

## DIVISION 23 HEATING, VENTILATING AND AIR CONDITIONING

### Section 23 31 00 – HVAC Ducts and Casing

#### **PART 1: GENERAL**

##### **1.01 Work Included**

- A. This section provides for furnishing and installing low velocity and high velocity ductwork and includes duct construction and accessories.

##### **1.02 Applicable Provisions**

- A. Refer to Section 23 00 00, Heating, Ventilating and Air Conditioning (HVAC).

##### **1.03 Guarantee**

- A. Guarantee all ductwork for one year from the date of final acceptance. The guarantee will cover workmanship, noise, chatter, whistling, or vibration. Ductwork must be free from pulsation under all conditions of operation. Correct any and all defects that appear after the system is put in operation. Submit corrective measures to Architect for review prior to implementation.

##### **1.04 Submittals**

- A. Submit ductwork shop drawings, including ¼ inch per foot floor plans and equipment room plans. Refer to Section 23 00 00 for requirements.
- B. Submit oval duct reinforcing methods; submit casing and plenum shop drawings.

##### **1.05 Contractor Coordination**

- A. Erect all ducts in the general locations shown, but conform to all structural and finish conditions of the building. Before fabricating any ductwork, check the physical conditions at the job site and make all necessary changes in cross sections, offsets, and similar items, whether they are specifically indicated or not.
- B. Refer to Section 23 00 00 for coordination requirements between ductwork and other trades. Especially careful coordination prior to commencement of any work will be required.

##### **1.06 Standards and Codes**

- A. Except as otherwise indicated, sheet metal ductwork material and installation shall comply with the latest edition of SMACNA HVAC Duct Construction

Standards (SMACNA) for the appropriate pressure classification. All air distribution devices (such as dampers) included in this specification shall comply with latest edition SMACNA and NFPA 90A.

## PART 2: PRODUCTS

### 2.01 Duct Material

- A. Except for the special ducts specified elsewhere, use prime galvanized steel sheets or coils up to 60 inches wide. Stencil each sheet with proper gage and manufacturer's name. Stencil coils of sheet steel throughout on 10-foot centers with gage and manufacturer's name. Contractor is cautioned that Engineer may random check duct and strap gauges with a micrometer to verify compliance with the specifications.

### 2.02 Sealing of Seams and Joints

- A. The entire duct system shall be sealed. Do not use oil solvent based sealants except where specifically allowed herein. Seal the seams and joints of ductwork and fittings by applying one layer of sealant, then immediately spanning the joint with a single layer of 3 inch wide open weave glass fiber tape, then apply sufficient additional sealant to completely embed the cloth. Thoroughly clean the duct areas to be sealed prior to application of tape and sealant.

### 2.03 Low Pressure Ductwork (Less Than 3 Inches Static Pressure)

- A. Ductwork downstream of terminal units and exhaust ductwork downstream of fans is defined as low pressure ductwork.
- B. Rectangular. Furnish rectangular low pressure ducts constructed of sheet metal with metal gages meeting or exceeding that required in latest edition SMACNA, heavy enough to withstand the physical abuse of installation, or in the following minimum gages:

<u>Largest Dimension</u>	<u>U.S. Gage</u>
12" and less	No. 26
13" to 30"	No. 24
31" to 54"	No. 22
55" to 84"	No. 20
85" and above	No. 18

- C. Round. Furnish round, low-pressure ducts which are spiral wound, such as manufactured by United McGill. Use the following gages for shop fabricated ducts:

<u>Diameter</u>	<u>U.S. Gage</u>
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- D. Low Pressure Insulated Flexible Duct

- Furnish factory-fabricated, flexible duct for connections between low velocity trunk ducts and supply air diffusers.

2. Furnish flexible duct with an airtight inner liner, insulation and outer jacket. Construct the inner liner of coated steel helix and fabric substantially bonded together to prevent the duct from collapsing or kinking in short radius bends.
3. Furnish fiberglass insulation at least 1-inch thick (R-6) and  $\frac{3}{4}$  pound minimum density around the inner liner. Sheath the entire assembly with heavy, outer vapor-barrier jacket or reinforced aluminum foil kraft.
4. Maximum length of flexible duct is 7 feet.
5. Use a supply duct rated at a minimum positive working pressure of 1-1/2 inches of water. Exhaust ducts must withstand a negative pressure of 1.5 inches of water.
6. Furnish duct listed by UL at flame spread rate of not over 25 and smoke developed rate of not over 50, and complying with NFPA Standard 90A, paragraph 113a.

#### 2.04 Medium Pressure Ductwork (3 Inches Through 6 Inches Static Pressure)

- A. Ductwork downstream of all air handlers, up to and including terminal units, plus all return ductwork and all exhaust ductwork upstream of fans is defined as medium pressure.
- B. Rectangular. Furnish rectangular, medium-pressure duct construction, gages and reinforcing in accordance with table 1.8 of the latest SMACNA HVAC Duct Construction Standards Manual.
- C. Round. Use spiral-wound ducts up to 48 inches in diameter, equivalent to those of United McGill. Also furnish fittings equal to those of United McGill.

<u>Largest Dimension</u>	<u>U.S. Gage</u>
18" and less	No. 24
19" through 48"	No. 22
49" through 72"	No. 20
73" and over	No. 18

- D. Oval. Furnish oval, medium-pressure ducts that are spiral-wound, flat oval, or welded flat oval equivalent to those of United McGill with gages and reinforcing as recommended by the manufacturer for medium-pressure. Use fittings equal to those of the United McGill. The ducts may be shop fabricated of completely welded construction of the following gage: (Add 3-133A)

<u>Major Axis Dimension</u>	<u>U.S. Gage</u>
20" and less	No. 24
21" through 30"	No. 22
31" through 46"	No. 20
47" through 50"	No. 18

51" and over No. 16

- E. Use longitudinal seam, rolled, welded, and provided in standard lengths of 4 and 5 ft. for oval ducts greater than 24" x 72". Factory weld or field connect with flanges or slip couplings, all transverse joints. Fabricate such ducts from galvanized steel meeting ASTM A527 and in accordance with the following table:

<u>Major Axis Dimension</u>	<u>U.S. Gage</u>
36" and less	No. 20
36" through 60"	No. 18
61" through 144"	No. 16

## 2.05 Fire and Smoke Dampers

- A. Quality Standards. Furnish and install fire and smoke dampers according to NFPA Standards and SMACNA Duct Manual. Dampers must bear UL label. Use blade dampers when blade width exceeds 12 inches.
- B. Furnish access doors in attached ductwork for inspection. Stencil each door "FIRE DAMPER ACCESS" or similar notation as appropriate for the type of damper to be accessed.
- C. Fire Dampers. Furnish Ruskin DIBD2 or equivalent, Style B for rectangular ducts, Style CR for round ducts, 95% minimum free area, UL Dynamic rating, constructed and tested in accordance with latest edition of UL Standard 555, for vertical or horizontal mounting, 1-1/2 hour fire rated under UL Standard 555,  
165°F fusible link, galvanized steel sleeve as required to meet applicable codes, retaining angles, and picture frame mounting angles.
- D. Combination Smoke and Fire Dampers. Furnish Ruskin FSD-60 dampers, or equivalent, with minimum 16 gage galvanize steel hat channels shape frame; stainless steel sleeve bearings; airfoil shaped double skin 14 inch galvanized steel blades; silicone rubber / galvanized steel mechanically locked-in blade edge seals that withstand 450°F; stainless steel flexible metal compression type jamb seals; 1-1/2 hour fire rated under UL Standard 555; UL classified as a Leakage Rated Damper for use in smoke control systems under the latest version of UL555S, and bear a UL label attesting to same; damper manufacturer shall have tested and qualified with UL a complete range of damper sizes covering all dampers required by this specification; leakage class I; demonstrated capacity to open and close under HVAC system operating conditions, with pressures of at least 4 in. w.g. in the closed position, and 500 fpm air velocity in the open position; 120 volt actuator motor; 20 inch long, caulked factory sleeve, gage as required to meet code; and TS150 Firestat 165°F option.

## 2.06 Duct Mounted Wall Detectors

- A. Wherever required by applicable codes and not shown on the Electrical drawings, furnish and install duct-mounted smoke detectors and coordinate with electrical to provide shutdown of air units as applicable. This includes but is not limited to the supply and return of all air units with a scheduled air quantity of 2,000 cfm or more.

**2.07 Wall Louvers**

- A. Louvers are furnished under other sections of these specifications.

**2.08 Acceptable Manufacturers**

- A. Round and flat oval ductwork and fittings. Spiral Pipe of Texas, United McGill, or accepted substitution.
- B. Proprietary duct joining systems. Ductmate, Ward Industries, no substitutions. May be used in lieu of flat oval ductwork at Contractor option.
- C. Low and medium pressure ductwork sealant. “MP” Hardcast Iron Grip 601; United Duct Seal water base, latex, or acrylic sealant; or accepted substitution.
- D. Exterior ductwork sealant. “Uni-weather” United McGill solvent-based sealant.
- E. Flexible duct. Thermaflex, Porter, Wiremold, or accepted substitution.
- F. Fire and smoke dampers. Nailor, Prefco, Rusko, or accepted substitution.

**PART 3: EXECUTION****3.01 Installation**

- A. Construction Standards. Construct and erect ductwork in a “first class” workmanlike manner. Use construction methods which follow the requirements outlined in the latest Edition of SMACNA HVAC Duct Construction Standards, as well as SMACNA Balancing and Adjusting publications, unless otherwise indicated in these specifications or accompanying drawings.
- B. Reinforcement. Reinforce ducts having one side equal to 25 inches or more in accordance with recommended construction practice of SMACNA.
- C. Plenum Construction. Construct Plenum chambers of not less than No. 20 U.S. gage metal reinforced with galvanized structural angles.
- D. Cross Breaking or Beading: Cross break or bead sheet metal for rigidity, except ducts which are 12 inches or less in the longest dimension.
- E. All duct sizes shown on the drawings are clear inside dimensions.
- F. Drill or machine punch all holes in ducts required for damper rods and other necessary devices, no larger than necessary.
- G. Temporarily cap with sheet metal any duct openings left unconnected overnight.
- H. Wall Penetrations. Where ducts pass through walls in exposed areas, furnish and install suitable escutcheons made of sheet metal angles as closers. At all locations where ductwork passes through floors, furnish and install watertight sleeves projecting 3 inches above finished floor and flush with bottom of floor slab. Fabricate sleeves of 1/8 inch thick steel, galvanized after fabrication. Anchor into adjacent floor slab as required. Sleeves are

required inside as well as outside chases. Support ducts where passing through floors with steel structural angles of adequate bearing surface, galvanized after fabrication and resting on top of the sleeve.

- I. Interior Painting. Interior painting of metal ductwork exposed to view through grilles, registers, and other openings is specified in the section on painting. Do not install grilles, registers, or similar items until painting is complete.

### **3.02 Low Pressure Ductwork**

- A. Splitters. Furnish and install adjustable, galvanized splitter-dampers pivoted at the downstream end with appropriate control device at each supply duct split, in accordance with SMACNA Duct Manual. Furnish and install a splitter for each duct branch to two or more outlets.
- B. Extractors. Furnish and install Titus AG225 extractors with an appropriate control device at each rectangular zone or branch supply duct connection in accordance with SMACNA Duct Manual.
- C. Volume Dampers. Furnish and install opposed-blade volume dampers with an appropriate control device in each return air, outside air and exhaust branch duct, in exhaust connections to hoods or equipment, and where otherwise indicated, in accordance with SMACNA Duct Manual.
- D. Furnish and install multi-blade dampers when blade width exceeds 12 inches.
- E. Elbows:
  1. Rectangular. Use radius elbows with a centerline radius of not less than 1-1/2 times the duct width wherever possible. Mitered elbows may be used in lieu of radius elbows where space requirements dictate. Where square elbows are used, furnish and install Barber-Coleman double-wall airfoil turning vanes. Job-fabricated turning vanes, if used, must be double thickness of vanes of galvanized steel sheets of the same gage metal as the duct in which they are installed. Furnish vanes fabricated for the same angle as the duct offset.
  2. Round and Oval Duct. Use elbows with a centerline radius of 1-1/2 times the duct diameter or duct width wherever possible. For round ducts, furnish smooth elbows or 5-piece, 90 degree elbows and 3-piece, 45 degree elbows, slip type, minimum three sheet metal screws.
- F. Controls. For control devices concealed by ceilings, furring, or in other inaccessible locations, use extension rods and appropriate recessed-type Young regulators, mounted on the surface of the ceiling or the furring, unless specified, or shown otherwise. For ducts which are not concealed, or ducts which are above lay-in ceiling but accessible, furnish heavy-duty, quadrant-type, adjustable regulators having wing nuts for locking in position. Saw-mark the ends of all operating rods for dampers and air control devices to indicate damper position. Mount all controls outside duct insulation, with standoffs from the ductwork as required.

- G. **Obstruction.** Install streamline deflectors at any point where dividing a sheet metal duct around piping or where other such obstruction is permitted. Where such obstructions occur in insulated ducts, fill space inside streamliner and around obstructions with glass fiber insulation.
- H. **Remote Operated Dampers.** Furnish factory-fabricated volume dampers for remote, manual volume control. Use opposed-blade, balanced type, pivoted in bronze bearings and mounted in a channel frame. Operate damper through a flexible-drive cable from a wall-mounted operating knob. Use remote operated dampers for all dampers above hard ceilings, and other locations as required.
- I. **Low Pressure Insulated Flexible Duct.** Do not exceed 6 feet in length with any flexible duct. Support duct independently of lights, ceiling and piping.
- J. **Low Pressure Duct Supports.**
1. **Horizontal Ducts Up To 40 Inch.** Support horizontal ducts up to and including 40 inches in their greater dimension by means of No. 18 U.S. gage band iron hangers attached to the ducts by means of screws, rivets or clamps, and fastened to inserts with toggle bolts, beamclamps or other approved means. Place supports on no more than 8 ft. centers. Use clamps to fasten hangers to reinforcing on sealed ducts.
  2. **Horizontal Ducts Larger Than 40 Inch.** Support horizontal ducts larger than 40 inches in their greatest dimension by means of hanger rods bolted to angle iron trapeze hangers. Place supports on no more than 8 ft. centers according to the following:

<u>Angle Length</u>	<u>Angle</u>	<u>Rod Diameter</u>
4'-0"	1-1/2" x 1-1/2" x 1/8"	1/4"
6'-0"	1-1/2" x 1-1/2" x 1/8"	1/4"
8'-0"	2" x 2" x 1/8"	5/16"
10'-0"	3" x 3" x 1/8"	3/8"

3. **Vertical Ducts.** Support vertical ducts where they pass through the floor lines with 1-1/2" x 1-1/2" x 1/4" angles for ducts up to 60 inches. Above 60 inches the angles must be increased in strength and sized on an individual basis considering space requirements.

### **3.03 Medium Pressure Ductwork**

- A. **Rectangular.** Construct rectangular ducts as noted in latest edition SMACNA. Furnish reinforcing method as shown without tie rods through 60-inch-size. For ducts 61 inches and over, use tie rods to keep reinforcing angles to 2-inch
- B. **minimum.** Use sealant (3M EC-800) and 4-inch-wide Glasfab at all of the joints on rectangular ducts in shop and field to provide positive seal. Furnish sufficient sealant to completely embed the cloth.

- C. Round Furnish round, medium-pressure duct construction as noted in latest edition SMACNA. Seal joints with 3M EC-800, lapped a minimum of 3 inches, secured with sheet metal screws and covered with sealant, over which is applied a 4-inch—wide Glasfab cloth. Apply additional sealant until the cloth is completely embedded, or welded. Make 90-degree branch take-offs with conical tees. Weld take-off fittings to fittings or to the main duct. Clean and coat all welds with rust-inhibiting paint. Stamp elbows as smooth-type, or 5-or 3-piece gore type, with either type having centerline radius of 1-1/2 times the duct diameter.
- D. Oval. Use construction, taps sealing, and other features similar to that specified for round, medium-pressure ductwork.
- E. Elbows.
  - 1. Rectangular. Construct radius and vaned elbows in accordance with SMACNA.
  - 2. Round and Oval. Furnish elbows having centerline radii 1-1/2 times the duct diameter or width. For round ducts, smooth elbows, or 5-piece, 90° elbows and 3-piece, 45-degree elbows are permitted.
- F. Connections to VAV Terminal Units. Make hard duct connections, with a minimum of 3 times the duct diameter upstream of the connection as straight duct, at all terminal units. Flexible duct connections are not acceptable.
- G. Medium Pressure Duct Supports. Install hangers and supports in accordance with SMACNA.

### **3.04 Exhaust Ductwork**

- A. Construct and leak test all exhaust ductwork as specified above for medium pressure ductwork.

### **3.05 Flexible Connections**

- A. Where ducts connect to fans or air handling units, make flexible airtight connections using “Ventglas” fabric. The fabric must be fire-resistant, waterproof and mildew resistant with a weight of approximately 30 ounces per square yard.

Furnish a minimum of ½ –inch slack in the connections, and a minimum of 2-1/2-inches distance between the edges of the ducts. Also furnish a minimum of 1-inch slack for each inch of static pressure on the fan system. Securely fasten fabric to apparatus and to adjacent ductwork by means of galvanized flats or draw bands. Where rectangular connections are made in outdoor locations, seal fabric to metal with mastic. For connections to belted vent sets outdoors, furnish Duall fan connector, Koroseal, black with UV inhibitors. Secure with stainless steel bands.

### **3.06 Access Doors**

- A. Install ductwork access doors in structural angle frames and furnish with sash locks and hinges arranged for convenient access. Construct doors which occur in insulated ducts with insulation filler.

**3.07 Flashing**

- A. Where ducts pass through roofs or exterior walls, furnish suitable flashing to prevent rain or air currents from entering the building.

Furnish flashing not less than No. 26 gage stainless steel or 16-ounce copper.

**3.08 Duct Lining**

- A. Install glass fiber acoustical lining in return air sound traps only. Size duct to keep clean inside dimensions as indicated on the drawings. Furnish ½-inch thick, 1-1/2 pound density, flexible lining coated on the air stream side to reduce attrition. Secure to duct surfaces with Benjamin Foster 85-25 adhesive and sheet metal fasteners on 12-inch centers. Omit lining as necessary to permit satisfactory operation of air control devices. Coat all exposed edges and leading edges of cross joints with adhesive. Use liner such as Johns-Manville Lina-Coustic, which meets requirements of NFPA 90-A.

**3.09 Tests**

- A. Equipment. Furnish equipment necessary for performing tests, including rotary blower, orifice section and U-tube gage board complete with cocks and rubber tubing.
- B. Low Pressure Ductwork.
1. Allowable Leakage. Test ductwork for leaks before concealing. Maximum allowable leakage is 5 percent of total flow.
  2. Risers and Branch. Test duct riser or branch duct including flexible duct runouts in accordance with SMACNA manual.
  3. Mains. Test mains after risers and branches are tied in and all equipment set. Close runout connections and place fan in operation. Furnish pressure in mains above design pressure. Visually inspect joints. Repair leaks detected by sound or touch. Release mains for completion after joints are tight.
- C. Medium Pressure Ductwork.
1. Pressure test according to 1985 SMACNA Chapter 10 procedures to 6 in. w.g. Maximum allowable leakage is 1% of the total system design air flow rate. When partial sections of the duct system are tested, the summation of the leakage for all sections must not exceed the allowable leakage.
  2. Test the entire system including the VAV Terminal Units. After testing has proven that the ductwork is installed and performs as specified, connect the terminal units to the ductwork and seal the connections with extra care. Inform the Owner when splits, or improper sealing of the joints. Repair any leakage in the connections discovered after the systems have been put into service by complete removal of the sealing materials, thorough cleaning of the joint surfaces, and installation of multiple layers of sealing materials.

3. At Owner's option, Contractor may be allowed to exclude the terminal units from testing by capping the supply ductwork upstream of the terminal units, then inspecting the connection to terminal units when completed. This option may only be exercised by the Owner, and then only if documented in writing prior to testing.

END OF SECTION 23 31 00