

## **SECTION 23 89 00 - SHEET METAL AND DUCTWORK ACCESSORIES CONSTRUCTION**

### **PART 1 - GENERAL**

#### **1.1 WORK INCLUDED**

- A. Provide labor, materials, equipment and services required for the complete installation designed in Contract Documents.

#### **1.2 QUALITY ASSURANCE**

- A. Ductwork Shall Be Fabricated And Installed In Compliance With Latest Edition Of The Following Standards:
  - 1. SMACNA Duct Construction Standards - Metal and Flexible Ductwork.
  - 2. SMACNA Duct Liner Application Standard.
  - 3. NFPA Standards, Bulletin 90A, 96, 101.
  - 4. Plans and Specifications which exceed the requirements in any of the referenced standards.
- B. All sheet metal shall be fabricated and installed by an experienced Contractor specializing in this type of Work.

#### **1.3 SUBMITTALS**

- A. Shop drawings of all sheet metal equipment being provided. Submit a complete shop standard manual including construction details for all shop fabricated materials.
- B. Ductwork Detail Drawings.

#### **1.4 DUCTWORK CLASSIFICATION**

- A. Duct Systems are Classified and Constructed Per The SMACNA Velocity-Pressure Classification as follows:
  - 1. All ductwork shall be constructed for a minimum pressure class of 2 in. w.g. unless stated otherwise.
  - 2. Supply duct upstream of air terminal boxes shall be constructed for a minimum pressure class of 3 in. w.g.
  - 3. Pressure classes above 3 in. w.g. as called for.

#### **1.5 DUCTWORK SHOP DRAWINGS**

- A. Prepare Minimum 1/4 in. Scale Drawings:
  - 1. Constructed from actual field inspections and measurements so as to assure a complete job.
  - 2. Incorporating dimensions of actual equipment proposed for use on the project.

3. Showing adequate sections, elevations, and plan views and indicating the bottom of ductwork elevations from the finished floor.
  4. Indicating all volume dampers, damper access doors, air balance test plugs, and other accessories required for a complete project.
- B. Call to the attention of the Engineers, immediately, any Major Deviations from the Contract Drawings which must be made. All deviations shall be documented in writing.
  - C. Submit roof, wall and floor opening dimensions and locations shown on shop drawings.
  - D. Submit prints to each Contractor of other trades for review for interferences and coordination with their work.

## **1.6 DAMPERS**

- A. Provide volume dampers at all air outlets, diffusers, grilles.

## **PART 2 - PRODUCTS**

### **2.1 DUCTWORK MATERIALS**

- A. Unless otherwise called for, provide materials in accordance with Exhibit I at the end of this section.

### **2.2 SQUARE AND RECTANGULAR DUCTWORK**

- A. Transverse and longitudinal duct seams reinforcement shall conform to appropriate tables and figures per SMACNA Velocity -Pressure Classification for duct construction.
  1. Transverse joints shall be sealed with duct joint sealants. "Ductmate" or "Nexus" 4-bolt connection systems may be used in lieu of standard construction.
  2. Field assembled longitudinal seams shall be sealed with duct sealant. Factory or shop fabricated rolled or machine pressed longitudinal seams does not require sealant.
- B. Corner closures shall be required as described and illustrated by SMACNA Duct Construction Standards.
- C. Throat radius on all elbows shall not be less than dimension of duct in plane of radius. Where this cannot be maintained, use shorter radius with internal guide vanes, or square elbow with turning vanes.
- D. Bracing and hanging of ductwork shall be per SMACNA Standards for size and system class of ductwork being used.

- E. Any transformations shall not reduce the ductwork cross-sectional area. Maximum angle in straight duct, 20° for diverging flow and 30° for contraction flow. Transformation from square to round or flat oval seams welded or brazed.

### 2.3 ROUND DUCTWORK

A. Round Ductwork:

1. Manufactured of galvanized steel ASTM A527, gauges per SMACNA Duct Construction Standards, spiral lock-seam or longitudinal fusion-welded, as called for in Exhibit I.
2. All spiral duct shall have locked seams so made as to eliminate leakage under pressure for which this system has been designed. Longitudinal seams duct shall have fusion-welded butt seams. No stovepipe will be allowed. Longitudinal seam duct with snap lock seam (stovepipe) maybe used on ductwork where pressure class is 2 in. w.g. or less, seal longitudinal joints. Provide Flexmaster STO side takeoff fittings at duct mains for round duct takeoffs
3. Round ductwork fittings:
  - a) All fittings fabricated Per SMACNA Standards for round and flat-oval ductwork.
  - b) Fittings shall have continuous, welded seams.
  - c) 90° tees shall be conical type. 90° tees and 45° laterals up to and including 12 in. diameter tap size shall have a radiused entrance into the tap, produced by machine or press forming. The entrance shall be free of any restrictions.
  - d) Round taps off the bottom of rectangular ducts down to diffusers shall be made with a 45° square to round shoe-tap.
4. Elbows:
  - a) Diameters 3 in. through 8 in.: Two-section stamped and continuously welded elbows.
  - b) Over 8 in.: Gored construction with seams continuous welded. Less than 35° - two gores, 36° to 71° - three gores, over 71° - five gores.
  - c) Fabricated to a centerline radius of 1.5 times the cross-section diameter.
  - d) Adjustable elbows maybe used for round duct up to 12 in. diameter in Velocity-Pressure Classes 2 in. w.g. and below. Seal adjustable joints airtight after installation.

5. Joints:
  - a) Pipe-to-pipe joints in diameters up to 60 in. shall be by the use of sleeve couplings, reinforced by rolled beads.
  - b) Pipe-to-fitting joints in diameters up to 60 in. shall be by slip-fit of projecting collar of the fitting into the pipe.
  - c) Insertion length of sleeve coupling and fitting collar shall be 2 in. up to 36 in. diameter and 4 in. above 36 in. diameter.
  - d) Pipe-to-pipe and pipe-to-fitting connections in ductwork above 60 in. in diameter shall be made by angle ring flanges. The flange on the pipe shall be a 2 in. x 2 in. x 3/16 in. angle attached to the pipe with a continuous weld. The fittings shall have a loose ring "Van Stone" flange. A 5/8 in. flange shall be provided to act as a gasketing surface for sealing with the angle ring being a rolled, welded ring 2 in. x 2 in. x 3/16 in. Bolt hole spacing for angle rings shall be 6 in. centers.
  - e) If longitudinal seam duct greater than 60 in. in diameter is supplied in lengths greater than 4 ft., one angle ring must be welded to the duct on 4 ft. centers for support.

## 2.4 DUCTWORK SEALING

- A. SMACNA Duct Sealing Classification Shall Be Used For Duct Systems Using The Following Criteria:
  1. Seal Class A, shall include transverse and longitudinal joints and grommets at damper shafts Velocity-Pressure Classes above 2 in. w.g.
  2. Seal Class B, shall include transverse and field constructed longitudinal joints - Velocity-Pressure Classes 2 in. w.g. and below.
- B. All Ductwork Sealant shall be Hardcast "Iron Grip" for square and rectangular duct. Sealant shall be Hardcast "DT-5300" with "RTA-50" for round and rectangular duct.

## 2.5 TURNING VANES

- A. Standard Type:
  1. Provided in square elbows as shown on contract drawings. Vanes for ducts with areas greater than 100 sq. in. shall be "double" type having dimensions and spacing as detailed.
  2. Make: Elgen, or contractor fabricated.

## 2.6 DAMPERS IN DUCTWORK

- A. Blade Type Volume Dampers: Constructed per SMACNA, one gauge heavier than duct material, securely fastened to 3/8 in. sq., cold rolled steel operator rod. Provide multiblade dampers above 12 in. duct diameter in width or depth. Where multiblade dampers are required, they shall be equal to Ruskin Model CD35. Provide quadrant locking handle on air volume dampers.
- B. Fire and Smoke Dampers: See "Fire and Smoke Dampers" Section.
- C. Automatic Air Dampers: Furnished as part of "Control systems" Section 15A972 and installed by this Contractor.
- D. Self Operating: 26 gauge aluminum blades with felted edges. Substantial steel frameworks, .05 in. w.g. maximum pressure drop at rated cfm, guaranteed not to rattle.

## 2.7 FLEXIBLE DUCTWORK

- A. Shall be Constructed In Compliance With NFPA Bulletin 90A, And UL Standard 181, Class I Air Duct:
  - 1. Consisting of corrosion resistant galvanized steel helix mechanically locked to fabric. Fabric to be a trilaminate of aluminum foil, fiberglass and aluminized polyester.
  - 2. Factory applied, 1 in. fiberglass exterior insulation, sheathed in a seamless reinforced exterior vapor barrier jacket.
  - 3. Flexible ductwork shall be rated for 12 in. w.g. positive pressure, 5500 fpm, operating temperature range - 20°F to 250°F.
- B. Design Equipment: Flexmaster Type 3 (insulated), Flexmaster Type N1-35 (uninsulated).
- C. Make: Clevaflex, Flexmaster, Genflex, Thermafex.

## 2.8 FLEXIBLE CONNECTIONS TO FANS AND EQUIPMENT

- A. Materials For Flexible Connections Shall Be Fire Retardant, Water And Mildew Resistant, And Comply With UL Standard 214:
  - 1. Systems up to 2 in. w.g. s.p.: approximately 20 oz. of fabric per sq. yd. Ventfabrics, Inc., "Ventfab".
  - 2. Systems greater than 2 in. w.g. s.p., and watertight systems: Of heavy glass fabric, double neoprene coated, approximately 30 oz. per sq. yd. Ventfabrics Inc., "Ventglas".

## 2.9 ACCESS DOORS

- A. In Ductwork: Shall be double panel construction, 1 in. rigid insulation when in insulated ducts; SMACNA construction, hinged type. Double cam type only acceptable where hinged type will not fit and if approved by engineer. Same metal as duct, or factory fabricated. Doors airtight to fit system static pressure, minimum size 16 in. x 12 in.
- B. When installed in intake or exhaust plenums, access doors will be sized to allow for full access to plenum.
- C. Where plenums are greater than 4 feet wide or deep, the access door is to be at least 2 feet wide by 4 feet tall to allow for personnel entry.
- D. Door Hardware:
  - 1. Hinges: Minimum of two per door, at least 1-1/2 in. long by 1/8 in. thick, spaced no more than 2 ft. apart and no more than 1/4 of the door size from top to bottom of door. Maximum 4 in. length, 6 ft. door, for larger doors, length equal to 1/12 door height.
  - 2. Latches: As manufactured by Ventfabrics, Inc. or equivalent. Metal window sash latch not acceptable.
    - a) Access doors up to 2 in. w.g.: Ventlok #100/#102.
    - b) Walk-in doors up to 2 in. w.g.: Ventlok #260.
    - c) Access or walk-in above 2 in. w.g.: Ventlok #310.
- E. Make: Air Balance, Ruskin, Ventlok, Elgen.

## 2.10 ACOUSTIC-THERMAL DUCT LINING IN DUCTWORK

- A. Lining shall be 1 in. thickness (unless otherwise indicated), 1-1/2 lbs. density and be constructed of long fibers, firmly bonded together with a thermosetting resin. The airstream side shall have a strong, smooth mat, integrally laminated to the insulation to eliminate surface erosion. Coefficient of friction not over .022 in. w.g./100 ft.
  - 1. Lining shall meet UL No. 181, NFPA 90A, and shall have a flame spread classification of not more than 25 and a smoke developed rating of 50 maximum.
  - 2. Make: Manville "Linacoustic".
  - 3. For Velocity-Pressure classes above 2 in. w.g., provide metal "build-outs" of proper height, welded to the ductwork for turning vanes and dampers.
  - 4. Where acoustically lined flat oval duct is indicated, it shall have perforated metal lining. The perforated lining shall be 22 gauge.

## 2.11 INSTRUMENT TEST HOLES

- A. Suitable For Insertion Pitot Tubes And Other Test Instruments:
- B. Fabricated with heavy screw cap and gasket.
- C. With sufficient extension to accommodate exterior insulation where required.
- D. Make: Ventlok #699.

## PART 3 - EXECUTION

### 3.1 REQUIREMENTS

- A. Equipment and systems shall be installed in accordance with local and state codes and regulations having jurisdiction.
- B. Install all ductwork concealed and tight to the structure above unless noted otherwise on shop drawings. Fabricate only after the approval of shop drawings, and in locations to avoid interference. Ductwork installed without approved shop drawings, which requires removal/modification and/or reinstallation due to conflicts or improper installation shall be repaired at no cost to the Owner.
- C. Sizes given on contract drawings are inside dimensions. Keep openings closed with protective caps or blanks during construction to prevent entrance of dirt and debris.
- D. Provide sheet metal sleeves at each floor and wall duct opening.
- E. Extend access openings, damper rods and levers, to outside of external insulation make systems airtight.
- F. No piping, conduit or other obstruction to airflow is permitted in ductwork, except where shown on reviewed shop drawings. Provide with airtight streamlined sleeve, soldered or brazed joint between sleeve and ductwork. Increase size of ductwork to maintain proper cross-sectional area.
- G. Provide necessary openings, sleeves, hanger inserts, framing, chases, recesses, not provided by other trades.
- H. Exposed exhaust or return registers and grilles shall be flush with face of duct; exposed supply registers and grilles shall be mounted outside airstream with 45° shoe-tap extension collars.
- I. Provide sleeves for ducts passing through walls or floors. Use 14 gauge sleeve with framing through structural surfaces; 18 gauge sheet metal for other cases. Set sleeves 4 in. above finished floor in Mechanical Rooms, seal watertight to floor.

### **3.2 FLEXIBLE CONNECTIONS**

- A. Provide Flexible Connections For The Intake And Discharge Connections Of Duct Connected To Fans And Air Handling Equipment:
  - 1. Round connections made with adhesive and metal drawbands with ends tightly bolted.
  - 2. Rectangular connections made with material securely held in grooved seam between flanges, tightly clipped or riveted on 6 in. centers.
- B. Connections made with a minimum of 2 in. space between duct and equipment collars, installed in line, and with 1 in. excess material folded so as not to interfere with airflow through connection.

### **3.3 FLEXIBLE DUCTWORK**

- A. Joints made with Minnesota 3M adhesive applied to duct end or collar.
- B. Duct slid on depth of collar and 2 in. on duct end and secured with sheet metal screws and drawband, Wraplock 5900.
- C. For round-to-oval connections, provide round-oval flexible adapter.
- D. Maximum length 48 in.
- E. Maximum one 90° angle bend from ductwork to outlet.

### **3.4 TURNING VANES**

- A. Install only in square elbows of equal dimensions.
- B. Use large size vanes, 2-1/4 in. spacing when ducts are 20 in. or wider.
- C. Secure vane runners to duct with spot welding, riveting or sheet metal screws.
- D. When Installing In Ductwork With Internal Insulation:
  - 1. Install runners in ductwork inside insulation and bolt through insulation and duct sides, welding bolts to insure rigid installation. Provide build-outs for duct Velocity-Pressure classes above 2 in. w.g.

### **3.5 INSTRUMENT TEST HOLES**

- A. Locate In The Following Locations:
  - 1. Downstream of fan discharge
  - 2. Downstream of exhaust duct
  - 3. Downstream of fan inlet.

### **3.6 CLEANING DUCTWORK AFTER INSTALLATION**

- A. Clean rubbish and dirt from system before fans are turned on.

- B. Keep openings closed during this construction period.
- C. Pay damages resulting from dirt blown on painted or other finished surfaces.
- D. Repair or replace damaged fan wheels, dampers, or other system parts damaged as a result of dirt.
- E. Clean system as many times as required until the entire system is dirt-free.

### **3.7 INSTALLATION ROUND DUCTWORK**

- A. Use factory fabricated couplings for joints.
- B. After the joint is slipped together, sheet metal screws are placed 1/2 in. from the joint bead for mechanical strength.
- C. Sealer is applied to the outside of the joint and covering the screw heads.
- D. Flanged joints shall be made with neoprene rubber gaskets.

### **3.8 TEST OF DUCTWORK**

- A. Conduct duct leakage tests per SMACNA "HVAC Air Duct Leakage Test Manual", latest edition. When leakage above stated limits occurs, ascertain location of leaks and repair as required. Repeat tests as required to obtain allowable leakage rates. Prepare a report similar to that suggested by SMACNA and submit for review. Duct testing shall be conducted in the presence of the Owner's Representative. The following ductwork shall be tested.
  - 1. Fume hood exhaust duct from hood to fan inlet and from fan discharge to exhaust exit cone.
  - 2. Supply ductwork from unit discharge to terminal unit inlet.
- B. Ductwork not formally tested for leakage shall be checked and guaranteed to meet standards of SMACNA Seal and Leakage Classifications (seal Class A- 2 in. w.g. and above, seal Class B - up to 2 in. w.g.). Air balancing and testing shall be used to determine satisfactory operation of duct systems. Balancing reports indicating excessive leakage amounts shall be required to rebuild, repair or seal ductwork having excessive leakage.

### **3.9 DAMPERS AND AIR CONTROL DEVICES**

- A. Provide dampers necessary to permit proper balancing of air quantities. Comply with code requirements for smoke and fire control. Prevent introduction of uncontrolled outside air into building through roof and wall openings.
- B. When dampers are installed in acoustically lined ductwork, install with insulated "build-outs" per SMACNA.
- C. Install fire and smoke dampers in accordance with "Fire and Smoke Dampers" Section and applicable codes.

- D. Install all dampers furnished as part of "Control Systems" Section.

### **3.10 ACCESS DOORS**

- A. Provide as required for maintenance and service access at:
1. Control dampers
  2. Damper motors
  3. Fire dampers for replacement of fire damper link
  4. Smoke detectors
  5. Control instruments
  6. Fan bearings
  7. Both inlet and outlet of terminal heating and/or cooling coils
  8. Intake or exhaust plenums
  9. Any other equipment requiring periodic inspection or service, complete with angle iron frame.
- B. Provide service openings in accordance and as required by NFPA 96 at 20 ft. intervals along horizontal ducts and at each vertical riser for kitchen hood exhaust.

### **3.11 DUCT SUPPORTS**

- A. Provide per SMACNA, same material as duct. Hanger bands to extend down sides and turn under bottom 2 in. Minimum two metal screws per hanger. Angle iron on larger duct. Spaced per building structural system but not greater than 8 ft. Provide extra support angles as required.

### **3.12 AIR AND WATERTIGHT METAL WORK**

- A. Where water or snow may accumulate and ductwork or where odors or corrosive gasses may collect, ductwork and plenums shall be made watertight by soldering, brazing or welding of joints. Grade ducts down toward waste points and/or toward louvers. Provide valve and drain piping from low point to waste point.
1. Dishwasher hood and exhaust ductwork.
  2. Shower Room exhaust ductwork.
  3. Intake and exhaust plenums.
- B. Test For Watertightness: Before concealment, apply water by hose to check for leaks, witnessed by Owner's Representative.

### **3.13 ACOUSTIC-THERMAL DUCT LINING**

- A. Where called for, increase metal duct dimensions to accommodate lining. Adhere lining to interior sides of duct; minimum 50% coverage of Benjamin Foster 85-20 fire retardant adhesive, UL approved. Stapling method of attaching will not be permitted. Mechanical fasteners shall not pierce the sheet metal. Install fasteners with spacing as per SMACNA Standards.
- B. Abutting edges of acoustic linings shall be sealed with a fire resistant neoprene coating, and exposed edges of acoustic linings shall be installed with sheet metal

nosings to prevent erosion.

- C. Lining shall not impart odor to the air, delaminate or be loosened by the airstream under normal operating conditions. Lining, which is damaged during fabrication or shipment, shall not be installed.

**3.14 SMOKE DETECTION**

- A. Smoke detectors shall be furnished by Division 26 "Electrical". This Contractor shall install detectors located in ductwork. Clearly indicate locations of smoke detectors on the sheet metal shop drawings.
- B. Increase duct size at smoke detectors, where required for proper installation, per smoke detector manufacturer's recommendations. Coordinate minimum duct size required with Division 26 "Electrical".

EXHIBIT I - DUCTWORK MATERIALS  
 (Notes are at the end of Exhibit "I")

<u>SERVICE</u>	<u>MATERIAL</u>	<u>SPECIAL REQUIREMENTS</u>
Supply, return, vent, relief, and exhaust	Lock forming quality, galvanized steel ASTM 525	Joints and features as called for SEE NOTE 1
Air plenums at roof or wall, intake or exhaust	PVS, Type 302 stainless steel or galvanized steel	Braze or weld watertight. SEE NOTE 2 SEE NOTE 3
Accessories, dampers and air turns	Same or better as parent duct	-----
Lockerroom and Showers/ drying	Aluminum	Aluminum fasteners
Concealed kitchen hood exhaust	16 gage black steel	Joints welded, flanged and gasketed at connections to hood
Field constructed apparatus casings	Galvanized steel ASTM 525	

NOTES FOR EXHIBIT I:

NOTE 1: Supply ductwork downstream of air terminal heat pumps units shall be acoustically lined for a minimum of 8 10 ft.

NOTE 2: Wall plenums that are likely to see moisture collection due to rain or snow are to be provided with a sloped floor and trapped drain to indirect waste connection.

NOTE 3: Wall plenums greater than 4 feet wide are to have 16 gage floor, reinforced to

support maintenance or service personnel.

**END OF SECTION**