

PART 1 GENERAL**1.01 DESCRIPTION**

- A. Provide Air Distribution Materials as specified herein and as shown on the Drawings.
- B. Material characteristics and size shall be as indicated on the Drawings.
- C. Related Work: The requirements of Section 23 0500, Common HVAC Materials and Methods, also apply to this section.

1.02 QUALITY ASSURANCE

- A. Air Distribution Equipment Rating: In accordance with AMCA certified rating procedures and bearing the AMCA label.

1.03 SUBMITTALS

- A. Submit catalog data, construction details and performance characteristics for all manufactured materials.
- B. Submit operating and maintenance data.
- C. For adhesives and sealants used on the interior of the building (inside the waterproofing system), include printed statement of volatile organic compound (VOC) content.

PART 2 PRODUCTS**2.01 SHEET METAL**

- A. Sheet Metal Materials:
 - 1. General Material Requirements: Comply with the Mechanical Code and SMACNA'S "HVAC Duct Construction. Standards – Metal and Flexible, Third Edition" 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.
 - 2. All interior ducts shall be constructed with G-60 or better galvanized steel conforming to ASTM A653/A653M and A924/A924M Standards, LFQ, chem treat. Exterior ductwork or duct exposed to high humidity conditions (that is: kitchen exhausts, etc.) shall be G-90 or better galvanized steel, conforming to ASTM A653/A653M and A924/A924M Standards, LFQ, chem. treat.
 - 3. PVC-Coated Galvanized Steel: UL 181, Class 1 type listing. Lock-forming –quality, galvanized, sheet steel with ASTM A653/A653M, G60 or G90 coating designation: factory-applied, 0.10 mm (4-mil) PVC coating on exposed surfaces of ducts and fittings exposed to corrosive conditions, and a minimum of 0.025 mm (1-mil) thickness on opposite surface.
 - 4. Carbon-Steel Sheets: Comply with ASTM A1008/A1008M, with oiled, matte finish for exposed ducts.
 - 5. Stainless-Steel Sheets: Comply with ASTM A480/A480M, Type 304 or 316, and having a No. 2D finish for concealed ducts and No. 2B, No. 2D, No. 3 or No. 4 for exposed surfaces.
 - 6. Aluminum Sheets: Comply with ASTM B209/B209M, Alloy 3003, H14 temper; with mill finish for concealed ducts and standard, 1-side bright finish for exposed ducts.
 - 7. Reinforcement Shapes and Plates: ASTM A36/A36M, steel plates, shapes, and bars; black and galvanized.

8. Tie Rods: Galvanized steel, ¼ 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).
- B. Duct Fabrication requirements: Metal gauges, joints and reinforcement in accordance with Mechanical Code, ASHRAE and SMACNA standards. Ductwork shall be fabricated to the following pressure classifications:
1. Return ducts: 2" negative.
 2. Supply ducts from fan discharge to VAV box inlet: 4" positive. VAV box discharge to diffuser: 1" positive.
 3. Exhaust ducts: 1" negative.
- C. Acoustical Duct and Plenum Lining: Flexible or rigid duct liner composed of resin bonded glass fibers. Greenguard® certified. Maximum thermal conductivity of 0.25 at 75°F. Johns Manville, Owens Corning, Knauf, and Certainteed approved, meeting NFPA 90A requirements for maximum flame spread and smoke developed and containing less than 0.1% by weight deca-PDE fire retardant.
1. Line ducts with lining to meet R-5 insulation value for installation inside the building insulation envelope, and R-8 for installation outside the building insulation envelope. Owens Corning "Aeroflex Plus" or equal Schuller, Certainteed, or approved equal.
 2. Duct liner adhesive shall conform to ASTM C916. Mechanically attach lining to sheet metal duct with fasteners conforming to SMACNA Standard MF-1-1971, Schuller Grip Nails or Gramweld welding pins. Apply fire-retardant type adhesive similar to Schuller No. 44 adhesive, Benjamin Foster 81-99, Insul-Coustic 22 or 3M equivalent on all leading edges, joints and seams.
- D. Duct Tapes, Sealants, Adhesives & Gaskets:
1. Two-part sealing system with woven fiber, mineral gypsum impregnated tape and non-flammable adhesive. Hardcast "DT" tape and "FTA-20" adhesive, United "Uni-Cast" system, or accepted substitute.
 2. For joints and seams exposed to the weather in lieu of soldering, United "Uni-Cast" system or approved.
 3. Joint & Seam Sealants (Water Based): Flexible, adhesive sealant, resistant to UV light when cured, UL 723 listed, and complying with NFPA requirements for Class 1 ducts.
 4. Joint & Seam Sealants (Solvent Based): Flexible. Non sag, solvent-release-curing, for use in low temperature applications. Shall be resistant to UV light and shall be UL 723 Listed and meet NFPA requirements for Class 1 ductwork.
 5. Flange Gasket: Butyl rubber or EPDM polymer which complies with UL standard 181 and 723 testing. The gasket shall not contain vegetable oils, fish oils, or any other type of material that will support fungal and/or bacterial growth.
 6. Liner Adhesive: Water based, fire and moisture resistant, used to adhere insulation to metal duct. It shall comply with NFPA 90A and UL 723 requirements.
 7. Duct Liner Sealant: Water based sealant, fire and moisture resistant, used to encapsulate fiberglass duct insulation to eliminate airborne fibers. Must comply with UL requirements.
- E. Optional Duct Joints for Sheet Metal Ducts: Prefabricated slide-on transverse duct connectors will be accepted. Duct constructed using prefabricated connection systems will refer to the manufacturer guidelines for sheet gage, intermediate reinforcement size and spacing, and proper joint reinforcements. "Ductmate System" by Ductmate Industries, Inc., Ward Duct Connectors, Inc., Mez Industries, Elgen, or acceptable substitute. Spiramir self-sealing round duct connector system meeting Class 3 leakage standards with EPDM o-ring seal.

- F. Exterior and Roof Mounted Ductwork: Construct roof mounted ductwork and other ductwork exposed to outside weather of galvanized steel outer jacket, two gauges heavier than equivalent ductwork with all joints soldered in a weather-proof manner with 2" of internal duct lining. Submit shop drawings.
- G. Exposed to View Round Acoustic Supply Air Ductwork: Round and flat oval spiral seam galvanized sheet metal outer shell duct with 1" thick fiberglass insulation sandwiched between it and a perforated galvanized sheet metal inner liner. Provide factory manufactured fittings matching ductwork. United Sheet Metal, Rolock, Semco Air System, Robert Lloyd Sheet Metal, Arrow, Dees, Streimer Sheet Metal, Arjae Sheet Metal.
- H. Exposed to View Spiral Seam Duct: Round and flat oval spiral seam duct shall be manufactured of galvanized steel sheet metal with spiral lock seam. Sizes up to 36" diameter or 36" wide shall be 22 gauge; sizes over 36" shall be 20 gauge. Reinforcement or bracing shall be as detailed on the Drawings. Matching fittings shall be manufactured of galvanized steel with continuous welded seams. Fittings up to 36" diameter or width shall be 20 gauge, fittings larger than 36" shall be 18 gauge.
- I. Concealed Round Duct: Round and flat oval spiral seam duct shall be manufactured of galvanized sheet metal with spiral lock seam. Construction, gauges, and reinforcement in accordance with SMACNA standards. Fittings shall be manufactured of galvanized steel with spot welded or riveted and sealed seams or continuously welded seams. Snap lock longitudinal seam duct shall fully comply with SMACNA standards for duct gauge and seam type for appropriate pressure class. Adjustable elbows are prohibited.
- J. Flexible Ductwork-Low Pressure: Insulated low pressure flexible duct, factory fabricated assembly consisting of a zinc-coated spring steel helix seamless inner liner, wrapped with a nominal 1" thick insulation for installation inside the building insulation envelope, and 1-1/2", 2" in eastern Oregon for installation outside the building insulation envelope, 1 pound/cubic foot density fiberglass insulation. The assembly shall be sheathed in a vapor barrier jacket, factory vapor resistance sealed at both ends of each section. The composite assembly, including insulation and vapor barrier, shall meet the Class 1 requirements of NFPA Bulletin No. 90-A and be labeled by Underwriters Laboratories, Inc., with a flame spread rating of 25 or less and a smoke developed rating of 50 or under. The duct shall have factory sealed double air seal (interior and exterior) to assure an airtight installation. Genflex, ATCO, Wiremold, Thermaflox, Glassflex, Clevepak, Schuller, or accepted substitute.

2.02 ACCESSORIES

- A. Manual Volume Dampers: Construct of material two gauges heavier than duct in which installed; single plate up to 12" wide; multiple over 12" wide. Hem both edges 1/2" and flange sides 1/2". Use Young, Duro-Dyne, Elgen, MAT, Pottoroff or accepted substitute damper accessories. Young numbers are shown.
 1. No. 605 bearing set with No. 403 regulator for dampers up to 24" long.
 2. For dampers over 24" long use No. 660 3/8" rod, No. 656 end bearing and No. 403 regulator.
 3. Where damper regulators are not readily accessible, use No. 660 or No. 661 rod extensions and No. 301 and No. 315 concealed damper regulators or MAT cable operated dampers as required.

Location of all volume dampers is not necessarily shown on Drawings; minimum required is one in each supply, return or exhaust main, and one in each branch.

- B. Fire Dampers:

1. Provide dampers with rating equal to surrounding construction where penetrations are made through fire-resistant rated construction per applicable codes. Provide access panels of proper fire rating. Size dampers to maintain free area through damper same as unobstructed run of duct or opening.
 2. Static Fire Dampers: Constructed and installed in accordance with NFPA No. 90A and UL labeled.
 3. Dynamic Fire Dampers: Constructed and approved in accordance with UL Standard 555 for horizontal or vertical installations. Selection of dampers shall not exceed manufacturer's recommended CFM at 4" of static pressure for unducted dampers and 8" of static pressure for ducted dampers.
- C. Fire Rated Thermal Blanket and Diffuser Fire Damper: UL listed, non-asbestos ceramic thermal blanket for use on ceiling diffusers with curtain type fire damper to fit diffuser neck indicated.
- D. Smoke Dampers:
1. Constructed and installed in accordance with NFPA No. 90A, UL labeled. Provide dampers with rating equal to surrounding construction where penetrations are made through fire-resistant rated construction per applicable codes.
 2. Provide access panels of proper fire rating. Size dampers to maintain free area through damper same as unobstructed run of duct or opening.
 3. Each damper shall have a minimum leakage rating of Class II under UL555S for use in smoke control systems.
 4. In addition to the leakage rating specified herein, the dampers and their actuators shall be classified under UL555S to an elevated temperature of 250 degrees F (121 degrees C). Appropriate electric motorized operators shall be installed by the damper manufacturer at time of fabrication and damper/actuator assembly shall be factory cycled 10 times to assure operation. Assembly shall meet all applicable UL555S criteria for both damper and actuators. Damper shall be power open-fail close design.
 5. Damper manufacturer shall provide factory assembled minimum 20 gage steel sleeve. Damper shall be sealed to the sleeve with a 25/50 flame spread/smoke developed sealant material.
 6. Provide necessary relay to drop power to smoke damper motor when smoke detector at associated unit detects smoke and when unit is not running.
 7. Provide all necessary wiring and devices to close dampers on a signal from the building fire alarm system.
- E. Combination Fire/Smoke Dampers:
1. Constructed and installed in accordance with NFPA No. 90A, UL labeled. Provide dampers with rating equal to surrounding construction where penetrations are made through fire-resistant rated construction per applicable codes.
 2. Provide access panels of proper fire rating. Size dampers to maintain free area through damper same as unobstructed run of duct or opening.
 3. Each damper shall be classified by UL as a "corridor damper" for installation in tunnel corridors, shall be rated for one hour fire resistance under UL555, and shall have a minimum leakage rating of Class II under UL555S for use in smoke control systems. Each damper shall bear a UL label designating the damper as "corridor damper."
 4. In addition to the leakage rating specified herein, the dampers and their actuators shall be classified under UL555S to an elevated temperature of 250 degrees F (121 degrees C). Appropriate electric motorized operators shall be installed by the damper manufacturer at time of fabrication and damper/actuator assembly shall be factory cycled 10 times to assure operation. Assembly shall meet all applicable UL555 and UL555S criteria for both damper and actuators. Damper shall be power open-fail close design.

5. Damper manufacturer shall provide factory assembled minimum 20 gage steel sleeve. Damper shall be sealed to the sleeve with a 25/50 flame spread/smoke developed sealant material. Each corridor damper shall be equipped as standard with an electric fusible link. These fusible links shall be rated for 165 deg. F (74 deg. C) and shall be easily resettable for system testing.
 6. Provide necessary relay to drop power to smoke damper motor when smoke detector at associated unit detects smoke and when unit is not running.
 7. Provide all necessary wiring and devices to close dampers on a signal from the building fire alarm system.
 8. Provide area smoke detectors in the corridor arranged to activate the dampers.
- F. Locking Connection Straps: 1/2" wide positive locking steel straps or nylon self-locking straps. Panduit, Elgen, or accepted substitute.
- G. Connection Fittings: Connections to non-metallic ducts manufactured sheet metal "spin-in" fittings. Genflex, Wiremold, Thermaflex, Glassflex, Clevepak, Schuller, or accepted substitute.
- H. Access Doors In Sheet Metal Work:
1. Hollow core double construction of same or heavier gauge material as duct in which installed. Use no door smaller than 12" by 12" for simple manual access or smaller than 18" by 24" where personnel must pass through infrequently. Use 24" by 60" minimum for filters and more frequent maintenance. Use indicated Ventlok hinges and latches or equivalent Elgen on all doors.
 - a. 100 series hinges and latches on low pressure system doors up to 18" maximum dimension.
 - b. 200 series on larger low pressure system doors and 333 series on high pressure systems.
 2. Construct doors up to 18" maximum dimension with 1" overlap, furr and gasket with 3/4" by 1/8" sponge rubber. Fit larger doors against 1-1/2" by 1/8" or angle frame and gasket with 3/4" by 1/8" sponge rubber or felt.
- I. Visual Access Panels: Install visual access panels in inlet side of all coils, at all motorized dampers, and at all fire dampers where otherwise indicated on Drawings. Construct of 18 gauge steel, 20 gauge cold rolled cover, latex gasket and 1/4" plate glass. Minimum 12" by 12" unless indicated otherwise. Coordinate with manufacturer of air handling equipment, in mixing plenums, at coils, etc. Young Regulator Company No. 1311, or accepted substitute.
- J. Control Dampers: Construct of aluminum frame and aluminum airfoil blades with axle shafts and/or operating "jackshafts" with interconnecting blade linkages in the side channels of the frame to provide coordinate tracking of all blades. Interlocking multi-blade type, except where either dimension is less than 6", a single blade may be used. Opposed blade type on all modulating dampers and parallel blades on all two position dampers. Provide with stainless steel, silicone, or vinyl jamb seal and vinyl or silicone blade seals. Damper assembly rated for maximum air leakage of 3 CFM per square foot at 1" wg pressure or less and with interconnecting blade linkages in the side channels of the frame. Performance rating for the damper shall be tested under the AMCA Certified Ratings Program. Greenheck VCD-40, Ruskin CD 50 or TAMCO Series 1000.
- K. Anti-Backdraft Dampers: Connected, gasket-edged aluminum blades set in 14 gauge or heavier steel frame; brass, nylon or Teflon bearings; equip with spring helper with tension adjustment feature or with adjustable counterweight and adjust to open when not more than 0.10" wg pressure is applied. Ruskin CBS-4, Greenheck, Pacific Air Products, Air Balance, Controlair, Pottorff or accepted substitute.

- L. Splitter Dampers: Same specification as manual volume dampers except blade dimension in direction of air flow to be minimum 12" in all cases. Location as shown on Drawings. Splitter damper operators shall be as shown in SMACNA Low Velocity Duct Manual.
- M. Opposed Blade Volume Damper: Install opposed blade volume damper in each zone supply duct on discharge of multi-zone units and where indicated on Drawings. Young No. 817 or accepted substitute.
- N. Turning Vanes:
 - 1. General Requirements: Comply with SMACNA'S "HVAC Duct Construction Standards-Metal and Flexible"; Figure 4-3 "Vanes and Vane Runners" and Figure 4-4 "Vane Support in Elbows".
 - 2. Turning Vanes shall be 2" or 4" double wall fabricated from the same material as the duct. Mounting rails shall have insert tabs that align the vanes automatically.
 - 3. Acoustical Turning Vane: Shall be used in applications that require quiet operating systems. Mounting rails shall have insert tabs that align the vanes automatically.
- O. Flexible Connections: Flexible duct connectors shall be used to isolate vibrations and noises that may be transmitted by fans or blowers to ductwork. The flexible duct connector is an air-tight and water proof flexible connection. Connectors will comply with NFPA 90A and NFPA 90B. Ventglass, Duro-Dyne, Elgen, or accepted substitute.
 - 1. Indoor Flexible Connector Fabrics:
 - a. Fire Retardant Neoprene coated Fiberglass resistant to chemicals, gasoline and grease:
 - 1) Meets NFPA 701
 - 2) Minimum Weight: 32 oz/sq.yd.
 - 3) Tensile Strength: 500 lbs in the warp and 500 lbs in the filling
 - 4) Service Temperature: -40 to 200 deg F
 - b. Fire Retardant Neoprene coated Fiberglass for high pressure applications and large ducts:
 - 1) Meets NFPA 701
 - 2) Minimum Weight: 40 oz/sq.yd.'
 - 3) Tensile Strength: 630 lbs in the warp and 465 lbs in the filling
 - 4) Service Temperature: 285 deg F
 - 2. Outdoor Flexible Connector: Glass Fabric coated with weatherproof Hypalon resistant to UV Rays, ozone, chemicals, and grease.
 - a. Meets NFPA 701
 - b. Minimum Weight: 24 oz/sq.yd.
 - c. Tensile Strength: 350 lbs in the warp and 250 lbs in the filling
 - d. Service Temperature: -50 to 300 deg F
- P. Gravity Exhaust Head:
 - 1. Aluminum cap with backdraft dampers on relief only, curb connection, flashing, 1/2" mesh galvanized bird screen and hinged access. Greenheck, Carnes, Cook or accepted substitute.
 - 2. Install with automatic relief / outside air intake damper in curb as indicated on the Drawings.

2.03 GRILLES, REGISTERS AND DIFFUSERS

- A. Description: Provide grilles, registers and diffusers as shown on the Drawings. See plans for Titus numbers.
- B. Finishes:

1. Steel: Flat white enamel prime coat, factory applied on ceiling diffusers. Others are to have a baked enamel finish, color as selected by Architect.
 2. Aluminum: Anodized clear finish unless indicated otherwise.
- C. Manufacturers: Titus, Carnes, Krueger, Price, Nailor and Tuttle & Bailey are accepted substitutes where only Titus model numbers are listed. Where other manufacturer's products are listed and/or "accepted substitute" is indicated, only the products or an accepted substitute for that item shall be provided.
- D. Ceiling Matched Return and/or Exhaust Register: To match adjacent ceiling outlets. Use in spaces containing ceiling diffusers and/or T-bar ceilings. Titus PAR.
- E. Sidewall or Ceiling Return or Exhaust Register: Face bars parallel to long dimension on ceiling type and horizontal on wall type; bars set at 35 degrees to 45 degrees, spaced on 0.66" to 0.75" centers. Titus 350RL series.
- F. Sidewall or Ceiling Return, Exhaust or Relief Grille: Face bars parallel to long dimension on ceiling type and horizontal on wall type; bars set at 35 degrees to 45 degrees, spaced on 0.66" to 0.75" centers. Titus 350 series.
- G. Perforated Face Diffusers: 1 to 4-way pattern modular control. Pattern of distribution as indicated. Titus PMC.

2.04 LOUVERS

- A. General: Frame and sill styles compatible with adjacent substrate, specifically manufactured to fit into construction openings with accurate fit and adequate support for weatherproof installation. Refer to Drawings and Specifications for types of substrate which will contain each type of louver. Construct of aluminum extrusions, ASTM B221, Alloy 6063-T5. Weld units or use stainless steel fasteners. On inside face of exterior louvers, provide anodized aluminum wire insect screen mounted in removable extruded aluminum frames. AMCA licensed performance ratings.
- B. Blades set 3 to 5-inches on center, 37.5 degree angle with rain hook on blade, minimum blade thickness 0.080-inch, drainable blade style. Minimum 57 percent free area for 48-by 48-inch unit. Maximum water penetration 0.01 ounce water psf free area at 1000 FPM. Maximum intake pressure drop of 0.10-inch W.G. at 750 FPM free velocity. Provide downspouts in jambs, designed to drain water from louver for minimum water cascade from blade to blade. Provide drain gutter in head frame and each blade.
- C. Refer to Drawings for free area required.
- D. Provide access door in duct to clean birdscreen.
- E. Finish: factory prime coat finish color to be selected. Conform to AAMA 605.2. Apply coating following cleaning, and pretreatment. Dry louvers before final finish application. 1.2 mils total dry film thickness when baked at 450 degrees F for ten minutes. F. Manufacturers: Ruskin Manufacturing Model ELF6375DX, Pottorff, Carnes, Cesco, Greenheck or approved equivalent.

PART 3 EXECUTION**3.01 EQUIPMENT INSTALLATION**

- A. Air Handling Equipment Installation and Arrangement: Install and arrange as shown on Drawings. Comply with the manufacturer's recommendations for installation, connection, and start-up.
- B. Equipment Access Panels: Locate free of all obstructions such as ceiling bars, electrical conduit, lights, ductwork, etc.
- C. Filters: Install specified filters or accepted substitute temporary construction filters in supply units and systems prior to start-up or use for drying and/or temporary heat. Replace prior to acceptance of project.

3.02 INSTALLATION OF GRILLES, REGISTERS AND DIFFUSERS

- A. Size and air handling characteristics shall be as shown on the Drawings.
- B. Locate, arrange, and install grilles, registers and diffusers as shown on the Drawings. Locate registers in tee-bar ceilings with diffusers centered on the tile unless indicated otherwise.

3.03 DUCTWORK INSTALLATION

- A. Delivery, Storage and Handling:
 - 1. Protect shop fabricated and factory fabricated ductwork, accessories and purchased products from damage during shipping, storage and handling. Prevent end damage and prevent dirt and moisture from entering ducts and fittings with a polyethylene film with a high-tack pressure sensitive adhesive to attach to the ductwork and accessories.
 - 2. Where possible, store ductwork inside and protect from weather. Where necessary to store outside, store above grade and enclose with a polyethylene film with a high-tack pressure sensitive waterproof wrapping.
- B. Support: Install ductwork with 1" wide strap cradle hangers not more than 8' on centers or as required by code. Support terminal units independent of adjacent ductwork. Attach to available building construction according to good practices for materials involved. Manufactured hanger system acceptable in lieu of fabricated hangers at contractor's option. Ductmate "Clutcher" system or approved.
- C. Fan and Air Handling Unit Flexible Connections: Install flexible connections in ductwork at all rotating equipment.
- D. Elbows and Fittings: Construct elbows with throat radius equal to duct width in plane of turn or make them square and provide single wall, turning vanes.
- E. Fittings: Make transitions and take-offs as shown on Drawings. Provide volume dampers and splitter dampers as indicated on Drawings and as specified. Saddle tees are not allowed.
- F. Acoustical Duct Lining: Acoustically line all fan unit intake and discharge plenums, all ductwork indicated as lined on the Drawings, all sheet metal ductwork specified per Section 23 0700 as insulated, where exposed to view or subject to damage in areas such as mechanical rooms, and, at the Contractor's option, all insulated ductwork specified in Section 23 0700. The duct size noted on the Drawings is the clear opening of the duct with insulation. Insulation shall not reduce duct size listed.

1. All duct designated to receive duct liner shall be completely covered with a fire-resistant, fiber-bonding coating, or covering (composite, polymer, vinyl or neoprene) that reduces airflow resistance and controls fiber release. The duct lining shall be adhered to the sheet metal with 100% coverage of a fire retardant adhesive. The coated surface of the duct liner shall face the airstream. When width of duct exceeds 12" and also when height exceeds 24", use corrosion resistant mechanical fasteners 12" on center maximum lateral spacing and 18" on center maximum longitudinal spacing. Start fastening within 3" of upstream transverse edge of the liner and within 3" of the longitudinal joint. Mechanical fasteners shall be either impact-driven or weld-secured and shall not pierce the duct walls. Fasteners and washers of the specified type and length shall be used assuring no greater than 10% compression of the liner thickness. Installation shall be made so that no fastener pins protrude into the airstream. No gaps or loose edges shall occur in the insulation. Top pieces shall be supported by the side pieces. Provide insulated build out frames for attaching dampers at running vanes where required.
 2. All transverse and longitudinal abutting edges of duct lining shall be sealed and lapped 3" with a heavy coat of approved adhesive, in accordance with the manufacturer's recommendations. All upstream transverse edges shall be installed with sheet metal nosings. All raw exposed edges of lining shall be 'battered' with approved adhesive.
- G. Manual Volume Dampers: Location of all volume dampers are not necessarily shown on the Drawings. Provide a minimum of one volume damper in each supply, return or exhaust branch. Install dampers in fiberglass ductwork (where fiberglass ductwork is allowed) with galvanized sheet metal sleeves of sheet metal gauges required for metal duct systems of the same dimensions.
- H. Duct Insulation: Specified in Section 23 0700.
- I. Sleeves: Provide galvanized sheet metal plaster ring around ductwork penetrating exposed finished walls. Sleeve and flash all duct penetrations through exterior walls in an air tight and weatherproof manner.
- J. Plenums: Construct sheet metal plenums and partitions of not lighter than 18 gauge galvanized steel and reinforce with 1-1/2" by 1/2" by 1/8" angles as required to prevent drumming or breathing.
- K. Access: Install necessary access opening and covers for cleaning, wiring or servicing motors, filters, fans, both entering and leaving air sides of coils, fire and/or smoke dampers and to other equipment located within or blocked by sheet metal work.
- L. Sealing: Caulk, seal, grout and/or tape ductwork and plenums to make airtight at seams, joints, edges, corners and at penetrations. Solder all seams, joints, etc., on all ductwork exposed to the weather. Install specified tape in accordance with manufacturer's requirements using degreaser on surfaces to be taped and wiped to eliminate moisture.
- M. Flexible Duct Connections:
1. Install in full extended condition, free of sags and kinks, using only the minimum length required to make the connection.
 2. Make all joints and connections with 1/2" wide positive locking steel straps or nylon self-locking straps and make connections to non-metallic ducts with sheet metal sleeves or manufactured sheet metal "spin-in" fittings.
 3. On vertically suspended ducts, secure with a minimum of three sheet metal screws on a maximum of 8" on center.

3.04 FIELD QUALITY CONTROL

- A. Disassemble, reassemble, and seal segments of systems as required to accommodate leakage testing and as required for compliance with test requirements.
- B. Conduct test, in presence of Architect, at static pressures equal to maximum design pressure of system or section being tested. If pressure classifications are not indicated, test entire system at maximum system design pressure. Do not pressurize systems above maximum design operating pressure. Give seven days' advance notice for testing.
- C. Determine leakage from entire system or section of system by relating leakage to surface area of test section.
- D. Maximum Allowable Leakage: Comply with requirements for Leakage Classification 3 for round and flat-oval ducts, Leakage Classification 12 for rectangular ducts in pressure classifications less than and equal to 2-inch wg (both positive and negative pressures).
- E. Remake leaking joints and retest until leakage is less than maximum allowable.
- F. Leakage Test: Perform tests according to SMACNA's "HVAC Air Duct Leakage Test Manual."

3.05 NEW DUCTWORK CLEANING

- A. Store all ductwork materials on pallets or above grade, protected from weather, dirt/mud and other construction dust.
- B. Remove all accumulated dust, dirt, etc. from each duct section as it is being installed.
- C. Prior to installation of diffusers, grilles and registers, install temporary system filters and cover all diffuser, grille and register openings with temporary 25% efficiency filter materials and start the fan systems. Operate fans a minimum of 8 hours. Remove all temporary filters at the end of that period.
- D. Clean all diffusers, grilles and registers just prior to project final completion.

3.06 EXISTING DUCT CLEANING

- A. Power vacuum and air wash with compressed air the interior of the existing supply and exhaust ductwork, from the connection with new ductwork to the termination point at the supply or exhaust register. Ductwork cleaning shall be done by a subcontractor who is regularly engaged in this work. Powermaster or accepted substitute.

END OF SECTION