supply air temperature or duct pressure setpoint is specified to be reset by the space temperature of the zones calling for the most cooling/heating, employ the following method:
 - 1. Use a floating reset algorithm which increments the secondary variable (e.g., supply air temperature or duct pressure) setpoint on a periodic basis to maintain primary variable (e.g., space temperature) setpoint. The reset increment to be determined by the quantity of "need heat" or "need cool" requests from individual SCU's. A SCU's "need heat" virtual point to activate whenever the zone's space temperature falls below the currently applicable (occupied or unoccupied) heating setpoint throttling range. A SCU's "need cool" virtual point to activate whenever the zone's space temperature rises above the currently applicable (occupied, unoccupied, or economy) cooling setpoint throttling range. The recalculation time and reset increment to be chosen to maintain the primary variable within the specified maximum allowable variance while minimizing overshoot and settling time. Reset range maximum and minimum values to limit the setpoint range.
- L. Where a supply air temperature, duct pressure, or differential water pressure setpoint is specified to be reset by valve or damper position of the zone or zones calling for the most cooling/heating, the following method to be employed:
 - 1. A floating reset algorithm to be used which increments the secondary variable (e.g., supply air temperature, pipe or duct pressure) setpoint on a periodic basis to maintain primary variable (e.g., cooling valve, heating valve, damper position) setpoint of 85 percent open. The reset increment to be calculated based on the average position of the quantity of the worst (most open valve/damper) zone(s) as specified. The recalculation time, reset increment and control device position influence to be chosen to maintain the primal variable within the specified maximum allowable variance while overshoot and settling time. The BAS analog output value to be acceptable as indicating the position of the control device.
 - 2. Alternatively to continuously calculating the average of the quantity of worst valve/damper positions, a method similar to the one described above may be employed whereby the

"need heat" or "need cool" virtual point to increment by one unit each time a zone's valve/damper position rises to greater than 95 percent. The quantity of "need heat" or "need cool" points to then be the basis for reset.

- M. 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.
- N. BAS to provide for adjustable maximum rates of change for increasing and decreasing output from the following analog output points:
 - 1. Speed control of variable speed drives
 - 2. Control Reset Loop
 - 3. Valve Travel Limit
- O. 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.
- P. 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.
- Q. Terminal Units with Electric Reheat:
 - 1. Terminal unit controller receives signal from building controller which initiates occupied or unoccupied mode. Input from push button on room temperature sensor initiates occupied mode for a period of 2 hours (adj.). During unoccupied mode space temperature reset to unoccupied setpoints and during occupied mode space temperature reset to occupied setpoints. When entering occupied mode, use an optimal start algorithm for warm-up or cool-down. Minimize the warm-up or cool-down period while still achieving comfort conditions by the start of scheduled occupied period.
 - 2. Unoccupied Mode:
 - a. Close terminal unit damper and disable electric heater. Ignore any signals from space occupancy or carbon dioxide sensors.
 - b. If space temperature is greater than unoccupied cooling setpoint, and if central air handling unit supply fan is running, modulate damper between minimum and maximum cooling airflow setpoints to maintain space temperature at unoccupied cooling setpoint.
 - c. If space temperature is less than unoccupied heating setpoint, modulate damper between minimum and maximum heating airflow setpoints and initiate stages of electric heat to maintain space temperature at unoccupied heating setpoint.
 - 3. Occupied Mode:
 - a. Modulate damper to maintain minimum airflow setpoint and disable electric heater.
 - b. If space temperature is greater than occupied cooling setpoint, modulate damper between minimum and maximum cooling airflow setpoints to maintain space temperature at occupied cooling setpoint.
 - c. If space temperature is less than occupied heating setpoint, modulate damper between minimum and maximum heating airflow setpoints and initiate stages of electric heat to maintain space temperature at occupied heating setpoint.
 - d. For zones with occupancy sensors, enter "Standby Mode" if the occupancy sensor does not detect occupancy for 15 minutes (adj.). During standby mode, cooling setpoint resets to 3 degrees F (adj.) above normal occupied cooling setpoint and heating setpoint resets to 3 degrees F (adj.) below normal occupied heating

setpoint. When occupancy has been detected for 5 minutes (adj.), heating and cooling setpoints reset to normal occupied temperature setpoints.

- e. If space CO2 concentration is greater than 900 ppm (adj.) modulate damper between minimum and maximum cooling airflow setpoints to maintain concentration at setpoint.
- 4. Warm-up Mode: Terminal unit receives global signal from building controller to initiate warm-up mode. During warm-up mode modulate damper between minimum and maximum airflow setpoints and initiate stages of electric heat to maintain space temperature at occupied heating setpoint.
- 5. Warm-up Mode: Terminal unit receives global signal from building controller to initiate warm-up mode. During warm-up mode disable electric heater and modulate damper between minimum and maximum airflow setpoints to maintain space temperature at occupied heating setpoint.
- 6. Interlocks:
 - a. Interlock thermostat for VAV-1 with thermostat for VAV-2 to prevent simultaneous heating/cooling. BAS to take average of thermostat temperatures for control. VAV-1 thermostat to provide master temperature input for space.
 - b. Interlock VAV-3 with (E)TU1-8 to prevent simultaneous heating/cooling. BAS to take average of thermostat temperatures for control. (E)TU1-8 thermostat to provide master temperature input for space.
- 7. Terminal Units with Electric Reheat Points List:

Points List	Analog In	Analog Out	Digital In	Digital Out	Alarms	Trend
Zone Temp	Х					Х
Airflow Sensor Measured CFM	Х					X
Damper Position		X				x
Electric Heat SCR Staging		X				х
Discharge Air Temp	X				High 100 degrees (adj.)	X
Occupancy Override Request from Zone Temp Sensor			X			
Occupancy Sensor			X			
Carbon Dioxide Sensor Concentration (PPM)	X				High 1300 ppm (adj.)	X

R. 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.

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2	Conoral Exhaust Ean (C)/) Dainta List:
J.	

Points List	Analog In	Analog Out	Digital In	Digital Out	Alarms	Trend
Exhaust Fan Start/Stop				Х		
Exhaust Fan Status (Current Transformer)			Х		Fail	Х
Damper Open/Close				Х		

S. Combination Fire Smoke Dampers (FSD):

- 1. Dampers closed upon receiving signal from fire alarm system, or from central controller.
- 2. Dampers closed when their corresponding fan is not operating.
- 3. Dampers open when fan systems are operating, unless overridden by fire alarm system.
- 4. Provide LED indicators in ceiling for each FSD, indicating open, not open, status
- 5. Combination Fire Smoke Dampers (FSD) Points List:

Points List	Analog In	Analog Out	Digital In	Digital Out	Alarms
Damper Open/Close				Х	
Fire Alarm Signal			Х		

END OF SECTION

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SECTION 23 31 00 - HVAC DUCTS AND CASINGS

PART 1 - GENERAL

1.1 SUMMARY

- A. Work Included:
 - 1. Ductwork, Joints and Fittings
 - 2. Insulated Flexible Duct
 - 3. Drain Pans
 - 4. Ductwork Joint Sealers and Sealants

1.2 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.

1.3 REFERENCES AND STANDARDS

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

1.4 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

1.5 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.
- 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.
- 3. Provide ductwork pressure testing and leakage testing per Section 23 05 93, Testing, Adjusting and Balancing for HVAC.

1.6 WARRANTY

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

1.7 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

- 2.1 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

2.2 DUCTWORK, JOINTS AND FITTINGS

- A. Materials:
 - Galvanized Steel Ducts: Hot-dipped galvanized steel sheet, lock-forming quality, ASTM A 653/A 653M FS Type B, with G90/Z275 coating. Ducts to have mill phosphatized finish for surfaces exposed to view.
- 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.
- 2.3 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.
- 2.4 DRAIN PANS
 - A. Primary Drain Pans: Stainless Steel, Fabricated in accordance with ASTM A167 and A480.
 - B. Secondary Drain Pans: Galvanized Steel: Hot-dipped galvanized steel sheet, ASTM A 653/A 653M FS Type B, with G90/Z275 coating.
- 2.5 DUCTWORK JOINT SEALERS AND SEALANTS
 - A. Joint Sealers and Sealants: Non-hardening, water resistant, mildew and mold resistant.
 - B. 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.
 - C. Surface Burning Characteristics: Flame spread of zero, smoke developed of zero, when tested in accordance with ASTM E 84.
 - D. 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.
 - E. Flanged Joint Mastic: One-part, acid-curing, silicone, elastomeric joint sealant complying with ASTM C920, Type S, Grade NS, Class 25, Use O.
 - F. Flange Gaskets: Butyl rubber or EPDM polymer with polyisobutylene plasticizer.
 - G. Polyurethane Sealant: General-purpose, exterior use, non-brittle sealant for gunned application. Vulkem 616 or equal.

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION REQUIREMENTS

A. General: Use the following pressure seal, and leakage class(es) in design of ductwork specified in this section unless otherwise noted on Drawings.

SYSTEM	PRESSURE CLASS (Inches of Water)	SEAL CLASS	LEAKAGE CLASS ROUND DUCTS	LEAKAGE CLASS RECTANGULAR DUCTS
Medium pressure supply (fan to terminal unit)	0.5-inch higher than air handlers discharge pressure (min 4-inch pressure class).	A	3	6
Low pressure (downstream of terminal unit)	+ 1-inch	A	3	6
Return and exhaust	0.5-inch more negative than return/exhaust fan pressure or -2-inch pressure class, whichever is more negative.	A	3	6

- B. Ductwork Installation:
 - 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.
 - 8. Install ducts with a clearance of 1-inch, plus allowance for insulation thickness. Allow for easy removal of ceiling tile.
 - 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.
- 14. Install ducts with hangers and braces designed to withstand, without damage to equipment, seismic force required by applicable building codes. Reference SMACNA's Seismic Restraint Manual: Guidelines for Mechanical Systems, Mason Seismic Restraint and Support Systems.
- 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.
- 18. Install flexible ductwork to limit sag between support hangers to 1/2-inch per foot of spacing support.
- 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.

3.2 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.

Location or Application	Material
Supply, Return, Transfer, and Exhaust - Low Pressure	Single Wall, Galvanized Steel
(downstream of terminal units)	

Supply, Return, and Exhaust - Medium Pressure	Single Wall, Galvanized Steel
(upstream of terminal units)	

- 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.

3.3 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.

3.4 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.

3.5 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. Seal transverse joints, longitudinal seams and duct wall penetrations including screw, fastener, pipe, rod, and wire.
 - 3. Seal ducts before external insulation is applied.
 - 4. Fasteners such as sheet-metal screws, machine screws or rivets to be cadmium plated.
 - 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.
 - 6. 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.
 - 7. Seal joints and seams. Apply sealant to make end connectors before insertion, and afterward to cover entire joint and sheet metal screws.
 - 8. 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.
 - 9. Duct sizes indicated are inside clear dimensions. For lined ducts, maintain sizes inside lining.
 - 10. 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. Locate ducts with sufficient space around equipment to allow normal operating and maintenance activities as well as Code required clearances.

11.

END OF SECTION

SECTION 23 33 00 - AIR DUCT ACCESSORIES

PART 1 - GENERAL

1.1 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. Combination Fire and Smoke Dampers
 - 8. Flexible Connectors

1.2 RELATED SECTIONS

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

1.3 REFERENCES AND STANDARDS

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

1.4 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.

1.5 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.
 - 5. AMCA 611, latest edition Certified Ratings Program Product Rating Manual for Airflow Measurement Stations.
 - 6. AMCA 610, latest edition Laboratory Methods of Testing Airflow Measurement Stations for Performance Rating.
 - 7. NFPA 90A Installation of Air Conditioning and Ventilating Systems.

- 8. NFPA 92A Smoke-Control Systems.
- 9. NFPA 92B Smoke Control Systems in Atria, Covered Malls and Large Areas.
- 10. NFPA 101 Life Safety Code.
- 11. UL 555 Standard for Safety; Fire Dampers.
- 12. UL 555S Standard for Safety; Leakage Rated Dampers for Use in Smoke Control Systems.
- 1.6 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

- 2.1 MANUFACTURERS
 - A. Backdraft Dampers:
 - 1. Air Balance
 - 2. Cesco
 - 3. Greenheck
 - 4. Nailor
 - 5. Ruskin
 - B. Dampers:
 - 1. Air Balance
 - 2. Cesco
 - 3. Greenheck
 - 4. Nailor
 - 5. Ruskin
 - C. Concealed Damper Hardware, Cable System:
 - 1. Young Regulator Company
 - D. Access Doors:
 - 1. Ductmate
 - 2. Cesco
 - 3. Ruskin
 - 4. Nailor
 - 5. Outdoor Installation: Karp MX insulated exterior access door.
 - E. Duct Test Holes:
 - 1. Ventlok
 - F. Combination Fire and Smoke Dampers:
 - 1. Ruskin
 - 2. Greenheck
 - 3. Nailor
 - 4. Pottorff
 - G. Flexible Connectors:
 - 1. Duro Dyne Corp.
 - 2. Ventfabrics Inc.
 - 3. Ductmate Industries
 - 4. Hardcast

2.2 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. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts; compatible materials for aluminum and stainless-steel ducts.
- D. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36-inches or less; 3/8-inch minimum diameter for lengths longer than 36-inches.

2.3 BACKDRAFT DAMPERS

- A. 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:
 - 1. Closed Position: Maximum back pressure of 16-inches water gauge.
 - 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.

2.4 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: 16 gauge thick extruded aluminum.
 - e. Blade Axles: Minimum 1/2-inch diameter, plated steel, hex shaped, mechanically attached to blade.
 - f. Bearings: Molded synthetic sleeve, turning in extruded hole in frame.
 - g. Tie Bars and Brackets: Galvanized steel.
 - h. 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.
 - 2. Blades: Minimum 20 gauge thick, galvanized sheet steel, round, single-piece.
 - 3. Aluminum Frames: Minimum 10 gauge thick aluminum sheet.
 - 4. Aluminum Blades: Minimum 10 gauge thick aluminum sheet.
 - 5. Extruded-Aluminum Blades: Minimum 16 gauge thick extruded aluminum.
 - 6. Blade Axles: Minimum 3/8-inch square, plated steel, mechanically attached to blade.
 - 7. Bearings: Molded synthetic sleeve, turning in hole in frame.
 - 8. Finish: Mill galvanized.
 - 9. Capacity:
 - a. Closed Position: Maximum pressure of 3-inches wg
 - 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.

2.5 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.

2.6 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.

2.7 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.

2.8 COMBINATION FIRE AND SMOKE DAMPERS

- A. Basis-of-Design:
 - 1. Ruskin Model FSD25R, Leakage Class 1, 1-1/2 hour rated, for round ductwork up to 24-inch diameter.
 - 2. Ruskin Model FSD60, Leakage Class I, 1-1/2 hour rated, for rectangular ducts or round ductwork larger than 24-inch diameter. Provide duct transition between round and rectangular connections. Pressure drop of a 24-inch by 24-inch damper at 1,000 and 2,000 fpm face velocity shall not exceed 0.03 and 0.16 in-wc., respectively.
- B. Ratings:
 - 1. Fire Resistance: UL 555 classified and provide combination fire and smoke dampers with UL label for fire rating as appropriate for construction rating and in conformance with NFPA 90A.

- 2. Smoke Rating: Leakage Class Smoke Damper in accordance with UL555S. Leakage class at 4-inch wg
- 3. Elevated Temperature Rating: 250 degrees F.
- 4. Air Flow Rating: 2,000 feet per minute.
- 5. Differential Pressure Rating: 4-inch wg.
- C. Construction:
 - 1. Frame: 16 gauge roll formed, galvanized steel hat-shaped channel, reinforced at corners. Structurally equivalent to 13 gauge U-channel type frame.
 - 2. Blades (Leakage Class II):
 - a. Style: Single skin with 3 longitudinal grooves.
 - b. Action: Opposed.
 - c. Material: Minimum 16 gauge galvanized steel.
 - d. Width: Maximum 6-inches.
 - 3. Blades (Leakage Class I):
 - a. Style: True airfoil-shaped, single piece, double skin.
 - b. Action: Opposed.
 - c. Material: Minimum 14 gauge equivalent thickness, galvanized steel.
 - d. Width: Maximum 6-inches.
 - 4. Bearings: Self-lubricating stainless steel sleeve type, turning in extruded hole in frame.
 - 5. Seals:
 - Blade: Inflatable silicone fiberglass material to maintain smoke leakage rating to a minimum of 450 degrees F and galvanized steel for flame seal to 1,900 degrees F. Mechanically attached to blade edge (glue-on or grip type seals are not acceptable).
 - b. Jamb: Stainless steel, flexible metal compression type.
 - 6. Linkage: Concealed in frame.
 - 7. Axles: Minimum 1/2-inch diameter plated steel, hex-shaped, mechanically attached to blade.
 - 8. Mounting: Vertical or Horizontal, based on application.
 - 9. Temperature Release Device: Heat actuated, Quick Detect.
 - a. Close (in a controlled manner) and lock damper during test, smoke detection, power failure, or fire conditions through actuator closure spring. Actuator, at no time, to disengage from damper blades.
 - b. Allow damper to be automatically and remotely reset after test or power failure conditions. After exposure to high temperature or fire, inspect damper before reset to ensure proper operation.
 - c. Controlled closing and locking of damper in 7 to 15 seconds to allow duct pressure to equalize. Instantaneous closure is not acceptable.
 - 10. Release Temperature: 165 degrees F.
 - 11. Actuator: Electric, two-position, fail close.
 - 12. Finish: Mill galvanized for installation in galvanized sheet metal and Type 304 stainless steel for installation in stainless steel ductwork.
 - 13. Firestat:
 - a. UL classified dual temperature device allows the damper to be re-opened after initial closure from high heat.
 - b. Electrically and mechanically locks damper in closed position when duct temperatures exceed 165 degrees F.
 - c. Allow damper to remain operable through a high limit temperature sensor for smoke management purposes while temperature is below 250 degrees F.
 - d. Replaces EFL or PFL Ruskin Controlled Closure heat actuated temperature release devices on standard dampers.
 - e. Blade position indicator switches: Two position indicator switches linked directly to damper blade in order to allow remote indication of damper blade position. Provide separate switches for indication of closed and open position.

2.9 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.
- C. Provide a spring and bracket assembly to reinforce the fabric with sufficient tension to prevent connector collapse under negative or positive pressure. Number and positioning of spring-link fixture to be determined by the manufacturer to maintain straight axis and without kinks between two sections of duct, or between duct and the moving element. Hardcast Spring-Link SL-200, or equal.
- D. Indoor System, Flexible Connector Fabric (FC-I): Glass fabric double coated with neoprene.
 - 1. Minimum Weight: 26 ounces per square yard.
 - 2. Tensile Strength: 300 pounds of force per inch in the warp and 225 pounds of force per inch in the filling.
 - 3. Service Temperature: -40 degrees F to 200 degrees F.

PART 3 - EXECUTION

3.1 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.
- 3.2 SHEET METAL MATERIALS INSTALLATION
 - A. Install bracing for multiple sections to support assembly weights and hold against system pressure. Install bracing as needed.
- 3.3 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.
- 3.4 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.

3.5 CONCEALED DAMPER HARDWARE INSTALLATION

A. Coordinate location in Reflected Ceiling Plan and color of concealed damper hardware with Architect prior to installation.

3.6 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.
 - b. Two-Hand Access: 12-inches by 6-inches.
 - c. Head and Hand Access: 18-inches by 10-inches.
 - d. Head and Shoulders Access: 21-inches by 14-inches.
 - e. Body Access: 25-inches by 14-inches.
 - f. Body Plus Ladder Access: 25-inches by 17-inches.
 - 6. Install the following sizes for duct-mounting, round access doors:
 - a. One-Hand or Inspection Access: 8-inches in diameter.
 - b. Two-Hand Access: 10-inches in diameter.
 - c. Head and Hand Access: 12-inches in diameter.
 - d. Head and Shoulders Access: 18-inches in diameter.
 - e. Body Access: 24-inches in diameter.
 - 7. Label access doors.
- 3.7 DUCT TEST HOLES INSTALLATION
 - A. Provide test holes at fan inlets and outlets where indicated and where required for air testing and balancing.
- 3.8 COMBINATION FIRE AND SMOKE DAMPERS INSTALLATION
 - A. Verify that electric power is available and of correct characteristics.
 - B. Coordinate combination fire and smoke dampers with fire alarm system.
 - C. Install combination fire and smoke dampers, with fusible links, and in accordance with manufacturer's UL-approved written instructions.
 - D. Adjust fire and smoke dampers for proper action.
- 3.9 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. Securely attach spring-lock brackets to the metal strips of the connector collar using No. 8 sheet metal screws.

- D. For fans developing static pressures of 5-inch wg and higher, cover flexible connectors with loaded vinyl sheet held in place with metal straps.
- E. Adjust the following types in the following locations:1. FC-I: Indoors.

END OF SECTION

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SECTION 23 34 00 - HVAC FANS

PART 1 - GENERAL

1.1 SUMMARY

A. Work Included: 1. Roof Exhaust Fans

1.2 RELATED SECTIONS

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

1.3 REFERENCES AND STANDARDS

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

1.4 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.

1.5 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.

1.6 WARRANTY

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

1.7 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.

1.8 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.

1.9 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents. Belts: One set for each belt-driven unit.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Roof Exhaust Fans:
 - 1. Greenheck
 - 2. Cook
 - 3. Twin City

2.2 ROOF EXHAUST FANS

- A. Description: Direct-driven centrifugal fans consisting of housing, wheel, fan shaft, bearings, motor and disconnect switch, drive assembly, curb base, and accessories.
- B. Wheel:
 - 1. Single width, single inlet, backward inclined/airfoil blades
 - 2. Aluminum hub and wheel with steel inlet bell.
 - 3. Statically and dynamically balanced with its own bearings.
- C. Housing to match scheduled Basis of Design:
 - 1. One piece heavy gauge spun aluminum dome, hinged for service.
- 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.
- E. Pulleys: Cast-iron, adjustable-pitch motor pulley.
- F. Fan and motor isolated from exhaust airstream.
- G. Curb: Prefabricated insulated roof curb, galvanized steel, mitered ad welded corners; 1-1/2-inch thick, rigid, fiberglass insulation adhered to inside walls; and 1-1/2-inch wood nailer, hinged with curb seal. Provide curb for flat, pitched or ridged roof as indicated.

- H. Motor: Integrally mounted, 1800 RPM maximum, with pre-lubricated sealed ball bearings. ODP for motors located indoors and TEFC for motors exposed to moisture.
 - 1. Inverter duty motor for use with variable frequency drive where indicated on Fan Schedule on Drawings.
 - 2. Electrically Commutated Motor (ECM) where indicated on Fan Schedule on Drawings.
- I. Accessories:
 - 1. Inlet/Outlet Screens: Galvanized steel welded grid, removable.
 - 2. Backdraft Damper: 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.
 - 3. Variable-Speed Controller: Where scheduled on Drawings, provide solid-state control to reduce speed from 100 percent to less than 50 percent.
 - 4. 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.
 - 5. Vibration Isolation: Wheel and motor mounted on integral double deflection neoprene isolators.

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION REQUIREMENTS

- A. Install in accordance with manufacturer's instructions.
- B. Install power ventilators level and plumb.
- C. Units using vibration isolation devices are scheduled on Drawings.
- D. Support suspended units from structure threaded steel rods and vibration isolation device scheduled on Drawings.
- E. In seismic zones, restrain support units.
- F. Install units with clearances for service and maintenance.
- G. Provide fixed sheaves required for final air balance.
- H. Provide safety screen where inlet or outlet is exposed.
- I. Provide backdraft dampers on discharge of exhaust fans and as indicated on Drawings.
- J. 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.
- K. Install ducts adjacent to power ventilators to allow service and maintenance.
- L. Ground equipment.
- M. 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.
- N. 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.
- O. Starting Procedures:
 - 1. Energize motor and adjust fan to indicated rpm.
 - 2. Measure and record voltage and amperage.
- P. 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.
- Q. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- R. Shut unit down and reconnect automatic temperature-control operators.
- S. Replace fan and motor pulleys as required to achieve design airflow.
- T. Provide totally enclosed fan cooled motors when motor is located outdoors, whether under a cover or not, or exposed to moisture. Provide protective covering for electronically commutated motors located in outdoor or wet/wash-down locations.
- U. Repair or replace malfunctioning units. Retest as specified above after repairs or replacements are made.
- V. Adjust damper linkages for proper damper operation.
- W. Lubricate bearings.
- X. On completion of installation, internally clean fans according to manufacturer's written instructions. Remove foreign material and construction debris. Vacuum fan wheel and cabinet.
- Y. After completing system installation, including outlet fitting and devices, inspect exposed finish. Remove burrs, dirt, and construction debris and repair damaged finishes.
- Z. 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.
- 3.2 ROOF EXHAUST FANS
 - A. Secure roof exhaust fans to roof curbs with cadmium-plated hardware.

END OF SECTION

SECTION 23 36 00 - AIR TERMINAL UNITS

PART 1 - GENERAL

1.1 SUMMARY

- A. Work Included:1. Single Duct Variable Volume and Constant Volume Units
- 1.2 RELATED SECTIONS
 - A. Contents of Division 23, HVAC and Division 01, General Requirements apply to this Section.
- 1.3 REFERENCES AND STANDARDS
 - A. References and Standards as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.
- 1.4 SUBMITTALS
 - A. Submittals as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.
- 1.5 QUALITY ASSURANCE
 - A. Quality assurance as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

1.6 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

2.1 MANUFACTURERS

- A. Air Terminal Units:
 - 1. Titus
 - 2. Price
 - 3. Krueger
 - 4. Trane
 - 5. Nailor
 - 6. Or approved equivalent.

2.2 SINGLE DUCT VARIABLE VOLUME AND CONSTANT VOLUME UNITS

- A. Casings: Minimum 22 gauge galvanized steel.
- B. 1/2-inch dual density insulation which complies with UL 181 and NFPA 90A. Exposed insulation edges to be coated with NFPA 90A approved sealant to prevent entrainment of fibers in the airstream.
- C. Plenum Air Inlets: Round stub connections or S slip drive connections for duct attachment.
- D. Plenum Air Outlets: S slip and drive connections.
- E. Casing Leakage: Maximum casing leakage not to exceed 10 cfm at 1-inch static pressure for inlet size larger than 12-inches and not to exceed 7 cfm at 1-inch static pressure for inlet size 12-inches and smaller.
 - 1. Configuration: Air volume damper assembly inside unit casing. Locate control components inside protective metal shroud.

- 2. Volume Damper: Construct of galvanized steel with peripheral gasket and self lubricating bearings; maximum damper leakage: 7 cfm maximum at inlet static pressure. Shaft to be clearly marked on the end to indicate damper position. Stickers or other removable markings are not acceptable. Damper to incorporate a mechanical stop to prevent overstroking and a synthetic seal to limit close off leakage to the maximum values shown in the damper leakage table.
- 3. Flow Sensor: Integral averaging type flow sensor utilizing multiple sensing points with unit mounted calibration chart.
- 4. Mount damper operator to position damper normally open.
- F. Electric Heating Coils:
 - 1. Construction: UL listed, slip-in type, open coil design, integral control box factory wired and installed with:
 - a. Primary and secondary over-temperature protection.
 - b. Minimum airflow switch.
 - c. Integral door interlock disconnect switch.
 - d. Electric switches and relays.
 - 2. Electrical Characteristics: Reference Drawings.
- G. Acoustics: Sound ratings tested as power level 10-12 watts in accordance with AHRI 880 I-P at 1.5-inches wg inlet static pressure. NC ratings calculated per AHRI 885 with room attenuations as listed in Appendix E, and not to exceed values scheduled on drawings.
 - 1. MAXIMUM AIRBORNE SOUND POWER (db)
 - a. OCTAVE BAND AND CENTER FREQUENCY (HZ)
 - b. Units must have 5-feet of 2-inch thick lined duct downstream of terminal unit.

CFM	2	3	4	5	6	7
	125	250	500	1K	2K	4K
0-300	69	65	63	60	60	55
301-400	70	69	64	60	60	55
401-800	72	70	67	64	60	55
801-1100	74	71	68	67	60	60
1101-1700	75	73	70	67	60	60
1701 and above	80	78	76	67	63	62

MAXIMUM RADIATED SOUND POWER (db)

 a. OCTAVE BAND AND CENTER FREQUENCY (HZ)

CFM	2	3	4	5	6	7
	125	250	500	1K	2K	4K
All	71	65	61	55	55	50

- H. DDC Controls: Damper operator, sensor, and other devices compatible with temperature controls specified in Section 23 09 00, Instrumentation and Control Performance Specifications.
- I. Electric Controls: 24-V damper actuator with wall-mounted electric thermostat and appropriate mounting hardware.

PART 3 - EXECUTION

- 3.1 GENERAL INSTALLATION REQUIREMENTS
 - A. Install in accordance with manufacturer's instructions. Install level and plumb.
 - B. Verify that installation of each air terminal is according to the Contract Documents.
- C. Check that inlet duct connections are as recommended by air terminal manufacturer to achieve proper performance.
- D. Check that controls and control enclosure are accessible.
- E. Verify that control connections are complete.
- F. Check that nameplate and identification tag are visible.
- G. Verify that controls respond to inputs as specified.
- H. Provide ceiling access doors or locate units above easily removable ceiling components.
- I. Support units individually from structure. Do not support from adjacent ductwork.
- J. Provide 9-inch by 9-inch access door with quarter turn latches upstream and downstream of each heating coil.
- K. Provide minimum five duct diameters minimum straight duct run upstream of terminal unit.
- L. Minimum of 3-feet straight duct downstream of terminal unit prior to first outlet or first branch duct.
- M. Branch inlet duct size to match unit inlet connection. For branch inlet ducts over 15-feet long, increase branch duct size one size and provide transition immediately upstream of minimum straight duct run.
- N. Connect to ductwork in accordance with Section 23 31 00, HVAC Ducts and Casings.
- O. Verify that electric power is available and of the correct characteristics.
- P. Balance unit to air flows scheduled.
- Q. Upon completion of installation and prior to initial operation, test and demonstrate that air terminals and duct connection to air terminals are leak tight. Repair or replace air terminals and duct connections as required to eliminate leaks and retest to demonstrate compliance.

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SECTION 23 37 00 - AIR OUTLETS AND INLETS

PART 1 - GENERAL

1.1 SUMMARY

A. Work Included:1. Grilles, Registers, Diffusers

1.2 RELATED SECTIONS

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

1.3 REFERENCES AND STANDARDS

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

1.4 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.

1.5 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.

1.6 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

2.1 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. Krueger
- 5. Metalaire
- 6. Nailor
- 7. Price Co.
- 8. Shoemaker
- 9. Titus
- 10. Tuttle & Bailey
- 11. Seiho
- 12. Or approved equivalent.

2.2 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:
 - 1. Matching construction materials and appearance. Equal installation method/frame.
 - 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. Provide pattern controllers for linear supply air diffusers.
- D. 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.
- E. Coordinate mounting frames with ceiling construction type. Verify per reflected ceiling plans.

PART 3 - EXECUTION

3.1 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. 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.

3.2 GRILLES, REGISTERS AND DIFFUSERS INSTALLATION

- A. Coordinate with Architectural Reflected Ceiling Plan(s). Reflected ceiling plans determine final locations.
- 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.
- D. Linear Slot Diffusers:
 - 1. Coordinate connection plenum dimensions with linear slot final dimensions to conform with manufacturer's recommendations, or as indicated. Total and active lengths as noted on drawings. Blank off unused sections. Coordinate frame type with Architect.
 - 2. Paint surfaces visible behind air outlets and inlets, including blank-off sections, matte black unless otherwise called for on drawings.

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SECTION 23 81 26 - SMALL SPLIT SYSTEM AND UNITARY HVAC EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Work Included: Materials, installation and testing of:
 1. Ductless Split Systems - Cooling Only

1.2 RELATED SECTIONS

A. Contents of Section 23 00 00, HVAC Basic Requirements and Division 1, General Requirements apply to this Section.

1.3 REFERENCES AND STANDARDS

- A. References and Standards as required by Section 23 00 00, HVAC Basic Requirements and Division 1, General Requirements.
- B. In addition, meet the following:
 - 1. AHRI 210/240 Performance Rating of Unitary Air-Conditioning and Air-Source Heat Pump Equipment.

1.4 SUBMITTALS

A. Submittals as required by Section 23 00 00, HVAC Basic Requirements and Division 1, General Requirements.

1.5 QUALITY ASSURANCE

- A. Quality assurance as required by Section 23 00 00, HVAC Basic Requirements and Division 1, General Requirements.
- B. In addition, meet the following:
 - 1. Efficiency ratings, cooling/heating performance, fan performance, sound performance to meet or exceed Basis of Design as scheduled on Drawings.

1.6 WARRANTY

- A. Warranty of materials and workmanship as required by Section 23 00 00, HVAC Basic Requirements and Division 1, General Requirements.
- B. In addition, provide:
 - 1. Refrigeration compressor(s): 5-year warranty.
 - 2. Furnace heat exchanger: 5-year warranty.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Ductless Split Systems:
 - 1. Mitsubishi
 - 2. Sanyo
 - 3. Daikin Applied
 - 4. LG
 - 5. Friedrich
 - 6. Fujitsu
 - 7. Or approved equivalent.

2.2 DUCTLESS SPLIT SYSTEMS - COOLING ONLY

- A. Description: Self-contained, matched factory-engineered and assembled. Pre-wired indoor and outdoor units. UL/ETL listed.
- B. Outdoor Unit:
 - 1. Self contained, consisting of cabinet, compressor system, condenser fan matched to indoor unit.
 - 2. Cabinet: Fabricated of galvanized steel, bonderized, and finished with powder coated baked enamel.
 - 3. Refrigerant System:
 - a. HFC refrigerant or other refrigerant with zero ozone depletion potential (ODP).
 - b. Compressor: To be inverter driven, hermetic rotary type.
 - 4. Air System:
 - a. Fan: Propeller Type with one direct drive, inverter driven, variable speed motor.
 - b. Motor: Premium efficiency with inherent protection, permanently lubricated bearings and variable speed drive compatible.
 - Coil: Copper tubes and aluminum fins, coated for corrosion protection.
 - 5. Controls: Single source for both indoor and outdoor units, with low/high pressure switch, capable of communicating to/from the building DDC control system.
- C. Indoor Unit(s):
 - 1. Self contained wall mounted, ceiling mounted, or recessed ceiling mounted evaporator unit(s) matched to outdoor unit.
 - 2. Cabinet:

C.

- a. Non-flammable, high impact polymer with a white finish.
- b. Power Source: To be a single point power connection or sub-fed from outdoor condensing unit.
- 3. Refrigeration System: HFC refrigerant or other refrigerant with zero ozone depletion potential (ODP).
- 4. Air System:
 - a. Fan: An assembly with one or two inline fan(s) with a single direct drive motor.
 - b. Filter: Polypropylene, furnished with the unit, removable and washable.
 - c. Coil: Direct expansion type with copper tubes mechanically bonded into aluminum fins.
- 5. Condensate Drain:
 - a. Provide drain pan sloped to drain away from unit. Drain pan with a single drain connection.
 - b. Condensate pump kit provided with unit.
 - c. Secondary drain pan; Condensate overflow shut-off float switch and external alarm.
- 6. Controls: Wired thermostat. Control to be integral with unit.

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION REQUIREMENTS

- A. Install with required clearances and access for maintenance.
- B. Install factory furnished devices for field installation.
- C. Inspect for and remove shipping bolts, blocks and tie-down straps.
- D. After energizing units: Test units for proper fan rotation. Test and adjust controls and internal safeties. Replace malfunctioning units and retest.
- E. Thoroughly clean exposed portions of equipment. Install new filters prior to final test and balance and again prior to final acceptance.

- F. Provide vibration isolation: As scheduled.
- G. Provide seismic restraint.
- H. Condensate drain per manufacturer's piping diagram.
- I. Condensate piped to indirect waste connection; cleanouts at changes of direction; sized and sloped to drain per Code. Secondary drain routed to visible location.
- J. Shut-off/hose kits for all hydronic connections.

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SECTION 26 00 00 - ELECTRICAL BASIC REQUIREMENTS

PART 1 - GENERAL

1.1 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 Authorized Representative, and other reviewing entity whose approval is required to obtain systems acceptance.

1.2 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

1.3 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. OZERCC Oregon Zero Energy Ready Commercial 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.
- 1.4 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 posted to ftp site. For electronic format, provide one file per division containing one bookmarked PDF file with each bookmark corresponding to each Specification Section. Arrange bookmarks in ascending order of Specification Section number. 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.

- a. Provide separate submittals for lighting control cutsheets, and for lighting control shop drawings.
- 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.
 - 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. Electric motors are supplied and installed by Division 23 unless otherwise specified. During shop drawing stage of the project, verify correct disconnect sizes, conductor sizes, etc., and bring any discrepancies to the attention of the Mechanical trade. Be responsible for any modifications to electrical equipment or installations as a result of equipment incompatibility discovered after shop drawing review.
- 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, Owner's Instructions:
 - a. Submit, at one time, electronic files (PDF format) 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.
 - 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 CAD Drawings and make one set of black-line drawings created from CAD Files in version/release equal to contract drawings. Submit CAD disk and drawings upon substantial completion.
- d. At completion of project, show changes and deviations from the Drawings in red on one set of black-line drawings. Include written Addendums, RFIs, and change order items. Make changes to Drawings in a neat, clean, and legible manner.
- e. See Division 26, Electrical individual Sections for additional items to include in record drawings.

1.5 QUALITY ASSURANCE

- A. Regulatory Requirements: Work and materials installed to conform with all local, State and Federal codes, and other applicable laws and regulations. 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.
- B. 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.
- C. 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.
- D. Manufacturer's Instructions: Follow manufacturer's written instructions. If in conflict with Contract Documents, obtain clarification. Notify Engineer/Architect, in writing, before starting work.
- E. Items shown on Drawings are not necessarily included in Specifications or vice versa. Confirm requirements in all Contract Documents.
- F. Provide products that are UL listed.

1.6 WARRANTY

- A. Provide written warranty covering the work for a period of one year from date of Substantial Completion in accordance with Division 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.

1.7 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

2.1 MANUFACTURERS

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

2.2 STANDARDS OF MATERIALS AND WORKMANSHIP

- 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 or ETL approved or are not listed for installation.
- B. Names and manufacturer's names denote character and quality of equipment desired and are not to be construed as limiting competition.
- C. Hazardous Materials:
 - 1. Comply with local, State of Oregon, and Federal regulations relating to hazardous materials.
 - 2. Comply with Division 00, Procurement and Contracting Requirements and Division 01, General Requirements for this project relating to hazardous materials.
 - 3. Do not use any materials containing a hazardous substance. If hazardous materials are encountered, do not disturb; immediately notify Owner and Architect. Hazardous materials will be removed by Owner under separate contract.

2.3 ACCESS PANELS

- A. See Division 01, General Requirements and Division 08, 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.

d.

- c. Provide screwdriver operated catch.
 - 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

3.1 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 crawlspaces 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 and Engineer 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:
 - 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.

3.2 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.

3.3 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 or Engineer, 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.

3.4 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.

3.5 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.

3.6 EQUIPMENT SELECTION AND SERVICEABILITY

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

3.7 DELIVERY, STORAGE AND HANDLING

- 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.

3.8 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 Authorized 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.
- D. Training and Demonstration per Section 01 91 13, General Commissioning Requirements and 26 08 00, Commissioning of Electrical.

3.9 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

4.

- 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.
 - 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. 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.
- I. 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

- 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.

3.17 SALVAGED EQUIPMENT AND RECYCLED MATERIAL

- A. Salvage the following equipment not being reused and return to Owner:
 - 1. Luminaires
 - 2. Panelboards
 - 3. Breakers
 - 4. Transformers

- B. Electrical equipment that cannot be salvaged for reuse, sell/give to recycling company. Recycle following excess, removed, or demolished electrical material:
 - 1. Copper or aluminum conductors, buses, and motor/transformer windings.
 - 2. Steel and aluminum from raceways, boxes, enclosures, and housings.
 - 3. Acrylic and glass from luminaire lenses/refractors.
- C. Provide separate on-site storage space for recycled and salvaged material. Clearly label space.
- D. Confirm additional salvaged equipment and recycled materials in the Contract Documents.

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SECTION 26 05 09 - EQUIPMENT WIRING

PART 1 - GENERAL

1.1 SUMMARY

- A. Work Included:
 1. Equipment connections, whether furnished by Owner or other Divisions of the Contract.
- 1.2 RELATED SECTIONS
 - A. Contents of Division 26, Electrical and Division 01, General Requirements apply to this Section.

1.3 REFERENCES AND STANDARDS

A. References and Standards as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.

1.4 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.

1.5 QUALITY ASSURANCE

A. Quality assurance as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements apply to this Section.

1.6 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

- 2.1 MATERIALS
 - A. Materials and Equipment for Equipment Wiring: As specified in individual Sections.

2.2 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 Less than 5 HP Loads: 480 volt, 3 phase.
 - 3. 5 HP and Over: 480 volt, 3 phase.

PART 3 - EXECUTION

- 3.1 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 8, Openings

- 2. Division 11, Equipment
- 3. Division 21, Fire Suppression
- 4. Division 22, Plumbing
- 5. Division 23, HVAC, Heating, Ventilating and Air Conditioning
- 6. Division 27, Communications
- 7. Division 28, Electronic Safety and Security

3.2 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. Door Hardware:
 - 1. Provide dedicated circuit from nearest 208/120V emergency panelboard for door hardware power supplies. Provide complete control connections for door hardware locking mechanisms to building security system.
 - 2. Provide control connection for door hardware locking mechanisms to building fire alarm system.
 - 3. Coordinate with Division 08, Openings and Drawing requirements.
- G. 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.

3.3 FIELD QUALITY CONTROL

A. Perform field inspection and testing in accordance with Division 01, General Requirements.

3.4 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 Authorized Representative.

SECTION 26 05 19 - LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 SUMMARY

- A. Work Included:
 - 1. Lugs and Pads
 - 2. Wires and Cables
 - 3. Connectors

1.2 RELATED SECTIONS

A. Contents of Division 26, Electrical and Division 01, General Requirements apply to this Section.

1.3 REFERENCES AND STANDARDS

A. References and Standards as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.

1.4 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.

1.5 QUALITY ASSURANCE

A. Quality assurance as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.

1.6 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

2.1 MANUFACTURERS

- A. Lugs and Pads:
 - 1. Anderson
 - 2. Ilsco
 - 3. Panduit
 - 4. Thomas & Betts
 - 5. 3M

Β.

- 6. Or approved equivalent.
- Wires and Cables:
 - 1. General:
 - a. General Cable
 - b. Okonite
 - c. Southwire
 - d. Encore Wire
 - e. Or approved equivalent.
 - 2. Metal Clad Cable Type MC:
 - a. Alflex
 - b. AFC
 - c. General Cable

- d. Southwire
- e. Encore Wire
- f. Or approved equivalent.
- C. Connectors:
 - 1. Anderson Power Products
 - 2. Burndy
 - 3. Ilsco
 - 4. 3M
 - 5. Thomas & Betts
 - 6. Or approved equivalent.
- 2.2 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.

2.3 WIRES AND CABLES

- A. Building Wires:
 - Copper: Soft-drawn with conductivity of not less than 98 percent IACS at 20 degrees C (68 degrees F). 600 volt rated throughout. Conductors 12 AWG and 10 AWG, solid. Conductors 8 AWG and larger, stranded. 12 AWG minimum conductor size. Minimum insulation rating of 90 degrees C. Insulation Type: THHN/THWN-2.
- B. Phase color to be consistent at feeder terminations; A-B-C, top to bottom, left to right, front to back.
- C. Color Code Conductors as Follows:

PHASE	208 VOLT WYE	240 VOLT DELTA	480 VOLT
A	Black	Black	Brown
В	Red	Orange (High Leg)	Orange
С	Blue	Blue	Yellow
Neutral	White	White	Gray or White w/colored strip
Ground	Green	Green	Green
Isolated Ground	Green w/yellow trace	N/A	N/A

D. MC Cable:

- 1. Standard: High strength galvanized steel flexible armor. Full length minimum size No. 12 copper ground wire, copper dual rated THHN/THWN-2, full length tape marker phase/circuit identification on cable armor. Short circuit throat insulators, mechanical compression termination.
- E. AC Cable (Armored Cable): Not allowed.
- F. NMB Cable: Not allowed.
- 2.4 CONNECTORS
 - A. Split bolt connectors not allowed.

B. 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

3.1 GENERAL INSTALLATION REQUIREMENTS

- A. Install per manufacturer instructions and NEC.
- B. Field Quality Control:
 - 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.

3.2 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.

3.3 WIRES AND CABLES

- A. General:
 - Do not install or handle thermoplastic insulated wire and cable in temperatures below -10 degrees C (14 degrees F). Do not handle thermoset insulated wire and cable in temperatures below -40 degrees C (-40 degrees F). All wire and cable must be acclimated to temperatures above freezing for no less than 24 hours prior to installation.
 - 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. Conductor Size and Quantity:
 - a. Install no conductors smaller than 12 AWG unless otherwise shown.
 - b. Provide required conductors for a fully operable system.
 - c. Power Circuits: No. 12 AWG minimum, except as follows:
 - 1) No. 10 AWG for 15A, 120V circuits longer than 100 ft.
 - 2) No. 8 AWG for 15A, 120V circuits longer than 150 ft.
 - 3) No. 10 AWG for 20A, 120V circuits longer than 70 ft.
 - 4) No. 8 AWG for 20A, 120V circuits longer than 100 ft.
 - d. When exact run lengths are determined for all branch circuits, and prior to installation of the conductors, ensure that the maximum voltage drop, based on 80 percent of the circuit protective device, does not exceed 3 percent. Increase wire size from #12AWG, if necessary, to ensure that the 3 percent voltage drop is not exceeded.
 - 7. Provide dedicated neutrals (one neutral conductor for each phase conductor) in all 120V circuits.

- B. Conductors in Cabinets:
 - 1. Cable and tree wires in panels and cabinets for power and control. Use plastic ties in panels and cabinets.
 - 2. Tie and bundle feeder conductors in wireways of panelboards.
 - 3. Hold conductors away from sharp metal edges.
- C. Homeruns:
 - 1. 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.
 - 2. MC cable homeruns are not allowed unless indicated on drawings.
- D. 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.
- E. Exposed cable is not allowed.
- F. All cable must be run parallel or perpendicular to building lines and hidden from view when possible. Where installed in tray each power cable is to be identified with Lamacoid nametag engraved with identification of equipment being fed. Tag to be fastened to cable using tie-wraps. Provide nametag at each floor level.
- G. Do not install PVC jacketed cables in return air plenums, unless they are specially rated plenum cables.
- H. 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.
 - 1. 15 and 20 amp branch wiring where following conditions apply:
 - a. Use MC cable for final flexible connections from junction or outlet boxes to recessed fixtures. Do not use MC cables to loop between fixtures, except where it is not practical to provide conduit connections between boxes or where existing inaccessible ceilings prevent installation of conduit runs. Each individual luminaire is to be serviced by an individual cable drop from the associated junction box in the ceiling space. Maximum length 6-feet of MC cable. Luminaire drops secured to, and supported by, the building structure with nylon tie wraps. The use of the ceiling suspension system for support of any type of cabling is not permitted.
 - b. MC cable may be routed in the void space above hard lid ceilings, and routed within wall cavities below glazing, provided NEC requirements are otherwise met, and a minimum one 0.75-inch conduit is routed from nearest accessible ceiling space to inaccessible location, terminating in a j-box with blank faceplate, for future circuits.

3.4 CONNECTORS

- A. Install to assure a solid and safe connection.
- B. Select hand twist connectors for wire size and install tightly on conductors.
- C. Install compression connectors using methods and tools recommended by the manufacturer.
- D. Do not install stranded conductors under screw terminals unless compression lugs are installed.
- E. Do not connect wiring without UL listed connectors that are listed for the purposes.

SECTION 26 05 26 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. Work Included:
 - 1. Connectors and Accessories
 - 2. Grounding Conductor

1.2 RELATED SECTIONS

A. Contents of Division 26, Electrical and Division 01, General Requirements apply to this Section.

1.3 REFERENCES AND STANDARDS

A. References and Standards as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.

1.4 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.

1.5 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.

1.6 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

2.1 MANUFACTURERS

- A. 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.
- B. Grounding Conductor
 - 1. General Cable
 - 2. Okonite
 - 3. Southwire
 - 4. Or approved equivalent

2.2 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.
- 2.3 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.

PART 3 - EXECUTION

- 3.1 GENERAL INSTALLATION REQUIREMENTS
 - A. Verify site conditions prior to beginning work.
 - B. Bond Sections of service equipment enclosure to service ground bus.
 - C. 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.
 - D. Inspect and test in accordance with NETA Standard ATS, Except Section 4.
 - E. Perform inspections and tests listed in NETA Standard AB, Section 7.13.
- 3.2 CONNECTORS AND ACCESSORIES INSTALLATION
 - A. Install per manufacturer's instructions.
- 3.3 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.

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SECTION 26 05 29 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

- A. Work Included:
 - 1. Anchors, Threaded Rod and Fasteners
 - 2. Support Channel, Hangers and Supports

1.2 RELATED SECTIONS

A. Contents of Division 26, Electrical and Division 01, General Requirements apply to this Section.

1.3 REFERENCES AND STANDARDS

A. References and Standards as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.

1.4 SUBMITTALS

A. Submittals not required for this Section.

1.5 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.

1.6 WARRANTY

A. Warranty of materials and workmanship as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.

1.7 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

2.1 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.

2.2 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.
 - 4. Concrete Surfaces: Use self-drilling anchors.
 - 5. Hollow Masonry, Plaster, and Gypsum Board Partitions: Use toggle bolts.
 - 6. Solid Masonry Walls: Use expansion anchors.
 - 7. Sheet Metal: Use sheet metal screws.
 - 8. Wood Elements: Use wood 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.
2.3 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.
 - 1. Channel Material: Carbon steel.
 - 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

3.1 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.

3.2 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.

3.3 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 rigid PVC conduits unless otherwise required by NEC is as follows:
 - 1. 1/2-inch or 3/4-inch and 1-inch conduit, 3-feet apart.
 - 2. 1-1/4-inch or 1-1/2-inch and 2-inch conduit, 4-feet apart.
 - 3. 2-1/2-inch and 3-inch conduit, 5-feet apart.
 - 4. 4-inch and 5-inch conduit, 6-feet apart.
 - 5. 6-inch conduit, 7-feet apart.
- O. 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.
- P. 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.
- Q. 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.
- R. 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.
- S. Provide seismic bracing per IBC requirements.
- T. Where service disconnects are mounted on building exterior, physically attach service disconnect to the building or structure served.
- U. Install surface-mounted cabinets and panelboards with minimum of four anchors.
- V. Use sheet metal channel to bridge studs above and below cabinets and panelboards recessed in hollow partitions.
- W. Wet and Damp Locations:
 - 1. In wet and damp locations use steel channel supports to stand cabinets and panelboards 1-inch off wall.

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SECTION 26 05 33 - RACEWAYS

PART 1 - GENERAL

1.1 SUMMARY

- A. Work Included:
 - 1. Electrical Metallic Tubing (EMT)
 - 2. Liquidtight Flexible Metal Conduit (LFMC)
 - 3. 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.

1.2 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
- 1.3 REFERENCES AND STANDARDS
 - A. References and Standards as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.

1.4 SUBMITTALS

- A. Submittals as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.
- 1.5 QUALITY ASSURANCE
 - A. Quality assurance as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.

1.6 WARRANTY

A. Warranty of materials and workmanship as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.

1.7 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

2.1 MANUFACTURERS

- A. Electrical Metallic Tubing (EMT):
 - 1. Allied Tube & Conduit
 - 2. Beck Manufacturing WL
 - 3. Picoma
 - 4. Wheatland Tube Company
 - 5. Or approved equivalent.
- B. Liquidtight Flexible Metal Conduit (LFMC):

- 1. AFC Cable Systems Inc.
- 2. Electri-Flex Company
- 3. International Metal Hose
- 4. Or approved equivalent.
- C. Conduit Fittings:
 - 1. Bushings:
 - a. Insulated Type for Threaded Raceway 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 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.
- 2.2 ELECTRICAL METALLIC TUBING (EMT)
 - A. Description: UL 797, ANSI C80.3; steel galvanized tubing.
 - B. Fittings: NEMA FB 1; steel, compression type.
- 2.3 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.
- 2.4 CONDUIT FITTINGS
 - A. Bushings:
 - 1. Insulated type for threaded raceway connectors without factory-installed plastic throat conductor protection.
 - 2. Insulated grounding type for threaded raceway connectors.
 - B. Raceway Connectors and 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

- 3.1 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.
 - 4. Minimum Size: 1-inch.
 - 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. Feeders: Polyester measure/pulling tape, Greenlee 4436 or approved.
 - 2. Branch Circuits and Low Voltage: Greenlee Poly Line 431 or approved.
 - 3. If fish tape is used for pulling line or low voltage wiring, fiberglass type to be used. Metal fish tapes will not be allowed.
 - 4. Secure pull string/tape at each end.
 - 5. Provide caps on ends of empty conduit to be used in future.
 - 6. Label both ends of empty conduits with location of opposite end.
 - F. Elbows: Use fiberglass or PVC coated RMC for underground installations.
 - G. Elbow for Low Energy Signal Systems: Use long radius factory ells where linking sections of raceway for installation of signal cable.
 - 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. Arrange conduit to maintain headroom and present neat appearance.
- Z. 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.
- AA. 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.
- AB. 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.
- AC. Install continuous conduit and raceways for electrical power wiring and signal systems wiring.
- AD. Route conduit installed above accessible ceilings parallel and perpendicular to walls.

- AE. Maintain adequate clearance between conduit and piping.
- AF. 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.
- AG. Cut conduit square using saw or pipecutter; deburr cut ends.
- AH. Bring conduit to shoulder of fittings; fasten securely.
- Al. Use conduit hubs to fasten conduit to cast boxes in damp and wet locations.
- AJ. 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.
- AK. Use hydraulic one shot bender to fabricate elbows for bends in metal conduit larger than 2-inch size.
- AL. Avoid moisture traps; provide junction box with drain fitting at low points in conduit system.
- AM. Provide suitable fittings to accommodate expansion and deflection where conduit crosses seismic, control, and expansion joints.
- AN. Conduit Terminations for Signal Systems: Provide a plastic bushing on the end of conduit used for signal system wiring.
- AO. Feeders: Do not combine or change feeder runs.
- AP. Install conduit to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Division 07, Thermal and Moisture Protection.
- AQ. 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.
- 3.2 ELECTRICAL METALLIC TUBING (EMT) INSTALLATION
 - A. Dry Locations:
 - 1. Concealed: EMT.
 - 2. Exposed: EMT.
 - B. Dry, Protected: EMT.

3.3 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.
- 3.4 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.
 - 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.

SECTION 26 05 34 - BOXES

PART 1 - GENERAL

1.1 SUMMARY

- A. Work Included:
 - 1. Outlet Boxes
 - 2. Floor Boxes
 - 3. Pull and Junction Boxes
 - 4. Box Extension Adapter
- 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.

1.2 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

1.3 REFERENCES AND STANDARDS

A. References and Standards as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.

1.4 SUBMITTALS

- A. Submittals as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.
- 1.5 QUALITY ASSURANCE
 - A. Quality assurance as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.
- 1.6 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

2.1 MANUFACTURERS

- A. Outlet Boxes:
 - 1. Hubbell
 - 2. Thomas & Betts
 - 3. Eaton/Crouse-Hinds
 - 4. Or approved equivalent.
- B. Floor Boxes:
 - 1. Legrand (Wiremold)
 - 2. FSR
 - 3. Hubbell
 - 4. Thomas & Betts
 - 5. MonoSystems
 - 6. Eaton/Crouse-Hinds
 - 7. Or approved equivalent.

- C. Pull and Junction Boxes:
 - 1. Eaton/Crouse-Hinds
 - 2. Hoffman
 - 3. Or approved equivalent.
- D. Box Extension Adapter:
 - 1. Hubbell
 - 2. Thomas & Betts
 - 3. Eaton/Crouse-Hinds
 - 4. Or approved equivalent.

2.2 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 for non-USB type devices. Installation of one or two devices at common locations, minimum 4-inches square, minimum 2-inches deep for USB type devices. 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. All surface mounted outlet boxes are to be drawn. Welded boxes are not acceptable.
- 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.
- 2.3 FLOOR BOXES
 - A. Floor Boxes: Refer to Drawings for floor box basis of design specifications.
- 2.4 PULL AND JUNCTION BOXES
 - A. Construction: Provide ANSI 61 gray polyester powder 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.

2.5 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.

PART 3 - EXECUTION

3.1 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 shown on Architectural Elevations.
- 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.
- 3.2 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, back splashes, 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.
- 3.3 FLOOR BOXES INSTALLATION
 - A. Use cast floor boxes for installations in slab on grade.
 - B. Use steel boxes matching fire-rating of floor slab for slab above grade.
 - C. Set floor boxes level.
 - D. Adjust floor boxes flush with finish flooring material.
 - E. Provide sufficient concrete cover around floor box to maintain fire rating of floor slab for slab above grade, and meet manufacturer installation directions for floor box on grade.
- 3.4 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.
- 3.5 BOX EXTENSION ADAPTER INSTALLATION
 - A. Match material to box.
 - B. Install gaskets at exterior and wet locations.

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SECTION 26 05 53 - IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. Work Included:
 - 1. Equipment Nameplates
 - 2. Device Labels
 - 3. Wire Markers

1.2 RELATED SECTIONS

A. Contents of Division 26, Electrical and Division 01, General Requirements apply to this Section.

1.3 REFERENCES AND STANDARDS

- A. References and Standards as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.
- 1.4 SUBMITTALS
 - A. Submittals not required for this Section.

1.5 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.

1.6 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

2.1 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.

2.2 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.
 - 2. Life Safety/Critical (Emergency Systems): Black letters on orange background.
 - 3. Equipment Branch (Legally Required Standby Systems): Black letters on yellow 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. Switchgear, switchboards, sub-distribution switchboards, distribution panels, and branch panels.
 - 2. Main breakers and distribution breakers in switchgear, switchboards, and 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.

2.3 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.

2.4 WIRE MARKERS

- A. Description: Vinyl-cloth self-adhesive type wire markers.
- B. Locations: Each conductor at panelboard gutters, pull boxes, outlet boxes, junction boxes, and each load connection.
- 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.

PART 3 - EXECUTION

- 3.1 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.

3.2 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. Switchgear, switchboards, and 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). 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.
 - 1. See Specification Section 26 05 19, Low-Voltage Electrical Power Conductors and Cables, for required conductor color code for this project.

3.3 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.

3.4 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.

SECTION 26 09 20 - LIGHTING RELAY CONTROL PANEL

PART 1 - GENERAL

1.1 SUMMARY

- A. Work Included:
 - 1. Materials and Components
- B. Extent of lighting control system work is indicated by Drawings and consists of extending and modifying the existing GE Low Voltage Relay Cabinet located on second floor. Exact existing specific system specifications are to be determined onsite by the Contractor. Any additional components required for modification of existing zoning to match new layout are to be supplied and installed by the Contractor. Contractor to provide a complete and operational system.
- 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.
- 1.2 RELATED SECTIONS
 - A. Contents of Division 26, Electrical and Division 01, General Requirements apply to this Section.
- 1.3 REFERENCES AND STANDARDS
 - A. References and Standards as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.

1.4 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.

1.5 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.
 - 2. International Energy Conservation Code (IECC) Compliance.
 - 3. Comply with applicable NEC 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.

1.6 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

2.1 MANUFACTURERS

A. GE lighting control panels

2.2 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.

PART 3 - EXECUTION

3.1 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.
- D. Emergency and Standby Circuits: Provide NC contacts for switching circuits on backup power, so that if the relay panel loses power, the circuits default to ON.

3.2 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.

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SECTION 26 09 23 - OCCUPANCY AND VACANCY SENSORS

PART 1 - GENERAL

1.1 SUMMARY

- A. Work Included:
 - 1. Occupancy/Vacancy Sensors (Ceiling Mounted)
 - 2. Combined Occupancy Sensor/Wall Switches ("Sensor/Switches")
 - 3. Automatic Switches

1.2 RELATED SECTIONS

A. Contents of Division 26, Electrical and Division 01, General Requirements apply to this Section.

1.3 REFERENCES AND STANDARDS

A. References and Standards as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.

1.4 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.

1.5 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.

1.6 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

2.1 MANUFACTURERS

- A. Occupancy/Vacancy Sensors (Ceiling Mounted):
 - 1. Passive Infrared Occupancy/Vacancy Sensors:
 - a. Acuity Controls
 - b. WattStopper
 - c. Leviton
 - d. Hubbell
 - e. Cooper/Greengate
 - f. Lutron
 - g. Steinel
 - h. Or approved equivalent.
 - 2. Ultrasonic Occupancy/Vacancy Sensors:

- a. WattStopper
- b. Leviton
- c. Hubbell
- d. Cooper/Greengate
- e. Acuity Controls
- f. Lutron
- g. Steinel
- h. Or approved equivalent.
- 3. Dual Technology Occupancy/Vacancy Sensors:
 - a. WattStopper
 - b. Leviton
 - c. Hubbell
 - d. Cooper/Greengate
 - e. Acuity Controls
 - f. Lutron
 - g. Steinel
 - h. Or approved equivalent.
- B. Combined Occupancy/Vacancy Sensor:
 - 1. Lutron
 - 2. Acuity Controls
 - 3. WattStopper
 - 4. Leviton
 - 5. Hubbell
 - 6. Cooper/Greengate
 - 7. Steinel
 - 8. Or approved equivalent.
- C. Automatic Switches:
 - 1. Acuity Controls
 - 2. WattStopper
 - 3. Leviton
 - 4. Hubbell
 - 5. Cooper/Greengate
 - 6. Lutron
 - 7. Steinel
 - 8. Or approved equivalent.
- D. Basis of Design: Occupancy/Vacancy sensor layout on Drawings are designed based on Steinel 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.
- 2.2 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.

2.3 OCCUPANCY/VACANCY SENSORS (CEILING 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.
 - 3. Sensor utilizes DIP switches for adjustment to time delay and override. Field adjustable settings for sensitivity.
 - 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. Provide internal form C dry contacts for HVAC control.
 - 8. Building Exterior Sensor:
 - a. Čapable of mounting on walls, eaves or ceilings.
 - b. On/off control based on daylight levels via adjustable light level setting.
 - c. Line Voltage: provide sensor to match voltage of lighting controlled; capable of switching up to 1000 watts ballast and incandescent load.
 - d. Adjustable time delay from 5 to 30 minutes.
 - e. Silicon gasketed to prevent water and dust intrusion. UL listed raintight.
 - f. Rated to operate in temperatures from -40 degrees F to 167 degrees F.
 - g. Coverage:
 - 1) 360 degree lens with maximum coverage 48 feet diameter from 8-foot height.
 - 2) 360 degree lens with maximum coverage 40 feet diameter from 20-foot height.
 - 3) 360 degree lens with maximum coverage 100 feet diameter from 40-foot height.
 - h. Finish: White.
- 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.
- 3. Sensor utilizes DIP switches for adjustment to time delay and override. Field adjustable settings for sensitivity.
- 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.
 - d. Provide internal form C dry contacts for HVAC control.
- 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. Provide internal form C dry contacts for HVAC control.
- 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.
 - d. Provide internal form C dry contacts for HVAC control.

2.4 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.
- H. Finish: White.
- 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. Dual Relay Sensor/Switch:
 - 1. Programmable to operate as an occupancy sensor (automatic-on and automatic-off) or a vacancy sensor (manual-on and automatic-off).
 - 2. Dual auto-off buttons on face of switch allow end-user to turn off two switch legs in room space. Built-in light adjustable level sensor only turns off second of two relays when desired footcandle level is present. Otherwise similar to specifications above for single-zone sensor/switch.
 - 3. Defaults to Manual-ON to 50 percent operation for maximum energy savings.
 - 4. 180 degree sensor range; coverage: 150 SF for desktop activity.
 - 5. Finish: White.
- L. Sensor/Slide Dimmer:
 - 1. Line voltage dimmer allows for 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.
- M. Passive Infrared Wall Switch Vacancy-Only Sensors:
 - 1. Operates only as a vacancy sensor (manual-on and automatic-off).
 - 2. Adjustable sensitivity (high, low presets).
- N. Dual Technology Wall Switch Vacancy-Only Sensors:
 - 1. Operates only as a vacancy sensor (manual-on and automatic-off).
 - 2. Adjustable sensitivity (high, medium, low, and off presets) individually for passive infrared and ultrasonic sensing.
- O. Passive Infrared Wall Dimmer Vacancy-Only Sensors:
 1. Operates only as a vacancy sensor (manual-on and automatic-off).
- P. Passive Infrared 0-10 V Wall Dimmer Vacancy-Only Sensors:
 1. Operates only as a vacancy sensor (manual-on and automatic-off).
- Q. Dual Technology 0-10V Wall Dimmer Vacancy Sensors:
 1. Operates only as a vacancy sensor (manual-on and automatic-off).

2.5 AUTOMATIC SWITCHES

- A. Automatic ("Shut-Off") Switch:
 - 1. Programmable to operate as an occupancy sensor (automatic-on and automatic-off) or a vacancy sensor (manual-on and automatic-off).
 - 2. Controls up to 1800 watts at 120-volt, 4100-watts at 277-volt, suitable for ballast and motor loads.
 - 3. Compatible with Decora style faceplate.
 - 4. Zero crossing circuitry.

- 5. Finish: Match wiring devices unless selected otherwise by Architect.
- 6. Capable of being connected with other sentry switches to produce 3 and 4 way switching.
- 7. Based on power interruptions of following durations from an upstream control panel, produces following effects:
 - a. 5 Seconds: Turns lighting off with no delay.
 - b. 3 Seconds: Turns lighting on with no delay.
 - c. 1 to 2 Seconds: Delayed off. Blinks lights and provides audible signal to room occupant. If switch push button is not pressed within 5 minutes, lights are turned off.
- B. Digital Timer Switch:
 - 1. Controls up to 1800 watts at 120 volt, 4100 watts at 277 volt, suitable for ballast and motor loads.
 - 2. Compatible with Decora style faceplate.
 - 3. Provide low voltage (24VAC/VDC) version where used as input to lighting relay panel; includes single-pole, double-throw isolated relay rated for 1A at 30VDC.
 - 4. Electroluminescent LCD display shows timer countdown.
 - 5. Time out setting range from 5 minutes to 12 hours. Lights can be turned off before time-out setting by holding down on/off button.
 - 6. Timer countdown can be reset to beginning by holding down push button for 2 seconds.
 - 7. Zero crossing circuitry.
 - 8. Finish: White.
 - 9. Room lighting flashed and switch beeps 5 minutes and 1 minute prior to switching room lighting off. Either visible or audible features can be disabled.

PART 3 - EXECUTION

3.1 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 noted below:
 - 1. Restrooms: 15 minutes.
 - 2. Storage Rooms, Janitor's Closets, Unisex Restrooms: 5 minutes.
 - 3. All Other Spaces: 15 minutes.
 - 4. Time Switches: 2-hours.
- F. Coordinate HVAC control requirements with controls contractor prior to installation.
- G. 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

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SECTION 26 09 24 - DAYLIGHTING CONTROLS

PART 1 - GENERAL

1.1 SUMMARY

- A. Work Included:1. Continuous Dimming Daylighting Controller
- 1.2 RELATED SECTIONS
 - A. Contents of Division 26, Electrical and Division 01, General Requirements apply to this Section.

1.3 REFERENCES AND STANDARDS

A. References and Standards per Division 01, General Requirements and Section 26 00 00, Electrical Basic Requirements.

1.4 SUBMITTALS

- A. Submittals as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.
- B. In addition, provide:
 - 1. Wiring diagrams indicating low voltage and line voltage wiring requirements.
 - 2. A layout of sensors indicating their sensing distribution on reproducible architectural floor plan.

1.5 QUALITY ASSURANCE

A. Quality assurance as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.

1.6 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. Daylighting controls that carry a factory warranty for a minimum 5-year duration.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Continuous Dimming Daylighting Controller:
 - 1. WattStopper
 - 2. Greengate
 - 3. Acuity Controls
 - 4. Steinel
 - 5. Or approved equivalent.
 - 6. Basis of Design: Daylighting sensor layout on Drawings are designed based on Steinel product line. Approved manufacturers listed below are allowed on condition of meeting specified conditions including complete sensor coverage of area controlled and switching of luminaires in area controlled. Provide additional sensors and power switch packs as needed to provide same level of functionality as shown on Drawings. Remove and replace electrical equipment installed not meeting these conditions at no cost to Owner.

2.2 CONTINUOUS DIMMING DAYLIGHT CONTROLLER

- A. Control dimming of interior lights in response to light level data, compatible with 0 to 10VDC dimming ballasts. Control system to be open loop, to provide three output control zones consisting of a 0 to 10VDC signals compatible with fluorescent dimmable ballasts. Control system to include three relay outputs capable of switching each of three output zones off after an adjustable time delay when a given channel is fully dimmed.
- B. Control module to include following characteristics:
 - 1. Seven individually adjustable parameters for each channel:
 - a. Setpoint: 5 to 60 footcandles;
 - b. Minimum Output: 0 to 4 volts DC;
 - c. Maximum Output: 6 to 10 volts DC;
 - d. Ramp Rate: 5 to 60 seconds;
 - e. Fade Rate: 5 to 60 seconds;
 - f. Cutoff Time Delay: 0 to 20 minutes or disabled;
 - g. Load Shed Limit: 0 to 10 volts DC.
 - 2. Compatible with 0 to 10VDC dimming ballasts.
 - 3. Suitable for panel mounting on DIN rail.
 - 4. When daylighting is adequate for a channel to fully dim; lights switch off after an adjustable time delay via relay pack connected to controller. This feature can also be disabled if lights must remain when fully dimmed.
 - 5. LCD display with menu-driven, pushbutton programming without special tools or accessories; automatic internal calculation for dimming requirements of individual channels for simplified setup.
 - 6. Operates from either 120VAC or 277VAC power source.
 - 7. Automatic Off Control.
- C. Utilize low voltage photosensor to continuously measure light levels. Photosensor range is 30 to 6000 footcandles. Adjustments and calibrations capable of being made at control module, not at remote photosensor.
- PART 3 EXECUTION
- 3.1 GENERAL INSTALLATION REQUIREMENTS
 - A. Install photocells as directed by manufacturer's instructions. Complete connections to control circuits, photocells, control modules, power supply pack and low voltage wiring.
 - B. Photocell placement and wiring:
 - 1. Drawings are schematic, and show photocell quantities together with the daylighting zones that they control.
 - 2. Reference manufacturer installation instructions for the recommended location and orientation of photocell with respect to exterior glazing and both interior and exterior lighting.
 - 3. Reposition sensor at no additional cost to Owner to avoid conflict between sensor and object obscuring its view, and between sensor and both interior and exterior lighting that causes daylighting controls to repeatedly increase and decrease in brightness (i.e. "cycling").
 - 4. Field wire photocell for correct footcandle range (i.e., WattStopper LS-290C photocell has three jumper selectable footcandle ranges: 3 to 300 fc, 30 to 3000 fc, 60 to 6000 fc).
- 3.2 LIGHTING SYSTEM CALIBRATION, DEMONSTRATION, TRAINING, TESTING AND COMMISSIONING
 - A. Prior to adjusting and calibrating daylighting control system and local photocell field adjustable settings, contact local manufacturer representative and arrange for representative to visit site to

educate both field installer and Owner's Authorized Representative on the operation of the controls.

- B. Use manufacturer's published testing and adjusting procedures to adjust sensors and daylight sensitivity to the satisfaction of Owner.
- C. Daylight Dimming Zone Calibration:
 - 1. After all furniture is installed, all daylighting zones are to be field calibrated using a digital photometer. Adjust photocell and control system parameters to maintain an even light level at the work plane.
 - 2. Single and dual daylighting zones are to be adjusted to maintain an even light level at the work plane throughout connected zones and adjoined areas.
- D. Daylight Dimming Zone Lighting Level Setpoints:

Area	Setpoint (Average Footcandles)
Atrium	50 FC
Open Offices	30 FC
Private Offices	40 FC
Conference Rooms	30 FC
Corridors	5 FC
Lobby	10 FC
Classrooms	30 FC
Gymnasiums	50 FC
Kitchen	50 FC
Labs	50 FC
Library	30 FC
Museum Display Areas	30 FC
General Warehouse/Storage	10 FC

- E. Prepare and complete report of test procedures and results including the final daylighting level setpoints as set while using a digital photometer. Submit these test procedures and results to Engineer and Commissioning Authority.
- F. 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 Commissioning Authority and insert approved copy into project closeout documents.
- G. Testing Includes:
 - 1. Daylight Automatic Controls
 - 2. Occupant Sensing Automatic Controls
 - 3. Automatic Time and Override Controls for Interior Lighting
 - 4. Automatic Time and Photo Controls for Exterior Lighting
- H. Training: Provide minimum 2-hour training session to Owner's Authorized Representatives at a time approved by Owner after Owner has received approved operation and maintenance manuals. Training to include discussion of operation, adjustment, and replacement of sensors, photocells and control.

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SECTION 26 27 26 - WIRING DEVICES

PART 1 - GENERAL

1.1 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

1.2 RELATED SECTIONS

- A. Contents of Division 26, Electrical and Division 01, General Requirements apply to this Section.
- 1.3 REFERENCES AND STANDARDS
 - A. References and Standards as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.
- 1.4 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
 - 2. Receptacles
 - 3. Wall Plates
 - 4. Dimmers
 - 5. In-Use Cover
- 1.5 QUALITY ASSURANCE
 - A. Quality assurance as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.

1.6 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

1.

2.1 MANUFACTURERS

- A. Wall Switches:
 - Toggle Type Characteristics:
 - a. Cooper AH1201
 - b. Hubbell HBL1221
 - c. Leviton 1221
 - d. Legrand P&S PS20AC1
 - e. Or approved equivalent.
- B. Receptacles:
 - 1. Industrial Grade:
 - a. Cooper 5362
 - b. Hubbell HBL5362
 - c. Bryant BRY5362

- d. Leviton 5362
- e. Legrand P&S 5362A
- f. Or approved equivalent.
- 2. Commercial Grade:
 - a. 20 Amp:
 - 1) Cooper 5362
 - 2) Hubbell 5362
 - 3) Bryant CBRS20
 - 4) Leviton 5362S
 - 5) Legrand P&S 5362
 - 6) Or approved equivalent.
- 3. Ground Fault Circuit Interrupter (GFCI) Receptacle 20 Amp:
 - a. Cooper WRSGF20W
 - b. Hubbell GFR5362SGW
 - 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:

2.

- 1. Aluminum with Gasket, Blanks, Single Gang:
 - a. Bell 240-ALF
 - b. Carlon
 - c. Or approved equivalent.
 - 2-Gang:

a.

- a. Bell 236-ALF
- b. Carlon
- c. Or approved equivalent.
- 3. While-in-Use Weatherproof Cover:
 - Die Cast Cover:
 - 1) Intermatic
 - 2) Hubbell
 - 3) Cooper
 - 4) Or approved equivalent.
- F. Provide lighting switches and receptacles of common manufacturer and appearance.

2.2 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: Gray.
- 2.3 RECEPTACLES
 - A. Duplex Receptacles Characteristics: Straight parallel blade, 125 volt, 2 pole, 3 wire grounding.

- 1. Commercial Grade: Riveted. Back and side wired. Brass ground contact on steel strap. Nylon face and nylon base. 20 amp.
- B. Ground Fault Circuit Interrupter (GFCI) Receptacle: Feed through type, back-and-side wired, tamper-resistant, weather resistant self-testing, 20 amp, 125VAC.
- C. Special Purpose Receptacles: Reference Drawings for NEMA Standard Specification.
- D. Finish:
 - 1. Same exposed finish as switches.
 - 2. Receptacles installed in surface raceway to match raceway finish. See Section 26 05 33, Raceways.
 - 3. All automatically controlled, nonlocking type, 125 volt, 15 amp and 20 amp rated receptacles to be permanently marked by the manufacturer with the "universal power" symbol and the word "controlled."

2.4 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.

2.5 WALL DIMMERS

- 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.

2.6 SURFACE COVERS

- A. Material: Galvanized steel, drawn, 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

3.1 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.
- 3.2 WALL SWITCHES INSTALLATION
 - A. At time of substantial completion, replace those items which have been damaged.
- 3.3 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. In the following outlet locations, regardless of whether shown as GFCI on Drawings, either provide a GFCI duplex receptacle, or use a GFCI breaker where code would require a GFCI outlet to have a remote test switch:
 - 1. Bathrooms.
 - 2. Where receptacles are installed within 6-feet, 0-inches from edge of sinks.
 - 3. Kitchens above counters.
 - 4. On rooftops.
 - 5. Outdoors.
 - 6. Where serving vending machines.
 - 7. Where serving electric drinking fountains.
 - C. GFCI Receptacles: One GFCI receptacle may not be used to provide GFCI protection to downstream duplex receptacles on the same branch circuit.
- 3.4 FINISH PLATES INSTALLATION
 - A. Do not install items until finish painting is complete. Replace scratched and paint splattered finish plates and wiring devices.
- 3.5 WALL DIMMERS INSTALLATION
 - A. Install per manufacturer's recommendations and wiring diagrams.
- 3.6 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 28 00 - OVERCURRENT PROTECTIVE DEVICES

PART 1 - GENERAL

1.1 SUMMARY

A. Work Included:

- 1. Fuses
- 2. Molded Case Circuit Breakers
- 3. Fuse Cabinets

1.2 RELATED SECTIONS

A. Contents of Division 26, Electrical and Division 01, General Requirements apply to this Section.

1.3 REFERENCES AND STANDARDS

A. References and Standards as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.

1.4 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.

1.5 QUALITY ASSURANCE

A. Quality assurance as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements apply to this Section.

1.6 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

2.1 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. ABB/General Electric
 - 3. Siemens
 - 4. Schneider Electric/Square D
 - 5. Or approved equivalent.
- C. Fuse Cabinet:
 - 1. Bussmann
 - 2. Circle AW

- 3. Ferraz-Shawmut
- 4. Littelfuse
- 5. Siemens
- 6. Schneider Electric/Square D
- 7. Or approved equivalent.

2.2 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.

2.3 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.
- F. Greater than 401 Amp: Electronic trip type with adjustments for long-time, instantaneous, and short-time functions.
- G. Circuit breakers 1200 Amp and Greater: Provide breaker with energy-reducing maintenance switching with local status indicator per NEC Article 240.87(B).
- H. Provide ground fault function for breakers greater than 800 amps where applied at 480 volts line-to-line; and where indicated on drawings.

2.4 FUSE CABINET

- A. Enclosure:
 - 1. Metallic cabinet surface mounted, with internal shelves, trim cover with hinged and latched door.
 - 2. Size cabinet such that spare fuses required by these Documents do not exceed 50 percent of cabinet volume.
- B. Label: Provide engraved label to identify as spare fuse cabinet.

PART 3 - EXECUTION

- 3.1 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.

3.2 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.
- 3.3 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.
- 3.4 FUSE CABINETS
 - A. Install fuse cabinet on wall in the Electrical Room in coordination with electrical equipment.

END OF SECTION

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SECTION 26 51 00 - LIGHTING

PART 1 - GENERAL

1.1 SUMMARY

- A. Work Included:
 - 1. Luminaires
 - 2. LED Drivers
 - 3. Lamps
- B. Provide wiring for complete and operating lighting system.

1.2 RELATED SECTIONS

A. Contents of Division 26, Electrical and Division 01, General Requirements apply to this Section.

1.3 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.

1.4 SUBMITTALS

- A. Submittals as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.
- B. In addition, provide:
 - 1. Submit product data for:
 - 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

1.5 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).

1.6 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

2.1 MANUFACTURERS

- A. Luminaires:
 - 1. Reference description and manufacturers in Luminaire Schedule on Drawings.
 - 2. Or approved equivalent.
- B. LED Drivers:

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- 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.
- 2.2 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.
 - 3. Standards: ANSI C78.377, LM-79 and LM-82 compliant for performance characteristics, photometry, colorimetry, efficacy and thermal characteristics.
 - 4. LM-80 + TM-21: Testing and measurement, and statistical prediction of LED lamp life. Report provided by DOE certified independent testing laboratory.
 - 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).
 - 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.

2.3 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.
 - a. Base specification: NEMA 410 standard for inrush current for electronic drivers.
 - 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 10 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 luminaire 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:
 - a. Meet IEC 60929 Annex E for General White Lighting LED 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.

2.4 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.

PART 3 - EXECUTION

3.1 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 or MC Cable as allowed by Section 26 05 19 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:
 - 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.

3.2 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 circuit for battery charging and autotransfer circuiting for exit signs and luminaires with integral batteries. Where test switch cannot be integral to luminaire, mount remote test switch flush-to-ceiling and adjacent to egress luminaire.
- 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.

3.3 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.

END OF SECTION

SECTION 27 00 00 - COMMUNICATIONS BASIC REQUIREMENTS

PART 1 - GENERAL

1.1 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 Authorized 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. Main Point of Entry (MPOE): Area or location where service providers terminate and handoff to customer owned premise cabling system.
 - 10. Main Telecommunications Room (MTR): Location that services as the main distribution point for client/Owner telecommunications system. The MTR connects to each TR and the MPOE. MTR should not be accessible by the service providers. In most cases the MTR is a private space.
 - 11. 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.
 - 12. 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.

- 13. 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.
- 14. Interbuilding Cable: Backbone cable associated with connecting buildings together in a multibuilding or campus environment.
- 15. 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.

1.2 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
- C. Related Products/Systems within Division 28, Electronic Safety and Security:
 1. Section 28 10 00, Access Control and Intrusion Detection

1.3 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, 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. OZERCC Oregon Zero Energy Ready Commercial Code
 - h. ORSC Oregon Residential Specialty Code
 - i. 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-526-7-A Measurement of Optical Power Loss of Installed Single-Mode Fiber Cable Plant
 - b. ANSI/TIA-526-14-C Optical Power Loss of Installed Multimode Fiber Cable Plant
 - c. ANSI/TIA-568.0-E Generic Telecommunications Cabling for Customer Premises

- d. ANSI/TIA-568.1-E Commercial Building Telecommunications Infrastructure Standard
- e. ANSI/TIA-568.2-D Balanced Twisted-Pair Telecommunications Cabling and Components Standard
- f. ANSI/TIA-568.2-D-2 Balanced Twisted-Pair Telecommunications Cabling and Components Standard Addendum 2
- g. ANSI/TIA-568.3-D Optical Fiber Cabling Components Standard. Commercial Building Telecommunicating Cabling Standard
- h. ANSI/TIA-568.3-D-1- Optical Fiber Cabling Components Standard.
- i. ANSI/TIA-568.4-D Broadband Coaxial Cabling and Components
- j. ANSI/TIA-569-E Commercial Building Standard for Telecommunications Pathways and Spaces
- k. ANSI/TIA-570-D Residential Telecommunications Infrastructure Standard
- I. ANSI/IA-598-D Optical Fiber Cable Color Coding
- m. ANSI/TIA-598-D-1 Optical Fiber Color Coding in Cable Addendum 1, additional Colors for Elements 3-16
- n. ANSI/TIA-598-D-2 Optical Fiber Cable Color Coding Addendum 2, Jacket Color for OM5 Indoor Fiber Cables
- o. ANSI/TIA-606-C Administration Standard for Commercial Telecommunications Infrastructure
- p. ANSI/TIA-J-STD-607-D Generic Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications
- q. ANSI/TIA-942 Telecommunications Infrastructure Standard for Data Centers
- 4. APWA American Public Works Association
- 5. ASCE American Society of Civil Engineers
- 6. ASHRAE Guideline 0, the Commissioning Process
- 7. ASIS INTL American Society for Industrial Security International
- 8. ASTM ASTM International
- 9. AVIXA Producer of InfoComm and international trade organization representing the audiovisual industry
- 10. BICSI Building Industry Consulting Service International
 - a. BICSI TDMM Telecommunications Distribution Methods Manual, 14th Edition
 - b. BICSI ESSDRM Electronic Safety & Security Design Reference Manual
 - c. BICSI OSPDRM Outside Plant Design Reference Manual, 6th Edition
- 11. CFR Code of Federal Regulations
- 12. EPA Environmental Protection Agency
- 13. ETL Electrical Testing Laboratories
- 14. FCC Federal Communications Division
- 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. NEC National Electric Code
- 20. NEMA National Electrical Manufacturers Association
- 21. OSHA Occupational Safety and Health Administration
- 22. TIA Telecommunications Industry Association
- 23. UL Underwriters Laboratories Inc.
- 1.4 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. In addition:

- "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 posted to ftp site. For electronic format, provide one file per division containing one bookmarked PDF file with each bookmark corresponding to each Specification Section. Arrange bookmarks in ascending order of Specification Section number. Individual submittals sent piecemeal in a per Specification Section method will be returned without review or comment. Copy Architect on all transmissions/submissions.
- 3. Product Data: Provide manufacturer's descriptive literature for products specified in Division 27, Communications 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. Provide a red rectangle around part number and description with corresponding red arrow pointing to the item/material being submitted.
 - 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.
 - c. See Division 27, Communications 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 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 7-16 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 27, Communications Coordination Documents. For equipment with electrical connections, furnish copy of approved submittal for inclusion in Division 26, Electrical submittals.
- 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 27, Communications specification Sections for additional requirements for Shop Drawings outside of these requirements.
 - 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. 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.
 - b. Resubmit for review until review indicates no exception taken, or "make corrections as noted."
 - c. 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, Owner's Instructions:
 - a. Submit, at one time, electronic files (PDF format) 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.
 - 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: batteries, lamp lenses, speakers and filters.
 - Include Warranty per Division 00, Procurement and Contracting Requirements and Division 01, General Requirements, Section 27 00 00, Communications 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 subassemblies.
- 6) Include copy of burn-in and test reports specific to each piece of equipment.
- 7) Include copy of software/appliance programming.
- 8) Include commissioning reports.
- 9) 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. Submit copy of material used for Owner instruction. Field instruction per Section 27 00 00, Communications 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 conduit, and location of concealed communication items. Include items changed by field orders, supplemental instructions, and constructed conditions.
 - b. Record Drawings are to include equipment and connection schedules that accurately reflect "as constructed or installed" for project.
 - c. At completion of project, input changes to original project on CAD Drawings and make one set of black-line Drawings created from CAD Files in version/release equal to Contract Drawings. Submit CAD disk and Drawings upon substantial completion.
 - d. At completion of project, show changes and deviations from the Drawings in red on one set of black-line drawings. Include written Addendums, RFIs, and change order items. Make changes to Drawings in a neat, clean, and legible manner.
 - e. Invert elevations and dimensioned locations for incoming utilities and site raceways below grade extending to 5-feet outside building line.
 - f. See Division 27, Communications individual Sections for additional items to include in Record Drawings.

1.5 QUALITY ASSURANCE

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

- D. Manufacturer's Instructions: Follow manufacturer's written instructions. If in conflict with Contract Documents, obtain clarification. Notify Engineer/Architect, in writing, before starting work.
- E. Items shown on Drawings are not necessarily included in Specifications or vice versa. Confirm requirements in all Contract Documents.
- F. Provide products that are UL listed.
- G. 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. Be able to provide project references for 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.

1.6 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.

1.7 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

2.1 MANUFACTURERS

A. Articles, fixtures, and equipment of a kind to be standard product of one manufacturer, including but not limited to jacks, patch panels, equipment connection cords and wall plates.

2.2 STANDARDS OF MATERIALS AND WORKMANSHIP

- 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/fixture not UL or ETL approved or not listed for installation.
- B. Names and manufacturer's names denote character and quality of equipment desired and are not to be construed as limiting competition.
- C. Hazardous Materials:
 - 1. Comply with local, State of Oregon, and Federal regulations relating to hazardous materials.
 - 2. Comply with Division 00, Procurement and Contracting Requirements and Division 01, General Requirements for this project relating to hazardous materials.
 - 3. Do not use any materials containing a hazardous substance. If hazardous materials are encountered, do not disturb; immediately notify Owner and Architect. Hazardous materials will be removed by Owner under separate contract.

2.3 ACCESS PANELS

- A. See Division 01, General Requirements and Division 08, Openings for products and installation requirements.
- B. Confirm Access Panel requirements in Division 01, General Requirements and 08. In absence of specific requirements, comply with individual Division 27, Communications Sections and the following:
 - 1. Provide flush mounting access panels for service of systems, equipment 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 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) Manufacturers: Karp, Milcor, Elmdor, Acudor, or approved equivalent.

PART 3 - EXECUTION

3.1 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 and Engineer 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.
- 3.2 SEISMIC CONTROL
 - A. Confirm Seismic Control requirements in Division 01, General Requirements, Structural documents, and individual Division 27 Communications Sections.
 - B. General:
 - 1. 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.
 - 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 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.
 - 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.
 - 5. Provide means to prohibit excessive motion of communications equipment during earthquake.

3.3 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 and Engineer, 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.

3.4 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 27. Communications Sections and the following:
 - 1. During remodeling or addition to existing structures, or addition of a structure to existing structure, 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 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. If overtime is necessary, there will be no allowance made by Owner for extra expense for such overtime or shift work.
 - 4. Organize work to minimize duration of power interruption.

3.5 CUTTING AND PATCHING

- A. Confirm Cutting and Patching Requirements in Division 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.

3.6 EQUIPMENT SELECTION AND SERVICEABILITY

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

3.7 DELIVERY, STORAGE AND HANDLING

- 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.

3.8 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 Authorized 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.
- D. Training and Demonstration per Section 01 91 13, General Commissioning Requirements.

3.9 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.

3.10 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.

3.11 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. Fire rated plywood backboards to receive two coats of fire retardant paint on all six sides; color to be white.
 - 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 handholes, maintenance holes, vaults, pullboxes and the like will be furnished with finishes which resist corrosion and rust. Covers shall be identified with 'Communications'. It is the contractor's responsibility to proactively seek and obtain approval with Owner prior to purchasing and prior to installation for terms of satisfaction.

3.12 ACCESS PANELS

- A. Confirm Access Panel requirements in Division 01, General Requirements. In absence of specific requirements, comply with individual Division 27, Communications 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 27, Communications Sections and the following:
 - 1. Scope:
 - a. It is the intent of these documents to provide necessary information and adjustments to communications systems 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 raceways behind finished surfaces (floor, walls, ceilings, etc.). Cap raceways and patch surfaces to match surrounding finish.

- 4. Unless specifically indicated on Drawings, remove unused equipment, electrical boxes, fittings and connectors. Removal is to be to a point behind finished surfaces (floors, walls, and ceilings).
- 5. 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 communications outlets, racks, panels, etc. in field.
 - d. Report discrepancies to Architect before disturbing existing installation.
- 6. Promptly notify Owner if utilities are found which are not shown on Drawings.
- 7. Execution:
 - a. Remove existing connectors, backboxes, wall plates and other communications 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 communications continuity of existing systems during construction. Remove or relocate communications boxes, conduit, wiring, equipment, and the like, as encountered in removed or remodeled areas in existing construction affected by this work. In no event shall existing systems that are to remain operational, be diminished in any capacity by the demolition efforts.
 - c. Remove and restore cable 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 communications equipment which is being retained, provide new conduit and cable to bypass abandoned outlets.
 - e. If existing conduits pass through partitions or ceiling which are being removed or remodeled, provide new conduit and cable to reroute clear of construction or demolition and maintain service to existing equipment. If these are conduits which require a new cable home run, e.g. telecom cable, request clarification from Architect or Engineer prior to proceeding with demo.
 - f. Extend cable slack and devices in existing walls to be furred out.
 - g. Remove abandoned cable to point of origin, and servicing locations such as the serving telecommunications room or any other room or space.
 - 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. Maintain access to existing communications installations which remain active. Modify installation or provide access panel as appropriate.
 - I. Existing communications outlets and devices are indicated on technology demolition plans. Verify exact location and number of existing communications outlets and devices in field. Only partial existing communications shown. Locations of items shown on Drawings as existing are partially based on Record and other Drawings which may contain errors. Verify accuracy of information shown prior to bidding and provide such labor and material as is necessary to accomplish intent of Contract Documents.

- m. Remove abandoned cable to leave site clean.
- B. Existing Communication Systems: Maintain existing systems in service until new system is complete and ready for service.
 - 1. Make temporary connections to maintain service in areas adjacent to work area.

3.14 ACCEPTANCE

- 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, as outlined in their respective Division sections
 - b. Cleaning
 - c. Operation and Maintenance Manuals
 - d. Training of Operating Personnel
 - e. Record Drawings, including cabling identifications, symbols, and locations
 - f. Warranty and Guaranty Certificates, including extended manufacturer's warranties
 - g. Start-up/test Documents and Commissioning Reports

3.15 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. All cabling test results shall be included.
 - 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 Communications items were installed in accordance with manufacturer's recommendations, and UL listings and approvals. Include Letter of Conformance, copies of manufacturers' warranties and extended warranties in Operation and Maintenance Manuals.

END OF SECTION

SECTION 27 05 28 - PATHWAYS FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. Work Included:
 - 1. Raceway
 - 2. Electrical Metallic Tubing and Fittings
 - 3. Conduit Accessories
 - 4. Penetration Sealing Systems
 - 5. Telecommunications Outlet Boxes
 - 6. Pull Boxes
 - 7. J-Hooks
- B. This Section specifies the requirements to provide communications conduit raceways, boxes, cable trays, innerduct and fittings.

1.2 RELATED SECTIONS

- A. Contents of Division 27, Communications and Division 01, General Requirements apply to this Section.
- 1.3 REFERENCES AND STANDARDS
 - A. References and Standards as required by Section 27 00 00, Communications Basic Requirements and Division 01, General Requirements.

1.4 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.
- 1.5 QUALITY ASSURANCE
 - A. Quality assurance as required by Section 27 00 00, Communications Basic Requirements and Division 01, General Requirements.

1.6 WARRANTY

- A. Warranty of materials and workmanship as required by Section 27 00 00, Communications Basic Requirements and Division 01, General Requirements.
- 1.7 DEFINITIONS
 - A. Cabinet: A freestanding floor-mounted modular enclosure designed to house and protect rackmounted 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

2.1 MANUFACTURERS

A. Raceway:

1.

2.

4.

- 1. Koppers Bitumastic
- 2. Scotchwrap
- 3. Or approved equivalent.
- B. Electrical Metallic Tubing and Fittings:
 - 1. Allied Tube and Conduit
 - 2. Wheatland Tube
 - 3. Appleton
 - 4. Or approved equivalent.
- C. Conduit Accessories:
 - Duct Spacers:
 - a. Carlon
 - b. Allied Tube and Conduit
 - c. Or approved equivalent.
 - Expansion/Deflection Fittings:
 - a. Appleton
 - b. Emerson
 - c. Or approved equivalent.
 - 3. Pulltape:
 - a. George-Ingraham
 - b. Greenlee
 - c. Or approved equivalent.
 - Duct Plugs:
 - a. Carlon
 - b. Vikimatic
 - c. Or approved equivalent.
- D. Penetration Sealing Systems:
 - 1. SEMCO
 - 2. Or approved equivalent.
- E. Telecommunications Outlet Boxes:
 - 1. Raco
 - 2. Or approved equivalent.
- F. Pull Boxes:
 - 1. Hoffman
 - 2. Oldcastle (concrete)
 - 3. Or approved equivalent.
- G. J-Hooks:

- 1. Erico
- 2. Or approved equivalent.

2.2 RACEWAYS

- A. Raceways: Labeled and/or listed as acceptable to the AHJ as suitable for the use intended.
- B. Table 1: Product Identification:

Product Designation	Product Type
RGS	Rigid Galvanized Steel
CRS	PVC Externally Coated RGS
EMT	Galvanized Steel Tubing
PVC	Polyvinylchloride Conduit
LMC	Liquidtight Metal Conduit
LNC	Liquidtight Nonmetal Conduit

- 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.
- 2.3 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.

2.4 CONDUIT ACCESSORIES

- A. Duct Spacers:
 - 1. Nonmetallic base and intermediate duct spacers with locking keyways designed specifically for use with nonmetallic conduit; e.g., Carlon SNAP-LOC duct spacers for 4-inch diameter conduit with 1-1/2-inch separation.
 - 2. Base Spacer: S288NHN.
 - 3. Intermediate Spacer: S289NHN.
- B. Expansion/Deflection Fittings: Similar to Crouse-Hinds XD expansion/deflection coupling or Appleton DF Series deflection and expansion coupling.
- C. 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.
- D. Duct Plugs:
 - 1. Aboveground Conduit Openings: Tapered PVC plugs with tab for pulltape; e.g., Carlon 4inch 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.

2.5 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.

2.6 TELECOMMUNICATIONS OUTLET BOXES

- A. Sheet Metal Outlet Boxes: Minimum 4-inch square by 2-1/8-inch deep, galvanized steel for use with single- or double-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- or double-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- or double-gang cover.
- D. Cast Boxes: 4-inch square by 2-1/8-inch deep cast Feralloy, gasketed single- or double-gang cover, threaded hubs. For hazardous locations, provide boxes approved for applicable atmosphere classification.
- 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.
- F. Plaster Rings: Single- or Double-gang as shown on the Drawings.

2.7 PULL BOXES

- A. Construction: NEMA Standard No. 250. Type 1 galvanized steel enclosures designed for use as junction boxes and pull boxes with flat screw-applied covers, with or without knockouts and gray enamel finish.
- 2.8 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

3.1 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 2feet 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 4inches 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.

3.2 RACEWAYS

- A. Reference 3.01, General Installation Requirements.
- B. Install per manufacturer's written instructions and recommendations.
- C. Raceway Identification Banding:
 - 1. Degrease and clean surfaces to receive tape labels.
 - 2. Exposed conduits and wireway, including raceways above lay-in or accessible ceilings, together with associated pull boxes to be banded at intervals of not over 10-feet and at direction changes. Two-band identification to be different contrasting colors as follows:

Raceway Use	Color
Grounding	Green
Telecom/datacom	Yellow

CCTV	White
Building monitoring and security	Grey

3.3 ELECTRICAL METALLIC TUBING AND FITTINGS

- A. Reference 3.01, General Installation Requirements.
- B. Install per manufacturer's written instructions and recommendations.
- C. Minimum Conduit Size: Size recessed conduits to surface raceway serving multiple data outlets as follows. Sizing is based on TIA/EIA 569-B for 28 percent conduit fill, assuming Category 5e cables (nominal outer diameter 0.24-inch) to each data outlet. Provide recessed backbox between surface raceway and recessed conduit sized for conduit.

1 to 6 cables	1-inch conduit
7 to 10 cables	1-1/4-inch conduit
11 to 15 cables	1-1/2-inch conduit
16 to 20 cables	2-inch conduit
Above 20 cables	Use multiple runs of conduit from surface
	raceway based on above table

- D. Minimum Backbone Conduit Requirements: Install three 4-inch conduits from MER to each TR, unless otherwise noted on Drawings.
- E. 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.
- F. 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.

3.4 CONDUIT ACCESSORIES

- A. Reference 3.01, General Installation Requirements.
- B. Install per manufacturer's written instructions and recommendations.
- C. Duct Spacers: Install per manufacturer's recommendation.
- D. Expansion/Deflection Fittings: Install per manufacturer's recommendation.
- E. Pulltape: Install per manufacturer's recommendation.
- F. Duct Plugs: Install per manufacturer's recommendation.

3.5 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.

3.6 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 or double-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.
- 3.7 PULL BOXES
 - A. Reference 3.01, General Installation Requirements.
 - B. Install per manufacturer's written instructions and recommendations.
 - C. In-Ground: Size and install per manufacturer's recommendations.
 - D. Aboveground: Size and install per manufacturer's recommendations.

3.8 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 15 00 - COMMUNICATIONS HORIZONTAL CABLING

PART 1 - GENERAL

- 1.1 SUMMARY
 - A. Work Included:
 - 1. Station Cabling
 - 2. Modular Jacks
 - 3. Work Area Outlets
 - 4. Patch Panels
 - 5. Patch Cords

1.2 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.

1.3 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.

1.4 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.

1.5 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.

1.6 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:
 - 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.

1.7 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 6A 100 ohm, 4-pair, unshielded twisted pair cables from the telecom rooms to the outlets.
 - 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, spaces below raised floors, open ceiling areas, nonventilated 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

2.1 MANUFACTURERS

- A. Station Cabling:
 - 1. Belden
 - 2. CommScope
 - 3. Corning fiber optic only
 - 4. Leviton/Berk-Tek
 - 5. Ortronics/Superior Essex
 - 6. Panduit
 - 7. Siemon
 - 8. Or approved equivalent.
- B. Modular Jacks:
 - 1. Belden
 - 2. CommScope
 - 3. Corning fiber optic only
 - 4. Leviton/Berk-Tek
 - 5. Ortronics/Superior Essex
 - 6. Panduit
 - 7. Siemon
 - 8. Or approved equivalent.
- C. Work Area Outlets:
 - 1. Belden
 - 2. CommScope
 - 3. Corning fiber optic only
 - 4. Leviton/Berk-Tek
 - 5. Ortronics/Superior Essex
 - 6. Panduit

- 7. Siemon
- 8. Or approved equivalent.
- D. Patch Panels:
 - 1. Belden
 - 2. CommScope
 - 3. Corning fiber optic only
 - 4. Leviton/Berk-Tek
 - 5. Ortronics/Superior Essex
 - 6. Panduit
 - 7. Siemon
 - 8. Or approved equivalent.

E. Patch Cords:

- 1. Belden
- 2. CommScope
- 3. Corning fiber optic only
- 4. Leviton/Berk-Tek
- 5. Ortronics/Superior Essex
- 6. Panduit
- 7. Siemon
- 8. Or approved equivalent.

2.2 STATION CABLING

- A. Category 6A Unshielded Twisted Pair:
 - 1. 100 ohm, Category 6A, 23 AWG, 4-pair unshielded twisted pair, CMP rated jacket, color blue.
 - 2. 100 ohm, Category 6A, 23 AWG, 4-pair unshielded twisted pair, CMR rated jacket, color blue.

2.3 MODULAR JACKS

- A. Category 6A Modular Jacks:
 - 1. Eight-position modular jack, Category 6A, IDC terminals, T568A/B wiring scheme
 - 2. Each jack must be stamped or have icons to identify it as CAT 6A.
 - 3. Coordinate color with building finishes.

2.4 WORK AREA OUTLETS

A. Flush Mounted Faceplate:

- 1. One-port faceplate with mounting lugs for wall phone, constructed from high impact thermo-plastic, mounts within a single-gang wall box.
- 2. One, Two, Three, or Four-port faceplate, constructed from high impact thermo-plastic, with recessed label fields; mounts within a single-gang wall box as indicated on the drawings.
- 3. Coordinate faceplate color with building finishes. Submit to Architect for approval prior to installation.
- B. Flush Mounted Stainless Steel Faceplates:
 - 1. One, Two, Three, or Four-port stainless steel faceplate, with recessed label fields; mounts within a single gang wall box as indicated on the drawings.
- C. Surface Mounted Outlet Boxes:
 - 1. Two, Four, or Six-port surface mount box, constructed from high impact thermo-plastic, with recessed label fields.
 - 2. Coordinate surface box colors with building finishes. Submit to Architect for approval prior to installation.

- D. Modular Furniture Faceplates:
 - 1. 0.125-inch deep modular furniture bezel fits 1.375-inch x 2.71-inch furniture knockout.
 - 2. 0.625-inch deep modular furniture bezel fits 1.375-inch x 2.71-inch furniture knockout, with recessed label field.
 - 3. 1-inch deep modular furniture bezel fits 1.375-inch x 2.71-inch furniture knockout, with recessed label field.
 - 4. Three-port modular furniture adapter plate
 - 5. Adjustable Four-port modular furniture faceplate fits 2.67-inch to 2.75-inch x 1.34-inch to 1.41-inch furniture knockout.
 - 6. Four-port modular furniture faceplate fits Herman Miller Beltline furniture openings 2.35inch x 3.41-inch.
 - 7. Six-port modular furniture faceplate fits Herman Miller Beltline furniture openings 2.35inch x 3.41-inch.
 - 8. Six-port modular furniture faceplate fits Herman Miller Baseline furniture openings 1.89inch x 2.99-inch.
 - 9. Coordinate furniture plate colors with building finishes. Submit to Architect for approval prior to installation.
- E. Modular Mounting Frames/Covers:
 - 1. Two, Three, or Four-port 106-Type duplex frame; mounts within a single gang wall box.
 - 2. Three or Four-port Stylistics rectangular (GFCI) footprint frame; mounts within a single gang wall box.
 - 3. Single or Double-gang 106-Type Plastic Cover Plate.
 - 4. Single or Double-gang Stylistics Plastic Cover Plate.
 - 5. Coordinate mounting frame colors with building finishes. Submit to Architect for approval prior to installation.
- F. Multimedia Outlets:
 - 1. Multimedia outlet with up to 6 ports of copper exiting from the front and up to 12 strands of fiber exiting from the bottom. Constructed from high impact thermo-plastic, with recessed label fields.
 - 2. Bottom adapter plate for up to six LC or SC simplex adapter modules.
 - 3. Bottom adapter plate for up to three SC duplex adapter modules.
 - 4. Bottom adapter plate for up to four TracJack adapter modules.
 - 5. Protective bottom shrouds.
- G. Dust Covers: Single port dust cover for modular openings, color to match faceplate.

2.5 PATCH PANELS

- A. Category 6A Modular Patch Panels:
 - 1. 24 port, eight-position modular jack panel, high density, 6 port modules, Category 6A, IDC terminals, T568A/B wiring scheme.
 - 2. 48 port, eight-position modular jack panel, high density, 6 port modules, Category 6A, IDC terminals, T568A/B wiring scheme.
 - 3. 24 port, Angled, eight-position modular jack panel, high density, 6 port modules, Category 6A, IDC terminals, T568A/B wiring scheme.
 - 4. 48 port, Angled, eight-position modular jack panel, high density, 6 port modules, Category 6A, IDC terminals, T568A/B wiring scheme.
- 2.6 PATCH CORDS
 - A. Category 6A Modular Patch Cords: Factory terminated double ended, eight-position to eightposition, modular, stranded conductors, 4 pair, color, blue. 3-feet, 5-feet, 7-feet, 9-feet, 15-feet, 20-feet, and 25-feet.

PART 3 - EXECUTION

3.1 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, wireway, 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 in doubt, seek determination in writing by Authority Having Jurisdiction (AHJ) prior to ordering. Without written confirmation from the AHJ, Contractor to assume that a plenum rating is required.
- 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:

- 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 5e or 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 at each outlet 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.
- 3.2 STATION CABLING
 - A. Reference 3.01, General Installation Requirements.
 - B. Install per manufacturer's instructions and recommendations.

3.3 MODULAR JACKS

- A. Reference 3.01, General Installation Requirements.
- B. Install per manufacturer's instructions and recommendations.

3.4 WORK AREA OUTLETS

- A. Reference 3.01, General Installation Requirements.
- B. Install per manufacturer's instructions and recommendations.

3.5 PATCH PANELS

- A. Reference 3.01, General Installation Requirements.
- B. Install per manufacturer's instructions and recommendations.

3.6 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

SECTION 28 00 00 - ELECTRONIC SAFETY AND SECURITY BASIC REQUIREMENTS

PART 1 - GENERAL

1.1 FIRE ALARM DESIGN-BUILD SUMMARY

A. Work included in 28 00 00 applies to Division 28, Electronic Safety and Security work to provide materials, labor, tools, permits and incidentals to make electronic safety and security systems ready for Owner's use for proposed project.

1.2 FIRE ALARM DESIGN-BUILD INSTRUCTIONS

- A. This document is issued to give Bidders a basis for preparing a proposal to design and install a complete Electronic Safety and Security system for this project.
- B. Alternates to this Document may be offered as a separate proposal.
- 1.3 FIRE ALARM DESIGN-BUILD DESIGN APPROACH
 - A. Use this Specification as a guide for design/engineering requirements, workmanship and materials or construction. Utilize design-build concept throughout construction phase of project.
 - B. Investigate and be apprised of applicable codes, rules, and regulations as enforced by AHJ.
 - C. Visit the Site of the proposed construction. Verify and inspect the existing site to determine conditions that affect this work.

1.4 FIRE ALARM DESIGN-BUILD DESIGN CRITERIA/CALCULATIONS

- A. Related Work Specified Elsewhere:
 - 1. Contents of Section apply to Division 28, Electronic Safety and Security Specifications.
 - 2. Requirements of Section are a minimum for Division 28, Electronic Safety and Security Sections, unless otherwise stated in each Section, in which case that Section's requirements take precedence.
- B. Fire Alarm Design Criteria: Refer to Section 28 31 00, Fire Detection and Alarm, for fire alarm system design criteria.
- C. Fire Alarm Equipment: Refer to Section 28 31 00, Fire Detection and Alarm, for fire alarm equipment requirements.

1.5 SECTION INCLUDES

- A. Work included in 28 00 00, Electronic Safety and Security Basic Requirements applies to Division 28, Electronic Safety and Security work to provide materials, labor, tools, permits, incidentals, and other services to provide and make ready for Owner's use of electronic safety and security 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 Authorized Representative, and other reviewing entity whose approval is required to obtain systems acceptance.
- 1.6 RELATED SECTIONS
 - A. Contents of Section apply to Division 28, Electronic Safety and Security 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.
 - D. Comply with related products/systems requirements for Internet Protocol Communication devices located in Division 27:
 - 1. Section 27 13 00, Communications Backbone Cabling.
 - 2. Section 27 15 00, Communications Horizontal Cabling.
- 1.7 REFERENCES AND STANDARDS
 - A. References and Standards per Division 00, Procurement and Contracting Requirements and Division 01, General Requirements, individual Division 28, Electronic Safety and Security 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. OZERCC Oregon Zero Energy Ready Commercial 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 and Security individual Sections for additional references.

1.8 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 posted to ftp site. For electronic format, provide one file per division containing one bookmarked PDF file with each bookmark corresponding to each Specification Section. Arrange bookmarks in ascending order of Specification Section number. 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 and Security 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 and Security specification Sections for specific items required in product data submittal outside of these requirements.
 - 3. See Division 28, Electronic Safety and Security 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 7-16 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 and Security Coordination Documents. For equipment with electrical connections, furnish copy of approved submittal for inclusion in Division 26, Electrical and Division 28, Electronic Safety and Security 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 and Security 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, Owner's Instructions:
 - 1. Reference individual Division 28, Electronic Safety and Security Specification Sections for additional requirements for operations and maintenance manuals.
 - 2. Submit, at one time, electronic files (PDF format) 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 00, Electronic Safety and Security 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 00, Electronic Safety and Security 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 CAD Drawings and make one set of black-line drawings created from CAD Files in version/release equal to contract drawings. Submit CAD disk and drawings upon substantial completion.

- 4. At completion of project, show changes and deviations from the Drawings in red on one set of black-line drawings. Include written Addendums, RFIs, and change order items. Make changes to Drawings in a neat, clean, and legible manner.
- 5. See Division 28, Electronic Safety and Security individual Sections for additional items to include in Record Drawings.

1.9 QUALITY ASSURANCE

- A. Regulatory Requirements: Work and materials installed to conform with all local, State and Federal codes, and other applicable laws and regulations. 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.
- B. 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.
- C. 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.
- D. Manufacturer's Instructions: Follow manufacturer's written instructions. If in conflict with Contract Documents, obtain clarification. Notify Engineer/Architect, in writing, before starting work.
- E. Items shown on Drawings are not necessarily included in Specifications or vice versa. Confirm requirements in all Contract Documents.
- F. Provide products that are UL listed.

1.10 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 00, Electronic Safety and Security Basic Requirements and individual Division 28, Electronic Safety and Security 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.

1.11 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

2.1 MANUFACTURERS

A. Articles, fixtures, and equipment of a kind to be standard product of one manufacturer, including but not limited to panels, devices and equipment unless otherwise specified in individual Division 28, Electronic Safety and Security Sections.

2.2 STANDARDS OF MATERIALS AND WORKMANSHIP

- 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 FM approved or have adequate approval or be acceptable by state, county, and city authorities.
- B. Names and manufacturer's names denote character and quality of equipment desired and are not to be construed as limiting competition.
- C. Hazardous Materials:
 - 1. Comply with local, State of Oregon, and Federal regulations relating to hazardous materials.
 - 2. Comply with Division 00, Procurement and Contracting Requirements and Division 01, General Requirements for this project relating to hazardous materials.
 - 3. Do not use any materials containing a hazardous substance. If hazardous materials are encountered, do not disturb; immediately notify Owner and Architect. Hazardous materials will be removed by Owner under separate contract.

2.3 ACCESS PANELS

- A. See Division 01, General Requirements and Division 08, 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 and Security Sections. In absence of specific requirements, comply with the following:
 - 1. Provide flush mounting access panels for systems and individual components, service of electrical safety and security 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 Models:
 - 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

3.1 ACCESSIBILITY AND INSTALLATION

- A. Confirm Accessibility and Installation requirements in Division 00, Procurement and Contracting Requirements, Division 01, General Requirements, Section 28 00 00, Electronic Safety and Security Basic Requirements and individual Division 28, Electronic Safety and Security 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 and Engineer 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 and Security 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.
 - 2. In absence of specific requirements, comply with individual Division 28, Electronic Safety and Security Sections and 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.

3.2 SEISMIC CONTROL

- A. Confirm Seismic Control requirements in Division 01, General Requirements, Structural documents, and individual Division 28 Electronic Safety and Security Sections.
- B. Earthquake resistant designs for Electronic Safety and Security (Division 28) 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 and security equipment during earthquake.

3.3 REVIEW AND OBSERVATION

- A. Confirm Review and Observation requirements in Division 00, Procurement and Contracting Requirements, Division 01, General Requirements, Section 28 00 00, Electronic Safety and Security Basic Requirements and individual Division 28, Electronic Safety and Security Sections.
- B. Notify Architect and Engineer, 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 electrical, safety and security 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.

3.4 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 and Security 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. If overtime is necessary, there will be no allowance made by Owner for extra expense for such overtime or shift work.
 - 4. Organize work to minimize duration of power interruption.

3.5 CUTTING AND PATCHING

- A. Confirm Cutting and Patching Requirements in Division 00, Procurement and Contracting Requirements and Division 01, General Requirements. In absence of specific requirements, comply with individual Division 28, Electronic Safety and Security 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.

3.6 EQUIPMENT SELECTION AND SERVICEABILITY

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

3.7 DELIVERY, STORAGE AND HANDLING

- 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 and Security 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.

3.8 DEMONSTRATION

- A. Confirm Demonstration requirements in Division 00, Procurement and Contracting Requirements and Division 01, General Requirements, Section 28 00 00, Electronic Safety and Security Basic Requirements and individual Division 28, Electronic Safety and Security Sections.
- B. Upon completion of work and adjustment of equipment, test systems, demonstrate to Owner's Authorized 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 00, Electronic Safety and Security Basic Requirements and individual Division 28, Electronic Safety and Security 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.

3.9 CLEANING

- A. Confirm Cleaning requirements in Division 00, Procurement and Contracting Requirements and Division 01, General Requirements, Section 28 00 00, Electronic Safety and Security 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 00, Electronic Safety and Security Basic Requirements and individual Division 28, Electronic Safety and Security 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 and Security 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 ACCESS PANELS

- A. Confirm Access Panel requirements in Division 01, General Requirements.
- B. In absence of specific requirements, comply with individual Division 28, Electronic Safety and Security Sections and 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 28, Electronic Safety and Security Sections and the following:
 - 1. Scope:
 - a. It is the intent of these documents to provide necessary information and adjustments to electronic safety and security system required to meet code, and accommodate installation of new work.
 - b. 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.
 - c. Coordinate with Owner so that work can be scheduled not to interrupt operations, normal activities, building access, 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.
 - 2. 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 safety and security system devices, panels, etc. in field.
- d. Report discrepancies to Architect before disturbing existing installation.
- 3. Promptly notify Owner if systems are found which are not shown on Drawings.
- 4. Execution:
 - a. Remove existing safety and security equipment, 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 and equipment 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 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 and remove electrical devices and equipment serving utilization equipment that has been removed.
 - j. Maintain access to existing electrical installations which remain active. Modify installation or provide access panel as appropriate.
 - k. Existing electronic safety and security system components are indicated on demolition plans. Verify exact location and number of existing devices and components in field. Only partial existing systems shown. Locations of items shown on Drawings as existing are partially based on Record and other Drawings which may contain errors. Verify accuracy of information shown prior to bidding and provide such labor and material as is necessary to accomplish intent of Contract Documents.
 - I. Remove abandoned wiring to leave site clean.
 - m. If existing electrical equipment contains PCBs (Polychlorinated Biphenyl), replace with new non-PCB equipment. Dispose of material containing PCBs as required by federal and local regulations.
 - n. Repair adjacent construction and finishes damaged during demolition work.
 - o. Maintain access to existing electrical installations which remain active. Modify installation or provide access panel as appropriate.
- B. Existing Fire Alarm System: Maintain existing system in service during construction. Disable system only to make switchovers and connections.
 - 1. Notify Owner before partially or completely disabling system.
 - 2. Notify local fire service.

- 3. Make notifications at least five working days in advance.
- 4. Make temporary connections to maintain service in areas adjacent to work area.
- C. Existing Security Systems: Maintain existing systems in service until new system is complete and ready for service. Disable system only to make switchovers and connections.
 - 1. Notify Owner at least five working days before partially or completely disabling system.
 - 2. Make temporary connections to maintain service in areas adjacent to work area.

3.14 ACCEPTANCE

- 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 and Security 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

3.15 FIELD QUALITY CONTROL

- 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 and Security 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.

3.16 LETTER OF CONFORMANCE

A. Provide Letter of Conformance, copies of manufacturers' warranties and extended warranties with a statement in the letter that electronic safety and security 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

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SECTION 28 10 00 - ACCESS CONTROL AND INTRUSION DETECTION

PART 1 - GENERAL

1.1 SUMMARY

A. Work included:

- 1. Card Reader
- 2. Door Position Switch/Contact
- 3. Request to Exit Device (REX)
- 4. Electric Latch or Strike (provided by others see Architectural door hardware schedule)
- 5. Cable and Wire
- B. Scope of work: Add three additional card access controlled doors to existing access control panel. Provide additional expansion cards or control panels to allows for the additional doors if required. Provide all security devices, conduit and wire to produce a complete and operational system and indicated on drawings and described herein.

1.2 RELATED SECTIONS

A. Contents of Division 28, Electronic Safety and Security and Division 01, General Requirements apply to this Section.

1.3 REFERENCES AND STANDARDS

- A. References and Standards as required by Division 28, Electronic Safety and Security and Division 01, General Requirements.
- B. In addition, meet the following:
 - 1. Federal Information Processing Standard Publication 201-1, Personal Identity Verification (PIV) of Federal Employees and Contractors. (FIPS 201-1)
 - 2. Homeland Security Presidential Standard Directive 12: Policy for a Common Identification Standard for Federal Employees and Contractors. (HSPD-12)
- 1.4 SUBMITTALS
 - A. Submittals as required by Division 28, Electronic Safety and Security and Division 01, General Requirements.

1.5 QUALITY ASSURANCE

- A. Quality assurance as required by Division 28, Electronic Safety and Security and Division 01, General Requirements.
- 1.6 WARRANTY
 - A. Warranty of materials and workmanship as required by Division 28, Electronic Safety and Security and Division 01, General Requirements.

PART 2 - PRODUCTS

- 2.1 MANUFACTURERS
 - A. Card Reader:
 - 1. HID
 - 2. Or approved equivalent.
 - B. Door Position Switch/Contact:
 - 1. Sentrol
 - 2. Or approved equivalent.

- C. Request to Exit Device (REX):
 - 1. Bosch
 - 2. Or approved equivalent.
- D. Electric Latch or Strike: Provided by others; see Architectural door hardware schedule.
- E. Cable and Wire:
 - 1. West Penn Wire
 - 2. Or approved equivalent.

2.2 CARD READER

- A. Furnish and install card readers at locations indicated on the Drawings. Mounting height to be 48-inches unless noted otherwise on the Drawings.
- B. Furnish and install a single gang size, wall mount proximity card reader or mullion mount card reader on store front applications.
- C. Card Readers to be suitable for indoor or outdoor use.
- D. Card Readers to be ADA compliant.
- 2.3 DOOR POSITION SWITCH/CONTACT
 - A. Furnish and install recessed door position switches designed to be compatible with and operate with the access control and intrusion system, in the locations indicated on the Drawings.
 - B. In situations where a recessed switch cannot be used, utilize a surface mount switch (roll-up door).
 - C. Coordinate switch type and installation with architectural door hardware schedule and requirements.
- 2.4 REQUEST TO EXIT DEVICE (REX)
 - A. Furnish and install a REX at each door indicated on the Drawings.
 - B. Coordinate with the door hardware schedule for type of device required.
 - C. If the REX is not built into the door hardware, install a surface mount passive infrared sensor (PIR) type device per architect's direction.
- 2.5 ELECTRIC LATCH OR STRIKE
 - A. Provided by others; see Architectural door hardware schedule.

2.6 CABLE AND WIRE

- A. Copper:
 - 1. Power: 18 AWG, 2 pair, unshielded twisted pair.
 - 2. RS-232: 18 AWG, 4 conductor, shielded.
 - 3. Category 6 cabling to match that installed by the telecom contractor in Division 27, Communications.
 - 4. Indicate all other wire required by manufacturer installation instructions on submittal Drawings and diagrams.
 - 5. All cabling to be plenum rated where required.
- B. Connectors:
 - 1. Modular connector.
 - 2. 24 V Power: Screw-down on spade lug.

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION REQUIREMENTS

- A. This specification is to be used in conjunction with the Drawings. There may be circumstances where a device listed here is not present or required on the project Drawings.
- B. Contractor to coordinate conduit installation with the electrical contractor.
- C. Preparation:
 - 1. Order required parts and equipment upon notification of award of the work.
 - 2. Bench test equipment prior to delivery to the job site.
 - 3. Verify the availability of power where required. If a new source of power is required, a licensed electrician is required to install it.
 - 4. Arrange to obtain programming information including access times, free access times, door groups, operator levels, etc.
- D. Carefully follow the instructions in the manufacturer's Installation Manual to ensure steps have been taken to provide a reliable, easy to operate system.
- E. Perform work as indicated in the Drawings and Specifications.
- F. Install 3/4-inch conduit to designated card readers, door contacts, request-to-exit devices and electric lock at each door.
- G. Ensure minimum separation requirements are met between communications cables and power circuits.
- H. Integrate card readers with power assisted doors so that the door will not function without a valid card read while in secure mode.
- I. Double doors that are electronically controlled will unlock one leaf upon valid card read and unlock both leaves during programmed time to be unlocked.
- J. Execute adequate testing of the system to ensure proper operation.
- K. Training Requirements:
 - 1. Provide adequate training of the system users to ensure adequate understanding to prevent operating errors.
 - 2. Provide eight hours of training of operational instruction and two hours of maintenance instruction. Training seminars are to be hands-on instruction held at Owner's facility.
 - 3. Provide Owner with manufacturer's operating instructions.
 - 4. Provide factory trained representatives to instruct Owner's personnel in the operation of system equipment.
 - 5. Provide Owner's Authorized Representative with training plan and training checklist two weeks before planned training according to manufacturer's instructions.
 - 6. Provide comprehensive training for Owner's Authorized Representative for operation, maintenance and troubleshooting of system. Attend training session and video tape by Commissioning Authority.
 - 7. Security contractor will fully explain and demonstrate operation, function and override of system including, but not limited to: Software operation, remote access, programming, priority levels and monitoring station.
- L. Workmanship:
 - 1. Comply with highest industry standards, except when specified requirements indicate more rigid standards or more precise workmanship.
 - 2. Perform work with persons experienced and qualified to produce workmanship specified.
 - 3. Maintain quality control over suppliers and Subcontractors.

- M. Equipment Pretest: Bench test prior to delivery to job site and prior to installation. Bench test per manufacturer's installation instructions.
- N. Fire-Rated Doors and Frames: Do nothing to modify a UL rated door or frame that would void the UL label or fire rating.
- O. Grounding: Provide earth-grounding of equipment as required by equipment manufacturer. Earth ground to be connected to ground rod or approved cold water pipe. Do not use electrical or telephone ground connections as earth grounds. Do not use connections to mounting posts or building structural steel as earth grounds.
- P. Cutting and Patching: Responsible for cutting, fitting or patching that may be required to complete the work.
- 3.2 CARD READER
 - A. Reference 3.01, General Installation Requirements.
 - B. Install per manufacturer's instructions and recommendations.
- 3.3 DOOR POSITION SWITCH/CONTACT
 - A. Reference 3.01, General Installation Requirements.
 - B. Install per manufacturer's instructions and recommendations.
- 3.4 REQUEST TO EXIT DEVICE (REX)
 - A. Reference 3.01, General Installation Requirements.
 - B. Install per manufacturer's instructions and recommendations.
- 3.5 ELECTRIC LATCH OR STRIKE
 - A. Reference 3.01, General Installation Requirements.
 - B. Install per manufacturer's instructions and recommendations.
 - C. Provided by others; see Architectural door hardware schedule.
- 3.6 CABLE AND WIRE
 - A. Reference 3.01, General Installation Requirements.
 - B. Install per manufacturer's instructions and recommendations.
 - C. Design, layout, size and plan new wire and cable runs as required.
 - D. Wire and cable from the processors to devices at each door "home-run" unless otherwise specified.
 - E. Wire and cable installed in conduit or surface metal raceway, except as follows: Wire or cable, in lengths of less than 10-feet, that is "fished" within walls, ceilings and door frames.
 - F. Wire and cable passing through metalwork to be sleeved by an approved grommet or bushing.
 - G. Avoid splicing conductors. Make splices in junction boxes (except at equipment). Make splices with an approved crimp connection. Do not use wire nuts on any low-voltage wiring.
 - H. Identify wire and cable at terminations and at every junction box. Make identification with an approved permanent label, Brady or equal.

- I. Cable and Wire Terminations:
 - 1. Identify inputs and outputs on terminal strips with permanent marking labels.
 - Neatly dress and tie all wiring. The length of conductors within enclosures to be sufficient to neatly train the conductor to the terminal point with no excess. Run wire and cable parallel or normal to walls, floors and ground.
 - 3. Install connectors as required by equipment manufacturers.
 - 4. Make terminations so that there is no bare conductor at the terminal. Conductor insulation to bear against the terminal or connector shoulder.
 - 5. Do not obstruct equipment controls or indicators with wire or cable. Route wire and cable away from heat producing components such as resistors and regulators.
- J. Install the appropriate cable from the CPU to card readers, door contacts, request-to-exit devices and electric locks at each door.

END OF SECTION

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SECTION 28 31 00 - FIRE DETECTION AND ALARM

PART 1 - GENERAL

1.1 SUMMARY

- A. Work Included:
 - 1. Notification Appliance Circuit Panels
 - 2. Manual Pull Stations
 - 3. Fixed Temperature Heat Detectors
 - 4. Rate-of-Rise and Fixed Temperature Heat Detectors
 - 5. Photoelectric Type Detectors
 - 6. Duct-Mounted Smoke Detectors
 - 7. Relay Modules
 - 8. Control Modules
 - 9. Input Modules
 - 10. Fault Isolation Modules
 - 11. Combination Horn/Strobes
 - 12. Strobes
 - 13. Horns
 - 14. Miscellaneous Accessories
- B. Scope: Provide modification and extension of the existing JCI branded Notifier fire alarm system to accommodate tenant improvement, remodel, and addition.
- C. In addition, provide design for the following as required in these Contract Documents: Fire Alarm 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: Match Existing.
 - c. Supervisory Sequence of Operation: Match Existing.
 - d. Trouble Sequence of Operation: Match Existing.

1.2 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.

1.3 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. NFPA 72, National Fire Alarm and Signaling Code, adopted edition.
 - 2. NFPA 70, National Electrical Code, adopted edition.
- 1.4 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.
- I. 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
- 1.5 QUALITY ASSURANCE
 - A. Quality assurance as required by Division 28, Electronic Safety and Division 01, General Requirements.
 - B. In addition, meet City of Oregon City, Oregon requirements, ordinances and amendments.
- 1.6 WARRANTY
 - A. Warranty of materials and workmanship as required by Division 28, Electronic Safety and Division 01, General Requirements.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Notification Appliance Circuit Panels:
 - 1. Match existing.
 - 2. No substitutions permitted.

- B. Manual Pull Stations:
 - 1. Same manufacturer as fire alarm control equipment.
 - 2. No substitutions permitted.
- C. Fixed Temperature Heat Detectors:
 - 1. Same manufacturer as fire alarm control equipment.
 - 2. No substitutions permitted.
- D. Rate-of-Rise and Fixed Temperature Heat Detectors:
 - 1. Same manufacturer as fire alarm control equipment.
 - 2. No substitutions permitted.
- E. Photoelectric Type Detectors:
 - 1. Same manufacturer as fire alarm control equipment.
 - 2. No substitutions permitted.
- F. Duct-Mounted Smoke Detectors:
 - 1. Same manufacturer as fire alarm control equipment.
 - 2. No substitutions permitted.
- G. Relay Modules:
 - 1. Same manufacturer as fire alarm control equipment.
 - 2. No substitutions permitted.
- H. Control Modules:
 - 1. Same manufacturer as fire alarm control equipment.
 - 2. No substitutions permitted.
- I. Input Modules:
 - 1. Same manufacturer as fire alarm control equipment.
 - 2. No substitutions permitted.
- J. Fault Isolation Modules:
 - 1. Same manufacturer as fire alarm control equipment.
 - 2. No substitutions permitted.
- K. Combination Horn/Strobes:
 - 1. Must be compatible with fire alarm control equipment and notification appliance circuit panels.
 - 2. System Sensor
 - 3. Or approved equivalent.
- L. Strobes:
 - 1. Must be compatible with fire alarm control equipment and notification appliance circuit panels.
 - 2. System Sensor
 - 3. Or approved equivalent.
- M. Horns:
 - 1. Must be compatible with fire alarm control equipment and notification appliance circuit panels.
 - 2. System Sensor
 - 3. Or approved equivalent.
- N. Miscellaneous Accessories:
 - 1. Weatherproof/Surface Backboxes:
 - a. Same manufacturer as fire alarm detection devices or notification appliances.
 - b. Or approved equivalent.

- 2. Protective Guard:
 - a. Wire Guard:
 - 1) Same manufacturer as fire alarm control equipment.
 - 2) American Wire Guards
 - 3) Chase Security Systems
 - 4) Safety Technology International
 - 5) Shaw-Perkins
 - 6) Or approved equivalent.
 - b. Protective Cover:
 - 1) Safety Technology International
 - 2) Or approved equivalent.
- 3. Circuit Conductors:
 - a. Allied Wire and Cable
 - b. Belden
 - c. CCI
 - d. West Penn Wire
 - e. Or approved equivalent.
- 4. Surge Protection:
 - a. Ditek
 - b. Transtector
 - c. Or approved equivalent.
- 5. Batteries:
 - a. Same manufacturer as fire alarm control equipment.
 - b. Power-Sonic
 - c. Werker
 - d. Or approved equivalent.
- 6. Locks and Keys:
 - a. Same manufacturer as fire alarm control equipment.
 - b. Or approved equivalent.
- O. 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.
- P. Equipment to be supplied by a certified manufacturer representative.

2.2 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.
- 2.3 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.

2.4 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.

2.5 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.

2.6 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.
- 2.7 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.

2.8 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.

2.9 CONTROL MODULES

- A. Signaling line circuit interface module that provides notification appliance circuits or system control outputs.
- B. Module powered from control panel.
- 2.10 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.

2.11 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.
- 2.12 COMBINATION HORN/STROBES
 - A. Multi-candela, flush wall and ceiling mount, red finish, insect-proof.
 - B. Provide horn/strobes that meet the latest requirements of NFPA 72, ANSI 117.1 and UL 1971. Candela rating as required by NFPA 72.

2.13 STROBES

- A. Multi-candela, flush wall and ceiling mount, red 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.

2.14 HORNS

- A. Flush wall and ceiling mount, white finish, insect-proof.
- B. Provide horns that meet the latest requirements of NFPA 72.

2.15 MISCELLANEOUS ACCESSORIES

- A. Protective Guard:
 - 1. Wire Guard: Steel wire guard.
 - 2. Protective Cover: Polycarbonate construction.
- B. 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.
- C. Surge Protection: In accordance with IEEE C62.41 B3 combination waveform and NFPA 70; except for optical fiber conductors.
- D. Batteries: Sealed lead acid type. Provide additional cabinet, if required due to space limitations in control panels.
- E. 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.
- F. Framed Floor Map:
 - 1. Provide framed floor plan of facility.
 - 2. Frame: Stainless steel or aluminum with polycarbonate or glass cover.

PART 3 - EXECUTION

- 3.1 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:
 - 1. Notification Appliance Circuits: Minimum 25 percent spare current capacity. Utilize UL maximum current draw values for notification appliances. Maximum 10 percent voltage drop.
 - 2. Signaling Line Circuit: Minimum 25 percent 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 five 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. Existing Components:
 - 1. Existing Fire Alarm System:
 - a. Maintain fully operational during construction in all areas except areas of remodel.
 - 2. Disable system only to make switchovers and connections.
 - a. Notify Owner before partially or completely disabling system.
 - b. Notify local fire service.
 - c. Make notifications at least five working days in advance.
 - d. Make temporary connections to maintain service in areas adjacent to work area.
 - 3. Provide fire watch in areas where the system is not functioning if required by the AHJ.
 - 4. Equipment Removal:
 - a. Remove existing system after acceptance of new fire alarm system. Restore damaged surfaces.
 - b. Package operational fire alarm and detection equipment that has been removed and deliver to Owner.
 - c. Remove from site and legally dispose of remainder of existing material.
 - 5. On-Premises Supervising Station: Include, as part of this work, modifications necessary to existing supervising station to accommodate new fire alarm work.
- N. 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) Fire sprinkler water flow switches.
- 2) Fire sprinkler drv-pipe alarm pressure switches.
- Kitchen hood fire suppression activation. 3)
- 4) Other alarm inputs.
- Supervisory Inputs: Provide connection in accordance with NFPA 72 for the b. following systems and components:
 - Fire sprinkler water control valve tamper switches. 1)
 - 2) Fire sprinkler dry-pipe system low air pressure switches.
 - Elevator shunt trip power monitoring circuit. 3)
 - 4) Other supervisory inputs.
- Trouble Inputs: Provide connection in accordance with NFPA 72 for the following C. systems and components: 1)
 - Other trouble inputs.
- Fire Safety Functions: Provide power and control conduit, wiring, boxes and terminations 2. to power devices and interface to fire alarm system.
 - Doors: a.
 - Provide smoke detectors and addressable control relays to release magnetic 1) hold open devices and roll-down fire doors and door locks. Verify requirements and quantities prior to bidding.
 - Smoke Barrier Door Magnetic Holders: Release upon activation of smoke 2) detectors in smoke zone on either side of door.
 - Electronic Locks or Electromagnetic Door Locks on Egress Doors: Unlock 3) 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. Elevators:
 - 1) Provide elevator recall smoke detectors, addressable control relays and connection to elevator equipment per NFPA 72 and as required by the AHJ.
 - Provide elevator shunt trip heat detectors, addressable control relays for 2) shunt trip operation, addressable input module for monitoring shunt trip power and connection to elevator equipment per NFPA 72 and as required by the AHJ.
 - Elevator Lobby and Machine Room Smoke Detectors: Elevator recall for fire 3) fighters' service.
 - 4) Elevator Machine Room Heat Detector: Shut down elevator power prior to Elevator Machine Room sprinkler activation.
 - HVAC Systems: C.
 - Fire/Smoke Dampers and Smoke Dampers: 1)
 - Provide required smoke detectors, relays, wiring and the like. a)
 - Connect control and power wiring to dampers per manufacturer's b) instructions.
 - Verify quantities, location and requirements of dampers with Division c) 23, HVAC Drawings and Specifications and mechanical system installer.
 - Air Moving Systems: 2)
 - Provide duct-mounted smoke detectors on air systems with air flow a) rates exceeding 2000 CFM. Coordinate with Division 23, HVAC.
 - Install duct-mounted smoke detector(s) on return side of air system. b)
 - Provide control wiring from addressable relay contacts to air handling c) 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.
- O. 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."
- P. 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.
- Q. 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.

3.2 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.
- 3.3 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.

3.4 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.

3.5 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.

3.6 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.

3.7 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.

3.8 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.

3.9 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.
- 3.10 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.
- 3.11 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.
- 3.12 COMBINATION HORN/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.

3.13 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.
- 3.14 HORNS
 - 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.
- 3.15 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. Protective Guard:
 - 1. Wire Guard.
 - 2. Protective Cover.
 - E. 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.
 - F. 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.
 - G. Document Storage Cabinet: Provide document storage cabinet adjacent to fire alarm control panel.
 - H. Instruction Charts: Install chart adjacent to fire control unit.

I. 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.

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PERMIT SET APRIL 22, 2021

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