

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. This Section includes the following:
 - 1. Backdraft dampers.
 - 2. Volume dampers.
 - 3. Motorized control dampers.
 - 4. Fire dampers.
 - 5. Ceiling fire dampers.
 - 6. Smoke dampers.
 - 7. Combination fire and smoke dampers.
 - 8. Duct silencers.
 - 9. Turning vanes.
 - 10. Duct-mounting access doors.
 - 11. Flexible connectors.
 - 12. Flexible ducts.
 - 13. Duct accessory hardware.
- B. Related Sections include the following:
 - 1. Division 23 Section "Instrumentation and Control for HVAC" for electric and pneumatic damper actuators.
 - 2. Division 28 Section "Fire Detection and Alarm" for duct-mounting fire and smoke detectors.

1.3 SUBMITTALS

- A. Product Data: For the following:
 - 1. Backdraft dampers.
 - 2. Volume dampers.
 - 3. Motorized control dampers.
 - 4. Fire dampers.
 - 5. Ceiling fire dampers.
 - 6. Smoke dampers.
 - 7. Combination fire and smoke dampers.
 - 8. Duct silencers.
 - 9. Turning vanes.

10. Duct-mounting access doors.
 11. Flexible connectors.
 12. Flexible ducts.
- B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
1. Special fittings.
 2. Manual-volume damper installations.
 3. Motorized-control damper installations.
 4. Fire-damper, smoke-damper, and combination fire- and smoke-damper installations, including sleeves and duct-mounting access doors.
- C. Coordination Drawings: Reflected ceiling plans, drawn to scale and coordinating penetrations and ceiling-mounting items. Show ceiling-mounting access panels and access doors required for access to duct accessories.

1.4 QUALITY ASSURANCE

- A. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems," and NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.

2.2 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.
- B. Galvanized Sheet Steel: Lock-forming quality; complying with ASTM A 653/A 653M and having **G60 (Z180)** coating designation; ducts shall have mill-phosphatized finish for surfaces exposed to view.
- C. Stainless Steel: ASTM A 480/A 480M.
- D. Aluminum Sheets: ASTM B 209 (ASTM B 209M), alloy 3003, temper H14; with mill finish for concealed ducts and standard, 1-side bright finish for exposed ducts.

- E. Extruded Aluminum: 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 (900 mm) or less; 3/8-inch (10-mm) minimum diameter for lengths longer than 36 inches (900 mm).

2.3 BACKDRAFT DAMPERS

A. Available Manufacturers:

- 1. Air Balance, Inc.
- 2. American Warming and Ventilating.
- 3. CESCO Products.
- 4. Duro Dyne Corp.
- 5. Greenheck.
- 6. Penn Ventilation Company, Inc.
- 7. Prefco Products, Inc.
- 8. Ruskin Company.
- 9. Vent Products Company, Inc.

- B. Description: Multiple-blade, parallel action gravity balanced, with **center-pivoted** blades of maximum 6-inch (150-mm) width, with sealed edges, assembled in rattle-free manner with 90-degree stop, steel ball bearings, and axles; adjustment device to permit setting for varying differential static pressure.
- C. Frame: **0.052-inch- (1.3-mm-) thick, galvanized sheet steel**, with welded corners **and mounting flange**.
- D. Blades: **0.025-inch- (0.6-mm-) thick, roll-formed aluminum**.
- E. Blade Seals: **Neoprene**.
- F. Blade Axles: **Nonferrous**.
- G. Tie Bars and Brackets: **Galvanized steel**.
- H. Return Spring: Adjustable tension.

2.4 VOLUME DAMPERS

A. Available Manufacturers:

- 1. Air Balance, Inc.
- 2. American Warming and Ventilating.
- 3. Flexmaster U.S.A., Inc.
- 4. McGill AirFlow Corporation.
- 5. METALAIRE, Inc.
- 6. Nailor Industries Inc.

7. Penn Ventilation Company, Inc.
 8. Ruskin Company.
 9. Vent Products Company, Inc.
- B. General Description: Factory fabricated, with required hardware and accessories. Stiffen damper blades for stability. Include locking device to hold single-blade dampers in a fixed position without vibration. Close duct penetrations for damper components to seal duct consistent with pressure class.
1. Pressure Classes of 3-Inch wg (750 Pa) or Higher: End bearings or other seals for ducts with axles full length of damper blades and bearings at both ends of operating shaft.
- C. Standard Volume Dampers: Multiple- or single-blade, parallel- or opposed-blade design as indicated, standard leakage rating, **with linkage outside airstream**, and suitable for horizontal or vertical applications.
1. Steel Frames: Hat-shaped, **galvanized** sheet steel channels, minimum of 0.064 inch (1.62 mm) thick, with mitered and welded corners; frames with flanges where indicated for attaching to walls and flangeless frames where indicated for installing in ducts.
 2. Roll-Formed Steel Blades: 0.064-inch- (1.62-mm-) thick, **galvanized** sheet steel.
 3. Aluminum Frames: Hat-shaped, 0.10-inch- (2.5-mm-) thick, aluminum sheet channels; frames with flanges where indicated for attaching to walls; and flangeless frames where indicated for installing in ducts.
 4. Roll-Formed Aluminum Blades: 0.10-inch- (2.5-mm-) thick aluminum sheet.
 5. Extruded-Aluminum Blades: 0.050-inch- (1.2-mm-) thick extruded aluminum.
 6. Blade Axles: **Nonferrous**.
 7. Bearings: **Molded synthetic**.
 8. Tie Bars and Brackets: Galvanized steel.
- D. Low-Leakage Volume Dampers: Multiple- or single-blade, parallel- or opposed-blade design as indicated, low-leakage rating, **with linkage outside airstream**, and suitable for horizontal or vertical applications.
1. Steel Frames: **Angle**-shaped, **galvanized** sheet steel channels, minimum of 0.064 inch (1.62 mm) thick, with mitered and welded corners; frames with flanges where indicated for attaching to walls and flangeless frames where indicated for installing in ducts.
 2. Roll-Formed Steel Blades: 0.064-inch- (1.62-mm-) thick, **galvanized** sheet steel.
 3. Blade Axles: **Nonferrous**.
 4. Bearings: **Molded synthetic** thrust or ball.
 5. Blade Seals: **Neoprene**.
 6. Jamb Seals: Cambered **stainless steel**.
 7. Tie Bars and Brackets: **Galvanized steel**.
- E. Jackshaft: 1-inch- (25-mm-) diameter, galvanized-steel pipe rotating within pipe-bearing assembly mounted on supports at each mullion and at each end of multiple-damper assemblies.
1. Length and Number of Mountings: Appropriate to connect linkage of each damper in multiple-damper assembly.
- F. Damper Hardware: Zinc-plated, die-cast core with dial and handle made of 3/32-inch- (2.4-mm-) thick zinc-plated steel, and a 3/4-inch (19-mm) hexagon locking nut. Include center hole to suit damper operating-rod size. Include elevated platform for insulated duct mounting.

2.5 MOTORIZED CONTROL DAMPERS

A. Available Manufacturers:

1. Air Balance, Inc.
2. American Warming and Ventilating.
3. CESCO Products.
4. Duro Dyne Corp.
5. Greenheck.
6. McGill AirFlow Corporation.
7. METALAIR, Inc.
8. Nailor Industries Inc.
9. Penn Ventilation Company, Inc.
10. Ruskin Company.
11. Vent Products Company, Inc.

B. General Description: AMCA-rated, **opposed**-blade design; minimum of 0.1084-inch- (2.8-mm-) thick, galvanized-steel frames with holes for duct mounting; minimum of 0.0635-inch- (1.61-mm-) thick, galvanized-steel damper blades with maximum blade width of 8 inches (203 mm).

1. Secure blades to 1/2-inch- (13-mm-) diameter, zinc-plated axles using zinc-plated hardware, with nylon blade bearings, blade-linkage hardware of zinc-plated steel and brass, ends sealed against spring-stainless-steel blade bearings, and thrust bearings at each end of every blade.
2. Operating Temperature Range: From minus 40 to plus 200 deg F (minus 40 to plus 93 deg C).
3. Provide **closed-cell neoprene edging**.

2.6 FIRE DAMPERS

A. Available Manufacturers:

1. Air Balance, Inc.
2. CESCO Products.
3. Greenheck.
4. McGill AirFlow Corporation.
5. METALAIR, Inc.
6. Nailor Industries Inc.
7. Penn Ventilation Company, Inc.
8. Prefco Products, Inc.
9. Ruskin Company.
10. Vent Products Company, Inc.
11. Ward Industries, Inc.

B. Fire dampers shall be labeled according to UL 555.

C. Fire Rating: As indicated.

D. Frame: **Curtain type with blades outside airstream**; fabricated with roll-formed, 0.034-inch- (0.85-mm-) thick galvanized steel; with mitered and interlocking corners.

- E. Mounting Sleeve: Factory- or field-installed, galvanized sheet steel.
 - 1. Minimum Thickness: 0.052 or 0.138 inch (1.3 or 3.5 mm) thick as indicated and of length to suit application.
 - 2. Exceptions: Omit sleeve where damper frame width permits direct attachment of perimeter mounting angles on each side of wall or floor, and thickness of damper frame complies with sleeve requirements.
- F. Mounting Orientation: Vertical or horizontal as indicated.
- G. Blades: Roll-formed, interlocking, 0.034-inch- (0.85-mm-) thick, galvanized sheet steel. In place of interlocking blades, use full-length, 0.034-inch- (0.85-mm-) thick, galvanized-steel blade connectors.
- H. Horizontal Dampers: Include blade lock and stainless-steel closure spring.
- I. Fusible Links: Replaceable, **212 deg F (100 deg C)** rated.

2.7 CEILING FIRE DAMPERS

- A. **Available Manufacturers:**
 - 1. Air Balance, Inc.
 - 2. CESCO Products.
 - 3. Greenheck.
 - 4. McGill AirFlow Corporation.
 - 5. METALAIRE, Inc.
 - 6. Nailor Industries Inc.
 - 7. Penn Ventilation Company, Inc.
 - 8. Prefco Products, Inc.
 - 9. Ruskin Company.
 - 10. Vent Products Company, Inc.
 - 11. Ward Industries, Inc.
 - 12.
- B. General Description: Labeled according to UL 555C; comply with construction details for tested floor- and roof-ceiling assemblies as indicated in UL's "Fire Resistance Directory."
- C. Frame: Galvanized sheet steel, round or rectangular, style to suit ceiling construction.
- D. Blades: Galvanized sheet steel with refractory insulation.
- E. Fusible Links: Replaceable, **212 deg F (100 deg C)** rated.

2.8 FIRE DAMPERS

- A. **Available Manufacturers:**
 - 1. Air Balance, Inc.
 - 2. CESCO Products.

3. Greenheck.
 4. Nailor Industries Inc.
 5. Penn Ventilation Company, Inc.
 6. Ruskin Company.
- B. General Description: Labeled according to UL 555S. Combination fire and smoke dampers shall be labeled according to UL 555 for 1-1/2-hour rating.
- C. Fusible Links: Replaceable, **212 deg F (100 deg C)** rated.
- D. Frame and Blades: 0.064-inch- (1.62-mm-) thick, galvanized sheet steel.
- E. Mounting Sleeve: Factory-installed, 0.052-inch- (1.3-mm-) thick, galvanized sheet steel; length to suit wall or floor application.
- F. Damper Motors: Modulating and two-position action.
1. Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."
 2. Permanent-Split-Capacitor or Shaded-Pole Motors: With oil-immersed and sealed gear trains.
 3. Spring-Return Motors: Equip with an integral spiral-spring mechanism where indicated. Enclose entire spring mechanism in a removable housing designed for service or adjustments. Size for running torque rating of 150 in. x lbf (17 N x m) and breakaway torque rating of 150 in. x lbf (17 N x m).
 4. Outdoor Motors and Motors in Outside-Air Intakes: Equip with O-ring gaskets designed to make motors weatherproof. Equip motors with internal heaters to permit normal operation at minus 40 deg F (minus 40 deg C).
 5. Nonspring-Return Motors: For dampers larger than 25 sq. ft. (2.3 sq. m), size motor for running torque rating of 150 in. x lbf (17 N x m) and breakaway torque rating of 300 in. x lbf (34 N x m).
 6. Electrical Connection: 115 V, single phase, 60 Hz.

2.9 DUCT SILENCERS

- A. **Available Manufacturers:**
1. Industrial Noise Control, Inc.
 2. McGill AirFlow Corporation.
 3. Ruskin Company.
 4. Vibro-Acoustics.
- B. General Description: Factory-fabricated and -tested, round or rectangular silencers with performance characteristics and physical requirements as indicated.
- C. Fire Performance: Adhesives, sealants, packing materials, and accessory materials shall have fire ratings not exceeding 25 for flame-spread index and 50 for smoke-developed index when tested according to ASTM E 84.

- D. Rectangular Units: Fabricate casings with a minimum of 0.034-inch- (0.85-mm-) thick, solid galvanized sheet metal for outer casing and 0.022-inch- (0.55-mm-) thick, ASTM A 653/A 653M, **G60 (Z180)**, perforated galvanized sheet metal for inner casing.
- E. Round Units:
 - 1. Outer Casings:
 - a. ASTM A 653/A 653M, **G60 (Z180)**, galvanized sheet steel.
 - b. Up to 24 Inches (600 mm) in Diameter: 0.034 inch (0.85 mm) thick.
 - c. 26 through 40 Inches (660 through 1000 mm) in Diameter: 0.040 inch (1.0 mm) thick.
 - d. 42 through 52 Inches (1060 through 1300 mm) in Diameter: 0.052 inch (1.3 mm) thick.
 - e. 54 through 60 Inches (1370 through 1500 mm) in Diameter: 0.064 inch (1.62 mm) thick.
 - f. Casings fabricated of spiral lock-seam duct may be one size thinner than that indicated.
 - 2. Interior Casing, Partitions, and Baffles:
 - a. ASTM A 653/A 653M, **G60 (Z180)**, galvanized sheet steel.
 - b. At least 0.034 inch (0.85 mm) thick and designed for minimum aerodynamic losses.
- F. Sheet Metal Perforations: 1/8-inch (3-mm) diameter for inner casing and baffle sheet metal.
- G. Fill Material: **Inert and vermin-proof fibrous material, packed under not less than 5 percent compression.**
 - 1. Erosion Barrier: Polymer bag enclosing fill and heat-sealed before assembly.
- H. Fabricate silencers to form rigid units that will not pulsate, vibrate, rattle, or otherwise react to system pressure variations.
 - 1. Do not use nuts, bolts, or sheet metal screws for unit assemblies.
 - 2. Lock form and seal or continuously weld joints.
 - 3. Suspended Units: Factory-installed suspension hooks or lugs attached to frame in quantities and spaced to prevent deflection or distortion.
 - 4. Reinforcement: Cross or trapeze angles for rigid suspension.
- I. Source Quality Control:
 - 1. Acoustic Performance: Test according to ASTM E 477.
 - 2. Record acoustic ratings, including dynamic insertion loss and self-noise power levels with an airflow of at least 2000-fpm (10-m/s) face velocity.
 - 3. Leak Test: Test units for airtightness at 200 percent of associated fan static pressure or 6-inch wg (1500-Pa) static pressure, whichever is greater.

2.10 TURNING VANES

- A. Fabricate to comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for vanes and vane runners. Vane runners shall automatically align vanes.
- B. Manufactured Turning Vanes: Fabricate 1-1/2-inch- (38-mm-) wide, **single**-vane, curved blades of galvanized sheet steel set 3/4 inch (19 mm) o.c.; support with bars perpendicular to blades set 2 inches (50 mm) o.c.; and set into vane runners suitable for duct mounting.
 - 1. **Available Manufacturers:**
 - a. Ductmate Industries, Inc.
 - b. Duro Dyne Corp.
 - c. METALAIRE, Inc.
 - d. Ward Industries, Inc.
- C. Acoustic Turning Vanes: Fabricate airfoil-shaped aluminum extrusions with perforated faces and fibrous-glass fill.

2.11 DUCT-MOUNTING ACCESS DOORS

- A. General Description: Fabricate doors airtight and suitable for duct pressure class.
- B. Door: Double wall, duct mounting, and rectangular; fabricated of galvanized sheet metal with insulation fill and thickness as indicated for duct pressure class. Include vision panel where indicated. Include 1-by-1-inch (25-by-25-mm) butt or piano hinge and cam latches.
 - 1. **Available Manufacturers:**
 - a. American Warming and Ventilating.
 - b. CESCO Products.
 - c. Ductmate Industries, Inc.
 - d. Flexmaster U.S.A., Inc.
 - e. Greenheck.
 - f. McGill AirFlow Corporation.
 - g. Nailor Industries Inc.
 - h. Ventfabrics, Inc.
 - i. Ward Industries, Inc.
 - 2. Frame: Galvanized sheet steel, with bend-over tabs and foam gaskets.
 - 3. Provide number of hinges and locks as follows:
 - a. Less Than 12 Inches (300 mm) Square: Secure with two sash locks.
 - b. Up to 18 Inches (450 mm) Square: Two hinges and two sash locks.
 - c. Up to 24 by 48 Inches (600 by 1200 mm): Three hinges and two compression latches.
 - d. Sizes 24 by 48 Inches (600 by 1200 mm) and Larger: One additional hinge.
- C. Door: Double wall, duct mounting, and round; fabricated of galvanized sheet metal with insulation fill and 1-inch (25-mm) thickness. Include cam latches.

1. **Available Manufacturers:**
 - a. Ductmate Industries, Inc.
 - b. Flexmaster U.S.A., Inc.
 2. Frame: Galvanized sheet steel, with spin-in notched frame.
- D. Pressure Relief Access Door: **Double** wall and duct mounting; fabricated of galvanized sheet metal **with insulation fill and thickness** as indicated for duct pressure class. Include vision panel where indicated, latches, and retaining chain.
1. **Available Manufacturers:**
 - a. American Warming and Ventilating.
 - b. CESCO Products.
 - c. Ductmate Industries, Inc.
 - d. Greenheck.
 - e. KEES, Inc.
 - f. McGill AirFlow Corporation.
 - g. Nexus PDQ.
 2. Frame: Galvanized sheet steel, with bend-over tabs and foam gaskets.
- E. Seal around frame attachment to duct and door to frame with neoprene or foam rubber.
- F. Insulation: 1-inch- (25-mm-) thick, fibrous-glass or polystyrene-foam board.

2.12 FLEXIBLE CONNECTORS

- A. **Available Manufacturers:**
1. Ductmate Industries, Inc.
 2. Duro Dyne Corp.
 3. Ventfabrics, Inc.
 4. Ward Industries, Inc.
- B. General Description: Flame-retardant or noncombustible fabrics, coatings, and adhesives complying with UL 181, Class 1.
- C. Metal-Edged Connectors: Factory fabricated with a fabric strip **5-3/4 inches (146 mm)** wide attached to two strips of 2-3/4-inch- (70-mm-) wide, 0.028-inch- (0.7-mm-) thick, galvanized sheet steel or 0.032-inch- (0.8-mm-) thick aluminum sheets. Select metal compatible with ducts.
- D. Indoor System, Flexible Connector Fabric: Glass fabric double coated with neoprene.
1. Minimum Weight: 26 oz./sq. yd. (880 g/sq. m).
 2. Tensile Strength: 480 lbf/inch (84 N/mm) in the warp and 360 lbf/inch (63 N/mm) in the filling.
 3. Service Temperature: Minus 40 to plus 200 deg F (Minus 40 to plus 93 deg C).

- E. Outdoor System, Flexible Connector Fabric: Glass fabric double coated with weatherproof, synthetic rubber resistant to UV rays and ozone.
 - 1. Minimum Weight: 24 oz./sq. yd. (810 g/sq. m).
 - 2. Tensile Strength: 530 lbf/inch (93 N/mm) in the warp and 440 lbf/inch (77 N/mm) in the filling.
 - 3. Service Temperature: Minus 50 to plus 250 deg F (Minus 45 to plus 121 deg C).

2.13 FLEXIBLE DUCTS

- A. **Available Manufacturers:**
 - 1. Flexmaster U.S.A., Inc.
 - 2. Hart & Cooley, Inc.
 - 3. McGill AirFlow Corporation.
- B. Noninsulated-Duct Connectors: UL 181, Class 1, 2-ply vinyl film supported by helically wound, spring-steel wire.
 - 1. Pressure Rating: 10-inch wg (2500 Pa) positive and 1.0-inch wg (250 Pa) negative.
 - 2. Maximum Air Velocity: 4000 fpm (20.3 m/s).
 - 3. Temperature Range: Minus 10 to plus 160 deg F (Minus 23 to plus 71 deg C).
- C. Insulated-Duct Connectors: UL 181, Class 1, 2-ply vinyl film supported by helically wound, spring-steel wire; fibrous-glass insulation; **polyethylene** vapor barrier film.
 - 1. Pressure Rating: 10-inch wg (2500 Pa) positive and 1.0-inch wg (250 Pa) negative.
 - 2. Maximum Air Velocity: 4000 fpm (20.3 m/s).
 - 3. Temperature Range: Minus 10 to plus 160 deg F (Minus 23 to plus 71 deg C).
- D. Flexible Duct Clamps: **Stainless-steel band with cadmium-plated hex screw to tighten band with a worm-gear action**, in sizes 3 through 18 inches (75 to 450 mm) to suit duct size.

2.14 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 APPLICATION AND 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. Provide 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 backdraft dampers on exhaust fans or exhaust ducts nearest to outside and where indicated.
- D. Install volume dampers in ducts with liner; avoid damage to and erosion of duct liner.
- E. Provide balancing dampers at points on supply, return, and exhaust systems where branches lead from larger ducts as required for air balancing. Install at a minimum of two duct widths from branch takeoff.
- F. Provide test holes at fan inlets and outlets and elsewhere as indicated.
- G. Install fire and smoke dampers, with fusible links, according to manufacturer's UL-approved written instructions.
- H. Install duct silencers **independent of ducts with flexible duct connectors, lagged with loaded vinyl sheet on inlets and outlets.**
- I. Install duct access doors to allow for inspecting, adjusting, and maintaining accessories and terminal units as follows:
 - 1. On both sides of duct coils.
 - 2. Downstream from volume dampers and equipment.
 - 3. Adjacent to fire or smoke dampers, providing access to reset or reinstall fusible links.
 - 4. To interior of ducts for cleaning; before and after each change in direction, at maximum 50-foot (15-m) spacing.
 - 5. On sides of ducts where adequate clearance is available.
- J. Install the following sizes for duct-mounting, rectangular access doors:
 - 1. One-Hand or Inspection Access: 8 by 5 inches (200 by 125 mm).
 - 2. Two-Hand Access: 12 by 6 inches (300 by 150 mm).
 - 3. Head and Hand Access: 18 by 10 inches (460 by 250 mm).
 - 4. Head and Shoulders Access: 21 by 14 inches (530 by 355 mm).
 - 5. Body Access: 25 by 14 inches (635 by 355 mm).
 - 6. Body Plus Ladder Access: 25 by 17 inches (635 by 430 mm).
- K. Install the following sizes for duct-mounting, round access doors:
 - 1. One-Hand or Inspection Access: 8 inches (200 mm) in diameter.

2. Two-Hand Access: 10 inches (250 mm) in diameter.
 3. Head and Hand Access: 12 inches (300 mm) in diameter.
 4. Head and Shoulders Access: 18 inches (460 mm) in diameter.
 5. Body Access: 24 inches (600 mm) in diameter.
- L. Install the following sizes for duct-mounting, pressure relief access doors:
1. One-Hand or Inspection Access: **7 inches (175 mm)** in diameter.
 2. Two-Hand Access: 10 inches (250 mm) in diameter.
 3. Head and Hand Access: 13 inches (330 mm) in diameter.
 4. Head and Shoulders Access: 19 inches (480 mm) in diameter.
- M. Label access doors according to Division 23 Section "Identification for HVAC Piping and Equipment."
- N. Install flexible connectors immediately adjacent to equipment in ducts associated with fans and motorized equipment supported by vibration isolators.
- O. For fans developing static pressures of 5-inch wg (1250 Pa) and higher, cover flexible connectors with loaded vinyl sheet held in place with metal straps.
- P. Connect terminal units to supply ducts **directly or** with maximum 12-inch (300-mm) lengths of flexible duct. Do not use flexible ducts to change directions.
- Q. Connect diffusers or light troffer boots to low pressure ducts **directly or** with maximum 60-inch (1500-mm) lengths of flexible duct clamped or strapped in place.
- R. Connect flexible ducts to metal ducts with **liquid adhesive plus tape**.
- S. Install duct test holes where indicated and required for testing and balancing purposes.

3.2 ADJUSTING

- A. Adjust duct accessories for proper settings.
- B. Adjust fire and smoke dampers for proper action.
- C. Final positioning of manual-volume dampers is specified in Division 23 Section "Testing, Adjusting, and Balancing for HVAC."

END OF SECTION