

**SECTION 233100 – DUCTWORK**

- 1.0 Acoustical duct lining in any part of the duct system is prohibited. All ductwork requiring insulation shall be externally insulated (Refer to the Sheet Metal Ductwork Insulation Schedule in Section 230700 for insulation types and thickness). Double walled ducts consisting of an outer wall of galvanized sheet metal, an inner wall of perforated galvanized sheet metal with insulation sandwiched between the layers is permitted.
- 2.0 All ductwork shall be designed, constructed, supported and sealed in accordance with SMACNA HVAC Duct Construction Standards and pressure classifications. When the ductwork pressure classification of these standards is exceeded, construct ductwork in accordance with SMACNA Round and Rectangular Industrial Duct Construction Standards. The following preferences or modifications to the Standards shall be specified:
- A. Radius elbows with a construction radius of 1.5 the duct width are preferred to square elbows.
  - B. All square elbows must be constructed with single thickness turning vanes, Runner Type 2 as shown in Figures 4-3 and 4-4 of SMACNA Duct Construction Standards - Metal and Flexible. Where a rectangular duct changes in size at a square-throat elbow fitting, use single thickness turning vanes with trailing edge extensions aligned with the sides of the duct.
  - C. Air extractors and splitter dampers are not permitted.
  - D. Transitions and offsets shall follow Figure 4-7 of SMACNA HVAC Duct Construction Standards - Metal and Flexible, except that sides of transitions shall slope a maximum of 15 degrees.
  - E. Minimum duct gauge shall be 22 for ducts up through 43", 20 gauge up through 60" and 18 gauge above 60".
  - F. Transverse/Longitudinal Joints:
    - 1. Transverse joints for all supply, return, make-up air and outside air ducts serving an application that requires ductwork to be inspected and cleaned periodically shall be gasketed flanged Vanstone joints with minimum 1.5 inch flanges fastened 6 inches on center or "Ductmate" transverse sheet metal duct connection system with manufacturer-furnished gasketing system. Gasket shall be "440 Gasket Tape" by Ductmate Industries, Inc. or approved equal.
    - 2. Duct transverse and longitudinal joints (except for the above requirements) shall be selected and used consistent with the static pressure class, applicable sealing requirements, materials involved, duct support intervals and other provisions for proper assembly of ductwork outlined in the SMACNA HVAC Duct Construction Standards - Metal and Flexible. Transverse joints T-15 through T-24, shown in Figure 2-1 are acceptable construction. Type L-2 (button punch snap lock) or Type L-3 (grooved seam) longitudinal seams, shown in Figure 2-2, are not acceptable
  - G. Seal all ductwork seams, joints, fastener penetrations and fitting connections with sealants in accordance with SMACNA Seal Classification as required by SMACNA Duct Pressure Classification. Specify that all ductwork, regardless of pressure classification, shall be constructed to Seal Class A. Where ducts are not continuously welded, provide liquid, mastic, and embedded fabric tape type sealants or combination, and gaskets as required to meet the specified duct leakage allowance. Sealant composite fire and smoke rating, when tested in

accordance with ASTM E 84, NFPA 255 or UL 723, shall not exceed Flame Spread of 25 and Smoke Developed of 50.

- H. The aspect ratio (ratio of width to height) of rectangular ducts should be minimized to reduce pressure losses and initial costs. Duct aspect ratios should not exceed 4:1.
  - I. To minimize fan energy, consideration must be given to the lowest practical velocity and pressure criteria which will provide adequate service. In general, size ductwork to maintain a maximum pressure drop of 0.08' per 100 lineal feet of ductwork.
- 3.0 Industrial Duct Construction:
- A. Prior approval must be attained from the University Engineering Department for the use of systems requiring industrial duct construction.
  - B. Follow SMACNA Round and Rectangular Industrial Duct Construction Standards.
  - C. Specify sealing requirements in terms of percent leakage appropriate for the application.
  - D. To minimize fan energy, consideration must be given to the lowest practical velocity and pressure criteria which will provide adequate service.
- 4.0 All duct systems must be designed to meet the sound level requirements listed in Section 230000. The specification shall state that the Contractor is responsible for all duct generated noises which will result in noise levels greater than those stated in Section 230000, and for all discrete frequency noises generated by the ductwork, such as oil canning, banging, clicking, hissing or rattling. All such deficiencies shall be corrected by the Contractor as directed by the Architect or Engineer.
- 5.0 Contract drawings must have adequate notation which correlates each duct and diffuser with the central air handling unit from which it is served. The notation must be completed in such a manner as to clearly identify each system and its components without tracing systems between drawings.
- 6.0 The contract drawings (plans or diagrams) shall indicate the changes in pressure classification of duct systems by the use of pressure flags per the convention indicated in Figure 1-1 of the SMACNA Duct Construction Standards - Metal and Flexible.
- 7.0 Shop drawings of all sheetmetal ductwork and related equipment must be furnished in a minimum scale of 3/8 inch to the foot or shall be submitted electronically. Architect/Engineer shall carefully review all contractor-generated sheet-metal submittals and mark appropriately.
- 8.0 All materials for all duct systems shall be specified as follows:
- A. General Ductwork - Galvanized sheet steel meeting ASTM A 653 and ASTM A 924 with G60 coating designation. G90 shall be required in specific applications such as general laboratory exhaust.
  - B. Stainless Steel - Specify type as dictated by the application. Specify finish for exposed ductwork.
  - C. Aluminum Duct - ASTM B-209, Alloy Number 3003, H-14. Specify finish for exposed ductwork.
- 9.0 All rectangular panels above 10 inches in width must be cross broken on all four sides.

- 10.0 All ductwork and accessories must be supported from the structure only using trapeze, strap or angle iron hangers conforming to SMACNA HVAC Duct Construction Standards - Metal and Flexible.
- A. Provide supplemental structural steel to span joists where required. Deflection of supplemental structural steel shall be limited to length/180 of the span.
  - B. Do not support ductwork from furring, hung ceilings, metal floor deck, metal roof deck or from another duct or pipe.
  - C. Do not hang lighting fixtures or piping from ductwork.
  - D. Do not use perforated band iron for duct support.
  - E. Support ductwork at each change in direction.

- F. Where vertical ducts penetrate floor openings, and require support, provide two horizontal galvanized steel angle supports attached to the long side of the duct and anchored to the floor with expansion bolts. Extend angles 3 inches beyond edge of opening. Provide the following angle sizes:

Duct Size (inches)	Angle Size (inches)
Thru 36	1 1/4 by 1 1/4 by 1/8
37 thru 59	2 by 2 by 3/16
60 and larger	3 by 3 by 3/8

- G. Where ducts penetrate mechanical room floors, provide 4 inch high concrete curbs similar to piping penetrations. (Refer to Section 231000).
  - H. Where duct connects to or terminates at masonry openings or at floors where concrete curbs are not used, provide a continuous 1 1/2 inch by 1 1/2 inch by 3/16 inch galvanized steel angle support around the ductwork. Bolt and seal the supports to the building construction using expansion bolts and caulking compound. Seal shall be watertight at floor or wall and duct such that a spill will not pass down through the opening.
  - I. All exterior duct work shall be double walled insulated construction. Exterior ductwork shall be round or sloped (rectangular) to avoid standing water on top. Any exterior ductwork with standing water will be replaced at the contractor's expense. Service stairs up and over the ductwork may be required to maintain access to the roof.
  - J. For insulated ductwork, install hangers on the outside of the insulation. To maintain the insulation value, inset a piece of 1-inch thick, 6 pcf fiberglass board with a foil/scrim/kraft (FSK) jacket at these supports.
- 11.0 Plenum chambers shall be constructed of minimum 18 gauge metal with 1/2" x 1/2" x 3/16" galvanized angles up to 10' in height Above 10' angles of 2" x 2" x 1/4" must be used. Angles must be installed on all vertical and longitudinal seams and on a maximum center of 4'.
- 12.0 Low pressure (class 2 or lower) round ductwork shall be specified as follows:
- A. Lock-type spiral seam or lock-type longitudinal seam duct construction.

- B. Round galvanized gauge selection shall be in accordance with Table 3-5 of the SMACNA Duct Construction Standards - Metal and Flexible, except that the following minimum gauges are required:
    - 1. Longitudinal lock - 22 gauge
    - 2. Spiral lock - 24 gauge
  - C. Fittings shall have a construction radius of 1-1/2" times the diameter.
  - D. All branch connections from duct headers shall be made using tee (90 degrees), lateral (45 degrees), tee cross, lateral cross or "Y" branch fittings of the conical type. All fittings fabricated as separate fittings shall have continuous welds along all seams and joints.
  - E. All seams shall be sealed.
- 13.0 Flexible Ductwork:
- A. Flexible ducting constructed of wire frames and fiberglass or plastic film is prohibited.
  - B. Ducts shall be aluminum with spiral fabricated triple lock construction. Pressure drop shall not exceed 0.23 inches of water for 100 feet of duct for 300 CFM in an 8" duct.
  - C. Duct shall conform to NFPA 90A and shall be UL listed, Specification 181, Class 1, including insulation.
  - D. Insulation where required, shall be on the exterior of the duct.
  - E. In general, maximum length shall be 6 feet or less. The remainder of the branch ductwork shall be sheet metal. Provide flexible duct runs as short and straight as possible.
- 14.0 Ducts penetrating through masonry walls, floors and roofs shall be clearly detailed on the drawings. The details shall, as a minimum, indicate curbs, flashing, counterflashing, fire dampers, sealing and weatherproofing.
- 15.0 Horizontal exterior rectangular ducts shall be fabricated with all seams at the bottom and installed with a top surface slope of 1/4" per foot, side to side. Supports shall be detailed on the drawings.
- 16.0 Specify special duct sealing and weatherproofing requirements for all exterior duct applications.
- 17.0 Dishwasher, sterilizer, autoclave, cagewasher, etc. exhaust hoods and ductwork shall be constructed of welded stainless steel. Ductwork shall be sloped and provided with drain connections at low points. Ducts to be installed with all longitudinal seams at the top of the duct. Kitchen exhaust ductwork shall be provided with adequate access doors to facilitate cleaning.
- 18.0 Kitchen exhaust hoods and exposed range hood exhaust duct shall be constructed of No. 18 gauge welded stainless steel. Concealed range hood exhaust ductwork shall be constructed and supported by of minimum No. 12 gauge black iron, or No. 18 gauge stainless steel with no turning vanes. All joints shall be welded liquid tight. As an alternative, pre-manufactured grease duct may be used when installed strictly in accordance with the manufacturer's instructions. Slope ductwork to hood or to the base of vertical risers and provide an accessible collection point for grease and residue at base of vertical risers. Provide approved access panels for cleaning at minimum 20-foot centers on horizontal duct and on each floor on vertical risers where personnel entry is not possible from the top of the riser. Hard connections to fans shall be utilized in lieu of flexible fabric connections. The

- construction and installation of all kitchen range hoods and grease duct shall comply with applicable codes.
- 19.0 Shower exhaust systems shall be constructed of aluminum and sloped to drain provisions. After the shower exhaust is mixed with a volume of general exhaust air equal to 200% of the shower exhaust rate, standard galvanized construction may be used.
- 20.0 Laboratory exhaust duct material must be reviewed and approved by the Office of the University Engineer and the Office of Environmental Health and Radiation Safety (OEHRs). All laboratory exhaust ductwork that is undiluted (fume hood branch ductwork, dedicated fume hood exhaust, etc.) shall be stainless steel. Acceptable duct materials for other lab exhaust applications are as follows:
- A. Galvanized (minimum G-90)
  - B. Stainless Steel
  - C. PVC-coated (pre-baked) steel, or epoxy-phenolic-coated (air dried) steel. Coatings for exhaust duct shall be evaluated on a case by case basis.
  - D. Plastic ducts such as Dynel reinforced polyester. When using plastic ductwork, all fire code and sprinkler code requirements must be addressed.
- 21.0 To reduce operating system pressure drop, manifold laboratory fume hoods to a common exhaust where possible.
- 22.0 ASHRAE 90.1-2016 Compliance Requirements: Duct leakage testing shall be performed in accordance with Section 6.4.4.2.2 of ASHRAE 90.1-2016. All duct systems shall be field leak tested at 100% of the duct construction rating. Leak testing shall follow general procedures (Chapter 3) and use apparatus (Chapter 5) as outlined in the SMACNA HVAC Air Duct Leakage Test Manual, Latest Edition. The A/E shall specify the allowable leakage in terms of percent of total rated airflow capacity for each duct system based on leakage allowances accounted for in airflow rate and fan selection calculations. The A/E shall specify that the allowable leakage rates for each duct section tested shall be determined by the use of Appendix C in the SMACNA HVAC Air Duct Leakage Test Manual. Ductwork to be leak tested after all branch connections are installed. All leak testing shall be witnessed by a representative from the Office of the University Engineer.
- 23.0 All Phoenix valves shall be provided with manufacturer's transition collar such that sheetmetal screws into the Phoenix valve are not required.
- 24.0 For all ductwork types, the screw type shall match the duct construction type.