

SECTION 23 05 00 - COMMON WORK RESULTS FOR HVAC**PART 1 - GENERAL****1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. All HVAC and plumbing work shall comply with applicable codes, industry standards, and local ordinances such as ASME, ASPE, ASTM, NFPA, and ASHRAE.

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Piping materials and installation instructions common to most piping systems.
 - 2. Transition fittings.
 - 3. Dielectric fittings.
 - 4. Mechanical sleeve seals.
 - 5. Sleeves.
 - 6. Escutcheons.
 - 7. Grout.
 - 8. HVAC demolition.
 - 9. Equipment installation requirements common to equipment sections.
 - 10. Painting and finishing.
 - 11. Concrete bases.
 - 12. Supports and anchorages.

1.3 DEFINITIONS

- A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct chases, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspace, and tunnels.
- B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.
- C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.
- D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and chases.
- E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.
- F. The following are industry abbreviations for plastic materials:
 - 1. CPVC: Chlorinated polyvinyl chloride plastic.
 - 2. PE: Polyethylene plastic.
 - 3. PVC: Polyvinyl chloride plastic.
- G. The following are industry abbreviations for rubber materials:
 - 1. EPDM: Ethylene-propylene-diene terpolymer rubber.
 - 2. NBR: Acrylonitrile-butadiene rubber.

1.4 SUBMITTALS

- A. Product Data: For the following:
 - 1. Transition fittings.
 - 2. Dielectric fittings.
 - 3. Mechanical sleeve seals.
 - 4. Escutcheons.
- B. Welding certificates.

1.5 QUALITY ASSURANCE

- A. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code--Steel."
- B. Steel Pipe Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."

1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
 2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.
- C. Electrical Characteristics for HVAC Equipment: Equipment of higher electrical characteristics may be furnished provided such proposed equipment is approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.
- 1.6 DELIVERY, STORAGE, AND HANDLING
- A. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.
 - B. Store plastic pipes protected from direct sunlight. Support to prevent sagging and bending.
- 1.7 COORDINATION
- A. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction, to allow for HVAC installations.
 - B. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.
 - C. Coordinate requirements for access panels and doors for HVAC items requiring access that are concealed behind finished surfaces. Access panels and doors are specified in Division 08 Section "Access Doors and Frames."
 - D. Prepare Coordination / Installation Shop drawings to a scale of 1/4"=1'-0" or larger; detailing major elements, components, and systems of mechanical equipment and materials in relationship with other systems, installations, and building components. Indicate locations where space is limited for installation and access and where sequencing and coordination of installations are of importance to the efficient flow of the Work, including (but not necessarily limited to) the following:
 1. Structural floor, wall and roof opening sizes and details.
 2. Clearances for installing and maintaining insulation.
 3. Locations of light fixtures and sprinkler heads.
 4. Clearances for servicing and maintaining equipment, including tube removal, filter removal, and space for equipment disassembly required for periodic maintenance.
 5. Equipment connections and support details.
 6. Exterior wall and foundation penetrations.
 7. Routing of sanitary sewer piping.
 8. Fire-rated wall and floor penetrations.
 9. Sizes and location of required concrete pads and bases.
 10. Valve stem movement.

PART 2 - PRODUCTS

- 2.1 SCOPE OF SERVICES
- A. Base bid includes Mechanical (HVAC), and Plumbing work as shown and described in the contract documents. Work will have to be done in a staged manner to allow continuous use of the balance of the facility by the building occupants. Refer to architectural staging criteria.
 - B. This Division requires the furnishing and installing of all items Specified herein, indicated on the Drawings or reasonably inferred as necessary for safe and proper operation; including every article, device or accessory (whether or not specifically called for by item) reasonably necessary to facilitate each system's functioning as indicated by the design and the equipment specified. Elements of the work include, but are not limited to, materials, labor, supervision, transportation, storage, equipment, utilities, all required permits, licenses and inspections. All work performed under this Section shall be in accordance with the Project Manual, Drawings and Specifications and is subject to the terms and conditions of the Contract.
 - C. The approximate locations of Mechanical (HVAC) and Plumbing items are indicated on the Drawings. These Drawings are not intended to give complete and accurate details in regard to location of outlets, apparatus, etc. Exact locations are to be determined by actual measurements at the building, and will in all cases be subject to the Review of the Owner or Engineer, who reserves the right to make any reasonable changes in the locations indicated without additional cost to the Owner.
 - D. Items specifically mentioned in the Specifications but not shown on the Drawings and/or items shown on Drawings but not specifically mentioned in the Specifications shall be installed by the Contractor under the appropriate section of work as if they were both specified and shown.

- E. All discrepancies between the Contract Documents and actual job-site conditions shall be reported to the Project Manager or Engineer so that they will be resolved prior to the bidding, where this cannot be done at least 7 working days prior to bid; the greater or more costly of the discrepancy shall be bid. All labor and materials required to perform the work described shall be included as part of this Contract.
- F. It is the intention of this Section of the Specifications to outline minimum requirements to furnish the Owner with a turn-key and fully operating system in cooperation with other trades.

2.2 APPLICABLE CODES

- A. Obtain all required permits and inspections for all work required by the Contract Documents and pay all required fees in connection thereof.
- B. Arrange with the serving utility companies for the connection of all required utilities and pay all charges, meter charges, connection fees and inspection fees, if required.
- C. Comply with all applicable codes, specifications, local ordinances, industry standards, utility company regulations and the applicable requirements of the following nationally accepted codes and standards:
 - 1. Underwriters' Laboratories, Inc., UL.
 - 2. Air Moving & Conditioning Association, AMCA.
 - 3. American Standards Association, ASA.
 - 4. American Society of Heating, Refrigerating, and Air-Conditioning Engineers, Inc., ASHRAE.
 - 5. American Society of Mechanical Engineers, ASME.
 - 6. American Society of Plumbing Engineers, ASPE.
 - 7. American Society of Testing Materials, ASTM.
 - 8. American Water Works Association, AWWA.
 - 9. National Bureau of Standards, NBS.
 - 10. National Fire Protection Association, NFPA.
 - 11. Sheet Metal & Air Conditioning Contractors' National Association, SMACNA.
- D. Where differences existing between the Contract Documents and applicable state or city building codes, state and local ordinances, industry standards, utility company regulations and the applicable requirements of the above listed nationally accepted codes and standards, the more stringent or costly application shall govern. Promptly notify the Engineer in writing of all differences.
- E. When directed in writing by the Engineer, remove all work installed that does not comply with the Contract Documents and applicable state or city building codes, state and local ordinances, industry standards, utility company regulations and the applicable requirements of the above listed nationally accepted codes and standards, correct the deficiencies, and complete the work at no additional cost to the Owner.

2.3 DRAWINGS & SPECIFICATIONS

- A. These Specifications are intended to supplement the Drawings and it will not be the province of the Specifications to mention any part of the work which the Drawings are competent to fully explain in every particular and such omission is not to relieve the Contractor from carrying out portions indicated on the Drawings only.
- B. Should items be required by these Specifications and not indicated on the Drawings, they are to be supplied even if of such nature that they could have been indicated thereon. In case of disagreement between Drawings and Specifications, or within either Drawings or Specifications, the better quality or greater quantity of work shall be estimated and the matter referred to the Architect or Engineer for review with a request for information and clarification at least 7 working days prior to bid opening date for issuance of an addendum.
- C. The listing of product manufacturers, materials and methods in the various sections of the Specifications, and indicated on the Drawings, is intended to establish a standard of quality only. It is not the intention of the Owner or Engineer to discriminate against any product, material or method that is equal to the standards as indicated and/or specified, nor is it intended to preclude open, competitive bidding. The fact that a specific manufacturer is listed as an acceptable manufacturer should not be interpreted to mean that the manufacturers' standard product will meet the requirements of the project design, Drawings, Specifications and space constraints.
- D. The Architect or Engineer and Owner shall be the sole judge of quality and equivalence of equipment, materials and methods.
- E. Products by other reliable manufacturers, other materials, and other methods, will be accepted as outlined, provided they have equal capacity, construction, and performance. However, under no circumstances shall any substitution be made without the written permission of the Architect or Engineer and Owner. Request for prior approval must be made in writing 10 days prior to the bid date with out fail.
- F. Wherever a definite product, material or method is specified and there is not a statement that another product, material or method will be acceptable, it is the intention of the Owner or Engineer that the specified product, material or method is the only one that shall be used without prior approval.

- G. Wherever a definite material or manufacturer's product is specified and the Specification states that products of similar design and equal construction from the specified list of manufacturers may be substituted, it is the intention of the Owner or Engineer that products of manufacturers that are specified are the only products that will be acceptable and that products of other manufacturers will not be considered for substitution without approval.
- H. Wherever a definite product, material or method is specified and there is a statement that "OR EQUAL" product, material or method will be acceptable, it is the intention of the Owner or Engineer that the specified product, material or method or an "OR EQUAL" product, material or method may be used if it complies with the specifications and is submitted for review to the Engineer as outline herein. Where permission to use substituted or alternative equipment on the project is granted by the Owner or Engineer in writing, it shall be the responsibility of the Contractor or Subcontractor involved to verify that the equipment will fit in the space available which includes allowances for all required Code and maintenance clearances, and to coordinate all equipment structural support, plumbing and electrical requirements and provisions with the Mechanical (HVAC) and Plumbing Design Documents and all other trades.
- I. Coordinate with Division 1 requirements for substitution, unless noted otherwise the Contractors wishing to substitute products, materials or methods from those indicated or specified, shall submit such requests to the Owner or Engineer in writing and within THIRTY (30) WORKING DAYS OF NOTIFICATION OF CONTRACT AWARD. Requests for permission to utilize alternates or substitutions will not be considered after that time, unless the Specified item is unavailable or will adversely effect to completion of the Project. Claims submitted for consideration will require notarized letters from all parties involved and will be considered only if the Contractor has been timely in his delivery for review of all required equipment and material submittals. Owner or Engineer will investigate such requests for substitution and if acceptable will issue a letter allowing the substitution.
- J. If any request for a substitution of product, material or method is rejected, the Contractor will automatically be required to furnish the product, material or method named in the Specifications. Repetitive requests for substitutions will not be considered.
- K. Requests shall be bound and shall consist of three (3) sets of descriptive literature and performance data covering each item of equipment or material. The submittal shall include the following:
1. Name of the individuals or company originating the submittal.
 2. Name of the project for which the submittal is made.
 3. An index page of the items submitted.
 4. A written list of variations between the specified product and the submitted product.
 5. Sufficient information, including scaled drawing of area and equipment involved at a scale of 1/4" = 1'-0" minimum, as required to demonstrate that the alternate or substituted product will fit in the space available.
 6. Identification of each item of material or equipment matching that indicated on the Drawings. All applicable industry or national Listings, Labels, Approvals and Standards shall be clearly indicated.
 7. Sufficient pictorial, descriptive and diagrammatic data on each item to show its conformance with the Drawings and Specifications. Any options or special requirements shall be so indicated. All non-applicable information shall be crossed out.
 8. Provide upon request of the Owner or Engineer, samples of materials and/or equipment as may be required.
- L. The Owner or Engineer will investigate all requests for substitutions when submitted in accordance with above and if accepted, will issue a letter allowing the substitutions. The Engineer shall be the sole authority to approve or disapprove any and all substitutions.
- M. Where equipment other than that used in the design as specified or shown on the Drawings is substituted (either from an approved manufacturers list or by submittal review), it shall be the responsibility of the substituting Contractor to coordinate space requirements, building provisions and connection requirements with his trades and all other trades and pay all additional costs to other trades, the Owner, the Architect or Engineer, if any, due to the substitutions.

2.4 RECORD DOCUMENTS

- A. Prepare record documents in accordance with the requirements in Special Project Requirements, in addition to the requirements specified in Division 15, indicate the following installed conditions.
1. Duct mains and branches, size and location, for both exterior and interior; locations of dampers, fire dampers, duct access panels, and other control devices; filters, fuel fired heaters, fan coils, condensing units, and roof-top A/C units requiring periodic maintenance or repair.
 2. Mains and branches of piping systems, with valves and control devices located and numbered, concealed unions located, and with items requiring maintenance located (i.e., traps, strainers, expansion compensators, tanks, etc.). Valve location diagrams, complete with valve tag chart. Indicate actual inverts and horizontal locations of underground piping.
 3. Equipment locations (exposed and concealed), dimensioned from prominent building lines.

4. Approved substitutions, Contract Modifications, and actual equipment and materials installed.
5. Contract Modifications, actual equipment and materials installed.
- B. The Contractor shall maintain a set of clearly marked black line record "AS-BUILT" prints on the job site on which he shall mark all work details, alterations to meet site conditions and changes made by "Change Order" notices. These shall be kept available for inspection by the Owner, Architect or Engineer at all times.
- C. Refer to Division 1 for additional requirements concerning record drawings. If the Contractor does not keep an accurate set of as-built drawings, the pay request may be altered or delayed at the request of the Architect. Mark the drawings with a colored pencil. Delivery of as-built prints and re-producible is a condition of final acceptance.
- D. The record prints shall be updated on a daily basis and shall indicate accurate dimensions for all buried or concealed work, precise locations of all concealed pipe or duct, locations of all concealed valves, controls and devices and any deviations from the work shown on the Construction Documents which are required for coordination. All dimensions shall include at least two dimensions to permanent structure points.
- E. At the Engineer's option, the Contractor shall transfer all data from the record "AS-BUILT" prints to an electronic media such as AutoCAD release 2007, in order to plot the reproducible media "AS-BUILT" drawings. Since data stored on electronic media can deteriorate undetected or be modified without the Engineer's knowledge, the AutoCAD electronic drawing files are provided without warranty or obligation on the part of the Engineer as to accuracy or information contained in the files. All information in the files shall be independently verified by the user. Any user shall agree to indemnify and hold the Engineer harmless from any and all claims, damages, losses, and expenses including but not limited to Attorney's fees arising out of the use of the AutoCAD drawing files. Engineer shall furnish to the Contractor electronic media files of Contract Documents for the Contractor to use for inputting of the data from the record "AS-BUILT" prints and the Contractor shall return the revised electronic files on CD ROM properly labeled to the Engineer and shall submit the plotted reproducible drawings and three (3) sets of black line prints to the Architect or Engineer for review prior to scheduling the final inspection at the completion of the work. The reproducible record "AS-BUILT" drawings shall have the Engineers Name and Seal removed or blanked out and shall be clearly marked and signed on each sheet as described in paragraph F. below.
- F. of the work, the Contractor shall transfer all marks from the submit a set of clear concise set of reproducible record "AS-BUILT" drawings and shall submit the reproducible drawings with corrections made by a competent draftsman and three (3) sets of black line prints to the Architect or Engineer for review prior to scheduling the final inspection at the completion of the work. The reproducible record "AS-BUILT" drawings shall have the Engineers Name and Seal removed or blanked out and shall be clearly marked and signed on each sheet.
- G. No retainage shall be released until LSCS has received all Operations and Maintenance manuals, keys, record drawings, and warranty certificates.

2.5 PIPE, TUBE, AND FITTINGS

- A. Refer to individual Division 23 piping Sections for pipe, tube, and fitting materials and joining methods.
- B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

2.6 JOINING MATERIALS

- A. Refer to individual Division 23 piping Sections for special joining materials not listed below.
- B. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.
 1. ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch maximum thickness unless thickness or specific material is indicated.
 - a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
 - b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.
 2. AWWA C110, rubber, flat face, 1/8 inch thick, unless otherwise indicated; and full-face or ring type, unless otherwise indicated.
- C. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.
- D. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, unless otherwise indicated.
- E. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.
- F. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for general-duty brazing, unless otherwise indicated; and AWS A5.8, BAg1, silver alloy for refrigerant piping, unless otherwise indicated.
- G. Welding Filler Metals: Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.
- H. Solvent Cements for Joining Plastic Piping:
 1. CPVC Piping: ASTM F 493.
 2. PVC Piping: ASTM D 2564. Include primer according to ASTM F 656.
- I. Fiberglass Pipe Adhesive: As furnished or recommended by pipe manufacturer.

2.7 TRANSITION FITTINGS

- A. Plastic-to-Metal Transition Fittings: PVC one-piece fitting with manufacturer's Schedule 80 equivalent dimensions; one end with threaded brass insert, and one solvent-cement-joint end.
 - 1. Manufacturers:
 - a. Eslon Thermoplastics.
- B. Plastic-to-Metal Transition Adaptors: One-piece fitting with manufacturer's SDR 11 equivalent dimensions; one end with threaded brass insert, and one solvent-cement-joint end.
 - 1. Manufacturers:
 - a. Thompson Plastics, Inc.
- C. Plastic-to-Metal Transition Unions: MSS SP-107, PVC four-part union. Include brass end, solvent-cement-joint end, rubber O-ring, and union nut.
 - 1. Manufacturers:
 - a. NIBCO INC.
 - b. NIBCO, Inc.; Chemtrol Div.

2.8 DIELECTRIC FITTINGS

- A. Description: Combination fitting of copper alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.
- B. Insulating Material: Suitable for system fluid, pressure, and temperature.
- C. Dielectric Unions: Factory-fabricated, union assembly, for 250-psig minimum working pressure at 180 deg F.
 - 1. Manufacturers:
 - a. Capitol Manufacturing Co.
 - b. Central Plastics Company.
 - c. Eclipse, Inc.
 - d. Epco Sales, Inc.
 - e. Hart Industries, International, Inc.
 - f. Watts Industries, Inc.; Water Products Div.
 - g. Zurn Industries, Inc.; Wilkins Div.
- D. Dielectric Flanges: Factory-fabricated, companion-flange assembly, for 150- or 300-psig minimum working pressure as required to suit system pressures.
 - 1. Manufacturers:
 - a. Capitol Manufacturing Co.
 - b. Central Plastics Company.
 - c. Epco Sales, Inc.
 - d. Watts Industries, Inc.; Water Products Div.
- E. Dielectric-Flange Kits: Companion-flange assembly for field assembly. Include flanges, full-face- or ring-type neoprene or phenolic gasket, phenolic or polyethylene bolt sleeves, phenolic washers, and steel backing washers.
 - 1. Manufacturers:
 - a. Advance Products & Systems, Inc.
 - b. Calpico, Inc.
 - c. Central Plastics Company.
 - d. Pipeline Seal and Insulator, Inc.
 - 2. Separate companion flanges and steel bolts and nuts shall have 150- or 300-psig minimum working pressure where required to suit system pressures.
- F. Dielectric Couplings: Galvanized-steel coupling with inert and noncorrosive, thermoplastic lining; threaded ends; and 300-psig minimum working pressure at 225 deg F.
 - 1. Manufacturers:
 - a. Calpico, Inc.
 - b. Lochinvar Corp.
- G. Dielectric Nipples: Electroplated steel nipple with inert and noncorrosive, thermoplastic lining; plain, threaded, or grooved ends; and 300-psig minimum working pressure at 225 deg F.
 - 1. Manufacturers:
 - a. Perfection Corp.
 - b. Precision Plumbing Products, Inc.
 - c. Sioux Chief Manufacturing Co., Inc.
 - d. Victaulic Co. of America.

2.9 MECHANICAL SLEEVE SEALS

- A. Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.

1. Manufacturers:
 - a. Advance Products & Systems, Inc.
 - b. Calpico, Inc.
 - c. Metraflex Co.
 - d. Pipeline Seal and Insulator, Inc.
2. Sealing Elements: EPDM interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
3. Pressure Plates: Plastic Carbon steel Stainless steel. Include two for each sealing element.
4. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.10 SLEEVES

- A. Galvanized-Steel Sheet: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.
- B. Steel Pipe: ASTM A 53, Type E, Grade B, Schedule 40, galvanized, plain ends.
- C. Cast Iron: Cast or fabricated "wall pipe" equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.
- D. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.
 1. Underdeck Clamp: Clamping ring with set screws.
- E. Molded PVC: Permanent, with nailing flange for attaching to wooden forms.
- F. PVC Pipe: ASTM D 1785, Schedule 40.
- G. Molded PE: Reusable, PE, tapered-cup shaped, and smooth-outer surface with nailing flange for attaching to wooden forms.

2.11 ESCUTCHEONS

- A. Description: Manufactured wall and ceiling escutcheons and floor plates, with an ID to closely fit around pipe, tube, and insulation of insulated piping and an OD that completely covers opening.
- B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with polished chrome-plated finish.
- C. One-Piece, Cast-Brass Type: With set screw.
 1. Finish: Polished chrome-plated.
- D. Split-Casting, Cast-Brass Type: With concealed hinge and set screw.
 1. Finish: Polished chrome-plated.
- E. One-Piece, Stamped-Steel Type: With set screw and chrome-plated finish.
- F. Split-Plate, Stamped-Steel Type: With concealed set screw or spring clips, and chrome-plated finish.
- G. One-Piece, Floor-Plate Type: Cast-iron floor plate.
- H. Split-Casting, Floor-Plate Type: Cast brass with concealed hinge and set screw.

2.12 GROUT & FOUNDATION

- A. Description: ASTM C 1107, Grade B, nonshrink and nonmetallic, dry hydraulic-cement grout.
 1. Characteristics: Post-hardening, volume-adjusting, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
 2. Design Mix: 5000-psi, 28-day compressive strength.
 3. Packaging: Premixed and factory packaged.
- B. Foundations and pads shall be constructed of reinforced concrete and shall be sized and reinforced as noted or detailed on the Drawings. As a minimum, pads shall be 6" thick, by width and length as required by item it is under, reinforced with 6 x 6 W2.9 x W2.9 Welded Wire mesh.
- C. Support attachments, unless otherwise noted on shown, shall be securely attached to the items foundation, pad or building structure, per manufacturers recommendations and shall be approved by the Architect.

PART 3 - EXECUTION

3.1 HVAC DEMOLITION

- A. Refer to Division 01 Section "Cutting and Patching" and Division 02 Section "Selective Structure Demolition" for general demolition requirements and procedures.
- B. Disconnect, demolish, and remove HVAC systems, equipment, and components indicated to be removed.
 1. Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.
 2. Piping to Be Abandoned in Place: Drain piping and cap or plug piping with same or compatible piping material.

3. Ducts to Be Removed: Remove portion of ducts indicated to be removed and plug remaining ducts with same or compatible ductwork material.
 4. Ducts to Be Abandoned in Place: Cap or plug ducts with same or compatible ductwork material.
 5. Equipment to Be Removed: Disconnect and cap services and remove equipment.
 6. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational.
 7. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to Owner.
- C. If pipe, insulation, or equipment to remain is damaged in appearance or is unserviceable, remove damaged or unserviceable portions and replace with new products of equal capacity and quality.

3.2 PIPING SYSTEMS - COMMON REQUIREMENTS

- A. Install piping according to the following requirements and Division 23 Sections specifying piping systems.
- B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
- C. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.
- D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- F. Install piping to permit valve servicing.
- G. Install piping at indicated slopes.
- H. Install piping free of sags and bends.
- I. Install fittings for changes in direction and branch connections.
- J. Install piping to allow application of insulation.
- K. Select system components with pressure rating equal to or greater than system operating pressure.
- L. Install escutcheons for penetrations of walls, ceilings, and floors according to the following:
 1. New Piping:
 - a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
 - b. Chrome-Plated Piping: One-piece, cast-brass type with polished chrome-plated finish.
 - c. Insulated Piping: One-piece, stamped-steel type with spring clips.
 - d. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass type with polished chrome-plated finish.
 - e. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, stamped-steel type.
 - f. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece or split-casting, cast-brass type with polished chrome-plated finish.
 - g. Bare Piping at Ceiling Penetrations in Finished Spaces: Split-plate, stamped-steel type with concealed hinge and set screw.
 - h. Bare Piping in Unfinished Service Spaces: One-piece, cast-brass type with polished chrome-plated finish.
 - i. Bare Piping in Unfinished Service Spaces: One-piece, stamped-steel type with concealed or exposed-rivet hinge and set screw or spring clips.
 - j. Bare Piping in Equipment Rooms: One-piece, cast-brass type.
 - k. Bare Piping in Equipment Rooms: One-piece, stamped-steel type with set screw.
 - l. Bare Piping at Floor Penetrations in Equipment Rooms: One-piece, floor-plate type.
 2. Existing Piping: Use the following:
 - a. Chrome-Plated Piping: Split-casting, cast-brass type with chrome-plated finish.
 - b. Insulated Piping: Split-plate, stamped-steel type with concealed or exposed-rivet hinge and spring clips.
 - c. Bare Piping at Wall and Floor Penetrations in Finished Spaces: Split-casting, cast-brass type with chrome-plated finish.
 - d. Bare Piping at Wall and Floor Penetrations in Finished Spaces: Split-plate, stamped-steel type with concealed hinge and spring clips.
 - e. Bare Piping at Ceiling Penetrations in Finished Spaces: Split-casting, cast-brass type with chrome-plated finish.
 - f. Bare Piping at Ceiling Penetrations in Finished Spaces: Split-plate, stamped-steel type with concealed hinge and set screw.
 - g. Bare Piping in Unfinished Service Spaces: Split-casting, cast-brass type with polished chrome-plated finish.

- h. Bare Piping in Unfinished Service Spaces: Split-plate, stamped-steel type with concealed or exposed-rivet hinge and set screw or spring clips.
 - i. Bare Piping in Equipment Rooms: Split-casting, cast-brass type.
 - j. Bare Piping in Equipment Rooms: Split-plate, stamped-steel type with set screw or spring clips.
 - k. Bare Piping at Floor Penetrations in Equipment Rooms: Split-casting, floor-plate type.
 - M. Sleeves are not required for core-drilled holes.
 - N. Permanent sleeves are not required for holes formed by removable PE sleeves.
 - O. Install sleeves for pipes passing through concrete and masonry walls and concrete floor and roof slabs.
 - P. Install sleeves for pipes passing through concrete and masonry walls, gypsum-board partitions, and concrete floor and roof slabs.
 - 1. Cut sleeves to length for mounting flush with both surfaces.
 - a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
 - 2. Install sleeves in new walls and slabs as new walls and slabs are constructed.
 - 3. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation. Use the following sleeve materials:
 - a. Steel Pipe Sleeves: For pipes smaller than NPS 6.
 - b. Steel Sheet Sleeves: For pipes NPS 6 and larger, penetrating gypsum-board partitions.
 - c. Stack Sleeve Fittings: For pipes penetrating floors with membrane waterproofing. Secure flashing between clamping flanges. Install section of cast-iron soil pipe to extend sleeve to 2 inches above finished floor level. Refer to Division 07 Section "Sheet Metal Flashing and Trim" for flashing.
 - 1) Seal space outside of sleeve fittings with grout.
 - 4. Except for underground wall penetrations, seal annular space between sleeve and pipe or pipe insulation, using joint sealants appropriate for size, depth, and location of joint. Refer to Division 07 Section "Joint Sealants" for materials and installation.
 - Q. Aboveground, Exterior-Wall Pipe Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
 - 1. Install steel pipe for sleeves smaller than 6 inches in diameter.
 - 2. Install cast-iron "wall pipes" for sleeves 6 inches and larger in diameter.
 - 3. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.
 - R. Underground, Exterior-Wall Pipe Penetrations: Install cast-iron "wall pipes" for sleeves. Seal pipe penetrations using mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
 - 1. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.
 - S. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Refer to Division 07 Section "Penetration Firestopping" for materials.
 - T. Verify final equipment locations for roughing-in.
 - U. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.
- 3.3 PIPING JOINT CONSTRUCTION
- A. Join pipe and fittings according to the following requirements and Division 23 Sections specifying piping systems.
 - B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
 - C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
 - D. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.
 - E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8.

- F. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
 - 1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
 - 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
- G. Welded Joints: Construct joints according to AWS D10.12, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.
- H. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.
- I. Plastic Piping Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:
 - 1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
 - 2. CPVC Piping: Join according to ASTM D 2846/D 2846M Appendix.
 - 3. PVC Pressure Piping: Join schedule number ASTM D 1785, PVC pipe and PVC socket fittings according to ASTM D 2672. Join other-than-schedule-number PVC pipe and socket fittings according to ASTM D 2855.
 - 4. PVC Non-pressure Piping: Join according to ASTM D 2855.
- J. Plastic Pressure Piping Gasketed Joints: Join according to ASTM D 3139.
- K. Plastic Non-pressure Piping Gasketed Joints: Join according to ASTM D 3212.
- L. PE Piping Heat-Fusion Joints: Clean and dry joining surfaces by wiping with clean cloth or paper towels. Join according to ASTM D 2657.
 - 1. Plain-End Pipe and Fittings: Use butt fusion.
 - 2. Plain-End Pipe and Socket Fittings: Use socket fusion.
- M. Fiberglass Bonded Joints: Prepare pipe ends and fittings, apply adhesive, and join according to pipe manufacturer's written instructions.

3.4 PIPING CONNECTIONS

- A. Make connections according to the following, unless otherwise indicated:
 - 1. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.
 - 2. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.
 - 3. Dry Piping Systems: Install dielectric unions and flanges to connect piping materials of dissimilar metals.
 - 4. Wet Piping Systems: Install dielectric coupling and nipple fittings to connect piping materials of dissimilar metals.

3.5 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

- A. Install equipment to allow maximum possible headroom unless specific mounting heights are not indicated.
- B. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.
- C. Install HVAC equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.
- D. Install equipment to allow right of way for piping installed at required slope.

3.6 PAINTING

- A. Painting of HVAC systems, equipment, and components is specified in Division 09 Sections "Interior Painting" and "Exterior Painting."
- B. Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

3.7 CONCRETE BASES

- A. Concrete Bases: Anchor equipment to concrete base according to equipment manufacturer's written instructions and according to seismic codes at Project.
 - 1. Construct concrete bases of dimensions indicated, but not less than 4 inches larger in both directions than supported unit.
 - 2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of the base.

3. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.
 4. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 5. Install anchor bolts to elevations required for proper attachment to supported equipment.
 6. Install anchor bolts according to anchor-bolt manufacturer's written instructions.
 7. Use 3000-psi, 28-day compressive-strength concrete and reinforcement as specified in Division 03 Section "Cast-in-Place Concrete Miscellaneous Cast-in-Place Concrete."
- 3.8 ERECTION OF METAL SUPPORTS AND ANCHORAGES
- A. Refer to Division 05 Section "Metal Fabrications" for structural steel.
 - B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor HVAC materials and equipment.
 - C. Field Welding: Comply with AWS D1.1.
- 3.9 ERECTION OF WOOD SUPPORTS AND ANCHORAGES
- A. Cut, fit, and place wood grounds, nailers, blocking, and anchorages to support, and anchor HVAC materials and equipment.
 - B. Select fastener sizes that will not penetrate members if opposite side will be exposed to view or will receive finish materials. Tighten connections between members. Install fasteners without splitting wood members.
 - C. Attach to substrates as required to support applied loads.
- 3.10 TRAINING
- A. The contractor shall provide manufacturer's orientation training to the college maintenance personnel on the HVAC and plumbing systems.
- 3.11 GROUTING
- A. Mix and install grout for HVAC equipment base bearing surfaces, pump and other equipment base plates, and anchors.
 - B. Clean surfaces that will come into contact with grout.
 - C. Provide forms as required for placement of grout.
 - D. Avoid air entrapment during placement of grout.
 - E. Place grout, completely filling equipment bases.
 - F. Place grout on concrete bases and provide smooth bearing surface for equipment.
 - G. Place grout around anchors.
 - H. Cure placed grout.

END OF SECTION 23 05 00

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SECTION 23 05 13 - MOTORS AND MOTOR CONTROLLERS**PART 1 - GENERAL**

1.1 GENERAL REQUIREMENTS

- A. The requirements of the General Conditions and Supplementary Conditions apply to all work herein.
- B. The Basic Materials and Methods, Section 23 05 00, are included as a part of this Section as though written in full in this document.

1.2 SCOPE

- A. Scope of the Work shall include the furnishing and complete installation of the equipment covered by this Section, with all auxiliaries, ready for owner's use.
- B. Work Specified Elsewhere:
 - 1. Painting
 - 2. Automatic temperature controls.
 - 3. Power control wiring to motors and equipment.

1.3 WARRANTY

- A. Warrant the Work specified herein for one year and motors for five years beginning on date of substantial completion against becoming unserviceable or causing an objectionable appearance resulting from either defective or non-conforming materials and workmanship.

1.4 SUBMITTALS

- A. Shop Drawings: Indicate size material, and finish. Show locations and installation procedures. Include details of joints, attachments, and clearances.
- B. Product Data: Submit schedules, charts, literature, and illustrations to indicate the performance, fabrication procedures variations, and accessories.
- C. Motor Nameplate Information: Manufacturer's name, address, utility and operating data.
- D. Refer to Division 1 for additional information.

1.5 DELIVERY AND STORAGE

- A. Delivery: Deliver clearly labeled, undamaged materials in the manufacturers' unopened containers.
- B. Time And Coordination: Deliver materials to allow for minimum storage time at the project site. Coordinate delivery with the scheduled time of installation.
- C. Storage: Store materials in a clean, dry location, protected from weather and abuse.

PART 2 - PRODUCTS

2.1 ELECTRIC MOTORS

- A. Approved Manufacturers: Provide motors by a single manufacturer as much as possible.
 - 1. Baldor.
 - 2. Allis-Chalmers.
 - 3. Siemens-Allis.
 - 4. Gould.
 - 5. ABB.
 - 6. Westinghouse.
- B. Temperature Rating: Provide insulation as follows:
 - 1. Class B: 40 degrees C maximum.
 - 2. Class F:
 - a. Between 40 degrees C and 65 degrees C maximum.
 - b. Totally enclosed motors.
- C. Starting Capability: As required for service indicated five starts minimum per hour.
- D. Phases And Current: Verify electrical service compatibility with motors to be used.
 - 1. UP TO 1/2 HP: Provide permanent split, capacitor-start single phase with inherent overload protection.
 - 2. 1/2 HP AND LARGER: Provide squirrel-cage induction polyphase.
 - 3. Provide two separate windings on 2-speed polyphase motors.

4. Name plate voltage shall be the same as the circuit's normal voltage, serving the motor.
- E. Service Factor: 1.15 for polyphase; 1.35 for single phase.
- F. Frames: U-frames 1.5 h.p. and larger.
- G. Bearings: Provide sealed re-greasable ball bearings; with top mounted alemite lubrication fittings and bottom side drains minimum average life 100,000 hours typically, and others as follows:
1. Design for thrust where applicable.
 2. PERMANENTLY SEALED: Where not accessible for greasing.
 3. SLEEVE-TYPE WITH OIL CUPS: Light duty fractional hp. motors or polyphase requiring minimum noise level.
- H. Enclosure Type: Provide enclosures as follows:
1. CONCEALED INDOOR: Open drip proof.
 2. EXPOSED INDOOR: Guarded.
 3. OUTDOOR TYPICAL: Type II. TEFC.
 4. OUTDOOR WEATHER PROTECTED: Type II. TEFC.
 5. EXPLOSION PROOF
- I. Overload Protection: Built-in sensing device for stopping motor in all phase legs and signaling where indicated for fractional horse power motors.
- J. Noise Rating: "Quiet" except where otherwise indicated.
- K. Efficiency: Provide premium high efficiency motors in accordance with minimum full load efficiency listed in the following table, when tested in accordance with IEEE Test Procedure 112A, Method B, including stray load loss measure.

<u>HP</u>	<u>RPM (Syn)</u>	<u>NEMA Frame</u>	<u>Percent Efficiency</u>	<u>Percent Power Factor</u>
1	1800	143T	82	84
1-1/2	1800	145T	84	85
2	1800	145T	84	85
3	1800	182T	86	86
5	1800	184T	87	87
7-1/2	1800	213T	88	86
10	1800	215T	89	85
15	1800	256T	91	85
20	1800	256T	91	86
25	1800	284T	91	85
30	1800	286T	92	88
40	1800	324T	92	83
50	1800	326T	93	85

2.2 MOTOR CONTROLLERS (STARTERS)

- A. All motor controllers (for equipment furnished under Division 23 shall be furnished under Division 26 and installed under Division 26 unless otherwise noted on the plans.
- B. Motor starters shall be furnished as follows.
1. General: Motor starters shall be Square D Company Class 853C across-the-line magnetic type, full-voltage, non-reversing (FVNR) starter. All starters shall be constructed and tested in accordance with the latest NEMA standards, sizes and horsepower. IEC sizes are not acceptable. Starters shall be mounted in a general purpose dead front, painted steel enclosure and surface-mounted. Provide size and number of poles as shown and required by equipment served. Provide two speed, two winding or two speed, single winding motor starter as required for two speed motors.
 2. Contacts: Magnetic starters contacts shall be double break solid silver alloy.
 3. All contacts shall be replaceable without removing power wiring or removing starter from panel. The starter shall have straight-through wiring. OPERATING COILS: Operating coils shall be 120 volts and shall be of molded construction. When the coil fails, the starter shall open and shall not lock in the closed position.
 4. Overload Relays: Provide manual reset, trip-free Class 20 overload relays in each phase conductor in of all starters. Overload relays shall be melting alloy type with visual trip indication. All 3 phase and single phase starters shall have one overload relay in each underground conductor. Relay shall not be field adjustable from manual to automatic reset. Provide 6 overload relays for two speed motor starters.

5. Pilot Lights: Provide a red running pilot light for all motor starters. Pilot lights shall be mounted in the starter enclosure cover. Pilot lights shall be operated from an interlock on the motor starter and shall not be wired across the operating coil.
 6. Controls: Provide starters with HAND-OFF-AUTOMATIC switches. Coordinate additional motor starter controls with the requirements of Division 23. Motor starter controls shall be mounted in the starter enclosure cover.
 7. Control Power Transformer: Provide a single-phase 480 volt control power transformer with each starter for 120 volt control power. Connect the primary side to the line side of the motor starter. The primary side shall be protected by a fuse for each conductor. The secondary side shall have one leg fused and one leg grounded. Arrange transformer terminals so that wiring to terminals will not be located above the transformer.
 8. Auxiliary Contacts: Each starter shall have one normally open and one normally closed convertible auxiliary contact in addition to the number of contacts required for the "holding interlock", remote monitoring, and control wiring. In addition, it shall be possible to field-install three more additional auxiliary contacts without removing existing wiring or removing the starter from its enclosure.
 9. Unit Wiring: Unit shall be completely pre-wired to terminals to eliminate any interior field wiring except for line and load power wiring and HVAC control wiring.
 10. Enclosures: All motor starter enclosures shall be NEMA 1, general purpose enclosures or NEMA-3R if mounted exposed to high moisture conditions. Provide NEMA 4X when located by cooling towers.
 11. Power Monitor: Provide a square "D" 8430 MPS phase failure and under-voltage relay, base and wiring required for starters serving motors 10 horse power and larger. Set the under-voltage setting according to minimum voltage required for the motor to operate within its range.
- C. Approved Manufacturers: Controller numbers are based on first named manufacturer. Provide one of the following manufacturers.
1. Siemens.
 2. Square D.
 3. ABB.

2.3 COMBINATION MOTOR STARTERS

- A. General: Combination motor starters shall consist of a magnetic starter and a fusible or non-fusible disconnect switch in a dead front, painted steel NEMA 1 enclosure unless otherwise noted and shall be surface-mounted. Size and number of poles shall as shown and required by equipment served. Combination motor starters shall be as specified for motor starters in Paragraph 2.01/B, except as modified herein.
- B. Disconnect Switch: Disconnect switches shall be as specified in Division 26.
- C. Approved Manufacturers: Controller numbers are based on first named manufacturer. Provide one of the following manufacturers.
1. Siemens.
 2. Square D.
 3. ABBc.

PART 3 - EXECUTION

3.1 MAINTNANCE / WARRANTY SERVICE

- A. Warranty to commence 12 months from the date of start-up, not to exceed 36 months from the date of shipment, and include all parts, labor, and travel time.

END OF SECTION 23 05 13

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SECTION 23 05 29 - HANGERS AND SUPPORTS FOR HVAC EQUIPMENT**PART 1 - GENERAL**

- 1.1 SECTION INCLUDES
- A. Furnish and install supports, anchors and sleeves applicable to mechanical, plumbing, and fire protection systems, including:
 - 1. Duct, and equipment hangers, supports, and associated anchors.
 - 2. Equipment bases and supports.
 - 3. Sleeves and seals.
 - 4. Flashing and sealing equipment and pipe stacks.
- 1.2 WORK FURNISHED BUT INSTALLED UNDER OTHER SECTIONS
- A. Provide hanger and support inserts and sleeves and coordinate placement into formwork.
- 1.3 RELATED SECTIONS
- A. Section 230700 – HVAC Insulation.
 - B. Section 230716 – HVAC Equipment Insulation.

PART 2 - PRODUCTS

- 2.1 MANUFACTURERS
- A. Grinnell
 - B. Superstruct
 - C. Unistrut
 - D. Specified Technologies, Inc.
 - E. FireSage
 - F. Link-Seal
 - G. 3M
 - H. Rectorseal
- 2.2
- 2.2 HANGER RODS
- A. Steel, threaded both ends, threaded one end or continuous threaded. Galvanized or cadmium plated.
- 2.3 INSERTS
- A. Provide malleable iron case of galvanized steel shell and expander plug for threaded connection with lateral adjustment, top slot for reinforcing rods, lugs for attaching to forms, size inserts to suit threaded hanger rods.
- 2.4 FLASHING
- A. Metal Flashing: 26 gauge galvanized steel.
 - B. Flexible Flashing: 47 mil thick sheet butyl: compatible with roofing.
 - C. Caps: Steel, 22 gauge minimum; use 16 gauge at fire resistant elements.
- 2.5 SLEEVES
- A. Sleeves for Round Ductwork: Form with galvanized steel.
 - B. Sleeves for Rectangular Ductwork: Form with galvanized steel.
 - C. Provide fire-stop compound at all penetrations of floor slabs or firewalls such that fire rating integrity of barrier is not lessened.
 - D. Caulk: Caulk all sleeves water and airtight.
 - E. Size sleeves large enough to allow for movement due to expansion and contraction. Provide for continuous insulation wrapping. Provide pipe sleeves one size larger than the pipe it serves, including insulation, except where "Link Seal" casing seals are used.
 - F. Sleeves Penetration Walls Below Grade: Provide "Link-Seal" and sleeve as manufactured by Thunderline Corporation, Wayne, Michigan, for all pipes passing through walls below grade.

2.6 FINISHES

- A. Prime coat and paint exposed steel hangers and supports. Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.
- B. Provide galvanized hangers and supports for all piping and ductwork located in crawlspace, pipe shafts, and above suspended ceiling spaces.
- C. Provide hanger rods, bolts, nuts, and all metal parts coated with the same material as hangers.

2.7 ANCHOR BOLTS

- A. Provide galvanized anchor bolts for all equipment placed on concrete pads or on concrete slabs of the size and number recommended by the manufacturer of the equipment.

PART 3 - EXECUTION**3.1****3.1 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, provide inserts flush with slab surface.
- E. Where inserts are omitted, drill through concrete slab from below and provide thru-bolt with recessed square steel plate and nut recessed into and grouted flush with slab.

3.2 FLASHING

- A. Provide flexible flashing and metal counter-flashing where sleeves, piping and ductwork penetrate weather or waterproofed walls, floors, and roofs.
- B. Flexible sheet flash and counter-flash all curbs for mechanical equipment on roof with sheet metal; seal watertight.
- C.

3.3 SLEEVES

- A. Provide sleeves for all pipe penetrations through walls, roof or slab above grade.
- B. Set sleeves in position in formwork. Provide reinforcing around sleeves.
- C. Extend sleeves through floors 2 inches above finished floor level. Caulk sleeves full depth and provide floor plate.
- D. Where ductwork penetrates floor, ceiling wall, close off space between pipe or duct and adjacent work with fire stopping insulation and seal air tight. Provide close fitting metal collar or escutcheon covers at both sides of penetration. When penetration is through a fire rated floor or wall, provide fire safing insulation so that the assembly when complete is UL listed and equals the fire rating of construction penetrated by the sleeve.
- E. Install chrome plated steel escutcheons at finished surfaces.
- F. Provide three 6 inch long reinforcing rods welded at 120-degree spacing to the sleeve on all sleeves supporting riser piping 4 inches and larger. Embed reinforcing rods in concrete or grout to existing concrete.
- G. Install sleeve assembly for walls below grade with 1/4-inch thick plate located in the middle of the wall.
- H. Neatly cut hose in existing walls, floors and roofs for placement of sleeves. Place sleeve and grout, and caulk annular space to provide finished appearance.

3.4 ANCHOR BOLTS

- A. Locate position of anchor bolts by means of suitable templates.
- B. When equipment is placed on vibration isolators, secure equipment to the isolator and the isolator to the floor, pad or support as recommended by the vibration isolator manufacturer.

END OF SECTION 23 05 29

SECTION 23 05 48 - VIBRATION CONTROLS FOR HVAC PIPING AND EQUIPMENT**PART 1 - GENERAL**

- 1.1 SECTION INCLUDES
- A. Furnish and install vibration isolators for rotary, dynamic, or reciprocating equipment or components; include:
 - 1. Inertia bases
 - 2. Vibration isolation
- 1.2 REFERENCES
- A. ASHRAE – Guide to average Noise Criteria Curves
 - B. Local codes and ordinances
 - C. Special conditions
- 1.3 SUBMITTALS
- A. Indicate isolation base dimensions.
 - B. Indicate vibration isolator locations, with static and dynamic load.
 - C. Include calculation required to certify compliance with specified requirements.
 - D. Submit manufacturer's certificate that isolators are properly installed and properly adjusted to meet or exceed specified requirements.
- 1.4 QUALITY ASSURANCE
- A. Maintain ASHRAE criteria for average noise criteria curves for all equipment at full load condition.
 - B. Provide vibration isolation devices, including auxiliary steel bases and pouring forms, from a single manufacturer or supplier who will be responsible for complete coordination of all phase of this work.
 - C. The mechanical systems shall have a maximum noise level of 50 decibels in occupied spaces.

PART 2 - PRODUCTS

- 2.1 MANUFACTURERS
- A. Amber-Booth Company
 - B. Korfund Dynamics Corporation
 - C. Mason Industries
 - D. Peabody Noise control Inc.
 - E. Vibration Eliminator Co., Inc.
- 2.2 ISOLATION BASES
- A. Type A: Integral structural steel fan and motor base with motor slide rails.
 - B. Type B: Slung structural steel base with gusseted brackets.
 - C. Type C: Reinforced 3,000 psi concrete set in full depth perimeter structural steel channel frame, with gusseted brackets and anchor bolts.
 - D. Type D: Reinforced 3,000 psi concrete base with chamfered edges without channel frame.
- 2.3 VIBRATION ISOLATORS
- A. Type 1: Closed spring mount with top and bottom housing separated with neoprene rubber stabilizers.
 - B. Type 2: Open spring mount with stiff springs (horizontal stiffness equal to vertical stiffness).
 - C. Type 3: Open spring mount with stiff springs, heavy mounting frame, and limit stop.
 - D. Type 4: Closed spring hanger with acoustic washer.
 - E. Type 5: Closed spring hanger with 1 inch thick acoustic isolator.
 - F. Type 6: Rubber waffle pads, 30 durometer, minimum 1/2-inch thick, maximum loading 40 psi. Use neoprene in oily or exterior locations.
 - G. Type 7: 1/2-inch thick rubber waffle pads bonded each side to 1/4-inch thick steel plate.
 - H. Type 8: Type BRD-1 rubber-in-shear isolators. Size isolator for 0.35-inch deflection.
- 2.4 FABRICATION
- A. Provide pairs of neoprene side snubbers or restraining springs where side torque or thrust may develop.

- B. Color code spring mounts.
- C. Select spring to operate at two-thirds maximum compression strain, with 1/4 inch ribbed neoprene pads.
- D. Type 1 Isolators: Fabricate with cast aluminum or hot-dipped galvanized steel housing with PVC coated steel spring and neoprene pad bonded to base plate.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install vibration isolators for motor driven equipment.
- B. Set steel bases for 1 inch clearance between housekeeping pad and base. Set concrete inertia bases for 2 inch clearance. Adjust equipment level.
- C. Provide spring isolators on piping connected to isolated equipment as follows: up to 4 inch diameter, first three points of support; five to 8 inch diameter, first four points of support; 10 inch diameter and over, first six points of support. Static deflection of first point to be twice deflection of isolated equipment.
- D. Provide minimum of four hangers for each fan coil unit and fan powered terminal units. Provide isolators for each hanger.

3.2 SCHEDULE

Isolated Equipment	Base Type	Isolator Type
Centrifugal Fans	A	1
Class I & II to 54 inches	A & C	1
Class I & II over 60 inches	A & C	1
Class III		
Ductwork		N/A
Fan Powered Terminal Units		8

END OF SECTION 23 05 48

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SECTION 23 05 53 - IDENTIFICATION FOR HVAC EQUIPMENT**PART 1 - GENERAL**

- 1.1 SECTION INCLUDES
 - A. Furnish and install materials for identification of mechanical products installed under Divisions 22 and 23.
- 1.2 RELATED SECTIONS
 - A. Section 090190 – Maintenance of Painting and Coatings.
- 1.3 REFERENCES
 - A. NFPA 90A – Installation of Air Conditioning and Ventilating Systems.
- 1.4 SUBMITTALS
 - A. Submit product data on plastic nameplates.

PART 2 - PRODUCTS

- 2.1 MANUFACTURERS
 - A. W.H. Brady Company
 - B. Marken Corporation
 - C. Seton Name Plate Company
- 2.2 MATERIALS
 - A. Color: Meet requirements of ANSI A13.1, unless specified otherwise.
 - B. Plastic Nameplates: Laminated three-layer plastic with engraved white letters on a black background; minimum size 3 inches long and 1 inch high. Minimum lettering height for numbers and names is 1/4-inch and other data is 1/8-inch.

PART 3 - EXECUTION

- 3.1 PREPARATION
 - A. Thoroughly clean all surfaces to be painted as required to remove all oil, grease, loose scale, rust, and foreign matter..
 - B. The ceiling grid shall be marked with plaques that designate the location of all isolation and emergency shut-off valves, resettable fire and smoke dampers, and other equipment that requires quick access in an emergency.
- 3.2 INSTALLATION
 - A. Plastic Nameplates: Secure nameplates to equipment fronts using corrosive resistant screws and rivets. Install nameplates parallel to equipment lines.
 - B. Equipment
 - 1. Identify mechanical equipment scheduled on Drawings with nameplates, except of air devices, sprinkler heads, plumbing fixtures, and plumbing shock absorbers.
 - 2. Identify name, number, function, capacity, and other pertinent information of air handling units, pumps, heat transfer equipment, tanks, and water treatment devices with plastic nameplates.
 - C. Controls: Identify control panels and major control components outside panels with plastic nameplates.
 - D. Fire Dampers: Label with plastic nameplates in accordance with NFPA 90A.
 - E. Use identification of equipment on the "Record Drawings" for nameplate designations.
 - F. Attach identification for items such as special switches, etc., located in finished areas, on or in the immediate vicinity of the item.
- 3.3

END OF SECTION 23 05 53

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SECTION 23 05 93 - TESTING, ADJUSTING AND BALANCING FOR HVAC**PART 1 - GENERAL****1.1 RELATED DOCUMENTS**

- A. Contract Documents, General Requirements for Building Construction and Related Work, apply to work specified in this section.

1.2 SCOPE

- A. An independent Testing, Adjusting and Balancing (TAB) Contractor for the HVAC systems shall be selected by Owner. The TAB contractor will be contracted by LSCS.
- B. This section provides for the testing, balancing, and commissioning of all systems and equipment.
- C. These tests are required to determine that all systems and equipment involved may be safely energized and equipment.
- D. Perform tests by and under the supervision of fully experienced and qualified personnel. Advise each respective manufacturer's representative of tests on their equipment.
- E. Record all test data.
- F. Each section of Divisions 22 and 23 that has the products or systems listed herein, incorporate this section by reference and is incomplete without the required tests stated herein.
- G. This Section includes testing, adjusting, balancing, and commissioning HVAC systems and alarm point reporting verification to produce design objectives, including the following:
 - 1. Balancing airflow and water flow within distribution systems, including sub-mains, branches, and terminals, to indicated quantities according to specified tolerances.
 - 2. Adjusting total HVAC systems to provide indicated quantities.
 - 3. Measuring electrical performance of HVAC equipment.
 - 4. Setting quantitative performance of HVAC equipment.
 - 5. Verifying that automatic control devices are functioning properly and perform their intended functions.
 - 6. Calibrating automatic temperature control sensors.
 - 7. Commissioning the HVAC system.
 - 8. Verification of building alarm and alarm remote monitoring.

1.3 REPORTS

- A. Submit test report forms for review a minimum of 90 prior to requesting a final review by the Architect/Engineer.
- B. Furnish six (6) individually bound copies of test data. Neatly type and arrange data. Include with the data the date tested, personnel present, weather conditions, nameplate record of test instrument and list all measurements take, both prior to and after any corrections are made to the system. Record all failures and corrective action taken to remedy incorrect situation.
- C. The Architect will retain on (1) copy and the Engineer will retain one (1) copy. The remaining four (4) copies will be returned to the Contractor for inclusion in the operation and maintenance manuals. Refer to Division 01 – Closeout Submittals.

1.4 REFERENCES

- A. AABC. 1989. National Standards for Total System Balance, 5th edition.
- B. AABC. 1997. Testing and Balancing Procedures.
- C. ASHRAE – 1999 Applications Handbook: Chapter 36 – Testing, Adjusting and Balancing.
- D. ASHRAE – 1999 Applications Handbook: Chapter 41 – Building Commissioning.
- E. ASHRAE – 1999 HVAC Application Handbook: Chapter 46, Sound and Vibration Control.

1.5 VIBRATION TESTS

- A. Location of Points for Fans:
 - 1. Fan bearing, drive end.
 - 2. Fan bearing, opposite end.
 - 3. Motor bearing, center (if applicable)
 - 4. Motor bearing, drive end.
 - 5. Motor bearing, opposite end.
- B. Test Readings.
 - 1. Horizontal, velocity and displacement.

2. Vertical, velocity and displacement.
3. Axial, velocity and displacement.
- C. Normally acceptable readings, velocity and acceleration.
- D. Unusual conditions at time of test.
- E. Vibration sources (if non-complying)

PART 2 - PRODUCTS – NOT USED

PART 3 - EXECUTION

3.1 PREPARATION

- A. Follow industry standard practices and procedures for testing, balancing, and commissioning as listed in paragraph 1.3 above.
- B. The A/E must be notified a minimum of 72 hours prior to any tests being conducted.
- C. The TAB Contractor must be notified a minimum of five working days prior to conduction any duct leakage tests and same must be present to witness all duct leakage tests.

3.2 PRELIMINARY PROCEDURES FOR AIR SYSTEM BALANCING

- A. Before operating the system, perform these steps:
 1. Obtain design Drawings and Specifications and become thoroughly acquainted with the design intent.
 2. Obtain copies of approved shop drawings of all exhaust fans, air distribution devices (supply, return, and exhaust) and temperature control diagrams.
 3. Compare design to installed equipment and field installations.
 4. Walk the system from the system air handling equipment to terminal units to determine variations of installation from design.
 5. Check filters for cleanliness.
 6. Check dampers (both volume and fire) for correct and locked position, and temperature control for completeness of installation before starting fans.
 7. Prepare report test sheets for both fans and air distribution devices. Obtain manufacturer's air distribution device area factors (Ak) and recommended procedures for testing. Prepare a summation of required air distribution device air flow volume to permit a crosscheck with required fan air flow volume.
 8. Determine best locations in main and branch duct for most accurate duct traverses.
 9. Place air distribution device and manual balancing dampers in the full open position.
 10. Prepare schematic diagrams of system "as-built" duct and piping layouts to facilitate reporting.
 11. Lubricate all motors and bearings.
 12. Check fan belt tension and pulley alignment.
 13. Check fan rotation

3.3 PERFORMING TESTING, ADJUSTING, AND BALANCING

- A. Perform testing and balancing procedures on each system identified, in accordance with the detailed procedures outlined in the referenced standards.
- B. Cut insulation and duct for installation of test probes to the minimum extent necessary to allow adequate performance of procedures.
- C. Patch insulation, duct, and housings, using materials identical to those removed.
- D. Seal ducts and test for and repair leaks.
- E. Seal insulation to re-establish integrity of the vapor barrier.
- F. Mark equipment settings, including damper control positions, valve indicators, fan speed control levers, and similar controls and devices, to show final settings. Mark with paint or other suitable, permanent identification materials.
- G. Retest, adjust, and balance systems subsequent to significant system modifications, and resubmit test results

3.4 MECHANICAL EQUIPMENT

- A. Verify the following:
 1. Equipment is operable and in safe and normal condition.
 2. Temperature control systems are installed complete and operable.
 3. Proper thermal overload protection is in place for electrical equipment.

4. Final filters are clean and in place. If required, install temporary media in addition to final filters.
5. Duct systems are clean of debris.
6. Correct fan rotation.
7. Fire and volume dampers are in place and open.
8. Access doors are closed and duct end caps are in place.
9. Air outlets are installed and operable.
10. Duct system leakage has been minimized.
11. Proper sequencing and operation of all DDC Control System components and equipment as required by ASHRAE Standard on Total Building Mechanical System Commissioning.
12. Perform sound power level tests and provide required data on each occupied space adjacent to, above, or below mechanical/ air handling unit equipment rooms.
13. Perform vibration test and provide required data on each piece of air handling/ ventilation equipment or fan. Vibration testing must be complete in compliance with the requirements of ASHRAE – 1999 HVAC applications Handbook Chapter 46, Sound and Vibration Control and the maximum listed RMS values listed herein.

B. Duct Leakage

1. Test all supply air ductwork, to include, but not limited to, downstream of all single zone and multi-zone air handling units, downstream of all VAV air handling units and upstream of fan powered terminal units at 2-1/2 inches of static pressure (except where this requirement would exceed the ductwork design pressure classification) to have a total leakage value not to exceed 2% of the total system airflow.
2. Test all supply, return, and exhaust air ductwork, to include, but not limited to, downstream of fan coil units and fan powered terminal units, upstream of air handling units, and upstream and downstream (where applicable) of fans at 1-1/2 inches of static pressure to have a total leakage value not to exceed 2% of the total system design airflow.
3. Ductwork that initially fails these tests shall be replaced, modified, resealed, etc. as required to meet the leakage requirement and then re-tested to ensure compliances.

3.5 PLUMBING EQUIPMENT

A. Plumbing System – Perform operational tests to demonstrate satisfactory operation. Include the following information:

1. Time date and duration of test for each system.
2. Water pressures at the most remote and highest fixtures.
3. Operation of each fixture and fixture trim.
4. Operation of each valve and faucet.
5. Temperature of each domestic hot water supply.
6. Operation of each floor drain by flooding and water.
7. Operation of each vacuum breaker and backflow preventer.
8. Piping systems: Test results of all pressure tests.

B. Sanitary Waste, Vent and Storm Drainage Systems: Test systems throughout upon completion of the rough work and without fixtures connected. Test underground lines with not less than 15 feet hydrostatic head and prove leak free for one hour. Plug and test sanitary system by floors and prove leak free for one hour. Flush floor drains for proper operation.

C. Domestic Water System

1. Test hot and cold water piping prior to being insulated. Test in place with 125 psi hydrostatic test at the low points and maintain pressure without pumping for one hour.
2. Completely flush water circulating system with water with strainers removed. Fill system with water for 48 hours minimum with a 1-inch open bleed valve or until bleed water is clear. After completing this operation, chemically treat system, clean strainer and open to central system.
3. Thoroughly flush all domestic water piping and tanks and then treat and sterilize with HTH or a liquid chlorine gas and water solution, or direct chlorine gas placed in the upstream side in amounts to give a dosage of 50 ppm chlorine calculated on the volume of water the piping will contain. A minimum residual of 5 ppm chlorine shall remain in all parts of the system for a minimum of 24 hours. After sterilizing, flush all lines thoroughly. The foregoing shall be in accordance with local utility company requirements.
4. Under no circumstances shall the Contractor permit the use of any portion of the domestic water system until it has been properly sterilized and certified same by the local water department.
5. Provide Test results of disinfection of domestic water piping system.

3.6 FIRE PROTECTION

A. Fire Protection System

1. Hydrostatically test all fire protection piping in accordance with NFPA. Test all standpipe fire protection and all sprinkler piping with 200 psi hydrostatic test at the lowest level with pressure maintained without loss for two hours.
2. Upon completion of test, prepare Contractors Material and Test Certificate and submit to A/E. Furnish copies to the authority having jurisdiction.

END OF SECTION 23 05 93

SECTION 23 07 00 - HVAC INSULATION**PART 1 - GENERAL**

- 1.1 SECTION INCLUDES
- A. Furnish and install thermal insulation for mechanical and plumbing piping systems including jackets and accessories.
 - B. HVAC system includes horizontal roof drain, lines, and waste lines which receive condensate from air handling units or evaporators.
- 1.2 RELATED SECTIONS
- A. Section 090190 – Maintenance of Painting and Coatings.
 - B. Section 210553 – Identification for HVAC Equipment.
- 1.3 REFERENCES
- A. ASTM C 178 – Steady State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-HOT-Plate Apparatus.
 - B. ASTM C 195 – Mineral Fiber Thermal Insulation Cement.
 - C. ASTM C 533 – Calcium Silicate Block and Pipe Thermal Insulation.
 - D. ASTM E 84 – Surface Burning Characteristics of Building Materials.
 - E. ASTM E 96 –Water Vapor Transmission of Materials.
- 1.4 SUBMITTALS
- A. Include product description, list of materials, and thickness for each service and locations.
 - B. Include detail drawings of insulation dams.
- 1.5 QUALITY ASSURANCE
- A. Application Company Qualifications: The installing company must be solely and exclusively in the business of insulation installation for the previous consecutive five year period. The installing company must also be regularly engaged in installing the specific specified insulation material types on projects of equal or greater magnitude and scope as this project for the previous consecutive five year period. Documentation of the above listed requirements must be submitted prior to insulation material submitted.
 - B. Application Personnel Qualifications: The installing company must provide qualified installation personnel on this project jobsite directly employed by them who are skilled and proficient at installing the specific specified insulation Material types.
 - C. Any material found, by the A/E, to be improperly installed or not installed in total compliance with the specific installation instructions and methods (written or implied) of the material manufacturer must be removed by the installing company. The preparation instructions must be followed prior to the re-installation of the insulation material using the correct installation instructions and methods of the material manufacturer.
 - D. All material (to include, but not limited to, insulation, jackets, facings, coatings, mastics, adhesive, sealants, etc.) Installed inside the building must have a certified and tested composite flame spread/smoke developed rating of 25/50 in accordance with ASTM E84.
- 1.6 ENVIRONMENTAL REQUIREMENTS
- A. Maintain ambient temperatures and conditions required by manufacturers of adhesive and insulation.

PART 2 - PRODUCTS

- 2.1 MANUFACTURERS
- A. Insulation
 - 1. Owens-Corning Fiberglass Corporation.
 - 2. UpJohn CRP/DOW Chemical Company.
 - 3. Manville Corporation.
 - 4. .
 - 5. Armstrong.
 - 6. Certained Corporation

2.2 DUCT INSULATION MATERIALS

- A. Type A: Flexible Fiberglass Duct Insulation (Indoor application): ASTM C 553, Type I, Class B-4, 2" thick, 1.5 PCF density, minimum R-5 with foil faced continuous vapor barrier. This application is limited to concealed indoor locations only.
- B. Type B: Rigid Fiberglass Duct Insulation (Indoor application): ASTM C 612, Class 1, 2" thick, 3.0 PCF density, for both supply and exhaust round ducts exposed to view locations, or spaces without ceilings. Round duct insulation shall be E. O. Wood Rigid Wrap® for all round ducts in areas without ceiling.
- C. Jackets for Duct Insulation: ASTM C 921, Type I for duct with temperatures below ambient; Type II for duct with temperatures above ambient.
- D. .
- E. Duct Insulation Accessories: Provide bands, wires, tape, anchors, corner angles and similar accessories as recommended by insulation manufacturer for applications indicated.
- F. Mechanical Fasteners:
 - 1. Gemco Type IH-A from Goodloe E. Moore, Inc., Danville, IL 800-331-1164.
 - 2. Eckoustic-Klip from Eckel Industries Inc., Cambridge, MA 617-491-3221.
 - 3. INC Stick-Pin from Industrial Noise Control Inc. Addison, IL 312-620-1998.
- G. Duct Insulation Compounds: Provide cements, adhesives, coatings, sealers, protective finishes and similar compounds as recommended by insulation manufacturer for applications indicated.
 - 1. 15-141 from King Co., St. Louis, MO 314-772-9953.
 - 2. Tuffbond from Goodloe E. Moore, Inc., Danville, IL 800-331-1164.
 - 3. INC C-700 from Industrial Noise Control Inc., Addison, IL 312-620-1998.
- H. All external duct wrap shall be 1-1/2" thick, 3.0 P.C.F. density minimum, and is required on all and supply air duct that also meets with the minimum R-value per International Energy Code 2003. External duct wrap shall be with foil faced continuous vapor barrier. This application is limited to concealed indoor locations only.
 - 1.

2.3 ACCESORIES

- A. Insulation Bands: 3/4 inch wide; 0.015 inch thick galvanized steel, stainless steel or 0.007 inch thick aluminum.
- B. Metal Jacket Bands: 3/8 inch wide; 0.015 inch thick aluminum or 0.010 inch thick stainless steel to match jacket.
- C. Insulating Cement: ASTM C 195; hydraulic setting mineral wool; Ryder One-Coat.
- D. Sealants: Used at valve, fittings and where insulation is terminated. Brush apply sealant to end of insulation and continued along pipe surface. Provide Childers CP-30 L.O. sealant.
- E. Adhesives: Used to adhere the longitudinal lap seam of vapor barrier jackets and at butt joints between insulation or fitting covers. Provide Childers CP-82 or approved equal as general purpose adhesive. Use Childers CP-97 fibrous adhesive for calcium silicate or when adhering pipe saddles and shields to the insulation.
- F. Primers: Provide Childers CP-50 diluted 50% with water primer to cover insulating cements prior to finish coating.
- G. Finish: Provide Childers CP-30 L.O. as a general purpose finish to coat the longitudinal seams and butt joints of vapor barrier jackets or glass cloth jackets. Use Childers CP-50 reinforced with glass cloth as an adhesive and seizing for canvas and in other locations as indicated.

PART 3 - EXECUTION**3.1 DUCT SYSTEM INSULATION**

- A. Insulation Omitted: Do not insulate exhaust duct unless otherwise indicated on the drawings or specified, or lined duct.
- B. Cold Ducts: Temperatures below the space dew point shall have the insulation vapor barrier be continuous and unbroken through inside walls, sleeves and floor openings. Where connection is made to fire or fire/smoke damper in wall or floor the vapor barrier must extend to the wall or floor to prevent ambient air water vapor from condensing on the cold surfaces of the fire damper.
- C. Duct Wrap: Fasten all longitudinal and circumferential laps with outward clinching staples 3" on center. On rectangular ducts over 24" wide, apply as above and hold insulation in place on bottom side with mechanical pins and clips on 12" centers.
- D. Duct Wrap: Seal all joints, fastener penetrations and other breaks in vapor barrier with 3 inch wide strips of the same facing materials with factory applied vapor barrier adhesive, or 3 inch wide strips of white glass fabric embedded between two coats of vapor barrier mastic, Childers CP-30 or approved equal.

- E. Cold Duct (Below Ambient Temperature):
1. Application Requirements: Insulate the following cold duct:
 - a. Outdoor air intake duct between air entrance and fan inlet or HVAC unit inlet.
 - b. HVAC supply duct between fan discharge, or HVAC unit discharge, and room terminal outlet.
 - 1) Insulate neck, backside, and bells of supply diffusers.
 - c. HVAC return duct between room terminal inlet and return fan inlet, or HVAC unit inlet.
 - d. HVAC plenums and unit housings not pre-insulated at factory or lined.
 - e. Exhaust duct work within the building non air-conditioned spaces.
 2. Insulate each duct system specified above with one of the following types and thicknesses of insulation:
 - a. Rigid Fiberglass: 2" thick, 3.0 PCF density, for both supply and exhaust round ducts exposed outdoor locations, or spaces without ceilings. Round duct insulation shall be E. O. Wood Rigid wrap® for all round ducts in areas without ceiling.
 - b. Flexible Fiberglass: 2 " thick, 1.5 PCF density, minimum R-5 with foil faced continuous vapor barrier. This application is limited to concealed indoor locations only.
 - c. Foamglass: two (2) layers of 1" thick insulation blocks or 2" thick Armstrong Type II Armaflex flexible elastomeric closed cell sheet insulation or approved equal. (For outdoors locations).
 - d. Round duct work within the non air-conditioned spaces shall be "Koolphen phenolic foam 2.2 # density as manufactured by FGH Fabricators, Inc.
 3. Ductwork exposed to view, any other exposed indoor locations, indoor non-conditioned spaces, or spaces without ceilings, such main laboratory without ceiling etc., installed in the mechanical rooms, AHU rooms and installed outdoors shall be finished above the insulation with canvas ALL SERVICE jacket of UL listed fabric of 8 oz. per square yard. Canvas joints and laps shall be glued and sealed with vapor seal mastic such as Foster 30-30 vapor barrier. Only outdoor ducts and insulated exhaust ductwork installed in the non-conditioned area shall be covered with 0.02" thick smooth aluminum rolled jacket. utilizing longitudinal "zee" closures.
 4. Exhaust ductwork within the air-conditioned spaces do not require to be insulated. Exhaust duct on roof exposed to the outside weather do not require to be insulated.

3.2 SCHEDULE

Piping	Type	Duct Size	Insulation Thickness
Indoor ductwork Insulation Concealed Spaces	A	All sizes	2" & 1.5 lbs density
Indoor ductwork Insulation Non-concealed Spaces	B	All sizes	2" & 3.0 lbs density

END OF SECTION 23 07 00

SECTION 23 08 00 - COMMISSIONING OF HVAC**PART 1 - GENERAL**

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes commissioning process requirements for HVAC systems, assemblies, and equipment.
- B. Related Sections:
 - 1. Division 01 Section "General Commissioning Requirements" for general commissioning process requirements.

1.3 DEFINITIONS

- A. Commissioning Plan: A document that outlines the organization, schedule, allocation of resources, and documentation requirements of the commissioning process.
- B. CxA: Commissioning Authority.
- C. HVAC: Heating, Ventilating, Air Conditioning, and Refrigeration.
- D. Systems, Subsystems, Equipment, and Components: Where these terms are used together or separately, they shall mean "as-built" systems, subsystems, equipment, and components.

1.4 ALLOWANCES

- A. Labor, instrumentation, tools, and equipment costs for technicians for the performance of commissioning testing are covered by the "Schedule of Allowances" Article in Division 01 Section "Allowances."

1.5 UNIT PRICES

- A. Commissioning testing allowance may be adjusted up or down by the "List of Unit Prices" Article in Division 01 Section "Unit Prices" when actual man-hours are computed at the end of commissioning testing.

1.6 CONTRACTOR'S RESPONSIBILITIES

- A. Perform commissioning tests at the direction of the CxA.
- B. Attend construction phase controls coordination meeting.
- C. Attend testing, adjusting, and balancing review and coordination meeting.
- D. Participate in HVAC systems, assemblies, equipment, and component maintenance orientation and inspection as directed by the CxA.
- E. Provide information requested by the CxA for final commissioning documentation.
- F. Provide measuring instruments and logging devices to record test data, and provide data acquisition equipment to record data for the complete range of testing for the required test period.

1.7 CxA'S RESPONSIBILITIES

- A. Provide Project-specific construction checklists and commissioning process test procedures for actual HVAC systems, assemblies, equipment, and components to be furnished and installed as part of the construction contract.
- B. Direct commissioning testing.
- C. Verify testing, adjusting, and balancing of Work are complete.
- D. Provide test data, inspection reports, and certificates in Systems Manual.

1.8 COMMISSIONING DOCUMENTATION

- A. Provide the following information to the CxA for inclusion in the commissioning plan:
 - 1. Plan for delivery and review of submittals, systems manuals, and other documents and reports.
 - 2. Identification of installed systems, assemblies, equipment, and components including design changes that occurred during the construction phase.
 - 3. Process and schedule for completing construction checklists and manufacturer's prestart and startup checklists for HVAC systems, assemblies, equipment, and components to be verified and tested.

4. Certificate of completion certifying that installation, prestart checks, and startup procedures have been completed.
5. Certificate of readiness certifying that HVAC systems, subsystems, equipment, and associated controls are ready for testing.
6. Test and inspection reports and certificates.
7. Corrective action documents.
8. Verification of testing, adjusting, and balancing reports.

1.9 SUBMITTALS

- A. Certificates of readiness.
- B. Certificates of completion of installation, prestart, and startup activities.

PART 2 - PRODUCTS

- 2.1 (Not Used)

PART 3 - EXECUTION

3.1 TESTING PREPARATION

- A. Certify that HVAC systems, subsystems, and equipment have been installed, calibrated, and started and are operating according to the Contract Documents.
- B. Certify that HVAC instrumentation and control systems have been completed and calibrated, that they are operating according to the Contract Documents, and that pretest set points have been recorded.
- C. Certify that testing, adjusting, and balancing procedures have been completed and that testing, adjusting, and balancing reports have been submitted, discrepancies corrected, and corrective work approved.
- D. Set systems, subsystems, and equipment into operating mode to be tested (e.g., normal shutdown, normal auto position, normal manual position, unoccupied cycle, emergency power, and alarm conditions).
- E. Inspect and verify the position of each device and interlock identified on checklists.
- F. Check safety cutouts, alarms, and interlocks with smoke control and life-safety systems during each mode of operation.
- G. Testing Instrumentation: Install measuring instruments and logging devices to record test data as directed by the CxA.

3.2 Testing AND BALANCING VERIFICATION

- A. Prior to performance of testing and balancing Work, provide copies of reports, sample forms, checklists, and certificates to the CxA.
- B. Notify the CxA at least 10 days in advance of testing and balancing Work, and provide access for the CxA to witness testing and balancing Work.
- C. Provide technicians, instrumentation, and tools to verify testing and balancing of HVAC systems at the direction of the CxA.
 1. The CxA will notify testing and balancing Contractor 10 days in advance of the date of field verification. Notice will not include data points to be verified.
 2. The testing and balancing Contractor shall use the same instruments (by model and serial number) that were used when original data were collected.
 3. Failure of an item includes, other than sound, a deviation of more than 10 percent. Failure of more than 10 percent of selected items shall result in rejection of final testing, adjusting, and balancing report. For sound pressure readings, a deviation of 3 dB shall result in rejection of final testing. Variations in background noise must be considered.
 4. Remedy the deficiency and notify the CxA so verification of failed portions can be performed.

3.3 GENERAL TESTING REQUIREMENTS

- A. Provide technicians, instrumentation, and tools to perform commissioning test at the direction of the CxA.
- B. Scope of HVAC testing shall include entire HVAC installation, from central equipment for heat generation and refrigeration through distribution systems to each conditioned space. Testing shall include measuring capacities and effectiveness of operational and control functions.
- C. Test all operating modes, interlocks, control responses, and responses to abnormal or emergency conditions, and verify proper response of building automation system controllers and sensors.

- D. The CxA along with the HVAC Contractor, testing and balancing Contractor, and HVAC Instrumentation and Control Contractor shall prepare detailed testing plans, procedures, and checklists for HVAC systems, subsystems, and equipment.
- E. Tests will be performed using design conditions whenever possible.
- F. Simulated conditions may need to be imposed using an artificial load when it is not practical to test under design conditions. Before simulating conditions, calibrate testing instruments. Provide equipment to simulate loads. Set simulated conditions as directed by the CxA and document simulated conditions and methods of simulation. After tests, return settings to normal operating conditions.
- G. The CxA may direct that set points be altered when simulating conditions is not practical.
- H. The CxA may direct that sensor values be altered with a signal generator when design or simulating conditions and altering set points are not practical.
- I. If tests cannot be completed because of a deficiency outside the scope of the HVAC system, document the deficiency and report it to the Owner. After deficiencies are resolved, reschedule tests.
- J. If the testing plan indicates specific seasonal testing, complete appropriate initial performance tests and documentation and schedule seasonal tests.

3.4 HVAC SYSTEMS, SUBSYSTEMS, AND EQUIPMENT TESTING PROCEDURES

- A. Boiler Testing and Acceptance Procedures: Testing requirements are specified in Division 23 boiler Sections. Provide submittals, test data, inspector record, and boiler certification to the CxA.
- B. HVAC Instrumentation and Control System Testing: Field testing plans and testing requirements are specified in Division 23 Sections "Instrumentation and Control for HVAC" and "Sequence of Operations for HVAC Controls." Assist the CxA with preparation of testing plans.
- C. Pipe system cleaning, flushing, hydrostatic tests, and chemical treatment requirements are specified in Division 23 piping Sections. HVAC Contractor shall prepare a pipe system cleaning, flushing, and hydrostatic testing plan. Provide cleaning, flushing, testing, and treating plan and final reports to the CxA. Plan shall include the following:
 - 1. Sequence of testing and testing procedures for each section of pipe to be tested, identified by pipe zone or sector identification marker. Markers shall be keyed to Drawings for each pipe sector, showing the physical location of each designated pipe test section. Drawings keyed to pipe zones or sectors shall be formatted to allow each section of piping to be physically located and identified when referred to in pipe system cleaning, flushing, hydrostatic testing, and chemical treatment plan.
 - 2. Description of equipment for flushing operations.
 - 3. Minimum flushing water velocity.
 - 4. Tracking checklist for managing and ensuring that all pipe sections have been cleaned, flushed, hydrostatically tested, and chemically treated.
- D. Energy Supply System Testing: Provide technicians, instrumentation, tools, and equipment to test performance of gas, steam and hot-water systems and equipment at the direction of the CxA. The CxA shall determine the sequence of testing and testing procedures for each equipment item and pipe section to be tested.
- E. Refrigeration System Testing: Provide technicians, instrumentation, tools, and equipment to test performance of chillers, cooling towers, refrigerant compressors and condensers, heat pumps, and other refrigeration systems. The CxA shall determine the sequence of testing and testing procedures for each equipment item and pipe section to be tested.
- F. HVAC Distribution System Testing: Provide technicians, instrumentation, tools, and equipment to test performance of air, steam, and hydronic distribution systems; special exhaust; and other distribution systems, including HVAC terminal equipment and unitary equipment.
- G. Vibration and Sound Tests: Provide technicians, instrumentation, tools, and equipment to test performance of vibration isolation and seismic controls.

END OF SECTION

SECTION 23 31 00 - SHEET METAL DUCTWORK**PART 1 - GENERAL**

- 1.1 WORK INCLUDED
- A. Low pressure duct.
 - B. Duct pressure testing.
- 1.2 RELATED WORK
- A. Section 09900 - Painting: Weld priming, weather resistant, paint or coating.
 - B. Section 230529 - Supports and Anchors: Sleeves.
 - C. Section 230700 - Mechanical Insulation.
 - D. Section 233300 - Duct Accessories.
 - E. Section 230593 - Testing, Adjusting and Balancing.
- 1.3 REFERENCES
- A. ASHRAE - Handbook 1993 Fundamentals; Chapter 32 - Duct Design.
 - B. ASHRAE - Handbook 1992 HVAC Systems and Equipment; Chapter 16 - Duct Construction.
 - C. ASTM A 90 - Weight of Coating on Zinc-Coated (Galvanized) Iron or Steel Articles.
 - D. ASTM A 525 - General Requirements for Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process.
 - E. ASTM A 527 - Steel Sheet, Zinc-Coated (Galvanized) by Hot-Dip Process, Lock Forming Quality.
 - F. NFPA 90A - Installation of Air Conditioning and Ventilating Systems.
 - G. NFPA 90B - Installation of Warm Air Heating and Air Conditioning Systems.
 - H. SMACNA - Low Pressure Duct Construction Standards.
 - I. UL 181 - Factory-Made Air Ducts and Connectors.
 - J. ASTM A 167 - Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip.
- 1.4 DEFINITIONS
- A. Duct sizes shown are net inside clear dimensions. Duct shall be externally insulated. Where offsets or transitions are required, the duct shall maintain the equivalent diameter based on hydraulic diameter and rectangular duct size for equal flow, velocity and pressure drop as calculated by Huebscher formulae #30 and/or 31 in ASHRAE Duct Design Fundamentals Handbook and Figure 5 Friction Chart for round duct.
 - B. Low Pressure: Three (3) pressure classifications: 1/2 inch WG positive or negative static pressure and velocities less than 2,000 fpm; 1 inch WG positive or negative static pressure and velocities less than 2,500 fpm, and 2 inch WG positive or negative static pressure and velocities less than 2,500 fpm. All duct shall be sealed as specified, independent of SMACNA pressure class.
- 1.5 SUBMITTALS
- A. Refer to other applicable sections for additional coordination drawings, duct shop drawings and product data and conform to provisions of Division 1.
 - B. Indicate duct fittings, particulars such as gages, sizes, welds, and configuration prior to start of work.
 - C. The Contract Documents are schematic in nature and are to be used only for design intent. The Contractor shall prepare coordination and sheet metal shop drawings, fully detailed and drawn to scale, indicating all architectural partitions, structural conditions, all plumbing pipe and light fixtures co-ordinations, and all offsets and transitions as required to permit the duct to fit in the space allocated and built and show all bottom of duct elevations. All duct revisions required as a result of the Contractor not preparing fully detailed shop drawings will be performed at no additional cost to the Owner.
 - D. Sheet metal ductwork "shop" drawings shall be made after actual job measurements are obtained. Sheet metal ductwork drawings shall indicate the coordination of the Contractor with sprinkler piping and other mechanical and electrical services installed under Division 15 and 16. These "Shop Drawings" shall be submitted for review as specified in Section 15010. Ductwork joint, connection, ductwork "shop" drawing submittal. Details shall be indexed and index number shall appear on ductwork "shop drawing" at its point of use.
- 1.6 DELIVERY, STORAGE, AND HANDLING
- A. Deliver products to site under provisions of Division 1.
 - B. Store and protect products under provisions of Division 1.
 - C. Protect duct from contamination by dirt, dust or rain by covering openings; do not store duct in open on site.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Armco - "Zinc-Grip".
- B. Flex-master.
- C. Substitutions: Under provisions of Division 1.
- D. Sheet Metal Connectors, Inc
- E. McGill Airflow LLC

2.2 MATERIALS

- A. General: Non-combustible and conforming to requirements for Class 1 air duct materials, or UL 181.
- B. Steel Ducts: ASTM A525 galvanized steel sheet, lock-forming quality, having zinc coating of 1.25 oz per sq. ft. for each side in conformance with ASTM A90. Minimum gauge for all duct shall be 26 gauge (0.019").
- C. Flexible Round Ducts:
 - 1. Low pressure: Interlocking spiral wire of galvanized steel or aluminum construction with flexible trilaminate inner fabric rated to 6 inches WG positive and 1 inches WG negative for low pressure ducts, insulated with 1" thick fiberglass insulation and reinforced metalized outer vapor barrier; Flexmaster type 5-m insulated or equal, NFPA 90A and U.L. 181 class 1 listed;
- D. Fasteners: Rivets, bolts, or sheet metal screws.
- E. Sealant: Non-hardening, water resistant, fire resistive, compatible with mating materials; liquid used alone or with tape, or heavy mastic.
- F. Hanger Rod: Steel, galvanized; continuously threaded.

2.3 LOW PRESSURE DUCT

- A. Fabricate and support in accordance with SMACNA Low Pressure Duct Construction Standards and ASHRAE handbooks, except as indicated. Provide duct material, gages, reinforcing, and sealing for operating pressures indicated, except that all duct joints and longitudinal seams for all SMACNA classes of duct shall be sealed with U.L. Listed Hardcast DT-tape and sealant FTA-20.
- B. Size round ducts installed in place of rectangular ducts in accordance with ASHRAE table of equivalent rectangular and round ducts. No variation of duct configuration or sizes permitted except by approved shop drawings.
- C. Construct tees, offsets, and elbows with radius of not less than 1-1/2 times width of duct on centerline. Where not possible and where rectangular elbows are used, provide single thickness turning vanes for duct velocities up to 1500 fpm and for higher duct velocities, provide airfoil turning vanes.
- D. Increase duct sizes gradually, not exceeding 15 degrees divergence wherever possible. Divergence upstream of equipment shall not exceed 30 degrees; convergence downstream shall not exceed 45 degrees.
- E. Use crimp joints with bead for joining round duct sizes 6 inch smaller with crimp in direction of air flow.
- F. Use double nuts and lock washers on threaded rod supports.

2.4 ACOUSTICAL DOUBLE WALL DUCTWORK

- A. As indicated on the drawings the double wall shall be constructed with a perforated inner shell surrounded by a layer of insulation and covered by a solid outer shell. The perforated inner shell has 3/32" diameter holes staggered at 3/16" on center for a clear open area of 23%. The minimum thickness of the internal liner shall be 2".

Solid Outer Shell

MATERIAL	THICKNESS	ASTM	TYPE	DUCT	END TREATMENT
Galvanized	26 - 18 gauge	A-653	G60-G90	44 1/2" - 68 1/2"*	TDC
Paint Grip	24 - 18 gauge	A-653	A60	56 1/2"	
PVS	24 - 18 gauge	A-653	4 x 1, 4 x 4	56 1/2"	
Aluminum	.032 - .050	B-316	3003 H-14	44 1/2"	
Stainless Steel	24 - 20 gauge	A-240	304 or 316	44 1/2"	

*Check with factory for availability of 68 1/2" in 26 gauge galvanized

Perforated Inner Shell

MATERIAL	THICKNESS	ASTM	TYPE	DUCT
Galvanized	24 - 22 gauge	A-653	G60-G90	TDC 56 1/2"

*Special order perforated available in other material - consult factory

PART 3 - EXECUTION**3.1 GENERAL INSTALLATION REQUIREMENTS**

- A. Obtain manufacturer's inspection and acceptance of fabrication and installation of duct at beginning of installation.
- B. Provide openings in duct where required to accommodate thermometers and controllers. Provide pilot tube openings where required for testing of systems, complete with metal well and closure device to ensure against air leakage. Where openings are provided in insulated duct, install insulation material inside a metal ring.
- C. Locate ducts with sufficient space around equipment to allow normal operating and maintenance activities.
- D. Connect fan coil units to low pressure OA intake ducts with short length of flexible duct. Hold in place with corrosion resistant clamp or strap.
- E. Connect air distribution devices to low pressure ducts with 6 feet maximum, 4 feet minimum, length of flexible duct. Hold in place with corrosion resistant strap or clamp.
- F. During construction provide temporary closures of metal or taped polyethylene on open duct to prevent construction dust from entering duct system.
- G. The interior surface of all duct shall be smooth. No sheet metal parts, tabs, angles, or anything else may project into the ducts for any reason, except as specified to be so. All seams and joints shall be external.
- H. Where ducts pass through floors, provide structural angles for duct support. Where ducts pass through walls in exposed areas, install suitable sheet metal escutcheons.
- I. All angles shall be carried around all four sides of the duct or group of ducts. Angles shall overlap corners and be welded or riveted.
- J. All duct shall be fabricated in a manner to prevent the seams or joints being cut for the installation of air distribution devices.
- K. All rectangular duct located exposed on roof shall have top horizontal surface "crowned or sloped" to prevent water from ponding. Ref: Insulation for additional requirements.
- L. Provide all new round flex duct minimum length 6'-0", for extension use round sheet metal duct externally insulated with 1-1/2" thick, 1.5 p.c.f. Density fiberglass insulation with "F-S-K-L" (foil-skrim-kraft-laminate) vapor barrier.
- M. Provide round spin-in fittings with locking quadrant butterfly volume dampers for all round duct connections to rectangular ducts. Spin-in and flex duct shall be same size as air distribution device neck diameter. Secure flex duct to spin-in and air distribution device neck with stainless steel worm gear clamps and seal vapor barrier. Suspend flex duct from structure above; round and flexible duct shall be as detailed by SMACNA in section iii round, oval and flexible duct. Round duct seams shall be type RL-1 spiral seam or seam type RL-5 grooved seam flat pipe lock constructed in accordance with SMACNA figure 3-1; flexible duct supports shall be constructed and installed in accordance with SMACNA figures 3-9 and 3-10.
- N. Duct dimensions shown are net clear Internal Dimensions; allowance must be made for 1-1/2" thick external insulation as specified; all rectangular and round supply air, return air, outside air and exhaust air duct shall be galvanized sheet metal.
- O. Provide duct test wells at all locations required for testing, adjusting balancing, and temperature measuring.
- P. All duct shall be mounted tight to underside of structure and shall be top level with bottom and side transitions only, except that allowance shall be made for duct to be externally insulated, which shall be mounted 3" below structural beams and joists or other obstruction to allow installation of the external duct insulation. Some ducts may require the use of "ESS"-drive joints or flat seams to allow crossing of duct or installation of other equipment or piping. Raise existing duct where required to allow installation of other duct or equipment; use 45 degree radius elbows (center line radius = 1.5 times duct height) to offset.
- Q. Typical supply, return and exhaust duct shall be as detailed by SMACNA in Section II fittings and other construction. All 90 degree elbows shall be constructed in accordance with SMACNA figure 2-2, style RE-1 radius elbow (center line radius = 1.5 times duct height or width), space permitting or style RE-2 square throat with turning vanes (provide duct access panel up stream of turning vanes for cleaning purposes).
- R. Turning vanes shall be installed in accordance with figure 2.3; single wall type with trailing edge for duct velocities up to 1500 fpm and double wall turning vanes above 1500 fpm duct velocity.
- S. Parallel flow branches shall be constructed in accordance with figure 2-7. Rectangular duct branch connections shall be expanded 45 degree entry type and round branch duct connections shall be spin-in type in accordance with figure 2-8 and offsets and transitions shall be in accordance with figure 2-9.
- T. Duct access doors shall be constructed in accordance with figure 2-12 and shall have a frame type 3, position 3 hinge with a type 2 locking handle; single and multi-blade volume dampers shall be in accordance with figures 2-14 and 2-15 respectively and shall have operator extensions when provided on externally insulated ducts; air distribution device connections shall be in accordance with figure 2-16 and ceiling diffuser branch ducts shall be in accordance with figure 2-17.
- U. Rectangular duct connections at all air moving equipment shall be flexible neoprene fabric and installed in accordance with figure 2-19.

- V. Seal all non-welded duct joints of all SMACNA pressure classes with Hard-cast DT-cotton tape and duct sealer FTA-20 for indoor duct and duct sealer FTA-50 for exterior duct.

3.2 DUCT APPLICATION SCHEDULE

AIR SYSTEM	MATERIAL
Low Pressure Supply or return	Galvanized Steel
Return and Relief	Galvanized Steel
General Exhaust	Galvanized Steel
Outside Air Intake	Galvanized Steel

3.3 DUCT HANGERS AND SUPPORTS

- A. All duct shall be properly suspended or supported from the building structure. Hangers shall be galvanized steel straps or hot-dipped galvanized rod with threads pointed after installation. Strap hanger shall be attached to the bottom of the duct. The spacing, size and installation of hangers shall be in accordance with the recommendations of SMACNA, latest edition.
- B. All duct risers shall be supported by angles or channels secured to the sides of the ducts at each floor with sheet metal screws or rivets. The floor supports may also be secured to ducts by rods, angles or flat bar to the duct joint or reinforcing. Miscellaneous steel supports for duct risers shall be provided under this Division.

3.4 ADJUSTING AND CLEANING

- A. Clean duct system and force air at high velocity through duct to remove accumulated dust. To obtain sufficient air, clean half the system at a time. Protect equipment which may be harmed by excessive dirt with temporary filters, or bypass during cleaning.

END OF SECTION 23 31 00

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SECTION 23 33 00 - AIR DUCT ACCESSORIES**PART 1 - GENERAL**

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Backdraft and pressure relief dampers.
 - 2. Barometric relief dampers.
 - 3. Manual volume dampers.
 - 4. Control dampers.
 - 5. Fire dampers.
 - 6. Duct-mounted access doors.
 - 7. Flexible connectors.
 - 8. Flexible ducts.
 - 9. Duct accessory hardware.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated.
 - 1. For duct silencers, include pressure drop and dynamic insertion loss data. Include breakout noise calculations for high transmission loss casings.
- B. Shop Drawings: For duct accessories. Include plans, elevations, sections, details and attachments to other work.
 - 1. Detail duct accessories fabrication and installation in ducts and other construction. Include dimensions, weights, loads, and required clearances; and method of field assembly into duct systems and other construction. Include the following:
 - a. Special fittings.
 - b. Manual volume damper installations.
 - c. Control damper installations.
 - d. Fire-damper, smoke-damper, combination fire- and smoke-damper, ceiling, and corridor damper installations, including sleeves; and duct-mounted access doors and remote damper operators.
 - e. Duct security bars.
- C. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which ceiling-mounted access panels and access doors required for access to duct accessories are shown and coordinated with each other, using input from Installers of the items involved.
- D. Source quality-control reports.
- E. Operation and Maintenance Data: For air duct accessories to include in operation and maintenance manuals.

1.4 QUALITY ASSURANCE

- A. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems," and with NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."
- B. Comply with AMCA 500-D testing for damper rating.

1.5 EXTRA MATERIALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Fusible Links: Furnish quantity equal to 10 percent of amount installed.

PART 2 - PRODUCTS**2.1 MATERIALS**

- A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.
- B. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.
 - 1. Galvanized Coating Designation: G90 (Z275).
 - 2. Exposed-Surface Finish: Mill phosphatized.
- C. Stainless-Steel Sheets: Comply with ASTM A 480/A 480M, Type 304, and having a No. 2 finish for concealed and exposed ducts.
- D. Aluminum Sheets: Comply with ASTM B 209, Alloy 3003, Temper H14; with mill finish for concealed ducts and standard, 1-side bright finish for exposed ducts.
- E. Extruded Aluminum: Comply with ASTM B 221 (ASTM B 221M), Alloy 6063, Temper T6.
- F. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts; compatible materials for aluminum and stainless-steel ducts.
- G. Tie Rods: Galvanized steel, 1/4-inch (6-mm) minimum diameter for lengths 36 inches (or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

2.2 BACKDRAFT AND PRESSURE RELIEF DAMPERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Air Balance Inc.; a division of Mestek, Inc.
 - 2. American Warming and Ventilating; a division of Mestek, Inc.
 - 3. Cesco Products; a division of Mestek, Inc.
 - 4. Duro Dyne Inc.
 - 5. Greenheck Fan Corporation.
 - 6. Lloyd Industries, Inc.
 - 7. Nailor Industries Inc.
 - 8. NCA Manufacturing, Inc.
 - 9. Pottorff; a division of PCI Industries, Inc.
 - 10. Ruskin Company.
 - 11. SEMCO Incorporated.
 - 12. Vent Products Company, Inc.
- B. Description: Gravity balanced.
- C. Maximum Air Velocity: 2000 fpm.
- D. Maximum System Pressure: 2-inch wg.
- E. Frame: 0.063-inch- thick extruded aluminum with welded corners and mounting flange.
- F. Blades: Multiple single-piece blades, maximum 6-inch width, 0.025-inch- thick, roll-formed aluminum noncombustible with sealed edges.
- G. Blade Action: Parallel.
- H. Blade Seals: Neoprene, mechanically locked.
- I. Blade Axles:
 - 1. Material: Stainless steel.
 - 2. Diameter: 0.20 inch.
- J. Tie Bars and Brackets: Galvanized steel.
- K. Return Spring: Adjustable tension.
- L. Bearings: Synthetic pivot bushings.
- M. Accessories:
 - 1. Adjustment device to permit setting for varying differential static pressure.
 - 2. Counterweights and spring-assist kits for vertical airflow installations.
 - 3. Electric actuators.
 - 4. Chain pulls.
 - 5. Screen Mounting: Front mounted in sleeve.
 - a. Sleeve Thickness: 20-gage minimum.
 - b. Sleeve Length: 6 inches minimum.
 - 6. Screen Material: Aluminum.
 - 7. Screen Type: Bird.
 - 8. 90-degree stops.

2.3 BAROMETRIC RELIEF DAMPERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Air Balance Inc.; a division of Mestek, Inc.

2. American Warming and Ventilating; a division of Mestek, Inc.
 3. Cesco Products; a division of Mestek, Inc.
 4. Duro Dyne Inc.
 5. Greenheck Fan Corporation.
 6. Lloyd Industries, Inc.
 7. Nailor Industries Inc.
 8. NCA Manufacturing, Inc.
 9. Pottorff; a division of PCI Industries, Inc.
 10. Ruskin Company.
 11. SEMCO Incorporated.
 12. Vent Products Company, Inc.
- B. Suitable for horizontal or vertical mounting.
- C. Maximum Air Velocity: 2000 fpm.
- D. Maximum System Pressure: 2-inch wg.
- E. Frame: 0.063-inch- (thick extruded aluminum], with welded corners and mounting flange.
- F. Blades:
1. Multiple, 0.025-inch-thick, roll-formed aluminum.
 2. Maximum Width: 6 inches (150 mm).
 3. Action: Parallel.
 4. Balance: Gravity.
 5. Eccentrically pivoted.
- G. Blade Seals: Neoprene.
- H. Blade Axles: Nonferrous metal.
- I. Tie Bars and Brackets:
1. Material: Aluminum
 2. Rattle free with 90-degree stop.
- J. Return Spring: Adjustable tension.
- K. Bearings: Synthetic.
- L. Accessories:
1. Flange on intake.
 2. Adjustment device to permit setting for varying differential static pressures.
- 2.4 MANUAL VOLUME DAMPERS
- A. Standard, Steel, Manual Volume Dampers:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Air Balance Inc.; a division of Mestek, Inc.
 - b. American Warming and Ventilating; a division of Mestek, Inc.
 - c. Flexmaster U.S.A., Inc.
 - d. McGill AirFlow LLC.
 - e. METALAIRE, Inc.
 - f. Nailor Industries Inc.
 - g. Pottorff; a division of PCI Industries, Inc.
 - h. Ruskin Company.
 - i. Trox USA Inc.
 - j. Vent Products Company, Inc.
 2. Standard leakage rating, with linkage outside air stream.
 3. Suitable for horizontal or vertical applications.
 4. Frames:
 - a. Hat-shaped, galvanized channels, 0.064-inch minimum thickness.
 - b. Mitered and welded corners.
 - c. Flanges for attaching to walls and flangeless frames for installing in ducts.
 5. Blades:
 - a. Multiple or single blade.
 - b. Parallel- or opposed-blade design.
 - c. Stiffen damper blades for stability.
 - d. Galvanized, 0.064 inch thick.
 6. Blade Axles: Nonferrous metal.
 7. Bearings:
 - a. Oil-impregnated bronze.
 - b. Dampers in ducts with pressure classes of 3-inch wg or less shall have axles full length of damper blades and bearings at both ends of operating shaft.
 8. Tie Bars and Brackets: Galvanized steel.

2.5 FIRE DAMPERS

- A. Manufacturers: Subject to compliance with requirements, [provide products by one of the following:
1. Air Balance Inc.; a division of Mestek, Inc.
 2. Arrow United Industries; a division of Mestek, Inc.
 3. Cesco Products; a division of Mestek, Inc.
 4. Greenheck Fan Corporation.
 5. McGill AirFlow LLC.
 6. METALAIRE, Inc.
 7. Nailor Industries Inc.
 8. NCA Manufacturing, Inc.
 9. PHL, Inc.
 10. Pottorff; a division of PCI Industries, Inc.
 11. Prefco; Perfect Air Control, Inc.
 12. Ruskin Company.
 13. Vent Products Company, Inc.
 14. Ward Industries, Inc.; a division of Hart & Cooley, Inc.
- B. Type: Static; rated and labeled according to UL 555 by an NRTL.
- C. Closing rating in ducts up to 4-inch wgstatic pressure class and minimum4000-fpmvelocity.
- D. Fire Rating: 1-1/2 hours.
- E. Frame: Curtain type with blades outside air stream fabricated with roll-formed, 0.034-inch thick galvanized steel; with mitered and interlocking corners.
- F. Mounting Sleeve: Factory- or field-installed, galvanized sheet steel.
1. Minimum Thickness: 0.052 or 0.138 inchthick, as indicated, and of length to suit application.
 2. Exception: Omit sleeve where damper-frame width permits direct attachment of perimeter mounting angles on each side of wall or floor; thickness of damper frame must comply with sleeve requirements.
- G. Mounting Orientation: Vertical or horizontal as indicated.
- H. Blades: Roll-formed, interlocking, 0.034-inch- thick, galvanized sheet steel. In place of interlocking blades, use full-length, 0.034-inch- thick, galvanized-steel blade connectors.
- I. Horizontal Dampers: Include blade lock and stainless-steel closure spring.
- J. Heat-Responsive Device: Replaceable, 165 deg Frated, fusible links.

2.6 DUCT-MOUNTED ACCESS DOORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. American Warming and Ventilating; a division of Mestek, Inc.
 2. Cesco Products; a division of Mestek, Inc.
 3. Ductmate Industries, Inc.
 4. Flexmaster U.S.A., Inc.
 5. Greenheck Fan Corporation.
 6. McGill AirFlow LLC.
 7. Nailor Industries Inc.
 8. Pottorff; a division of PCI Industries, Inc.
 9. Ventfabrics, Inc.
 10. Ward Industries, Inc.; a division of Hart & Cooley, Inc.
- B. Duct-Mounted Access Doors: Fabricate access panels according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 2-10, "Duct Access Doors and Panels," and 2-11, "Access Panels - Round Duct."
1. Door:
 - a. Double wall, rectangular.
 - b. Galvanized sheet metal with insulation fill and thickness as indicated for duct pressure class.
 - c. Vision panel.
 - d. Hinges and Latches: 1-by-1-inch butt or piano hinge and cam latches.
 - e. Fabricate doors airtight and suitable for duct pressure class.
 2. Frame: Galvanized sheet steel, with bend-over tabs and foam gaskets.
 3. Number of Hinges and Locks:
 - a. Access Doors Less Than 12 Inches Square: No hinges and two sash locks.
 - b. Access Doors up to 18 Inches Square: Two hinges and two sash locks.
 - c. Access Doors up to 24 by 48 Inches: Three hinges and two compression latches. Access Doors Larger Than 24 by 48 Inches: Four hinges and two compression latches with outside and inside handles.
- C. Pressure Relief Access Door:

1. Door and Frame Material: Galvanized sheet steel.
2. Door: Double wall with insulation fill with metal thickness applicable for duct pressure class.
3. Operation: Open outward for positive-pressure ducts and inward for negative-pressure ducts.
4. Factory set at 10-inch wg.
5. Doors close when pressures are within set-point range.
6. Hinge: Continuous piano.
7. Latches: Cam.
8. Seal: Neoprene or foam rubber.
9. Insulation Fill: 1-inch thick, fibrous-glass or polystyrene-foam board.

2.7 FLEXIBLE DUCTS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Flexmaster U.S.A., Inc.
 2. McGill AirFlow LLC.
 3. Ward Industries, Inc.; a division of Hart & Cooley, Inc.
- B. Insulated, Flexible Duct: UL 181, Class 1, 2-ply vinyl film supported by helically wound, spring-steel wire; fibrous-glass insulation; [polyethylene] [aluminized] vapor-barrier film.
 1. Pressure Rating: 10-inch wg positive and 1.0-inch wg negative.
 2. Maximum Air Velocity: 4000 fpm.
 3. Temperature Range: Minus 10 to plus 160 deg F.
 4. Insulation R-value: Comply with ASHRAE/IESNA 90.1-2004.
- C. Insulated, Flexible Duct: UL 181, Class 1, multiple layers of aluminum laminate supported by helically wound, spring-steel wire; fibrous-glass insulation; aluminized vapor-barrier film.
 1. Pressure Rating: 10-inch wg positive and 1.0-inch wg negative.
 2. Maximum Air Velocity: 4000 fpm.
 3. Temperature Range: Minus 20 to plus 210 deg F.
 4. Insulation R-value: Comply with ASHRAE/IESNA 90.1-2004.
- D. Flexible Duct Connectors:
 1. Clamps: Stainless-steel band with cadmium-plated hex screw to tighten band with a worm-gear action in sizes 3 through 18 inches to suit duct size.
 2. Non-Clamp Connectors: Adhesive plus sheet metal screws.

2.8 DUCT ACCESSORY HARDWARE

- A. Instrument Test Holes: Cast iron or cast aluminum to suit duct material, including screw cap and gasket. Size to allow insertion of pitot tube and other testing instruments and of length to suit duct-insulation thickness.
- B. Adhesives: High strength, quick setting, neoprene based, waterproof, and resistant to gasoline and grease.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install duct accessories according to applicable details in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for metal ducts and in NAIMA AH116, "Fibrous Glass Duct Construction Standards," for fibrous-glass ducts.
- B. Install duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel and fibrous-glass ducts, stainless-steel accessories in stainless-steel ducts, and aluminum accessories in aluminum ducts.
- C. Install volume dampers at points on supply, return, and exhaust systems where branches extend from larger ducts. Where dampers are installed in ducts having duct liner, install dampers with hat channels of same depth as liner, and terminate liner with nosing at hat channel.
 1. Install steel volume dampers in steel ducts.
 2. Install aluminum volume dampers in aluminum ducts.
- D. Set dampers to fully open position before testing, adjusting, and balancing.
- E. Install test holes at fan inlets and outlets and elsewhere as indicated.
- F. Install fire dampers according to UL listing.
- G. Install duct access doors on sides of ducts to allow for inspecting, adjusting, and maintaining accessories and equipment at the following locations:
 1. On both sides of duct coils.
 2. Upstream from duct filters.

3. At outdoor-air intakes and mixed-air plenums.
 4. At drain pans and seals.
 5. Downstream from manual volume dampers, control dampers, backdraft dampers, and equipment.
 6. Adjacent to and close enough to fire or smoke dampers, to reset or reinstall fusible links. Access doors for access to fire or smoke dampers having fusible links shall be pressure relief access doors and shall be outward operation for access doors installed upstream from dampers and inward operation for access doors installed downstream from dampers.
 7. At each change in direction and at maximum 50-foot spacing.
 8. Upstream and downstream from turning vanes.
 9. Upstream or downstream from duct silencers.
 10. Control devices requiring inspection.
 11. Elsewhere as indicated.
- H. Install access doors with swing against duct static pressure.
- 3.2 FIELD QUALITY CONTROL
- A. Tests and Inspections:
1. Operate dampers to verify full range of movement.
 2. Inspect locations of access doors and verify that purpose of access door can be performed.
 3. Operate fire, smoke, and combination fire and smoke dampers to verify full range of movement and verify that proper heat-response device is installed.
 4. Inspect turning vanes for proper and secure installation.
 5. Operate remote damper operators to verify full range of movement of operator and damper.

END OF SECTION 23 33 00

SECTION 23 34 19 - HVAC POWER VENTILATORS**PART 1 - GENERAL**

- 1.1 SECTION INCLUDES
- A. Furnish and install roof and wall exhausters and cabinet and ceiling exhaust fans for mechanical systems.
- 1.2 RELATED SECTIONS
- A. Section 016600 – Product Storage and Handling Requirements.
 - B. Section 230526 – Hangers and Supports for HVAC Equipment.
 - C. Section 230543 – Vibration Control for HVAC Equipment.
 - D. Section 233100 – HVAC Ducts and Casings.
 - E. Section 230593 – Testing, Adjusting, and Balancing for HVAC.
 - F. Section 230513 – Common Motor Requirements for HVAC.
- 1.3 REFERENCES
- A. AMCA 99 – Standards Handbook.
 - B. AMCA 210 – Laboratory Methods of Testing Fans for Rating Purposes.
 - C. AMCA 300 – Test Code for Sound Rating Air Moving Devices.
 - D. AMCA 301 – Method of Publishing Sound Ratings for Air Moving Devices.
 - E. SMACNA – Low Pressure Duct Construction Standard.
- 1.4 SUBMITTALS
- A. Include fan curves with specified operating point clearly plotted.
 - B. Include sound power levels for both fan inlet and outlet at rated capacity.
 - C. Indicate special coating when required.
 - D. Provide operation and maintenance manual.
 - E. Operation and Maintenance Data: For centrifugal fans to include in emergency, operation, and maintenance manuals.
- 1.5 QUALITY ASSURANCE
- A. Performance Ratings: Conform to AMCA 210 and bear the AMCA Certified Rating Seal.
 - B. Sound Ratings: AMCA 301, tested to AMCA 300.
 - C. Fabrication: Conform to AMCA 99.

PART 2 - PRODUCTS

- 2.1 MANUFACTURERS
- A. Greenheck.
 - B. Cook.
 - C. Twin City.
 - D. Bayley.
 - E. Penn Ventilator.
- 2.2 ROOF EXHAUSTERS
- A. Centrifugal or Axial Fan Unit: Backward inclined or airfoil design, v-belt or direct driven, with spun aluminum housing, resilient mounted motor and drive assembly, 1/2-inch mesh, 16 gauge aluminum bird screen; square base to suit roof curb with continuous curb gaskets; secured to roof curb with cadmium plated or stainless steel bolts and screws, as indicated in Drawings.
 - B. Roof Curb: 12 inch with continuously welded seams, built-in cant strip, 1 inch insulation and curb bottom, hinged curb adapter sand factory installed door mailer strip. Where scheduled, provide interior baffle with acoustic insulation and increase curb height as required.
 - C. Disconnect Switch: Factory wired, non-fusible, in housing for thermal overload protected motor.
 - D. Backdraft Damper: Gravity activated, aluminum multiple blade construction, felt edged with nylon bearings.
 - E. Sheaves: Cast-iron or steel, dynamically balanced, bored to fit shafts and keyed; adjustable pitch motor sheave selected so required rpm is obtained with sheaves set at mid position; and will not overload motor when adjusted to maximum pitch; fan shaft with self-aligning pre-lubricated ball bearings.

- F. Apply three coats of air dried Heresite coating both internal and external to all roof exhausters from corrosive areas.
 - G. Motors: In total compliance with Section 230513.
- 2.3 SOURCE QUALITY CONTROL
- A. The following tests must be conducted at the project site.
 - 1. Vibration test as described in Section 016600 – Product Storage and Handling Requirements, Section 016613 – Product Storage and Handling Requirements for Hazardous Materials, and Section 016616 – Product Storage and Handling Requirements for Toxic Materials.
 - B. The following listed tests must be conducted at the manufacturer's test facility.
 - 1. Vibration test as described in Section 230593 – Testing, Adjusting, and Balancing for HVAC.
 - 2. Sound test under AMCA Guidelines and Conditions. The sound power levels must not exceed those indicated on Drawings.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Secure roof exhausters with 1/2" x 2" S.S. lag screws roof curb.
- C. Install flexible ductwork connections when fan connects to ductwork.
- D. Provide all ventilating and exhaust fans with integral vibration isolation.
- E. Water test ventilators after installation.

3.2 FIELD QUALITY CONTROL

- A. Provide equipment with factory finish in accordance with the manufacturer's standards. Touch scratches and marks from handling and installation with masking enamel to match manufacturer's color.

END OF SECTION 23 34 19

SECTION 23 37 13 - DIFFUSERS, REGISTERS, AND GRILLES**PART 1 - GENERAL****1.1 RELATED DOCUMENTS**

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

1.2 SUMMARY**A. Section Includes:**

1. Round ceiling diffusers.
2. Rectangular and square ceiling diffusers.
3. Perforated diffusers.
4. Louver face diffusers.
5. Linear bar diffusers.
6. Linear slot diffusers.
7. Ceiling-integral continuous diffusers.
8. Drum louvers.
9. Modular core supply grilles.
10. Continuous tubular diffusers.

B. Related Sections:

1. Division 08 Section "Louvers and Vents" for fixed and adjustable louvers and wall vents, whether or not they are connected to ducts.
2. Division 23 Section "Air Duct Accessories" for fire and smoke dampers and volume-control dampers not integral to diffusers, registers, and grilles.

1.3 SUBMITTALS**A. Product Data:** For each type of product indicated, include the following:

1. Data Sheet: Indicate materials of construction, finish, and mounting details; and performance data including throw and drop, static-pressure drop, and noise ratings.
2. Diffuser, Register, and Grille Schedule: Indicate drawing designation, room location, quantity, model number, size, and accessories furnished.

B. Samples for Initial Selection: For diffusers, registers, and grilles with factory-applied color finishes.**C. Samples for Verification:** For diffusers, registers, and grilles, in manufacturer's standard sizes to verify color selected.**D. Coordination Drawings:** Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from Installers of the items involved:

1. Ceiling suspension assembly members.
2. Method of attaching hangers to building structure.
3. Size and location of initial access modules for acoustical tile.
4. Ceiling-mounted items including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.
5. Duct access panels.

E. Source quality-control reports.**PART 2 - PRODUCTS****2.1 SCHEDULE**

- A. Refer to air device schedule on the Drawings.

2.2 SOURCE QUALITY CONTROL

- A. Verification of Performance: Rate diffusers, registers, and grilles according to ASHRAE 70, "Method of Testing for Rating the Performance of Air Outlets and Inlets."

PART 3 - EXECUTION**3.1 EXAMINATION**

- A. Examine areas where diffusers, registers, and grilles are to be installed for compliance with requirements for installation tolerances and other conditions affecting performance of equipment.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install diffusers, registers, and grilles level and plumb.
- B. Ceiling-Mounted Outlets and Inlets: Drawings indicate general arrangement of ducts, fittings, and accessories. Air outlet and inlet locations have been indicated to achieve design requirements for air volume, noise criteria, airflow pattern, throw, and pressure drop. Make final locations where indicated, as much as practical. For units installed in lay-in ceiling panels, locate units in the center of panel. Where architectural features or other items conflict with installation, notify Architect for a determination of final location.
- C. Install diffusers, registers, and grilles with airtight connections to ducts and to allow service and maintenance of dampers, air extractors, and fire dampers.
- D. All exterior louvers shall have wire bird screens mounted in removable metal frames.

3.3 ADJUSTING

- A. After installation, adjust diffusers, registers, and grilles to air patterns indicated, or as directed, before starting air balancing.

END OF SECTION 23 27 13

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