

## **SECTION 23 31 13 - METAL DUCTS**

### **PART 1 - GENERAL**

#### **1.1 SUMMARY**

- A. This Section includes metal, rectangular ducts and fittings for supply, return, outside, and exhaust air-distribution systems in pressure classes from minus 2 to plus 10 inch wg.
- B. See Division 23 Section "Air Duct Accessories" for dampers, sound control devices, duct mounting access doors and panels, turning vanes, and flexible ducts.

#### **1.2 SUBMITTALS**

- A. Shop Drawings: Show fabrication and installation details for metal ducts.
  - 1. Penetrations through fire rated and other partitions.
  - 2. Duct accessories, including access doors and panels.

#### **1.3 QUALITY ASSURANCE**

- A. NFPA Compliance:
  - 1. NFPA 90A, "Installation of Air Conditioning and Ventilating Systems."
  - 2. NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."

### **PART 2 - PRODUCTS**

#### **2.1 SHEET METAL MATERIALS**

- A. Comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods, unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.
- B. Galvanized Sheet Steel: Lock forming quality; complying with ASTM A 653 and having G90 coating designation; ducts shall have mill-phosphatized finish for surfaces exposed to view.
- C. Stainless Steel: ASTM A 480, Type 316L, sheet form with No. 1 finish.
- D. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts.
- E. Tie Rods: Galvanized steel, 1/4 inch minimum diameter for lengths 36 inches or less; 3/8 inch minimum diameter for lengths longer than 36 inches.

## 2.2 DUCT LINER

- A. Fibrous Glass Liner: Comply with NFPA 90A or NFPA 90B and with NAIMA AH124.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following or approved equal.
    - a. CertainTeed Corp.; Insulation Group.
    - b. Johns Manville International, Inc.
    - c. Knauf Fiber Glass GmbH.
    - d. Owens Corning.
  2. Materials: ASTM C 1071; surfaces exposed to airstream shall be coated to prevent erosion of glass fibers.
    - a. Thickness: 1 inch.
    - b. Thermal Conductivity (K-Value): 0.26 at 75 deg F mean temperature.
    - c. Fire-Hazard Classification: Maximum flame spread index of 25 and smoke developed index of 50 when tested according to ASTM E 84.
    - d. Liner Adhesive: Comply with NFPA 90A or NFPA 90B and with ASTM C 916.
    - e. Mechanical Fasteners: Galvanized steel suitable for adhesive attachment, mechanical attachment, or welding attachment to duct without damaging liner when applied as recommended by manufacturer and without causing leakage in duct.
      - 1) Tensile Strength: Indefinitely sustain a 50 lb tensile, dead-load test perpendicular to duct wall.
      - 2) Fastener Pin Length: As required for thickness of insulation and without projecting more than 1/8 inch into airstream.
      - 3) Adhesive for Attaching Mechanical Fasteners: Comply with fire hazard classification of duct liner system.

## 2.3 SEALANT MATERIALS

- A. Water Based Joint and Seam Sealant: Flexible, adhesive sealant, resistant to UV light when cured, UL 723 listed, and complying with NFPA requirements for Class 1 ducts.
- B. Flanged Joint Mastic: One part, acid curing, silicone, elastomeric joint sealant complying with ASTM C 920, Type S, Grade NS, Class 25, Use O.
- C. Flange Gaskets: Butyl rubber or EPDM polymer with polyisobutylene plasticizer.

## 2.4 HANGERS AND SUPPORTS

- A. Building Attachments: Concrete inserts, mechanical-anchor fasteners, or structural-steel fasteners appropriate for building materials. Powder actuated concrete fasteners are not allowed.

1. Install mechanical-anchor fasteners in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions. Concrete inserts and mechanical anchor fasteners shall be made of steel.
  2. Expanding concrete anchors shall be made of steel.
- B. Hanger Materials: Galvanized sheet steel or threaded steel rod.
1. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for steel sheet width and thickness and for steel rod diameters.
- C. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.
- D. Trapeze and Riser Supports: Steel shapes and plates complying with ASTM A 36.
1. Supports for Galvanized-Steel Ducts: Galvanized-steel shapes and plates.
  2. Supports for Stainless-Steel Ducts: Stainless-steel support materials.

## 2.5 RECTANGULAR DUCT FABRICATION

- A. Fabricate ducts, elbows, transitions, offsets, branch connections, and other construction according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" and complying with requirements for metal thickness, reinforcing types and intervals, tie-rod applications, and joint types and intervals. Metal thickness no less than 26 gage.
1. Lengths: Fabricate rectangular ducts in lengths appropriate to reinforcement and rigidity class required for pressure class.
  2. Deflection: Duct systems shall not exceed deflection limits according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible."
- B. Transverse Joints: Prefabricated slide-on joints and components constructed using manufacturer's guidelines for material thickness, reinforcement size and spacing, and joint reinforcement.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following or approved equal.
    - a. Ductmate Industries, Inc.
    - b. Nexus Inc.
    - c. Ward Industries, Inc.
- C. Formed-On Flanges: Construct according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible," Figure 1-4, using corner, bolt, cleat, and gasket details.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following or approved equal.
    - a. Ductmate Industries, Inc.
    - b. Lockformer.

2. Duct Size: Maximum 30 inches wide and up to 2 inch wg pressure class.
3. Longitudinal Seams: Pittsburgh lock sealed with noncuring polymer sealant.

D. Branch Connections:

1. Round Branch: Conical or bell mouth connections.
2. Rectangular Branch: 45 degree entry fitting.

E. Cross Breaking or Cross Beading: Cross break or cross bead duct sides 19 inches and larger and 0.0359 inch thick or less, with more than 10 sq. ft. of nonbraced panel area unless ducts are lined.

## 2.6 APPLICATION OF LINER IN RECTANGULAR DUCTS

- A. Duct liner only allowed when indicated on the Drawings.
- B. Adhere a single layer of indicated thickness of duct liner with at least 90 percent adhesive coverage at liner contact surface area. Attaining indicated thickness with multiple layers of duct liner is prohibited.
- C. Apply adhesive to transverse edges of liner facing upstream that do not receive metal nosing.
- D. Butt transverse joints without gaps and coat joint with adhesive.
- E. Fold and compress liner in corners of rectangular ducts or cut and fit to ensure butted-edge overlapping.
- F. Do not apply liner in rectangular ducts with longitudinal joints, except at corners of ducts, unless duct size and standard liner product dimensions make longitudinal joints necessary.
- G. Apply adhesive coating on longitudinal seams in ducts with air velocity of 2500 fpm.
- H. Secure liner with mechanical fasteners 4 inches from corners and at intervals not exceeding 12 inches transversely; at 3 inches from transverse joints and at intervals not exceeding 18 inches longitudinally.
- I. Secure transversely oriented liner edges facing the airstream with metal nosings that have either channel or "Z" profiles or are integrally formed from duct wall. Fabricate edge facings at the following locations:
  1. Fan discharges.
  2. Intervals of lined duct preceding unlined duct.
  3. Upstream edges of transverse joints in ducts where air velocities are greater than 2500 fpm or where indicated.
- J. Terminate inner ducts with buildouts attached to fire-damper sleeves, dampers, turning vane assemblies, or other devices. Fabricated buildouts (metal hat sections) or other buildout means are optional; when used, secure buildouts to duct walls with bolts, screws, rivets, or welds.

## 2.7 ROUND AND FLAT-OVAL DUCT AND FITTING FABRICATION

- A. Diameter as applied to flat-oval ducts in this Article is the diameter of a round duct with a circumference equal to the perimeter of a given size of flat-oval duct.
- B. Round, Longitudinal- and Spiral Lock-Seam Ducts: Fabricate supply ducts of galvanized steel according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible."
- C. Flat-Oval, Longitudinal- and Spiral Lock-Seam Ducts: Fabricate supply ducts according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible." Fabricate ducts larger than 72 inches in diameter with butt-welded longitudinal seams.
- D. Duct Joints:
  - 1. Ducts up to 20 Inches in Diameter: Interior, center-beaded slip coupling, sealed before and after fastening, attached with sheet metal screws.
  - 2. Ducts 21 to 72 Inches in Diameter: Three-piece, gasketed, flanged joint consisting of two internal flanges with sealant and one external closure band with gasket.
  - 3. Ducts Larger Than 72 Inches in Diameter: Companion angle flanged joints per SMACNA "HVAC Duct Construction Standards--Metal and Flexible," Figure 3-2.
  - 4. Round Ducts: Prefabricated connection system consisting of double-lipped, EPDM rubber gasket. Manufacture ducts according to connection system manufacturer's tolerances.
    - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following or approved equal.
      - 1) Ductmate Industries, Inc.
      - 2) Lindab Inc.
  - 5. Flat-Oval Ducts: Prefabricated connection system consisting of two flanges and one synthetic rubber gasket.
    - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following or approved equal.
      - 1) Ductmate Industries, Inc.
      - 2) McGill AirFlow Corporation.
      - 3) SEMCO Incorporated.
- E. 90 Degree Tees and Laterals and Conical Tees: Fabricate to comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible," with metal thicknesses specified for longitudinal-seam straight ducts.
- F. Diverging Flow Fittings: Fabricate with reduced entrance to branch taps and with no excess material projecting from fitting onto branch tap entrance.
- G. Fabricate elbows using die formed, gored, pleated, or mitered construction. Bend radius of die-formed, gored, and pleated elbows shall be 1-1/2 times duct diameter. Unless elbow construction type is indicated, fabricate elbows as follows:

1. Gored-Elbow Number of Pieces: Welded construction.
  - a. 90 degree elbow: 5 gores.
  - b. 60 degree elbow: 4 gores.
  - c. 45 degree elbow: 3 gores.
2. Round Elbows: Welded construction with the following metal thickness for pressure classes from 2 to 10 inch wg, unless specifically indicated otherwise:
  - a. Ducts 3 to 14 Inches in Diameter: 24 gauge.
  - b. Ducts 15 to 26 Inches in Diameter: 22 gauge.
3. 90 Degree, Two Piece, Mitered Elbows: Use only where specifically indicated. Fabricate with single thickness turning vanes.
4. Round Elbows, 8 Inches and Smaller in Diameter: Fabricate die formed elbows for 45 and 90 degree elbows and pleated elbows for 30, 45, 60, and 90 degrees only. Die formed elbows shall be 20 gauge thick minimum with two-piece welded construction. Fabricate nonstandard bend angle configuration or nonstandard diameter elbows with gored construction.
5. Round Elbows, Larger 9 through 14 Inches in Diameter and All Flat Oval Elbows: Fabricate gored or pleated elbows for 30, 45, 60, and 90 degrees. Fabricate nonstandard bend angle configuration or nonstandard diameter elbows with gored construction.
6. Round Elbows, Larger than 14 Inches in Diameter: Fabricated gored elbows for all bend angle configurations.
7. Die Formed Elbows for Sizes through 8 Inches in Diameter and All Pressures 0.040 inch thick with 2 piece welded construction.
8. Round Gored Elbow Metal Thickness: Same as non-elbow fittings specified above.
9. Flat Oval Elbow Metal Thickness: Same as longitudinal seam flat oval duct specified above.
10. Pleated Elbows for Sizes through 14 Inches in Diameter and Pressures through 10 Inch wg: 0.022 inch.

## 2.8 FUME EXHAUST DUCT FABRICATION

- A. Fabricate fume hood exhaust ducts with minimum 18 gauge thick, stainless steel sheet. Continuously butt-weld longitudinal and transverse joints. Use appropriate filler rod for Type 316L stainless steel.
- B. Fabricate fume exhaust elbows with same welded construction as straight ductwork. Elbows shall be smooth with a centerline, bend radius equal to one and one-half times the duct diameter.
- C. Provide a flanged removable spool piece (minimum 24 inches long) at each fume hood connection. Use spool sections for leak tests, inspections, and to facilitate removal of equipment. Install gaskets at flanged joint connection acceptable to the Owner's Representative.

## PART 3 - EXECUTION

### 3.1 DUCT APPLICATIONS

- A. Static-Pressure Classes: Unless otherwise indicated, construct ducts according to the following:
1. Supply Ducts: 2 inch wg.
  2. Supply Ducts (before Air Terminal Units): 6 inch wg.
  3. Return Ducts (Negative Pressure): 2 inch wg.
  4. Exhaust Ducts (Negative Pressure): 2 inch wg.

### 3.2 DUCT INSTALLATION

- A. Construct and install ducts according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible," unless otherwise indicated.
- B. Install ducts with fewest possible joints.
- C. Install fabricated fittings for changes in directions, size, and shape and for connections.
- D. Install couplings tight to duct wall surface with a minimum of projections into duct. Secure couplings with sheet metal screws. Install screws at intervals of 12 inches, with a minimum of 3 screws in each coupling.
- E. Install ducts, unless otherwise indicated, vertically and horizontally and parallel and perpendicular to building lines; avoid diagonal runs.
- F. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.
- G. Install ducts with a clearance of 1 inch, plus allowance for insulation thickness.
- H. Conceal ducts from view in finished spaces. Do not encase horizontal runs in solid partitions unless specifically indicated.
- I. Coordinate layout with suspended ceiling, lighting layouts, and similar finished work.
- J. Seal all joints and seams. Apply sealant to male end connectors before insertion, and afterward to cover entire joint and sheet metal screws.
- K. Electrical Equipment Spaces: Route ducts to avoid passing through transformer vaults and electrical equipment spaces and enclosures.
- L. Non-Fire-Rated Partition Penetrations: Where ducts pass through interior partitions and exterior walls and are exposed to view, conceal spaces between construction openings and ducts or duct insulation with sheet metal flanges of same metal thickness as ducts. Overlap openings on 4 sides by at least 1-1/2 inches.

- M. Fire-Rated Partition Penetrations: Where ducts pass through interior partitions and exterior walls, install appropriately rated fire dampers, sleeves, and firestopping sealant. Fire and smoke dampers are specified in Division 23 Section "Air Duct Accessories." Firestopping materials and installation methods are specified in Division 07 Section "Penetration Firestopping."
- N. Protect duct interiors from the elements and foreign materials until building is enclosed. Follow SMACNA's "Duct Cleanliness for New Construction."

### 3.3 SEAM AND JOINT SEALING

- A. Seal duct seams and joints according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for duct pressure class indicated. For all pressure classes, Seal Class A; seal transverse joints, longitudinal seams and duct wall penetrations.
- B. Seal ducts before external insulation is applied.

### 3.4 HANGING AND SUPPORTING

- A. Install rigid round, rectangular, and flat-oval metal duct with support systems indicated in SMACNA "HVAC Duct Construction Standards--Metal and Flexible."
- B. Install duct seismic restraints in accordance with Division 23 Section "Vibration and Seismic Control for Mechanical Piping and Equipment."
- C. Support horizontal ducts within 24 inches of each elbow and within 48 inches of each branch intersection.
- D. Support vertical ducts at maximum intervals of 16 feet and at each floor.
- E. Install upper attachments to structures with an allowable load not exceeding one-fourth of failure (proof-test) load.
- F. Install concrete inserts before placing concrete.

### 3.5 CONNECTIONS

- A. Make connections to equipment with flexible connectors according to Division 23 Section "Air Duct Accessories."
- B. Comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for branch, outlet and inlet, and terminal unit connections.

### 3.6 FUME EXHAUST DUCT INSTALLATION

- A. Slope fume exhaust ductwork back to fume hood. Install without any traps where liquid can accumulate.



- B. Install two "Pete's Plugs" made of non-corrosive material in the exhaust duct at 90 degree to each other around the circumference for the purpose of pitot tube insertion.

### 3.7 ADJUSTING

- A. Refer to Division 15 Section "Testing, Adjusting, and Balancing" for detailed procedures.

### 3.8 CLEANING

- A. After completing system installation, including outlet fittings and devices, inspect the system. Vacuum ducts, and where possible, wipe ducts with moist cloth before final acceptance to remove dust and debris.

### 3.9 FUME EXHAUST DUCTWORK FINAL TEST PROCEDURE

- A. Connect a blower to the duct specimen through a shutoff valve. Provide a magnehelic gage or inclined manometer with 0 to 10 inches W.G. range on the duct side of the shutoff valve.
- B. Provide temporary seals at all open ends of the ductwork.
- C. Average test pressure shall be 6 inches W.G. Initial pressure shall be 7 inches W.G.
- D. All fume duct joints from the fume hood collar to the fan inlet flex connection, not inclusive, shall be tested.
- E. To prevent over-pressurizing the ducts, start the blower with the variable inlet damper closed. Controlling pressure carefully, pressurize the duct section to the required level. When the pressure of the duct reaches 7 inches W.G., close the shutoff valve.
- F. Using a stopwatch, measure the time elapsed from when the duct is at 7 inches W.G. to 5 inches W.G. Use the formula  $t = 6.23D$  to determine if the duct passes the test. ("D" is the nominal duct diameter, measured in inches; "t" is the MINIMUM allowable elapsed time, measured in seconds.)
- G. If the test fails to meet the allowable rate, make necessary repairs and retest until satisfactory results are obtained. Contact the Construction Coordinator to have Owner's Representative witness the test.
- H. Complete test reports.
- I. Comply with precautions listed in the current SMACNA HVAC Air Duct Leakage Test Manual.

**END OF SECTION 23 31 13**