

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

PART 1 - GENERAL

1.01 SECTION INCLUDES

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

1.02 RELATED SECTIONS

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

1.03 REFERENCES AND STANDARDS

- A. References and Standards per Division 01, General Requirements, individual Division 23, HVAC Sections and those listed in this Section.
- B. Codes to include latest adopted editions, including current amendments, supplements and local jurisdiction requirements in effect as of the date of the Contract Documents, of/from:
 - 1. State of Oregon:
 - a. OAR - Oregon Administrative Rules
 - b. OESC - Oregon Electrical Specialty Code

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- 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 Manufacturers 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 Manufacturers Association

- 36. TIMA - Thermal Insulation Manufacturers Association
- 37. UL - Underwriters Laboratories, Inc.
- D. See Division 23, HVAC individual Sections for additional references.

1.04 SUBMITTALS

- A. See Division 01, General Requirements for Submittal Procedures as well as specific individual Division 23, HVAC Sections.
- B. Provide drawings in format and software release equal to the design documents. Drawings to be the same sheet size and scale as the Contract Documents.
- C. In addition:
 - 1. "No Exception Taken" constitutes that review is for general conformance with the design concept expressed in the Contract Documents for the limited purpose of checking for conformance with information given. Any action is subject to the requirements of the Contract Documents. Contractor is responsible for the dimensions and quantity and will confirm and correlate at the job site, fabrication processes and techniques of construction, coordination of the work with that of all other trades, and the satisfactory performance of the work.
 - 2. Provide product submittals and shop drawings in electronic format only. Electronic format must be submitted via zip file via e-mail or posted to ftp site. For electronic format, provide one 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.
 - b. Include technical data, installation instructions and dimensioned drawings for products, fixtures, equipment and devices installed, furnished or provided. Reference individual Division 23, HVAC Specification Sections for specific items required in product data submittal outside of these requirements.
 - c. Provide pump curves, operation characteristics, capacities, ambient noise criteria, etc. for equipment.
 - d. For vibration isolation of equipment, list make and model selected with operating load and deflection.
 - e. See Division 23, HVAC individual Sections for additional submittal requirements outside of these requirements.
 - 5. Maximum of two reviews of submittal package. Arrange for additional reviews and/or early review of long-lead items; Bear costs of these additional reviews at Engineer's hourly rates. Incomplete submittal packages/submittals will be returned to contractor without review.

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6. Resubmission Requirements: Make corrections or changes in submittals as required, and in consideration of Engineer's comments. Identify Engineer's comments and provide an individual response to each of the Engineer's comments. Cloud changes in the submittals and further identify changes which are in response to Engineer's comments.
7. Structural/Seismic: Provide weights, dimensions, mounting requirements and like information required for mounting, seismic bracing, and support. Indicate manufacturer's installation and support requirements to meet ASCE 7-10 requirements for non-structural components. Provide engineered seismic drawings and equipment seismic certification. Equipment Importance Factor as specified in Division 01 and in Structural documents.
8. Trade Coordination: Include physical characteristics, electrical characteristics, device layout plans, wiring diagrams, and connections as required by Division 23, HVAC Coordination Documents. For equipment with electrical connections, furnish copy of approved submittal for inclusion in Division 26, Electrical submittals.
9. Make provisions for openings in building for admittance of equipment prior to start of construction or ordering of equipment.
10. Substitutions and Variation from Basis of Design:
 - a. The Basis of Design designated product establishes the qualities and characteristics for the evaluation of any comparable products by other listed acceptable manufacturers if included in this Specification or included in an approved Substitution Request as judged by the Design Professional.
 - b. If substitutions and/or equivalent equipment/products are being proposed, it is the responsibility of parties concerned, involved in, and furnishing the substitute and/or equivalent equipment to verify and compare the characteristics and requirements of that furnished to that specified and/or shown. If greater capacity and/or more materials and/or more labor is required for the rough-in, circuitry or connections than for the item specified and provided for, then provide compensation for additional charges required for the proper rough-in, circuitry and connections for the equipment being furnished. No additional charges above the Base Bid, including resulting charges for work performed under other Divisions, will be allowed for such revisions. Coordinate with the requirements of "Submittals". For any product marked "or approved equivalent", a substitution request must be submitted to Engineer for approval prior to purchase, delivery or installation.
11. Shop Drawings: Provide coordinated shop drawings which include physical characteristics of all systems, equipment, ductwork and piping layout plans, and control wiring diagrams. Reference individual Division 23, HVAC Specification Sections for additional requirements for shop drawings outside of these requirements.
 - a. Provide Shop Drawings indicating access panel locations for items that require Code or maintenance access, size and elevation for approval prior to installation.
12. Samples: Provide samples when requested by individual Sections.
13. Resubmission Requirements:
 - a. Make any corrections or change in submittals when required. Provide submittals as specified. The engineer will not be required to edit and/or interpret the Contractor's submittals. Indicate changes for the resubmittal in a cover letter with reference to page(s) changed and reference response to comment. Cloud changes in the submittals.

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- 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.
 - 1) Include copy of approved submittal data along with submittal review letters received from Engineer. Data to clearly indicate installed equipment model numbers. Delete or cross out data pertaining to other equipment not specific to this project.
 - 2) Include copy of manufacturer's standard Operations and Maintenance for equipment. At front of each tab, provide routine maintenance documentation for scheduled equipment. Include manufacturer's recommended maintenance schedule and highlight maintenance required to maintain warranty. Furnish list of routine maintenance parts, including part numbers, sizes, quantities, relevant to each piece of equipment: belts, motors, lubricants, and filters.
 - 3) Include Warranty per Division 00, Procurement and Contracting Requirements and Division 01, General Requirements, Section 23 00 00, HVAC Basic Requirements and individual Sections.
 - 4) Include product certificates of warranties and guarantees.
 - 5) Include copy of complete parts list for equipment. Include available exploded views of assemblies and sub assemblies.
 - 6) Include copy of startup and test reports specific to each piece of equipment.
 - 7) Include copy of final air and water systems balancing log along with pump, fan and distribution system operating data.
 - 8) Include commissioning reports.
 - 9) Include copy of valve charts/schedules.
 - 10) Engineer will return incomplete documentation without review. Engineer will provide one set of review comments in Submittal Review format. Contractor must arrange for additional reviews; Contractor to bear costs for additional reviews at Engineer's hourly rates.
 - b. Thoroughly instruct Owner in proper operation of equipment and systems. Where noted in individual Sections, training will include classroom instruction with applicable training aids and systems demonstrations. Field instruction per Section 23 00 00, HVAC Basic Requirements Article titled "Demonstration".
 - c. Copies of certificates of code authority inspections, acceptance, code required acceptance tests, letter of conformance and other special guarantees, certificates of warranties, specified elsewhere or indicated on Drawings.
15. Record Drawings:

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- a. Maintain at site at least one set of drawings for recording "As-constructed" conditions. Indicate on drawings changes to original documents by referencing revision document, and include buried elements, location of cleanouts, and location of concealed mechanical items. Include items changed by field orders, supplemental instructions, and constructed conditions.
- b. Record Drawings are to include equipment and fixture/connection schedules, control dampers, fire smoke dampers, fire dampers, valves, bottom of pipe, duct and equipment elevations and dimensioned locations for all distribution systems (hydronic and air). Invert elevations and dimensioned locations for underground systems below grade to 5-feet outside building that accurately reflect "as constructed or installed" for project.
- c. At completion of project, input changes to original project Revit Model and make one set of black-line drawings created from Revit Model in version/release equal to contract drawings. Submit Revit disk and drawings upon substantial completion.
- d. 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.

1.05 QUALITY ASSURANCE

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

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

1.06 WARRANTY

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

1.07 COORDINATION DOCUMENTS

- A. Prior to construction, coordinate installation and location of HVAC equipment, ductwork, grilles, diffusers, piping, equipment, fire sprinklers, plumbing, cable trays, lights, and electrical services with architectural and structural requirements, and other trades (including ceiling suspension, and tile systems), and provide maintenance access requirements. Coordinate with submitted architectural systems (i.e. roofing, ceiling, finishes) and structural systems as submitted, including footings and foundation. Identify zone of influence from footings and ensure systems are not routed within the zone of influence.
- B. Advise Architect in event a conflict occurs in location or connection of equipment. Bear costs resulting from failure to properly coordinate installation or failure to advise Architect of conflict.
- C. Verify in field exact size, location, invert, and clearances regarding existing material, equipment and apparatus, and advise Architect of discrepancies between that indicated on Drawings and that existing in field prior to installation related thereto.
- D. Submit final Coordination Drawings with changes as Record Drawings at completion of project.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. 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.

2.02 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.

2.03 ACCESS PANELS

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

PART 3 - EXECUTION

3.01 ACCESSIBILITY AND INSTALLATION

- A. Confirm Accessibility and Installation requirements in Division 00, Procurement and Contracting Requirements and Division 01, General Requirements, Section 23 00 00, HVAC Basic Requirements and individual Division 23, HVAC Sections.
- B. Install equipment having components requiring access (i.e., drain pans, drains, control operators, valves, motors and vibration isolation devices) so that they may be serviced, reset, replaced or recalibrated by service people with normal service tools and equipment. Do not install equipment in obvious passageways, doorways, scuttles or crawlspaces which would impede or block intended usage.
- C. Install equipment and products complete as directed by manufacturer's installation instructions including all appurtenances recommended in manufacturer's installation instructions, at no additional charge to Owner. Obtain installation instructions from manufacturer prior to rough-in of equipment and examine instructions thoroughly. When requirements of installation instructions conflict with Contract Documents, request clarification from Architect prior to proceeding with installation. This includes proper installation methods, sequencing and coordination with other trades and disciplines.
- D. Firestopping:
 - 1. Confirm Firestopping requirements in Division 07, Thermal and Moisture Protection. In absence of specific requirements, comply with individual Division 23, HVAC Sections and the following:
 - a. Coordinate location and protection level of fire and/or smoke rated walls, ceilings, and floors. When these assemblies are penetrated, seal around piping, ductwork and equipment with approved firestopping material. Install firestopping material complete as directed by manufacturer's installation instructions. Meet requirements of ASTM E814, Standard Test Method for Fire Tests of Through-Penetration Fire Stops.
- 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.

3.02 SEISMIC CONTROL

- A. Confirm Seismic Control requirements in Division 01, General Requirements, Structural documents, and individual Division 23 HVAC Sections.

B. General:

1. Earthquake resistant designs for HVAC (Division 23) equipment and distribution, i.e. motors, ductwork, piping, equipment, etc. to conform to regulations of jurisdiction having authority.
2. Restraints which are used to prevent disruption of function of piece of equipment because of application of horizontal force to be such that forces are carried to frame of structure in such a way that frame will not be deflected when apparatus is attached to a mounting base and equipment pad, or to structure in normal way, utilizing attachments provided. Secure equipment and distribution systems to withstand a force in direction equal to value defined by jurisdiction having authority.
3. Provide stamped Shop Drawings from licensed Structural Engineer of seismic bracing and seismic movement assemblies for piping equipment and water heaters. Submit Shop Drawings along with equipment submittals.
4. Provide stamped Shop Drawings from licensed Structural Engineer of seismic flexible joints for piping and crossing building expansion or seismic joints. Submit Shop Drawings along with seismic bracing details.

C. Piping and Ductwork:

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.

3.03 REVIEW AND OBSERVATION

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

- B. Notify Architect, in writing, at following stages of construction so that they may, at their option, visit site for review and construction observation:

1. Underground system installation prior to backfilling.
2. Prior to covering walls.
3. Prior to ceiling cover/installation.
4. After major equipment is installed.
5. When main systems, or portions of, are being tested and ready for inspection by AHJ.

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

3.04 CONTINUITY OF SERVICE

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

3.05 CUTTING AND PATCHING

- A. Confirm Cutting and Patching requirements in Division 00, Procurement and Contracting Requirements and Division 01, General Requirements. In absence of specific requirements, comply with individual Division 23, HVAC Sections and the following:
1. Proposed floor cutting/core drilling/sleeve locations to be approved by Project Structural Engineer. Submit proposed locations to Architect/Project Structural Engineer. Where slabs are of post tension construction, perform x-ray scan of proposed penetration locations and submit scan results including proposed penetration locations to Project Structural Engineer/Architect for approval. Where slabs are of waffle type construction, show column cap extent and cell locations relative to proposed penetration(s).
 2. Cutting, patching and repairing for work specified in this Division including plastering, masonry work, concrete work, carpentry work, and painting included under this Section will be performed by skilled craftsmen of each respective trade in conformance with appropriate Division of Work.
 3. Additional openings required in building construction to be made by drilling or cutting. Use of jack hammer is specifically prohibited. Patch openings in and through concrete and masonry with grout.
 4. Restore new or existing work that is cut and/or damaged to original condition. Patch and repair specifically where existing items have been removed. This includes repairing and painting walls, ceilings, etc. where existing conduit and devices are removed as part of this project. Where alterations disturb lawns, paving, and walks, surfaces to be repaired, refinished and left in condition matching existing prior to commencement of work.
 5. Additional work required by lack of proper coordination will be provided at no additional cost to the Owner.

3.06 EQUIPMENT SELECTION AND SERVICEABILITY

- A. Replace or reposition equipment which is too large or located incorrectly to permit servicing, at no additional cost to Owner.
- B. Maintain design intent where equipment other than as shown as Basis of Design in Contract Documents is provided. Where equipment requires ductwork or piping arrangement, controls/control diagrams, or sequencing different from that indicated in Contract Documents, provide at no additional cost to Owner.

3.07 DELIVERY, STORAGE AND HANDLING

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

3.08 DEMONSTRATION

- A. Confirm Demonstration requirements in Division 00, Procurement and Contracting Requirements and Division 01, General Requirements, Section 23 00 00, HVAC Basic Requirements and individual Division 23, HVAC Sections.
- B. Upon completion of work and adjustment of equipment and test systems, demonstrate to Owner's 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.

3.09 CLEANING

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

3.10 INSTALLATION

- A. Confirm Installation requirements in Division 00, Procurement and Contracting Requirements, Division 01, General Requirements, Section 23 00 00, HVAC Basic Requirements and individual Division 23, HVAC Sections.
- B. Install equipment and fixtures in accordance with manufacturer's installation instructions, plumb and level and firmly anchored to vibration isolators. Maintain manufacturer's recommended clearances.

- C. Start up equipment, in accordance with manufacturer's start-up instructions, and in presence of manufacturer's representative. Test controls and demonstrate compliance with requirements. Replace damaged or malfunctioning controls and equipment.
 - 1. Do not place equipment in sustained operation prior to initial balancing of HVAC systems.
- D. Provide miscellaneous supports/metals required for installation of equipment, piping and ductwork.

3.11 PAINTING

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

3.12 ACCESS PANELS

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

3.13 DEMOLITION

- A. Confirm requirements in Division 01, General Requirements and Division 02, Existing Conditions. In absence of specific requirements, comply with individual Division 23, HVAC Sections and the following:
 - 1. Scope:
 - a. It is the intent of these documents to provide necessary information and adjustments to the HVAC system required to meet code, and accommodate installation of new work.
 - b. Coordinate with Owner so that work can be scheduled not to interrupt operations, normal activities, building access or access to different areas.
 - c. Existing Conditions: Determine exact location of existing utilities and equipment before commencing work, compensate Owner for damages caused by failure to exactly locate and preserve utilities. Replace damaged items with new material to match existing. Promptly notify Owner if utilities are found which are not shown on Drawings.
 - 2. Equipment: Unless otherwise directed, equipment, fixtures, or fittings being removed as part of demolition process are Owner's property. Remove other

items not scheduled to be reused or relocated from job site as directed by Owner.

3. Unless specifically indicated on Drawings, remove exposed, unused ductwork and piping to behind finished surfaces (floor, walls, ceilings, etc.). Cap and patch surfaces to match surrounding finish.
4. Unless specifically indicated on Drawings, remove unused equipment, fixtures, fittings, rough-ins, and connectors. Removal is to be to a point behind finished surfaces (floors, walls, and ceilings).

3.14 ACCEPTANCE

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

3.15 FIELD QUALITY CONTROL

- A. Confirm Field Quality Control requirements in Division 01, General Requirements, Section 23 00 00, HVAC Basic Requirements and individual Division 23, HVAC Sections.
- B. Tests:
 1. Conduct tests of equipment and systems to demonstrate compliance with requirements specified. Reference individual Specification Sections for required tests. Document tests and include in Operation and Maintenance Manuals.
 2. During site evaluations by Architect or Engineer, provide appropriate personnel with tools to remove and replace trims, covers, and devices so that proper evaluation of installation can be performed.

3.16 LETTER OF CONFORMANCE

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

3.17 ELECTRICAL INTERLOCKS

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

3.18 TEMPORARY HEATING, COOLING AND HUMIDITY CONTROL

- A. Provide temporary heating, cooling, controls, humidification and dehumidification as required to facilitate the construction of the project. Size and select temporary system based on the requirements of the various trades during construction. This includes, but is not limited to, drywall, case work, wood flooring and wood finishes that are subject to warping. Size and install system to prevent mold growth. Coordinate the location of the

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temporary system. The house system can be used. Develop a procedure for how the house system will be used including a sketch depicting the house system, how filtration will be used to prevent construction debris from entering the system and how often the filters will be changed, how the ductwork will be cleaned after use to ensure a clean system is turned over to the Owner and how the units are sized. Submit this procedure to the Mechanical Engineer for review. Follow National Air Duct Cleaners Association (NADCA) duct cleaning procedures and guidelines. Warranties for the house system, if new, to commence when the Owner moves in if house system is used as the means to maintain the climate within the building during construction. Include this warranty requirement in the original bid or proposal amount. Coordinate and provide any temporary power, controls, ductwork, piping, plumbing anchorage, miscellaneous steel and structural supports required to support the temporary system. Installation of the system to comply with all applicable codes and be acceptable to the Authority Having Jurisdiction (AHJ).

END OF SECTION

SECTION 23 05 19
METERS AND GAUGES FOR HVAC PIPING

PART 1 - GENERAL

1.01 SUMMARY

- A. Work Included:
 - 1. Pressure Gauges
 - 2. Pressure-Gauge Fittings
 - 3. Test Plugs

1.02 RELATED SECTIONS

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

1.03 REFERENCES AND STANDARDS

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

1.04 SUBMITTALS

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

1.05 QUALITY ASSURANCE

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

1.06 WARRANTY

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

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Pressure Gauges:
 - 1. Trerice Model 600CB.
 - 2. Dwyer Instruments, Inc.
 - 3. Moeller Instrument Co., Inc.
 - 4. Omega Engineering, Inc.
 - 5. Or approved equivalent.
- B. Pressure-Gauge Fittings:
 - 1. Omega
 - 2. Weiss
 - 3. Trerice
 - 4. Or approved equivalent.
- C. Test Plugs:
 - 1. Petes Plug
 - 2. Or approved equivalent.

2.02 PRESSURE GAUGES

- A. ASME B40.100, phosphor-bronze bourdon type, dry type.
 - 1. Case: Cast aluminum, stem-mounted, flangeless.
 - 2. Size: 4-1/2 inch (115 mm) diameter.
 - 3. Window: Clear glass.
 - 4. Connector: Brass.
 - 5. Scale: White aluminum with black graduation and markings.

6. Pointer: Black, adjustable.
7. Mid-Scale Accuracy: One percent.
8. Scale: Psi.

2.03 PRESSURE-GAUGE FITTINGS

- A. Valves: NPS 1/4 (DN8) brass or stainless-steel needle type.
- B. Syphons: NPS 1/4 (DN8) coil of brass turbine with threaded ends.
- C. Snubbers: ASME B40.5, NPS 1/4 (DN8) brass bushing with corrosion-resistant porous-metal disc of material suitable for system fluid and working pressure.

2.04 TEST PLUGS

- A. Description: Nickel-plated, brass-body test plug in NPS 1/2 (DN15) fitting.
- B. Body: Length as required to extend beyond insulation.
- C. Pressure Rating: 500 PSIG (3450 kPa) minimum.
- D. Core Inserts: One or two self-sealing valves, suitable for inserting 1/8-inch OD probe from dial-type thermometer or pressure gauge.
- E. Core Material for Air, Water, Oil and Gas: 20 to 200 degrees F (Minus 7 to plus 93 Degrees Celsius), chlorosulfonated polyethylene synthetic rubber.
- F. Test Plug Cap: Gasketed and threaded cap, with retention chain or strap.
- G. Test Kit: Pressure gauge and adapter with probe, two bimetal dial thermometers, and carrying case.
 1. Pressure Gauge and Thermometer Ranges: Approximately two times the system's operating conditions.

PART 3 - EXECUTION

3.01 GENERAL INSTALLATION REQUIREMENTS

- A. Provide instruments with scale ranges selected according to service with largest appropriate scale.

3.02 PRESSURE GAUGES

- A. Install pressure gauges in piping tee with pressure gauge cock, located on pipe at most readable position, visible from floor.
- B. Locations: Install in the following locations as a minimum, and elsewhere as indicated.
 1. At each pump inlet and outlet.
 2. At inlet and discharge of each pressure reducing valve.
 3. At makeup water service outlets.
 4. At inlet and discharge of each chiller and boiler.
- C. Install in locations where they are easily read from normal operating level. Install vertical to 45 degrees off vertical.
- D. Adjust to final angle, clean windows and lenses, and calibrate to zero.
- E. Pressure Gauge Range/Graduations:

System	Pressure (PSI)	Graduations (PSI)
Heating Water	0-100	1

3.03 PRESSURE-GAUGE FITTINGS

- A. Install per manufacturer's instructions and recommendations.
- B. Reference "Pressure Gauges" Article above.

3.04 TEST PLUGS

- A. Locate test plugs adjacent to thermometers and thermometer sockets, adjacent to pressure gauges and pressure gauge taps, adjacent to control device sockets, or where indicated.

END OF SECTION

SECTION 23 05 23
GENERAL-DUTY VALVES FOR HVAC PIPING

PART 1 - GENERAL

1.01 SUMMARY

- A. Work Included:
 - 1. Ball Valves
 - 2. Swing Check Valves

1.02 RELATED SECTIONS

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

1.03 REFERENCES AND STANDARDS

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

1.04 SUBMITTALS

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

1.05 QUALITY ASSURANCE

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

1.06 WARRANTY

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

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Source Limitations for Valves: Obtain each type of valve from a single source and from a single manufacturer.
- B. Valves, General:
 - 1. Apollo
 - 2. Armstrong
 - 3. ASCO
 - 4. Cla-Val
 - 5. Conbraco
 - 6. Crane
 - 7. Clow
 - 8. Griswold
 - 9. Hammond
 - 10. Hays
 - 11. Jenkins
 - 12. Josam
 - 13. Kennedy
 - 14. Milwaukee
 - 15. Mueller
 - 16. Nibco
 - 17. Red-White Valve
 - 18. Smith
 - 19. Stockham

- 20. Tour Anderson
- 21. Wade
- 22. Watts
- 23. Wilkins
- 24. Zurn
- 25. Or approved equivalent.
- C. Ball Valves:
 - 1. See Valves General above.
- D. Swing Check Valves:
 - 1. See Valves General above.

2.02 VALVES - GENERAL

- A. General:
 - 1. Sizes: Unless otherwise indicated, provide valves of same size as upstream pipe size.
 - 2. Operators: Provide handwheels, fastened to valve stem, for valves other than quarter-turn. Provide lever handle for quarter-turn valves 6 inches and smaller. Provide gear operators for quarter-turn valves 8 inches and larger and plug valves 5 inches and larger. Provide chain-operated sheaves and chains for overhead valves installed over 5 feet above finished floor.
 - 3. Valve Identification: Manufacturer's name (or trademark) and pressure rating clearly marked on valve body.
- B. Valves in Insulated Piping: With 2-inch stem extension and following features:
 - 1. Ball Valves: With extended operating handle of non-thermal-conductive material, and protective sleeve that allows operation of valve without breaking the vapor seal or disturbing insulation and memory stops that are fully adjustable after insulation is applied.
 - a. Basis of Design Product: Subject to compliance with requirements. Provide NIBCO NIB-SEAL handle extension or comparable product by one of the following.
 - 1) Conbraco Industries, Inc.: Apollo Div.
- C. Valve-End Connections:
 - 1. Flanged: With flanges according to ASME B16.1 for iron valves, ASME B16.5 for steel valves.
 - 2. Grooved: With grooves according to AWWA C606.
 - 3. Solder Joint: With sockets according to ASME B16.18.
 - 4. Threaded: With thread according to ASME B1.20.1.
- D. Valve Bypass and Drain Connections: MSS SP-45.

2.03 BALL VALVES

- A. 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.
- C. 3 Inches and Larger: MSS SP-110, 400-600 PSI, three-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 82-100/82A 140 Series three-piece.
- D. Full Port Ball Valve: 2- to 4-inch ductile iron, ASTM A536, micro finish steel chrome plated or stainless steel ball and stem. TFE seats, 600 PSI.

2.04 SWING CHECK VALVES

- A. 2 Inches and Smaller: Class 125, bronze body, horizontal swing, regrinding type, Y-pattern, renewable disc. Nibco 413. MSS SP-80, Type 4.
- B. 2-1/2 Inches and Larger: Class 125, iron body, bolted bonnet, horizontal swing, renewable seat and disc, flanged ends. Nibco F918. MSS SP-71, Type 1.
- C. Gruvlok Check Valve: Horizontal installation. Working pressure to 300 PSI. Ductile body, ASTM A536, and stainless clapper, EPDM, nitrile or optional viton bumper and bonnet seals. Stainless wetted parts.

PART 3 - EXECUTION

3.01 GENERAL VALVE 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 angle valves closed to prevent rattling.
 - 4. Set ball open to minimize exposure of functional surfaces.
 - 5. Block check valves in either closed or open position.
- B. 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.
- C. 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.
- D. 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.
- E. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.
- F. Do not attempt to repair defective valves; replace with new valves.
- G. Install valves per manufacturer's recommendations.
- H. 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.
- I. Purge and clean piping to be connected to valve.
- 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. Determine that the valve and its 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 mating flanges are in line and parallel to minimize straining on joints and valve body.
- L. Insulation: Where insulation is indicated, install extended stem valves, arranged in proper manner to receive insulation.
- M. Mechanical Actuators: Install with chain operators where indicated. Extend chains to 5-feet above floor and hook to clips to clear aisle passage.

- N. Stem Selection: Outside screw and yoke stems, except provide inside screw, nonrising stem where space prevents full opening of OS&Y valves.
- O. Seats: Renewable seats, except where otherwise indicated.
- P. When soldering, use paste flux that is approved by the manufacturer for use with lead-free alloys.
- Q. Boiler isolation valves with adjustable packing gland per CSD-1 requirements.
- R. 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 23 05 53, Identification for HVAC Piping, Ductwork and Equipment.
- S. General Requirements for Valve Applications:
 - 1. If valve applications are not indicated, use the following:
 - a. Shutoff Service: Ball valves.
 - b. Throttling Service: Balancing valves.
 - c. Pump-Discharge Check Valves:
 - 1) 2 Inches and Smaller: Swing or spring-loaded lift check valves with bronze disc.
 - 2) 2-1/2 Inches and Larger: Swing check valves with lever and weight or with spring or wafer - seat check valves.
 - d. Provide isolation valve, check valve, automatic flow control valve and balancing valve on discharge side of pumps where indicated. Combination triple duty valves not allowed. Provide isolation valve and strainer on suction side of pump.
 - 2. 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.
 - 3. Valves, except wafer types, with the following end connections.
 - a. For Copper Tubing 2 Inches and Smaller: Threaded ends.
 - b. For Copper Tubing 2-1/2 Inches to NPS 4 Inches: Flanged ends.
 - c. For Copper Tubing 5 Inches and Larger: Flanged ends.
 - d. For Steel Piping 2 Inches and Smaller: Threaded ends.
 - e. For Steel Piping 2-1/2 inches to NPS 4 Inches: Flanged ends.
 - f. For Steel Piping 5 Inches and Larger: Flanged ends.
 - g. For Grooved-End Copper Tubing and Steel Piping: Valve ends may be grooved.

3.02 BALL VALVE INSTALLATION

- A. See General Installation Requirements above.

3.03 SWING CHECK VALVE INSTALLATION

- A. See General Installation Requirements above.
- B. Install in the horizontal or vertical position with upward flow. Install for proper direction of flow. Install with minimum three pipe diameters of straight pipe upstream of valve.

END OF SECTION

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

PART 1 - GENERAL

1.01 SUMMARY

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

1.02 RELATED SECTIONS

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

1.03 REFERENCES AND STANDARDS

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

1.04 SUBMITTALS

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

1.05 QUALITY ASSURANCE

- A. Quality assurance as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.
- B. In addition, meet the following:
 - 1. Welding:
 - a. Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications".
 - 2. Welding for Hangers:
 - a. Qualify procedures and personnel according to AWS D9.1, Sheet Metal Welding Code for duct joint and seam welding.
 - 3. Engineering Responsibility:
 - a. Design and preparation of Shop Drawings and calculations for each multiple pipe support, trapeze, duct support equipment hangers/supports, and seismic restraint by a qualified Structural Professional Engineer.
 - 1) Professional Engineer Qualifications: A professional engineer who is legally qualified to practice in jurisdiction where project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of hangers and supports that are similar to those indicated for this Project in material, design, and extent.

4. Manufacturers regularly engaged in the manufacture of bolted metal framing support systems, whose products have been in satisfactory use in similar service for not less than 10 years.
5. Support systems to be supplied by a single manufacturer.

1.06 WARRANTY

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

1.07 PERFORMANCE REQUIREMENTS

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

2.01 MANUFACTURERS

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

2.02 HANGERS AND SUPPORTS FOR HVAC PIPING, DUCTWORK AND EQUIPMENT

- A. Hanger Rods: Hanger rods continuously threaded or threaded ends only in concealed spaces and threaded ends only in exposed spaces; finish electro-galvanized or cadmium-plated in concealed spaces and prime painted in exposed spaces; sizes per MSS.
- B. Hanger Rod Couplings: Anvil Figure 136, B-Line Figure B3220, or approved equivalent; malleable iron rod coupling with elongated center sight gap for visual inspection; to have same finish as hanger rods.
- C. Channel Hanging System:
 - 1. Framing members No. 12 gauge formed steel channels, 1-5/8-inch square, conforming to ASTM A570 GR33, one side of channel to have a continuous slot within turned lips; framing nut with grooves and spring 1/2-inch size, conforming to ASTM 675 GR60; screws conforming to ASTM A307; fittings conforming to ASTM A575; parts enamel painted or electro-galvanized.
 - 2. Concrete Inserts: Malleable iron body, hot dipped galvanized finish. Lateral adjustment. MSS Type 18.
- D. Continuous Concrete Insert: Steel construction, minimum 12 gauge. Electrogalvanized finish. Pipe clamps and insert nuts to match.
- E. Pipe Hangers:
 - 1. Pipe Rings for Hanger Rods:
 - a. Pipe Sizes 2-inches and Smaller: Adjustable swivel ring hanger, UL listed. Erico 100 or 101, Anvil Figures 69 or 104, or approved equivalent.
 - b. Pipe Sizes 2-1/2-inches and Larger: Clevis type hangers with adjustable nuts on rod, UL listed. Anvil figure 260, Erico 400, or approved equivalent.
 - c. Pipe hangers to have same finish as hanger rods.
- F. 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).

2.03 BUILDING ATTACHMENTS

- A. Powder-Actuated Drive Pin Fasteners: Powder actuated type, drive pin attachments with pull-out and shear capacities appropriate for supported loads and building materials where used.
- B. Anchor Bolts:
 - 1. Anchor supports to existing masonry, block and tile walls per anchoring system manufacturer's recommendations or as modified by project structural engineer. Insert-type attachments with pull-out and shear capacities appropriate for supported loads and building materials where used.
 - 2. Anchor Bolts (Cast-In-Place): Steel bolts, ASTM A307. Nuts to conform to ASTM A194. Design values for shear and tension not more than 80 percent of the allowable listed loads.
 - 3. Anchor (Expansion) Bolts: Carbon steel to ASTM A307; nut to conform to ASTM A194; drilled-in type. Design values for shear and tension not more than 80 percent of the allowable listed loads.
 - 4. Anchor (Adhesive) Bolts: Consisting of two-part adhesive cartridge and zinc-plated Type A307 steel anchor bolt rod assembly with ASTM A194 nut.

2.04 FLASHING

- A. Steel Flashing: 26 gauge galvanized steel.

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

2.05 MISCELLANEOUS METAL AND MATERIALS

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

3.01 GENERAL INSTALLATION REQUIREMENTS

- A. Verify building materials to have hangers and attachments affixed in accordance with hangers to be used. Provide supporting calculations.
- B. Examine Drawings and coordinate for verification of exact locations of fire and smoke rated walls, partitions, floors and other assemblies. Indicate, by shading and labeling on Record Drawings such locations and label as "1-Hour Wall", "2-Hour Fire/Smoke Barrier", and the like. Determine proper locations for piping penetrations. Set sleeves in place in new floors, walls or roofs prior to concrete pour or grouting.
- C. Install hangers, supports, anchors and sleeves after required building structural work has been completed in areas where the work is to be installed. Coordinate proper placement of inserts, anchors and other building structural attachments.

- D. Equipment Clearances: Do not route ductwork, equipment, or piping through electrical rooms, 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.

3.02 HANGERS AND SUPPORTS FOR HVAC PIPING, DUCTWORK AND EQUIPMENT

- A. Hang rectangular sheet-metal ducts with a cross sectional area of less than 7 SF with galvanized strips of No. 16 USS gauge steel 1-inch wide, and larger ducts with steel angles and adjustable hanger rods similar to piping hangers. Support at a maximum of 8-feet on center.
- B. Support horizontal ducts within 24-inches of each elbow and within 48-inches of each branch intersection.
- C. Provide aluminum supports for aluminum ductwork.
- D. Install upper attachments to structures with an allowable load not exceeding one-fourth of failure (proof-test) load.
- E. Use double nuts and lock washers on threaded rod supports.
- F. Anchor ducts securely to building in such a manner as to prevent transmission of vibration to structure. Do not connect duct hanger straps to roof deck. Do not support ducts from other ducts, piping or equipment.
- G. Attach strap hangers installed flush with end of sheet-metal duct run to duct with sheet-metal screws.
- H. Construct exterior ductwork or ductwork which is otherwise exposed to weather watertight and slope 1/4-inch per foot to avoid standing water.
- I. 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.
- J. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers, and other accessories.
- K. 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.
- L. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.
- M. 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.
- N. Prime paint ferrous nongalvanized hangers, accessories, and supplementary steel which are not factory painted.
- O. Horizontal Piping Hangers and Supports; Horizontal and Vertical Piping, and Hanger Rod Attachments:
1. Factory fabricated horizontal piping hangers and supports complying with MSS SP-58, to suit piping systems and in accordance with 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. Pipe support spacing (pipe supported in ceiling or floor-supported) to meet latest applicable Code and manufacturer's requirements.

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5. Provide copper-plated hangers and supports for uninsulated copper piping systems.
- P. Plumber's Tape not permitted as pipe hangers or pipe straps.
- Q. Comply with MSS SP-58. 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.
- R. Pipe Support Brackets: Support pipe with pipe slides.
- S. 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.
- T. Do not support piping from other piping.
- U. Fire protection piping will be supported independently of other piping.
- V. Prevent electrolysis in support of copper tubing by use of hangers and supports which are copper plated.
- W. 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.
- X. Insulated Piping:
 1. Attach clamps and spacers to piping.
 - a. Piping Operating Above Ambient Air Temperature: Clamp may project through insulation.
 - b. Piping Operating Below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
 2. Do not exceed pipe stress limits according to ASME B31.9.
 3. Install MSS SP-58, Type 39 protection saddles, if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.
 4. Install MSS SP-58, Type 40 protective shields on cold piping with vapor barrier. Shields to span arc of 180 degrees.
 5. 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.
 6. Shield Dimensions for Pipe, not less than the following:
 - a. NPS 1/4 to NPS 3-1/2 (DN8 to DN 90): 12-inches long and 0.048-inch thick.
 - b. NPS 4 (DN100): 12-inches long and 0.06-inch thick.
 - c. NPS 5 and NPS 6 (DN125 and DN150): 18-inches long and 0.06-inch thick.
 - d. NPS 8 to NPS 14 (DN200 to DN350): 24-inches long and 0.075-inch thick.
 - e. NPS 16 to NPS 24 (DN400 to DN600): 24-inches long and 0.105-inch thick.
 7. Pipes NPS 8 (DN200) and Larger: Include wood inserts.
 - a. Insert Material: Length at least as long as protective shield.
 8. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.
- Y. 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.
- Z. Pipe Curb Assemblies:
 1. Provide prefabricated units for roof membrane and insulation penetrations related to equipment. Coordinate with roofing system. Set supports on the structural

deck. Do not set supports on insulation or roofing. Provide level supports by prefabricated pitch built into the curb.

2. Provide for piping and electrical conduit which penetrates the structural roof deck to service equipment above the roof level (i.e., piping, electrical power and control wiring). Meet requirements of roof warranty.
- AA. Escutcheon Plates: Install around horizontal and vertical piping at visible penetrations through walls, partitions, floors, or ceilings, including penetrations through closets, through below ceiling corridor walls, and through equipment room walls and floors.
- AB. Piping above roof to be supported with freestanding roof pipe supports unless detailed otherwise.

3.03 BUILDING ATTACHMENTS

- A. Factory fabricated attachments complying with MSS SP-58, selected to suit building substructure conditions and in accordance manufacturer's published product information.
- B. Select size of building attachments to suit hanger rods.
- C. 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. 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.
- I. Do not use powder-actuated concrete fasteners for lightweight aggregate concretes or for slabs less than 4-inches thick.
- J. 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.
- K. 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.

3.04 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.

3.05 MISCELLANEOUS METAL AND MATERIALS

- A. General: Verify dimensions prior to fabrication. Form metal items to accurate sizes and configurations as indicated on drawings and otherwise required for proper installation; make with lines straight and angles sharp, clean and true; drill, countersink, tap, and otherwise prepare items for connections with work of other trades, as required. Fabricate to detail of structural shapes, plates and bars; weld joints where practicable; provide bolts and other connection devices required. Include anchorages; clip angles, sleeves, anchor plates, and similar devices. Hot dipped galvanize after fabrication items installed in exterior locations. Set accurately in position as required and anchor securely to building construction. Construct items with joints formed for strength and rigidity, accurately machining for proper fit; where exposed to weather, form to exclude water.
- B. Finishes:
 - 1. Ferrous Metal: After fabrication, but before erection, clean surfaces by mechanical or chemical methods to remove rust, scale, oil, corrosion, or other substances detrimental to bonding of subsequently applied protective coatings. For metal items exposed to weather or moisture, galvanize in manner to obtain G90 zinc coating in accordance with ASTM A123. Provide other non-galvanized ferrous metal with 1 coat of approved rust-resisting paint primer, in manner to obtain not less than 1.0 mil dry film thickness. Touch-up damaged areas in primer with same material, before installation. Apply zinc coatings and paint primers uniformly and smoothly; leave ready for finish painting as specified elsewhere.
 - 2. Metal in Contact with Concrete, Masonry and Other Dissimilar Materials: Where metal items are to be erected in contact with dissimilar materials, provide contact surfaces with coating of an approved zinc-chromate primer in manner to obtain not less than 1.0 mil dry film thickness, in addition to other coatings specified in these specifications.
 - 3. For Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and apply galvanizing repair paint to comply with ASTM A780.
- C. Coordinate and furnish anchorages, setting drawings, diagrams, templates, instructions, and directions for installation of anchorages, such as concrete inserts, sleeves, anchor bolts and miscellaneous items having integral anchors, which are to be embedded in concrete or masonry construction. Coordinate delivery of such items to project site.
- D. Fastening to In-Place Construction: Provide anchorage devices and fasteners where necessary for securing miscellaneous metal fabrications to in-place construction; including, threaded fasteners for concrete and masonry inserts, toggle bolts, through-bolts, lag bolts, wood screws and other connectors as required. Avoid cutting concrete reinforcing when drilling for inserts. Reference structural drawings and reinforcing shop drawings and determine locations of stirrups prior to drilling into concrete.
- E. Cutting, Fitting and Placement: Perform cutting, drilling and fitting required for installation of miscellaneous metal fabrications. Set work accurately in location, alignment and elevation, plumb, level, true and free of rack, measured from established lines and levels. Provide temporary bracing or anchors in formwork for items, which are to be built into concrete masonry or similar construction.
- F. Field Welding: Comply with AWS Code for procedures of manual shielded metal-arc welding, appearance and quality of welds made, and methods used in correcting welding work.
- 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

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before packing with grout. Use metallic non-shrink grout in concealed locations where not exposed to moisture; use non-metallic non-shrink grout in exposed locations, unless otherwise indicated.

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

END OF SECTION

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

PART 1 - GENERAL

1.01 SUMMARY

- A. Work Included:
 - 1. Vibration Isolation
- 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.

1.02 RELATED SECTIONS

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

1.03 REFERENCES AND STANDARDS

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

1.04 SUBMITTALS

- A. Submittals as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.
- B. In addition, provide:
 - 1. Welding certificates.
 - 2. Equipment Certification: Provide seismic certification for equipment as noted in Seismic Design Summary or schedules on Drawings.

1.05 QUALITY ASSURANCE

- A. Quality assurance as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.
- B. In addition, meet the following:
 - 1. Vibration Isolation:
 - a. Except for packaged equipment with integral isolators, single manufacturer selects and furnishes isolation required.
 - b. Deflections indicated on drawings are minimum actual static deflections for specific equipment supported.
 - c. Isolator Stability:
 - 1) Size springs of sufficient diameter to maintain stability of equipment being supported. Spring diameters not less than 0.8 of compressed height at rated load.
 - 2) Springs have minimum additional travel to solid equal to 50 percent of rated deflection.
 - 3) Springs support 200 percent of rated load, fully compressed, without deformation or failure.

- d. Maximum Allowable Vibration Levels: Peak vibration velocities not exceed 0.08 in/sec. Correct equipment operating at vibration velocities that exceed this criteria.

1.06 WARRANTY

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

1.07 EXTRA MATERIALS

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

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Vibration Isolation:
 - 1. The VMC Group
 - 2. B-Line Systems, Inc.
 - 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.
 - 7. Or approved equivalent.

2.02 VIBRATION ISOLATION

- A. Type 1 - Neoprene Pad: Natural rubber waffle pads, arranged in single or multiple layers, 3/4-inch thick per layer with pattern repeating on 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 0.20-inches. Mason Type: BR.
- C. Type 3 - Spring: Freestanding, laterally stable, open-spring isolators.
 - 1. Outside Spring Diameter: Not less than 80 percent of compressed height of spring at rated load.
 - 2. Minimum Additional Travel: 50 percent of required deflection at rated load.
 - 3. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
 - 4. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
 - 5. Baseplates: Factory drilled for bolting to structure and bonded to 1/4-inch- thick, natural rubber or bridge bearing neoprene isolator pad attached to baseplate underside. Baseplates limit floor load to 100 PSIG (690 kPa).
 - 6. Top Plate and Adjustment Bolt: Threaded top plate with adjustment bolt and cap screw to fasten and level equipment.
 - 7. Brackets: Manufacturer's standard bracket, utilize height saving brackets to accommodate height restrictions.

8. Mason Type: SLFH 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 7 - Pipe Riser Resilient Support: All-directional, acoustical pipe anchor consisting of 2 steel tubes separated by a minimum of 1/2-inch thick, 60-durometer neoprene. Include steel and neoprene vertical-limit stops arranged to prevent vertical travel in both directions. Design support for a maximum load on isolation material of 500 PSIG (3.45 MPa) and for equal resistance in all directions. Mason Type: ADA.
- K. Type 8 - Resilient Pipe Vertical Sliding Guide: Telescopic arrangement of 2 steel tubes separated by a minimum of 1/2-inch thick, 60-durometer neoprene. Factory set guide height with a shear pin to allow vertical motion due to pipe expansion and contraction. Shear pin be removable and reinsertable to allow for selection of pipe movement. Guides be capable of motion to meet location requirements. Mason Type: VSG. Provide pipe expansion hangers to control load shifts as the riser expands or contracts, Mason HES.
- L. Type FC-1, Flexible duct connectors. See Specification Section 23 33 00 Air Duct Accessories.
- M. Type FC-2A, Flexible Pipe Connector, Steel:
1. 321 stainless steel, close pitch, annular corrugated hose.
 2. Exterior Sleeve: 304 stainless steel, braided.
 3. Pressure Rating: 125 PSI at 70 degrees F for 12-inch and smaller pipe.
 4. Joint: ANSI Class 150 carbon steel flanges.

5. Size: Use pipe sized units.
 6. Minimum Allowable Offset: 3/4-inch on each side of installed center line.
 7. Basis of Design: Metraflex Model MLP.
- N. Type FC-2B, Flexible Pipe Connector, Copper:
1. Inner Hose: Bronze, close pitch, annular corrugated hose.
 2. Exterior Sleeve: Braided bronze (for piping over 2-inches, to be 3 pound braided stainless steel).
 3. Minimum Allowable Pressure Rating: 125 PSI at 70 degrees F.
 4. Joint: Sweat ends.
 5. Size: Use pipe sized units.
 6. Minimum Allowable Offset: 3/8-inch on each side of installed center line.
 7. Basis of Design: Metraflex Model BBS.
- O. Type FC-2C, Flexible Pipe Connector, Gas:
1. Inner Hose: 304 stainless steel.
 2. Exterior Sleeve: Braided, 304 stainless steel.
 3. Minimum Allowable Pressure Rating: 150 PSI at 70 degrees F up to 4-inch pipe.
 4. Joint: Threaded carbon steel.
 5. Minimum Allowable Offset: 3/4-inch on each side of installed center line.
 6. Basis of Design: Metraflex GASCT.
- P. Type FC-3, Flexible Compensator, Double Sphere:
1. Body: Molded twin spherical type. Neoprene with internal cord or wire.
 2. Minimum Pressure Rating, Sizes 2-inch to 12-inch: 225 PSI at 170 degrees F.
 3. Minimum Pressure Rating, Sizes 14-inch to 20-inch: 125 PSI at 170 degrees F.
 4. Minimum Allowable Compression: 1-1/2 inches.
 5. Minimum Allowable Elongation: 1-1/8 inches.
 6. Minimum Allowable Offset: 1-1/8 inches.
 7. Minimum Allowable Angular Movement: 20 degrees.
 8. Joint: Steel flanges.
 9. Accessories: Galvanized aircraft-type cable or control rods to prevent over extension.
 10. Basis of Design: Metraflex Doublesphere.

PART 3 - EXECUTION

3.01 GENERAL INSTALLATION REQUIREMENTS

- A. Set floor-mounted equipment with steel base rails on minimum 4-inch-high concrete housekeeping pads. Extend pad minimum 6-inches beyond footprint of equipment in each direction, but not less than twice the embedment depth of concrete anchors.
- B. Provide mounts for equipment installed outdoors for wind loads of 30 lbs. psf applied to any exposed surface of isolated equipment.
- C. Do not install equipment or pipe which makes rigid contact with building slabs, beams, studs, walls, etc.
- D. 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.
- E. 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.

- F. Provide roof curbs, equipment supports and roof penetrations. Work to maintain roof warranty. Coordinate location, size, structural connections/requirements and flashing prior to installation.
- 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. Pipe Hangers in Equipment Rooms: Support water and gas piping connected to rotating equipment within equipment rooms on spring and neoprene hangers. The first three hangers from a piece of vibrating equipment are to have a minimum of 1/2 static deflection of equipment isolators. Other isolators should have a minimum of 1/4 static deflection of equipment isolators.
- I. 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.
- J. Testing: Perform following field quality-control testing:
 - 1. Isolator seismic-restraint clearance.
 - 2. Isolator deflection.
 - 3. Snubber minimum clearances.
- K. 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.
- L. Cleaning: After completing equipment installation, inspect vibration isolation and seismic-control devices. Remove paint splatters and other spots, dirt and debris.
- M. Demonstration: Engage factory-authorized service representative to train Owner's maintenance personnel to adjust, operate and maintain air-mounting systems. Reference Division 01, General Requirements.

3.02 VIBRATION ISOLATION

- A. Reference 3.01, General Installation Requirements.
- B. Install per manufacturer's instructions and recommendations.
- C. Vibration isolators must be installed in strict accordance with manufacturer's written instructions and certified submittal data.
- D. Install isolation as indicated on drawings by type and location and where indicated below.
- E. Equipment Vibration Isolation Schedule:

Equipment	Size	Vibration Isolator Type	Minimum Deflection (in)
Base-Mounted Pumps	0 to 5 HP	B-1, Type 1, FC-3	0.2
Utility Set Centrifugal Fans	All	4A	1.5
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.

END OF SECTION

**SECTION 23 05 53
IDENTIFICATION FOR HVAC PIPING, DUCTWORK AND EQUIPMENT**

PART 1 - GENERAL

1.01 SUMMARY

- A. Work Included:
 - 1. Plastic Nameplates

1.02 RELATED SECTIONS

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

1.03 REFERENCES AND STANDARDS

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

1.04 SUBMITTALS

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

1.05 QUALITY ASSURANCE

- A. Quality assurance as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.
- B. In addition, meet the following:
 - 1. Manufacturer's Qualifications: Firms regularly engaged in manufacture of identification devices of types and sizes required.
 - 2. Codes and Standards: Comply with ANSI A13.1 for lettering size, length of color field, colors, and viewing angles of identification devices unless otherwise indicated.

1.06 WARRANTY

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

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. General: Manufacturer's standard products of categories and types required for each application as referenced in other Division 23, HVAC Sections. Where more than a single type is specified for application, provide single selection for each product category.
- B. Plastic Nameplates:
 - 1. Brady Corporation
 - 2. Brimar
 - 3. Champion America
 - 4. Craftmark
 - 5. Seton
 - 6. Or approved equivalent.

2.02 PLASTIC NAMEPLATES

- A. Description: Engraving stock melamine plastic laminate in the size and thicknesses indicated, engraved with engraver's standard letter style of the sizes and wording indicated, black with white core (letter color), punched for mechanical fastening except where adhesive mounting is necessary because of substrate. Provide 1/8-inch thick material.
 - 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.

PART 3 - EXECUTION

3.01 GENERAL - INSTALLATION

- A. Identify air handling units, pumps, heat transfer equipment, tanks, and water treatment devices with plastic nameplates riveted to equipment body.
- B. Coordinate names, abbreviations and other designations used in mechanical identification work with corresponding designations shown, specified or scheduled. Provide numbers, lettering and wording as indicated or, if not otherwise indicated, as recommended by manufacturers or as required for proper identification and operation/maintenance of mechanical systems and equipment.
- C. Multiple Systems: Where multiple systems of same generic name are shown and specified, provide identification which indicates individual system number as well as service (as examples: Chiller No. 3, Air Handling Unit No. 42, Standpipe F12, and the like).
- D. Degrease and clean surfaces to receive adhesive for identification materials.
- E. Coordination: Where identification is to be applied to surfaces which require insulation, painting or other covering or finish, including valve tags in finished mechanical spaces, install identification after completion of covering and painting. Install identification prior to installation of acoustical ceilings and similar removable concealment.
- F. Coordinate with the facility maintenance personnel to ensure consistency with the existing tagging system.
- G. Install all products in accordance with manufacturer's instructions.
- H. Manual Balancing Dampers: Provide 12-inch long orange marker ribbon to end of balancing damper handle.

3.02 PLASTIC NAMEPLATES

- A. Install plastic nameplates with corrosive-resistant mechanical fasteners.

END OF SECTION

SECTION 23 05 93
TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 - GENERAL

1.01 SUMMARY

- A. Work Included:
 - 1. General Requirements and Procedures
 - 2. Temperature Control Verification
 - 3. Exhaust Fan Air Systems Balancing Procedures
 - 4. Kitchen Hoods
 - 5. Fundamental Procedures for Hydronic Systems
 - 6. Final Reports:
 - a. Report Requirements
 - b. General Report Data
 - c. Hydronic Coils
 - d. Fans
 - e. Instrument Calibration
 - 7. Additional Tests

1.02 RELATED SECTIONS

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

1.03 REFERENCES AND STANDARDS

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

1.04 SUBMITTALS

- A. Submittals as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.
- B. In addition, provide:
 - 1. Quality-Assurance Submittals: Submit two copies of evidence that the Testing, Adjusting, and Balancing (TAB) Agent and this Project's TAB team members meet the qualifications specified in the "Quality Assurance" Article below.
 - 2. Certified TAB Reports: Submit two copies of reports prepared, as specified in this Section, on approved forms certified by the TAB Agent.
 - 3. Test Instrument Calibration: Submit proof of calibration within the last 6 months.
 - 4. Final Report.
 - 5. Provide additional submittals to commissioning authority as dictated in commissioning specifications.

1.05 QUALITY ASSURANCE

- A. Quality Assurance as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.
- B. In addition, meet the following:
 - 1. Acceptable 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:
 - 1) Procure services of independent TAB agency to balance, adjust and test water circulating and air moving equipment and air distribution or exhaust systems. Minimum experience: 5 years.
 - 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. Do not perform TAB work until heating, ventilating, and air conditioning equipment has been completely installed and is operating continuously as required.
4. Conduct air testing and balancing with clean filters in place. Clean strainers prior to performing hydronic testing and balancing.
5. 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.
6. TAB Reports: Use standard forms from AABC's "National Standards for Testing, Adjusting, and Balancing" and NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems."
7. Instrumentation Type, Quantity, and Accuracy: As described in AABC national standards.
8. Instrumentation Calibration: Calibrate instruments at least every 6 months or more frequently if required by the instrument manufacturer.

1.06 WARRANTY

- A. Warranty of materials and workmanship as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.
- B. In addition, provide:

1. TAB Agency provides warranty for a period of 90 days following submission of completed report, during which time, Owner may request a recheck of up to 10 percent of total number of terminals, or resetting of any outlet, coil, or device listed in the final TAB report.
2. Guarantee: Meet the requirements of the following programs:
 - a. Provide a guarantee on AABC or NEBB forms stating that the agency will assist in completing the requirements of the Contract Documents if the TAB Agent fails to comply with the Contract Documents. Guarantee includes the following provisions:
 - 1) The certified Agent has tested, adjusted, and balanced systems according to the Contract Documents.
 - 2) Systems are balanced to optimum performance capabilities within design and installation limits.

1.07 DEFINITIONS

- A. Adjust: To regulate fluid flow rate and air patterns at the terminal equipment, such as to reduce fan speed or adjust a damper.
- B. Balance: To proportion flows within the distribution system, including submains, branches, and terminals, according to design quantities.
- C. Draft: A current of air, when referring to localized effect caused by one or more factors of high air velocity, low ambient temperature, or direction of airflow, whereby more heat is withdrawn from a persons skin than is normally dissipated.
- D. Procedure: An approach to and execution of a sequence of work operations to yield repeatable results.
- E. Report Forms: Test data sheets for recording test data in logical order.
- F. Static Head: The pressure due to the weight of the fluid above the point of measurement. In a closed system, static head is equal on both sides of the pump.
- G. Suction Head: The height of fluid surface above the centerline of the pump on the suction side.
- H. System Effect: A phenomenon that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.
- I. System Effect Factors: Allowances used to calculate a reduction of the performance ratings of a fan when installed under conditions different from those presented when the fan was performance tested.
- J. TAB: Testing, Adjusting, and Balancing.
- K. Terminal: A point where the controlled medium, such as fluid or energy, enters or leaves the distribution system.
- L. Test: A procedure to determine quantitative performance of a system or equipment.
- M. Testing, Adjusting, and Balancing (TAB) Agent: The entity responsible for performing and reporting the TAB procedures.
- N. AABC: Associated Air Balance Council.
- O. AMCA: Air Movement and Control Association.
- P. CTI: Cooling Tower Institute.
- Q. NEBB: National Environmental Balancing Bureau.
- R. SMACNA: Sheet Metal and Air Conditioning Contractors' National Association.

1.08 COORDINATION

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

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

PART 2 - PRODUCTS - NOT USED

PART 3 - EXECUTION

3.01 GENERAL REQUIREMENTS AND PROCEDURES

- A. Project Conditions:
1. 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.
- 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.
 13. Beginning of work means acceptance of existing conditions.
- D. Preparation:
1. Prepare a TAB plan that includes strategies and step-by-step procedures.
 2. Complete system readiness checks and prepare system readiness reports. Verify the following:
 - a. Permanent electrical power wiring is complete.
 - b. Hydronic systems are filled, clean, and free of air.
 - c. Automatic temperature-control systems are operational.
 - d. Equipment and duct access doors are securely closed.
 - e. Balance, smoke, and fire dampers are open.
 - f. Isolating and balancing valves are open and control valves are operational.
 - g. Ceilings are installed in critical areas where air-pattern adjustments are required and access to balancing devices is provided.
 - h. Windows, doors and other portions of the building envelope can be closed so design conditions for system operations can be met.
 3. Provide instruments required for TAB operations. Make instruments available to Architect to facilitate spot checks during testing.
- E. General TAB Procedures:
1. Perform TAB procedures on each system according to the procedures contained in AABC national standards or NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems" and this Section.
 2. 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. 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.

3.02 FUNDAMENTAL AIR SYSTEMS BALANCING PROCEDURES

- A. Examine fans installed as part of this project to ensure, bearings are greased, belts are aligned and tight, and equipment with functioning controls is ready for operation.
- B. Prepare test reports for fans. Obtain manufacturer's outlet factors and recommended testing procedures. Cross check the summation of required outlet volumes with required fan volumes.
- C. Determine the best locations in main and branch ducts for accurate duct airflow measurements.
- D. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.
- E. Verify that motor starters are equipped with thermal protection, sized for the connected load.
- F. Check dampers for proper position to achieve desired airflow path.
- G. Check for airflow blockages.
- H. Check for readily observable leaks in air-handling unit components and ductwork.

3.03 TEMPERATURE CONTROL VERIFICATION

- A. Examine automatic temperature system components to verify the following:
 1. Valves, and other controlled devices operate by the intended controller.
 2. Valves are in the position indicated by the controller.
 3. Integrity of valves for free and full operation and for tightness of fully closed and fully open positions. This includes dampers in multizone units, mixing boxes, and variable-air-volume terminals.
 4. Automatic modulating and shutoff valves, including 2-way valves and 3-way mixing and diverting valves, are properly connected.
 5. Thermostats are located to avoid adverse effects of sunlight, equipment, drafts, and cold walls.
 6. Sensors are located to sense only the intended conditions.
 7. Sequence of operation for control modes is according to the Contract Documents.
 8. Controller set points are set at design values. Observe and record system reactions to changes in conditions. Record default set points if different from design values.
 9. Interlocked systems are operating.
- B. Verify that controllers are calibrated and commissioned.
- C. Check transmitter and controller locations and note conditions that would adversely affect control functions.
- D. Record controller settings and note variances between set points and actual measurements.
- E. Verify free travel and proper operation of control devices such as damper and valve operators.
- F. Confirm interaction of electrically operated switch transducers.
- G. Note operation of electric actuators using spring return for proper fail-safe operations.

3.04 EXHAUST FAN BALANCING PROCEDURES

- A. Adjust fans to deliver total design airflows within the maximum allowable rpm listed by the fan manufacturer. Adjust fans to deliver design airflow at the lowest possible speed.

1. Measure fan static pressures to determine actual static pressure as follows:
 - a. Measure inlet static pressure of single-inlet fans in the inlet duct as near the fan as possible, upstream from flexible connection and downstream from duct restrictions.
2. 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.
3. Make required adjustments speed controller to accommodate fan-speed changes.
4. 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.

3.05 KITCHEN HOODS

- A. Energize the exhaust fan and adjust airflow to provide the indicated hood exhaust air flow rate.
- B. Record each face velocity measurement taken at 4- to 6-inch increments over the entire hood opening.
- C. Calculate the average face velocity by averaging velocity measurements.
- D. Calculate the airflow volume of exhaust-hood face velocity by multiplying the calculated face velocity by the opening area. Compare this quantity with exhaust volume at exhaust fan and report duct leakage.
- E. Measure airflow volume supplied by makeup fan. Verify that the makeup system supplies the proper amount of air to keep the space at the indicated pressure with the exhaust systems in all operating conditions.
- F. Retest for average face velocity. Adjust hood baffles, fan drives, and other parts of the system to provide the indicated average face velocity and the indicated auxiliary air-supply percentages.
- G. Retest and adjust the systems until fume-hood performance complies with Contract Documents.

3.06 FUNDAMENTAL PROCEDURES FOR HYDRONIC SYSTEMS

- A. Examine strainers for clean screens and proper perforations.
- B. Prepare test reports with pertinent design data and number in sequence starting at pump to end of system. Check the sum of branch-circuit flows against approved pump flow rate. Correct variations that exceed plus or minus 5 percent.
- C. Prepare hydronic systems for TAB according to the following, in addition to the general preparation procedures specified above:
 1. Open manual valves for maximum flow.
 2. Check expansion tank liquid level, or air charge if bladder type.
 3. Check makeup-water-station pressure gauge for adequate pressure for highest vent.
 4. Check flow-control valves for specified sequence of operation and set at design flow.
 5. Set system controls so automatic valves are wide open to heat exchangers and coils.
 6. Check pump-motor load. If motor is overloaded, throttle main flow-balancing device so motor nameplate rating is not exceeded.
 7. Check air vents for a forceful liquid flow exiting from vents when manually operated.

3.07 FINAL REPORTS

- A. Report Requirements:
 - 1. General:
 - a. Computer printout in letter-quality font, on standard bond paper, in 3-ring binder, tabulated and divided into sections by tested and balanced systems.
 - b. Include a certification sheet in front of binder signed and sealed by the certified TAB engineer.
 - 1) Include a list of the instruments used for procedures, along with proof of calibration.
 - c. Final Report Contents: In addition to the certified field report data, include the following:
 - 1) Fan Curves
 - 2) Manufacturers Test Data
 - 3) Field test reports prepared by system and equipment installers.
 - 4) Other information relative to equipment performance, but do not include approved Shop Drawings and Product Data.
- B. General Report Data:
 - 1. In addition to the form titles and entries, include the following data in the final report, as applicable:
 - a. Title Page
 - b. Name and Address of TAB Agent
 - c. Project Name
 - d. Project Location
 - e. Architect's Name and Address
 - f. Engineer's Name and Address
 - g. Contractor's Name and Address
 - h. Report Date
 - i. Signature of TAB Agent who Certifies the Report
 - j. Summary of Contents, Including the Following:
 - 1) Design versus Final Performance
 - 2) Notable Characteristics of Systems
 - 3) Description of System Operation Sequence if it varies from the Contract Documents
 - k. Nomenclature Sheets for Each Item of Equipment
 - l. Notes to explain why certain final data in the body of reports vary from design values.
 - m. Test Conditions for Fans and Pump Performance Forms, Including the Following:
 - 1) Settings for Exhaust-air Dampers
 - 2) Fan Drive Settings, including Settings and Percentage of Maximum Pitch Diameter
 - 3) Other System Operating Conditions that affect Performance
- C. Hydronic Coils in Replaced Unit Ventilators:
 - 1. For hydronic coils in all equipment with coils, include the following:
 - a. Coil Data: Include the following:
 - 1) System Identification

- 2) Location and Zone
 - 3) Room or Riser Served
 - 4) Coil Type
 - 5) Number of Rows
 - 6) Fin Spacing in Fins per Inch o.c.
 - 7) Make and Model Number
 - 8) Face Area in SF
 - 9) Tube Size in NPS (DN)
 - 10) Tube and fin Materials
 - 11) Circuiting Arrangement
- b. Test Data: Include design and actual values for the following:
- 1) Airflow Rate in cfm
 - 2) Average Face Velocity in fpm
 - 3) Air Pressure Drop in Inches wg
 - 4) Outside-air, Wet- and Dry-bulb Temperatures in Degrees F
 - 5) Return-air, Wet- and Dry-bulb Temperatures in Degrees F
 - 6) Entering-air, Wet- and Dry-bulb Temperatures in Degrees F
 - 7) Leaving-air, Wet- and Dry-bulb Temperatures in Degrees F
 - 8) Water Flow Rate in gpm
 - 9) Water Pressure Differential in Feet of Head or PSIG
 - 10) Entering-water Temperature in Degrees F
 - 11) Leaving-water Temperature in Degrees F

D. Fans:

1. Fan Test Reports: For supply, return, and exhaust fans, include the following:
 - a. Fan Data: Include the following:
 - 1) System Identification
 - 2) Location
 - 3) Make and Type
 - 4) Model Number and Size
 - 5) Manufacturer's Serial Number
 - 6) Arrangement and Class
 - 7) Sheave Make, Size in Inches, and Bore
 - 8) Sheave Dimensions, Center-to-center and Amount of Adjustments in Inches.
 - b. Motor Data: Include the following:
 - 1) Make and Frame Type and Size
 - 2) Horsepower and rpm
 - 3) Volts, Phase, and Hertz
 - 4) Full-load Amperage and Service Factor
 - 5) Sheave Make, Size in Inches, and Bore
 - 6) Sheave Dimensions, Center-to-center and Amount of Adjustments in Inches
 - 7) Number of Belts, Make, and Size
 - c. Test Data: Include design and actual values for the following:
 - 1) Total Airflow Rate in cfm

- 2) Total System Static Pressure in Inches wg
- 3) Fan rpm
- 4) Discharge Static Pressure in Inches wg
- 5) Suction Static Pressure in Inches wg

E. Instrument Calibration:

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

3.08 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

1.01 SUMMARY

- A. Work Included:
 - 1. Type 1, Glass Wool Pipe Insulation
 - 2. Accessories

1.02 RELATED SECTIONS

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

1.03 REFERENCES AND STANDARDS

- A. References and Standards as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.
- B. In addition, meet the following:
 - 1. Piping and duct insulation products to contain less than 0.1 percent by weight PBDE in all insulating materials.

1.04 SUBMITTALS

- A. Submittals as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.
- B. In addition, provide:
 - 1. Installer qualifications.
 - 2. Product Data: Identify thermal conductivity, thickness, and jackets (both factory and field applied, if any) for each type of product indicated.
 - 3. Material Test Reports: From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of insulation materials, sealers, attachments, cements, and jackets with requirements indicated. Include dates of tests.
 - 4. Installer Certificates: Signed by the Contractor certifying that installers comply with requirements.
 - 5. Submit manufacturer's installation instructions.

1.05 QUALITY ASSURANCE

- A. Quality assurance as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.
- B. In addition, meet the following:
 - 1. Formaldehyde Free: Should be third-party certified with UL Environment Validation.
 - 2. Recycled Content: A minimum of 40 percent post-consumer recycled glass content certified and UL validated.
 - 3. Low Emitting Materials: For all thermal and acoustical applications of Glass Mineral Wool Insulation products, provide materials complying with the testing and products requirements of UL GREENGUARD Gold Certification.
 - 4. Installer to have minimum 5 years' experience in the business of installing insulation.

1.06 WARRANTY

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

1.07 FIRE HAZARD CLASSIFICATION

- A. Maximum fire hazard classification of the composite insulation construction as installed to be not more than a Flame Spread Index (FSI) of 25 and Smoke Developed Index (SDI) of 50 as tested by current edition of ASTM E84 (NFPA 255) method.
- B. Test pipe insulation in accordance with the requirements of current edition of UL "Pipe and Equipment Coverings R5583 400 8.15".
- C. Test duct insulation in accordance with current edition of ASTM E84, UL 723, NFPA 255, NFPA 90A and NFPA 90B.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Type 1, Glass Wool Pipe Insulation:
 - 1. Certainteed
 - 2. Johns Manville
 - 3. Knauf
 - 4. Owens-Corning
 - 5. Or approved equivalent.
- B. Accessories:
 - 1. ITW Insulation Systems
 - 2. Or approved equivalent.

2.02 TYPE 1, GLASS WOOL PIPE INSULATION

- A. Glass Wool: ASTM C547 Type I and IV; rigid molded, noncombustible.
 - 1. Thermal Conductivity Value: As indicated in the insulation tables below.
 - 2. Maximum Service Temperature: 850 degrees F to 1000 degrees F.
- B. Vapor Retarder Jacket: White Kraft paper reinforced with glass wool and bonded to aluminum foil, secure with self-sealing longitudinal laps and butt strips or vapor barrier mastic.

2.03 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.

PART 3 - EXECUTION

3.01 GENERAL INSTALLATION REQUIREMENTS

- A. Verification of Conditions:
 - 1. Do not apply insulation until pressure testing and inspection of ducts and piping has been completed.
 - 2. Examine areas and conditions under which duct and pipe insulation will be installed. Do not proceed with work until unsatisfactory conditions have been corrected.
- B. Preparation: Clean and dry surfaces to be insulated.

- C. Installation:
1. Insulation: Continuous through walls, floors and partitions except where noted otherwise.
 2. Piping and Equipment:
 - a. Install insulation over clean, dry surfaces with adjoining sections firmly butted together and covering surfaces. Fill voids and holes. Seal raw edges. Install insulation in a manner such that insulation may be split, removed, and reinstalled with vapor barrier tape on strainer caps and unions. Do not install insulation until piping has been leak tested and has passed such tests. Do not insulate manholes, equipment manufacturer's nameplates, handholes, and ASME stamps. Provide beveled edge at such insulation interruptions. Repair voids or tears.
 - 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. 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.
- G. Piping Surfaces to be Insulated:

Item to be Insulated	System Insulation Type	Conductivity Range (Btu-inch per hour per SF per degrees F)	Pipe Size (Inches)	Insulation Thickness (Inches)
Heating, Steam, and Steam Condensate (141F to 200F)	1, 4	0.25-0.29 at a mean rating temperature of 125 degrees F	<1	1.5
			1 to <1.5	1.5
			1.5 to <4	2.0
			4 to <8	2.0
			>= 8	2.0

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

3.02 TYPE 1, GLASS WOOL PIPE INSULATION

- A. See General Installation Requirements above.
- B. Install insulation in conformance with manufacturer's recommendations and requirements.
- 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.

3.03 ACCESSORIES

- A. Install insulation in conformance with manufacturer's instructions, recommendations and requirements.
- B. See General Installation Requirements above.
- C. Provide and install accessories for all insulation types listed in this Section.

END OF SECTION

**SECTION 23 21 13
HVAC PIPING**

PART 1 - GENERAL

1.01 SUMMARY

- A. Work Included:
 - 1. Heating Water Piping, Above Ground
 - 2. Unions
 - 3. Refrigerant Piping

1.02 RELATED SECTIONS

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

1.03 REFERENCES AND STANDARDS

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

1.04 SUBMITTALS

- A. Submittals as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.
- B. In addition, provide:
 - 1. Welding Certificates: Copies of certificates for welding procedures and personnel.
 - 2. Field Test Reports: Written reports of tests specified in Part 3 of this Section. Include the following:
 - a. Test procedures used.
 - b. Test results that comply with requirements.
 - c. Failed test results and corrective action taken to achieve requirements.

1.05 QUALITY ASSURANCE

- A. Quality assurance as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.
- B. In addition, meet the following:
 - 1. Installer Qualifications: Company specializing in performing work of the type specified in this Section, with documented experience.
 - 2. Welder Qualifications: Certify in accordance with ASME (BPV IX).
 - 3. ASME Compliance: Comply with ASME B31.9 "Building Services Piping" for materials, products, and installation. Provide safety valves and pressure vessels with the appropriate ASME label. Fabricate and stamp air separators and expansion tanks to comply with the ASME Boiler and Pressure Vessel Code, Section VIII, Division 01.
 - 4. Refrigerant Piping:
 - a. Welding: Qualify procedures and personnel according to ASME Boiler and Pressure Vessel Code: Section IX "Welding and Brazing Qualifications."
 - b. ASHRAE Standard: Comply with ASHRAE 15, "Safety Code for Mechanical Refrigeration."
 - c. ASME Standard: Comply with ASME B31.5, "Refrigeration Piping."
 - d. UL Standard: Provide products complying with UL 207, "Refrigerant-Containing Components and Accessories, Nonelectrical" or UL 429 "Electrically Operated Valves."

1.06 WARRANTY

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

PART 2 - PRODUCTS

2.01 HEATING WATER PIPING, ABOVE GROUND

- A. Steel Pipe: ASTM A53/A 53M, Schedule 40, black, Type E (electric resistance welded), Grade B.
1. Fittings: ASME B16.3, malleable iron or ASTM A 234/A 234M, wrought steel welding type.
 2. Wrought Cast and Forged Steel Flanges and Flanged Fittings: ASME B16.5 including bolts, nuts, and gaskets of the following material group, end connections, and facings:
 - a. Material Group: 1.1.
 - b. End Connections: Butt welding.
 - c. Facings: Raised face.
 3. Joints: Threaded or AWS D1.1 welded.
- B. Copper Tube: ASTM B 88 (ASTM B 88M), Type L (B), drawn.
1. Fittings: ASME B16.18, cast brass, or ASME B16.22, solder wrought copper.
 2. Joints: Solder, lead free ASTM B32, HB alloy (95-5 tin antimony), or tin and silver.
 3. Joints: Brazed, AWS A5.8, Classification BAg-1 (silver). Pipes 2-1/2-inches or larger or piping routed over food preparation centers, food serving facilities, food storage areas, computer rooms, telecommunications rooms, and electrical rooms.

2.02 UNIONS

- A. Unions for Pipe 2-inches and Under:
1. Ferrous Piping: 150, 250, and 300 PSIG malleable iron, threaded, ASME B16.39.
 2. Copper Pipe: Bronze, soldered joints, ASME B16.22.
- B. Dielectric Connections: Provide dielectric waterway or brass nipple fitting with threaded ends. Dielectric unions are not allowed.

2.03 REFRIGERANT PIPING

- A. Piping:
1. Copper Tube: ASTM B 280, Type ACR, drawn-temper tube, clean, dry and capped.
 - a. Fittings: ASME B16.22 wrought copper.
 - b. Joints: Braze, AWS A5.8 BCuP silver/phosphorus/copper alloy (15 percent Silver).
 2. Copper Tube to 5/8-inch OD: ASTM B280. Tube ACR, annealed-temper copper tube, clean, dry and capped.
 - a. Fittings: ASME B16.26 cast copper.
 - b. Joints: Flared.
- B. Moisture and Liquid Indicators:
1. Manufacturers:
 - a. Henry Technologies.
 - b. Parker Hannifin/Refrigeration and Air Conditioning.
 - c. Sporlan Valve Company.

- d. Substitutions: See Section 23 00 00, HVAC Basic Requirements, Division 00, Procurement and Contracting Requirements and Division 01, General Requirements requirements.
 - 2. Indicators: Single port type, UL listed, with copper or brass body, flared or solder ends, sight glass, color coded paper moisture indicator and plastic cap; for maximum temperature of 200 degrees F and maximum working pressure of 300 PSI.
 - C. Valves:
 - 1. Manufacturers:
 - a. Hansen Technologies Corporation.
 - b. Henry Technologies.
 - c. Danfoss Flomatic.
 - d. Substitutions: See Section 23 00 00, HVAC Basic Requirements, Division 00, Procurement and Contracting Requirements and Division 01, General Requirements.
 - 2. Packaged Ball Valves:
 - a. Two piece bolted forged brass body with Teflon ball seals and copper tube extensions, brass seal cap, chrome plated ball, stem with neoprene ring stem seals; for maximum working pressure of and maximum temperature of 300 degrees F.
 - D. Filter-Driers:
 - 1. Manufacturers:
 - a. Flow Controls Division of Emerson Electric.
 - b. Parker Hannifin/Refrigeration and Air Conditioning.
 - c. Sporlan Valve Company.
 - d. Substitutions: See Section 23 00 00, HVAC Basic Requirements, Division 00, Procurement and Contracting Requirements and Division 01, General Requirements.
 - 2. Performance:
 - a. Flow Capacity - Liquid Line: As required by equipment manufacturer, rated in accordance with ANSI/AHRI 710 I-P.
 - b. Flow Capacity - Suction Line: As required by equipment manufacturer, rated in accordance with ANSI/AHRI 730 I-P.
 - c. Water Capacity: As recommended by equipment manufacturer, rated in accordance with AHRI 710 I-P.
 - d. Pressure Drop: No greater than maximum recommended by equipment manufacturer, when operating at full connected evaporator capacity.
 - e. Design Working Pressure: 350 PSI, maximum.
 - 3. Cores: Molded or loose-fill molecular sieve desiccant compatible with refrigerant, activated alumina, and filtration to 40 microns; of construction that will not pass into refrigerant lines.
 - 4. Construction: UL listed.
 - a. Replaceable Core Type: Steel shell with removable cap.
 - b. Sealed Type: Copper shell.
 - c. Connections: As specified for applicable pipe type.

PART 3 - EXECUTION

3.01 GENERAL INSTALLATION REQUIREMENTS

- A. Install per manufacturer's written instructions and requirements.

- B. Preparation:
1. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.
 2. Remove scale and dirt on inside and outside before assembly.
 3. Prepare piping connections to equipment with flanges or unions.
 4. Keep open ends of pipe free from scale and dirt. Protect open ends with temporary plugs or caps.
- C. Above Ground Piping Installation:
1. Install per manufacturer's written instructions and requirements.
 2. Install heating water, glycol, condenser water, piping to ASME B31.9 requirements. Install chilled water piping to ASME B31.5 requirements.
 3. PVC Pipe: Make solvent-welded joints in accordance with ASTM D 2855.
 4. Route piping in orderly manner, parallel to building structure, and maintain gradient.
 5. Install piping to conserve building space and to avoid interference with use of space.
 6. Install groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.
 7. Sleeve pipe passing through partitions, walls and floors allowing adequate space for pipe insulation.
 8. Slope piping at 0.2 percent upward in direction of flow and arrange to drain at low points.
 9. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.
 10. Install drains, consisting of a tee fitting, NPS 3/4 ball valve, and short NPS 3/4 threaded nipple with cap, at low points in piping system mains and elsewhere as required for system drainage.
 11. Unless otherwise indicated, install branch connections to mains using tee fittings in main pipe, with the takeoff coming out the bottom of the main pipe. For up-feed risers, install the takeoff coming out the top of the main pipe.
 12. Anchor piping for proper direction of expansion and contraction.
 13. Inserts:
 - a. Provide inserts for placement in concrete formwork.
 - b. Provide inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.
 - c. Provide hooked rod to concrete reinforcement section for inserts carrying pipe over 4-inches.
 - d. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.
 - e. Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut flush with top of slab.
 14. Pipe Hangers and Supports:
 - a. Install in accordance with Division 23, HVAC, Hangers and Supports.
 - b. Install hangers to provide minimum 1/2-inch space between finished covering and adjacent work.
 - c. Place hangers within 12-inches of each horizontal elbow.
 - d. Use hangers with 1-1/2-inch minimum vertical adjustment. Design hangers for pipe movement without disengagement of supported pipe.

- e. Support vertical piping at every floor. Support riser piping independently of connected horizontal piping.
 - f. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.
 - g. Prepare unfinished pipe, fittings, supports, and accessories, ready for finish painting.
 - h. Provide copper plated hangers and supports for copper piping.
 - i. Prime coat exposed steel hangers and supports. Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.
- 15. Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings.
 - 16. Provide access where valves and fittings are not exposed.
 - 17. Use eccentric reducers to maintain top of pipe level.
 - 18. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welds.
 - 19. Prepare unfinished pipe, fittings, supports, and accessories, ready for finish painting.
- D. Field Quality Control:
- 1. Leave joints, including welds, uninsulated and exposed for examination during test.
 - 2. Provide temporary restraints for expansion joints that cannot sustain reactions due to test pressure. If temporary restraints are impractical, isolate expansion joints from testing.
 - 3. Flush system with clean water. Clean strainers.
 - 4. Isolate equipment from piping. If a valve is used to isolate equipment, provide closure capable of sealing against test pressure without damage to valve. Install blinds in flanged joints to isolate equipment.
 - 5. Install safety valve, set at a pressure no more than one-third higher than test pressure, to protect against damage by expanding liquid or other source of overpressure during test.

3.02 REFRIGERANT PIPING INSTALLATION

- A. Install systems in accordance with ASHRAE Standard 15.
- B. Group piping whenever practical at common elevations and locations. Slope piping one percent in direction of oil return.
- C. Arrange piping to return oil to compressor. Provide traps and loops in piping, and provide double risers as required. Slope horizontal piping 0.40 percent in direction of flow.
- D. Flood piping system with nitrogen when brazing.
- E. Follow ASHRAE Standard 15 procedures for charging and purging of systems and for disposal of refrigerant.
- F. Provide replaceable cartridge filter-driers, with isolation valves and valved bypass.
- G. Locate expansion valve sensing bulb immediately downstream of evaporator on suction line.
- H. Fully charge completed system with refrigerant after testing.
- I. Field Quality Control:
 - 1. Test refrigeration system in accordance with ASME B31.5.
 - 2. Pressure test system with dry nitrogen to 200 PSI. Perform final tests at 27-inches vacuum and 200 PSI using electronic leak detector. Test to no leakage.

END OF SECTION

**SECTION 23 34 00
HVAC FANS**

PART 1 - GENERAL

1.01 SUMMARY

- A. Work Included:
 - 1. In-Line Centrifugal Fans

1.02 RELATED SECTIONS

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

1.03 REFERENCES AND STANDARDS

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

1.04 SUBMITTALS

- A. Submittals as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.
- B. In addition, provide:
 - 1. Certified fan performance curves with system operating conditions indicated.
 - 2. Certified fan sound-power ratings.
 - 3. Motor ratings and electrical characteristics, plus motor and electrical accessories.
 - 4. Material gauges and finishes, including color charts.
 - 5. Dampers, including housings, linkages, and operators.

1.05 QUALITY ASSURANCE

- A. Quality assurance as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.
- B. In addition, meet the following:
 - 1. Motors: Premium efficiency per Section 23 05 13, Common Motor Requirements for HVAC Equipment. Electrically Commutated Motors (ECM) where scheduled on Drawings.
 - 2. Sound power levels as scheduled on Drawings. If not scheduled, within 5 percent of Basis of Design at design flow.
 - 3. Project Altitude: Base air ratings on sea-level conditions for project sites below 2,000 feet in elevation. Base air ratings on actual site elevations for project sites above 2,000 feet in elevation.
 - 4. Operating Limits: Classify according to AMCA 99.
 - 5. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
 - 6. AMCA Compliance: Products are to comply with performance requirements and are to be licensed to use the AMCA-Certified Ratings Seal.
 - 7. NEMA Compliance: Motors and electrical accessories are to comply with NEMA standards.
 - 8. UL Standard: HVAC Fans are to comply with UL 705. Fans used in grease exhaust applications are to be UL 762 listed for grease exhaust.

1.06 WARRANTY

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

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Deliver fans as factory-assembled unit, to the extent allowable by shipping limitations, with protective crating and covering.
- B. Disassemble and reassemble units, as required for moving to final location, according to manufacturer's written instructions.
- C. Lift and support units with manufacturer's designated lifting or supporting points.

1.08 COORDINATION

- A. Coordinate size and location of structural-steel support members.
- B. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases.
- C. Coordinate installation of roof curbs, equipment supports, and roof penetrations.

1.09 EXTRA MATERIALS

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

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. In-Line Centrifugal Fans:
 - 1. Greenheck
 - 2. Cook
 - 3. Twin City

2.02 IN-LINE CENTRIFUGAL FANS

- A. Description: In-line, belt-driven, centrifugal fans consisting of housing, wheel, outlet guide vanes, fan shaft, bearings, motor and disconnect switch, drive assembly, mounting brackets, and accessories.
- B. Wheel: Cast aluminum backward inclined with inlet cone statically and dynamically balanced within its own bearings.
- C. Housing:
 - 1. Heavy gauge steel or aluminum, suitable for Fan Class, flat roof cap, hooded wall cap, pitched roof cap, elbow discharge with grille, and louvered wall discharge housing, factory standard finish.
 - 2. Removable panels for access to all interior components.
 - 3. Horizontal or vertical configuration, as indicated.
 - 4. Inlet and discharge duct collars.
 - 5. 1-inch thick, 1.5 pounds per cubic foot density fiberglass liner.
 - 6. Aluminum straightening vanes.
 - 7. Support bracket adaptable to floor, sidewall, or ceiling mounting.
- D. Bearings and Drives:
 - 1. Bearings: Heavy duty pillow block type, self greasing ball bearings with ABMA 9 life at 50,000 hours.
 - 2. Shafts: Hot rolled steel, ground and polished, with keyway, protectively coated with lubricating oil.
 - 3. Drive: Cast iron or steel sheaves, dynamically balanced, keyed. Variable and adjustable pitch sheaves for motors 5 hp and under, selected so required rpm is obtained with sheaves set at mid-position. Fixed sheave for 7.5 hp and over, matched belts, and drive rated as recommended by manufacturer or minimum 1.5 times nameplate rating of motor. Motor mounted on adjustable base, with adjustable sheaves, enclosure around belts within fan housing, and lubricating tubes from fan bearings extended to outside of fan housing.

- a. Inverter duty motor for use with variable frequency drive where indicated on Fan Schedule on Drawings.
- 4. Drive: Direct drive matched to fan loads with speed controller. Motor encased in housing outside of airstream, factory wired to disconnect switch located on outside of fan housing.
 - a. Electrically Commutated Motor (ECM) where indicated on Fan Schedule on Drawings.
- E. Accessories:
 - 1. Belt guard.
 - 2. AMCA 99 Type B spark proof construction where scheduled.
 - 3. Variable-Speed Controller: Provide solid-state control to reduce speed from 100 percent to less than 50 percent for motors 1/2 HP or smaller.
 - 4. Discharge Dampers: Parallel blade for mixing or open/close applications and opposed blade for modulating . Heavy duty steel or aluminum, where scheduled. Damper assembly with blades constructed of two plates formed around and welded to shaft, channel frame, sealed ball bearings, with blades linked out of air stream to single control lever. Motorized where indicated and gravity actuated with counterweight, where motorized is not indicated.
- F. Inlet/Outlet Screens: Galvanized steel welded grid, removable.
- G. Vibration Isolation: Wheel and motor mounted on integral double deflection neoprene isolators.
- H. Vibration isolation as scheduled and specified. Reference Section 23 05 48, Vibration and Seismic Controls for HVAC Piping and Equipment.
 - 1. Motor: Integrally mounted, 1800 RPM maximum, with pre-lubricated sealed ball bearings. ODP for motors located indoors and TEFC for motors exposed to moisture.

PART 3 - EXECUTION

3.01 GENERAL INSTALLATION REQUIREMENTS

- A. Install in accordance with manufacturer's instructions.
- B. Install power ventilators level and plumb.
- C. Fans used for exhaust of kitchen grease hoods are to be UL 762 listed for grease exhaust. Provide fans with grease terminator. Pipe from grease terminator to Code approved location.
- D. Fans used for exhaust of moist air are to be constructed of aluminum construction and be warranted for their application in moist conditions.
- E. Fans used in welding, chemical, and/or fume exhaust applications are to be of spark-proof construction and are to be protected with coatings as required to protect parts in the air stream from the chemicals and materials the fan will be exposed to.
- F. Support suspended units from structure threaded steel rods and vibration isolation device scheduled on Drawings.
- G. In seismic zones, restrain support units.
- H. Install units with clearances for service and maintenance.
- I. Provide safety screen where inlet or outlet is exposed.
- J. Provide backdraft dampers on discharge of exhaust fans and as indicated on Drawings.
- K. 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.
- L. Install ducts adjacent to power ventilators to allow service and maintenance.

- M. Ground equipment.
- N. 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.
- O. 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.
- P. Starting Procedures:
 - 1. Energize motor and adjust fan to indicated rpm.
 - 2. Measure and record voltage and amperage.
- Q. 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.
- R. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- S. Shut unit down and reconnect automatic temperature-control operators.
- T. Replace fan and motor pulleys as required to achieve design airflow.
- U. 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.
- V. Repair or replace malfunctioning units. Retest as specified above after repairs or replacements are made.
- W. Adjust damper linkages for proper damper operation.
- X. Adjust belt tension.
- Y. Lubricate bearings.
- Z. On completion of installation, internally clean fans according to manufacturer's written instructions. Remove foreign material and construction debris. Vacuum fan wheel and cabinet.
- AA. After completing system installation, including outlet fitting and devices, inspect exposed finish. Remove burrs, dirt, and construction debris and repair damaged finishes.
- AB. 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.

END OF SECTION

SECTION 23 62 13
PACKAGED AIR-COOLED REFRIGERANT COMPRESSOR AND CONDENSER UNITS

PART 1 - GENERAL

1.01 SUMMARY

- A. Work Included:
 - 1. Manufactured Units
 - 2. Casing
 - 3. Condenser Coils
 - 4. Fans and Motors
 - 5. Compressors
 - 6. Refrigerant Circuit
 - 7. Controls

1.02 RELATED SECTIONS

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

1.03 REFERENCES AND STANDARDS

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

1.04 SUBMITTALS

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

1.05 QUALITY ASSURANCE

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

1.06 WARRANTY

- A. Warranty of materials and workmanship as outlined in Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.
- B. In addition, provide:
 - 1. Five year warranty on compressor(s).

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. The Trane Company
- B. York International Corporation
- C. Daikin Applied
- D. AAON
- E. Or approved equivalent.

2.02 MANUFACTURED UNITS

- A. Units: Self-contained, packaged, factory assembled and pre-wired units suitable for outdoor use consisting of cabinet, compressors, condensing coil and fans, integral sub-cooling coil, controls, liquid receiver, and screens.
- B. Performance Ratings: Energy Efficiency Rating (EER) not less than prescribed by ASHRAE Std 90.1, or state energy code, whichever is more stringent.

2.03 CASING

- A. House components in steel panels with weather resistant, baked enamel finish.
- B. Mount starters, disconnects, and controls in weatherproof panel provided with full opening access doors. Provide mechanical interlock to disconnect power when door is opened.

- C. Provide removable access doors or panels with quick fasteners .

2.04 CONDENSER COILS

- A. Coils: Aluminum fins mechanically bonded to seamless copper tubing. Provide sub-cooling circuits. Air test under water to 425 PSIG, and vacuum dehydrate. Seal with holding charge of refrigerant.
- B. Coil Guard: PVC coat steel wire .

2.05 FANS AND MOTORS

- A. Weatherproof motors suitable for outdoor use, single phase permanent split capacitor or 3 phase, with permanent lubricated ball bearings and built in thermal overload protection.
- B. Vertical discharge direct driven propeller type condenser fans with fan guard on discharge.
- C. Horizontal discharge, double width, double inlet centrifugal type condenser fans, equipped with roller or ball bearings with grease fittings extended to outside of casing, V-belt drive with belt guard.

2.06 COMPRESSORS

- A. Compressor: Hermetic scroll type.
- B. Mounting: Statically and dynamically balance rotating parts and mount on rubber-in-shear vibration isolators. Internally isolate hermetic units on springs.
- C. Lubrication System: Centrifugal oil pump with oil charging valve, oil level sight glass, and magnetic plug or strainer.
- D. Motor: Constant speed 1800 rpm suction gas cooled with electronic sensor and winding over temperature protection, designed for across-the-line starting. Furnish with starter.

2.07 REFRIGERANT CIRCUIT

- A. Provide each unit with one refrigerant circuit, factory supplied and piped. Reference Section 23 23 00, Refrigerant Piping.
- B. For each refrigerant circuit, provide:
 - 1. Filter dryer replaceable core type.
 - 2. Liquid line sight glass and moisture indicator.
 - 3. Thermal expansion valve for maximum operating pressure.
 - 4. Insulated suction line.
 - 5. Suction and liquid line service valves .
 - 6. Charging valve.
 - 7. Discharge line check valve.
 - 8. Compressor discharge service valve.
 - 9. Condenser pressure relief valve.
- C. For heat pump units, provide reversing valve, suction line accumulator, discharge muffler; flow control check valve, and solid-state defrost control utilizing thermistors.

2.08 CONTROLS

- A. Provide card to allow system to communicate with BMS.
- B. On unit, mount weatherproof steel control panel, NEMA 250, containing power and control wiring, factory wired with single point power connection. Factory mount disconnect switch on unit under provisions of Section 26 27 16, Electrical Cabinets and Enclosures.
- C. For each compressor, provide across-the-line starter, non-recycling compressor overload, starter relay, and control power transformer or terminal for controls power. Provide manual reset current overload protection. For each condenser fan, provide across-the-line starter with starter relay.
- D. Provide safety controls arranged so any one will shut down machine:

1. High discharge pressure switch (manual reset) for each compressor.
 2. Low suction pressure switch (automatic reset) for each compressor.
 3. Oil Pressure switch (manual reset).
- E. Provide for the following operating controls:
1. Single stage cooling input room cycles compressors activates cylinder unloaders.
 2. One minute off timer prevents compressor from short cycling.
 3. Periodic pump-out timer to pump down on high evaporator refrigerant pressure.
 4. Low ambient temperature controls.
 5. Low ambient thermostat to lock out compressor at low ambient temperatures.

PART 3 - EXECUTION

3.01 GENERAL INSTALLATION REQUIREMENTS

- A. Install in accordance with manufacturer's written installation instructions and guidelines.
- B. Complete structural, mechanical, and electrical connections in accordance with manufacturer's installation instructions.
- C. Provide for connection to electrical service, primary power and low voltage wiring.
- D. Install units on concrete base as indicated.
- E. Provide connection to refrigeration piping system and evaporators. Comply with ASHRAE Standards.
- F. Starting Equipment and Systems:
 1. Supply initial charge of refrigerant and oil for each refrigeration system. Replace losses of oil or refrigerant prior to end of correction period.
 2. Charge system with refrigerant and test entire system for leaks after completion of installation. Repair leaks, put system into operation, and test equipment performance.
 3. Shut-down system if initial start-up and testing takes place in winter and machines are to remain inoperative. Repeat start-up and testing operation at beginning of first cooling season.
 4. Provide cooling season start-up, and winter season shut-down for first year of operation.
 5. Inspect and test for refrigerant leaks during first year of operation.

END OF SECTION

SECTION 23 82 00
TERMINAL HEAT TRANSFER EQUIPMENT

PART 1 - GENERAL

1.01 SUMMARY

- A. Work Included:
 - 1. Unit Ventilators

1.02 RELATED SECTIONS

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

1.03 REFERENCES AND STANDARDS

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

1.04 SUBMITTALS

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

1.05 QUALITY ASSURANCE

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

1.06 WARRANTY

- A. Warranty of materials and workmanship as outlined in Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Unit Ventilators:
 - 1. Trane
 - 2. Daikin Applied
 - 3. Nesbitt
 - 4. American Air Filter
 - 5. Or approved equivalent.

2.02 UNIT VENTILATORS

- A. Description: Vertical unit ventilator with cabinet, direct expansion cooling coil, hot water, fan and motor assembly, outdoor air/return air dampers, filter and controls. UL listed and wired per NEC.
- B. Cabinet: 16 gauge with exposed edges rounded, surfaces coated with baked prime paint and baked enamel finish, end pockets, removable panels for access, 1/2-inch fiberglass interior insulation, condensate drain pan, end pockets, 2, 4, or 6 -inch subbase, false back air plenum and leveling legs for vertical units.
- C. Water Coils: Seamless copper tubes with aluminum fins mechanically bonded to tubes, 250 PSI working pressure with manual air vent.
- D. Steam Coil: 5-8-inch OD, tube-in-tube distributing coil, pitched for condensate drainage.
- E. Refrigerant Coil: Direct expansion type with aluminum fins mechanically bonded to tubes, tested at 1.5 times maximum working pressure, with distributor assemblies Venture or orifice style with round copper distributor tubes, thermal expansion valve, pressure and temperature testing ports. Condensing Unit: Reference Section 23 62 13, Packaged Air-Cooled Refrigerant Compressor and Condenser Units.
- F. Electric Heating Coil: Extended surface fin-tube bundle with high temperature cut-out switch with automatic reset, magnetic contactor, dead front disconnect switch and contactor to disconnect power whenever fan motor power is interrupted.

- G. Fan and Motor: Forward curved centrifugal fan or fans, steel or aluminum construction, direct or belt drive, multi-speed permanent split capacitor motor with thermal overload protection, permanently lubricated bearings. ECM motor.
- H. Filter: 1-inch thick, disposable panel filters.
- I. Drain Pan: 18 gauge galvanized steel, insulated with fire retardant closed cell foam, 7/8-inch OD male sweat fittings, overflow drain connection and pitched for positive drainage. Provide auxiliary drain pan under piping package.
- J. Dampers:
1. Dual blade mixing dampers with actuators for outdoor air and return air with continuous divider between damper blades to prevent blow-through of outdoor air.
 2. Face and Bypass Dampers: Aluminum with tight seals and actuators to minimize heat pick-up in bypass.
- K. Outdoor Air Inlets: Wall louvers for outdoor air intake, vertical louver design constructed of extruded aluminum channels.
- L. Wall Boxes: Heavy gauge steel with frame in frame design.
- M. Maximum Sound Power Level: Sound power level (re: 10-12watts) not to exceed at specified airflow:
1. Octave Band Mid Frequency:

63 Hz	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	8000 Hz
65	68	62	60	56	52	45	38

- N. Configuration: As scheduled on drawings.
- O. Piping Package: 300 PSI working pressure, unions at coil connection, 20 mesh strainer on supply, ball valve on supply and return, flow control valve with two P/T plugs on return, two-way modulating control valve or three-way modulating valve as shown on drawings.
- P. Electrical:
1. Junction box: Pre-wire control components to junction box.
 2. Transformer: 120-volt to 24-volt for control
 3. Disconnect: Unit mounted disconnect switch on interior of unit.
 4. Speed Controller: Three speed switch mounted on side of unit or remotely.
 5. Single point power supply.
- Q. Control: Provide factory supplied controls wired to terminal strip including:
1. Heating and cooling valve actuators
 2. Outdoor air and return air damper actuators
 3. Face and bypass actuator
 4. Cooling relay for DX units
 5. Fan relay
 6. Low temperature sensor
 7. 24-volt transformer

PART 3 - EXECUTION

3.01 GENERAL INSTALLATION REQUIREMENTS

- A. Avoid interference with structure and with work of other trades, preserving adequate headroom and clearing doors and passageways. Check each piece of equipment for defects, verifying that items function properly and that adjustments have been made.

- B. Prior to acceptance, thoroughly clean exposed portions of terminal heat transfer equipment, remove shipping labels and traces of foreign substance. Touch up scratched surfaces of radiant panels with factory matching paint.

3.02 UNIT VENTILATORS INSTALLATION

- A. Damaged Coils: Make every effort to prevent damage to both built-up coils and coils of packaged equipment. Comb damaged coil fins to be straight.
- B. Provide for expansion of heating water lines with suitable anchors and swing joints or expansion bends made up with pipe fittings.

END OF SECTION

**SECTION 23 82 16
AIR COILS**

PART 1 - GENERAL

1.01 SUMMARY

- A. Work included: Materials, installation and testing of:
 - 1. Water Coils

1.02 RELATED SECTIONS

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

1.03 REFERENCES AND STANDARDS

- A. References and Standards as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.
- B. In addition, meet the following:
 - 1. AHRI 410 - Forced-Circulation Air-Cooling and Air-Heating Coils (with Addenda 1, 2 & 3).
 - 2. ASTM B117 - Standard Practice for Operating Salt Spray Apparatus.

1.04 SUBMITTALS

- A. Submittals as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements
- B. In addition, provide:
 - 1. Product data for each coil including performance, dimensions, operating weights, pressure ratings.
 - 2. Computer selection sheet indicating performance including hot and cold side entering and leaving fluid/air conditions, flows, pressure drops, square feet of heating surface, fouling factor, and heat transfer surface dimensions and configuration.
 - 3. Refrigerant Coils: Provide capacity plot of suction pressure versus total load.

1.05 QUALITY ASSURANCE

- A. Quality assurance as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.
- B. In addition, meet the following:
 - 1. Coil capacity certified in accordance with AHRI 410, latest edition.

1.06 WARRANTY

- A. Warranty of materials and workmanship as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.
- B. In addition, provide:
 - 1. Provide extended three year warranty for coils with corrosion protection coating.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Water Coils:
 - 1. Pace
 - 2. Trane
 - 3. Daikin Applied
 - 4. Colmac
 - 5. York
 - 6. Heatcraft
 - 7. USA Coil

8. Temtrol
9. Or approved equivalent.

2.02 WATER COILS

- A. General: Extended surface type consisting of copper tubing mechanically expanded to bond with plate fins. Design for serpentine flow with one or more feeds from common supply and return headers. Arrange for counter flow operation with supply connections at the bottom.
- B. Performance: Provide capacity indicated at water flows no greater than scheduled.
- C. Factory Testing: Leak test coils under water at 300 PSIG minimum.
- D. Working Pressure: 150 PSIG and 250 PSIG.
- E. Construction:
 1. Tubing: Seamless copper.
 2. Fins: copper or aluminum die formed plates. Continuous within the coil casing.
 3. Casing: 16 gauge stainless steel or galvanized steel.
 4. Headers: Seamless copper tube brazed to heat transfer tubes. Provide high point air vent fitting and low point drain fitting.
 5. Connections: Same end for supply and return unless noted otherwise.
 6. Intermediate Supports: Provide for coils with finned length greater than 44-inches, with maximum spacing of 42-inches.
- F. Corrosion Protection: Baked on phenolic coating suitable for 3000 hours salt spray per ASTM-B117. Heresite P413.

PART 3 - EXECUTION

3.01 WATER COIL INSTALLATION

- A. General:
 1. Comb damaged and bent fins.
 2. Install coils to drain in accordance with manufacturer's written instructions and written recommendations.
 3. Install filters upstream of supply and exhaust air handler coils prior to fan operation.
 4. Pipe drain connection to indirect waste receiver or floor drain.
 5. For duct mounted cooling coils, provide drain pan, provide drain piping to indirect waste receiver or floor drain.

END OF SECTION