SECTION 237000 – AIR DISTRIBUTION

PART 1 - GENERAL

1.1 DESCRIPTION

A. General provisions and other HVAC systems are specified in other Sections of Division 23.

B. This Section covers air distribution systems and equipment.

C. Motorized dampers not furnished with equipment shall be provided under Section 238000, Automatic Temperature Controls.

D. Testing, adjusting and balancing is specified in Section 230095, Testing, Adjusting and Balancing.

E. This Section includes responsibilities and obligations in support of the performance verification specified in Section 230090, HVAC Performance Verification.

1.2 QUALITY ASSURANCE

A. Air conditioning systems shall conform to the following:

1. North Carolina State Energy Conservation Code-2018.
2. North Carolina State Mechanical Code-2018.
3. SMACNA IAQ Guidelines for Occupied Buildings Under Construction-2007.

1.3 DEFINITIONS

A. Sizes for lined ductwork indicated on the Drawings are sheet metal sizes.

B. Ductwork shall have the following static pressure classifications, unless otherwise specified herein:

1. From variable volume air handling units to terminal units: 4 " wg.
2. From terminal units to grilles, registers and diffusers: 2 " wg.
3. On the inlet of return air and toilet exhaust fans: - 2 " wg.
4. On the discharge of return air and toilet exhaust fans: 2 " wg.
5. Field-fabricated plenums and casings on the suction side of air handling units and fans: -4" wg.
6. Field-fabricated plenums and casings on the discharge side of air handling units and fans: 6" wg.

C. The first 20' of rectangular supply and return ductwork outside the HVAC room and of supply air duct within the risers from the rooftop units shall be constructed of 16 gauge sheet metal with a 6" wg static pressure classification for ductwork and transverse joints. The test pressure for duct leakage testing specified in 230095, Testing, Adjusting and Balancing may be equal to that used for downstream ductwork.

PART 2 - PRODUCTS

2.1 SHEET METAL WORK - GENERAL

A. Ductwork, except where otherwise specified herein, including factory-fabricated round and flat oval, and apparatus casings shall be constructed of galvanized steel in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible, 2005.

B. Residential clothes dryer exhaust duct and supports shall be minimum 30 gauge galvanized steel.

2.2 SHEET METAL WORK - ACCESSORIES

A. Zinc-rich paint: Sherwin-Williams Zinc-Clad III HS 100 Primer, Carboline Co. Carbozinc 585, or ZRC Worldwide Zero VOC Water-Based Galvanizing Compound.

1. Zinc-rich primers that are applied on site and used inside the building must not exceed a volatile organic compound (VOC) content limit of 100 g/L per California CARB 2019 Suggested Control Measure (SCM) for Architectural Coatings.

B. Weld or mechanical grip pins: AGM, Duro-Dyne, or Erico.

C. Duct sealants: liquid, mastic, gasket, or tape and activator type, asbestos-free, complying with NFPA 90A-2018 and UL 181-2013.

1. Duct sealants applied on site shall not exceed a volatile organic compound content limit of 420 g/L per SCAQMD 1168, 2017. Additionally, duct sealants applied on-site and used inside the building must be tested and determined compliant in accordance with California Department of Public Health (CDPH) Standard Method v1.2-2017, using the applicable exposure scenario.

D. Draw bands: nylon type, complying with UL 181-2013, Class 1, and NFPA 90A-2018.

E. Lining adhesive: ASTM C916-2014.

1. Adhesives applied on site shall not exceed volatile organic compound content limits identified in SCAQMD 1168, 2017. Additionally, adhesives applied on-site and used inside the building must be tested and determined compliant in accordance with California Department of Public Health (CDPH) Standard Method v1.2-2017, using the applicable exposure scenario.

F. Instrument test ports: flanged base with screw cap and gasket, and flat mounting gasket for flat or round duct. Height shall accommodate duct insulation thickness.

1. Manufacturer: Ventlok 699 series, Hardcast, or Weicco.

2.3 PLENUM LINING

A. Nonfibrous:

1. Plenum lining shall be 1" thick, 3 pcf density, uncoated, nonfibrous board meeting ASTM C1534-2019, Type II.
2. Lining and accessories shall have a composite flame spread rating of not more than 25 and a smoke developed rating of not more than 50.

2.4 DUCT LINING

A. Fibrous:

1. Duct lining shall be coated fiberglass meeting ASTM C1071-2019, Type I. Coating shall not support the growth of fungus or bacteria when tested in accordance with ASTM G21-2015.
2. Density: 1" thick – 1.5 pcf; 2" thick – 1.5 pcf.
3. Lining and accessories shall have a composite flame spread rating of not more than 25 and a smoke developed rating of not more than 50.
4. Manufacturer:

a. Rectangular: CertainTeed ToughGard R Duct Liner, Johns Manville Linacoustic RC, or Owens Corning QuietR Rotary Duct Liner.
b. Round: CertainTeed ToughGard Ultra Round Spiral, Johns Manville Spiracoustic Plus, or Owens Corning QuietZone Spiral Duct Liner.

2.5 ROUND AND FLAT OVAL DUCTWORK

A. Round and flat oval ductwork (except runouts to diffusers), including fittings and access panels, shall be factory-fabricated by a manufacturer regularly engaged in the quality production of such ductwork.

B. Fittings shall have continuous welds along joints, and ductwork shall be the spiral type.

C. Divided flow fittings (tees, crosses, laterals) shall be manufactured as separate fittings, not as tap collars welded into spiral duct sections.

D. Entrances into laterals (side outlets) shall be made smooth by machining, press forming or grinding, and shall be without flow restrictions, projections, weld build-ups or burrs.

E. Where size equals or exceeds 6", 90° takeoffs shall be of the conical type.

F. Except where otherwise indicated on the Drawings, joints shall be made with slip couplings and screws or companion flanges as recommended by the manufacturer. Submit details for joints for exposed ductwork for approval.

G. Factory-fabricated access panels shall be provided immediately downstream of each fire damper and other locations as specified herein. For duct smaller than 8", a removable duct section shall be provided. For larger ducts, an access panel section with access cover held in place by positive duct pressure and spring clips shall be provided. The access cover shall be galvanized steel, and of the insulated panel type when installed in insulated duct. The access panel housing shall be of welded construction with a pressure seal gasket around the cover.

H. Lined round duct shall be factory-fabricated, and shall be provided with l" or 2" thick, as indicated on the Drawings, 3 pcf fiberglass lining and perforated galvanized sheet metal liner.

I. Elbows shall be smooth radius with a centerline radius of 1.5 times the duct diameter.

J. Openings in round ductwork for linear diffusers shall be factory-cut. Sheet metal collars for linear diffusers shall be factory-installed on the duct.

K. Manufacturer: Eastern Sheet Metal, Hamlin Sheet Metal, McGill AirFlow, or Semco.

2.6 FLEXIBLE CONNECTIONS

A. Coated glass fabric not less than 3" 6" active length.

B. Connections shall comply with NFPA 90A-2018, NFPA 701-2019, and shall be asbestos-free. Connections to engine-generator set radiators shall be designed for continuous use at 275°F. Connections exposed to weather shall also be sunlight and ozone resistant.

C. Manufacturer: Duro-Dyne, Ventfabrics, or Ductmate Industries.

2.7 ACCESS PANELS

A. Tight fitting, hinged, except removable where necessitated by space conditions, double-wall insulated type, manufactured in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible, 2005.

B. Manufacturer: Air Balance, Krueger, Louvers & Dampers, Nailor, National Controlled Air, Phillips-Aire, Ruskin, or Ventlok.

2.8 ACCESS DOORS

A. Tight fitting, hinged, double-wall insulated type, 24" x 60" clear inside opening.

1. Manufacturer: Air Balance, Louvers & Dampers, National Controlled Air, or Ruskin.

B. Handles, latches and hinges: cadmium-plated steel.

1. Manufacturer: Duro-Dyne, Ventlok, or Young Regulator.

2.9 PRESSURE RELIEF DOORS

A. Galvanized steel, 18" x 18", 12 gauge construction, insulated type with positive latch mechanism, perimeter door gasket, and automatic reset.

B. Doors shall have pressure relief settings equal to 0.5" wg less than the static pressure rating of the duct.

C. Manufacturer: Ruskin PRD18, Kees, Safe Air Dowco.

2.10 FLEXIBLE DUCTWORK

A. Chlorinated polyethylene; aluminum foil, fiberglass, and aluminized polyester trilaminate; or coated woven fiberglass cloth, mechanically locked or permanently bonded to a noncorrosive metal helix. Factory-insulated with fiberglass with a protective vapor barrier jacket to achieve an ADC certified minimum R-value of 6.0°F·ft²·h/Btu at 75°F.

B. Listed under UL 181-2013 as a Class 1 air duct, in compliance with NFPA 90A-2018, and rated for minimum 6" wg positive pressure and 0.75" wg negative pressure. Flexible ductwork upstream of terminal units shall be rated for a minimum of 10" wg positive pressure and 2" wg negative pressure.

C. Chlorinated polyethylene core, permanently bonded to a noncorrosive metal helix. Factory-insulated with fiberglass with a protective vapor barrier jacket to achieve an ADC certified minimum R-value of 6.0°F·ft²·h/Btu at 75°F.

D. Listed under UL 181-2013 as a Class 1 air duct, in compliance with NFPA 90A-2018, and rated for minimum 6" wg positive pressure and 0.5" wg negative pressure.

2.11 HANGERS AND SUPPORTS

A. Duct hangers and supports shall be in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible, 2005.

2.12 BACKDRAFT DAMPERS

A. Heavy duty type with anti-leakage features, counterbalanced, parallel blade operation.

B. Operating linkage: factory-assembled, steel construction.

C. Counterbalance weights: adjustable, and mounted on the entering side. Not required on dampers located in ductwork on the discharge of fans.

D. Frames: 16 gauge galvanized 3.5" channel with 0.875" double-thickness flanges, and corner bracing. Top and bottom stops and blade end seals shall be provided with galvanized angles spot welded to frame and sealed with sealer. Face of angles shall have replaceable, compressible polyurethane or neoprene seals.

E. Blades: minimum 14 gauge extruded aluminum with extruded vinyl seals locked into blade edges. Maximum length 48".

F. Pivot rods: plated steel or molded synthetic thermoplastic, 0.5" diameter or hex.

G. Bearings: dusttight, ball type.

H. Closed position guaranteed leakage rate: maximum 50 cfm/ft² at 1" wg differential static pressure based on a 48" damper width.

I. Manufacturer: American Warming, Arrow, Dowco, Ruskin, or Shipman.

2.13 FIRE DAMPERS

A. Factory-built curtain type, except where multiblade type is specified herein. Dampers shall be spring-operated with stainless steel constant tension springs, conforming to requirements of UL 555-2006 for dynamic operation, NFPA 90A-2018, and UL listed.

B. Rating: 1.5 hours.

C. Provide factory-built sleeves of design and length to permit mounting within the opening.

D. Dampers in round ductwork shall be Type C.

E. Dampers in rectangular ductwork with minimum dimension 30" and larger shall be the multiblade type with airfoil shaped blades.

F. Dampers in rectangular ductwork with minimum dimension less than 30" shall be as follows:

1. Dampers in return air openingsor behind grilles or registers shall be Type A.
2. For ductwork with a static pressure rating of 2" wg or less, dampers with a minimum dimension of 18" or smaller shall be Type B, and those with a minimum dimension of 19" and larger shall be Type A.
3. For ductwork with a static pressure rating greater than 2" wg, dampers shall be Type C.

G. Fusible links shall have a temperature rating approximately 50°F above the maximum temperature that would normally be encountered with the system in operation or shutdown, but not less than 165°F.

H. Manufacturer: Greenheck, Leader, Nailor, National Controlled Air, Phillips-Aire, Prefco, Ruskin, or Safe-Air.

2.14 SMOKE DAMPERS

A. Factory-fabricated type, complying with UL 555S-2014 at 250°F and a minimum test pressure differential of 4" wg.

1. Dampers in ductwork with a 2" wg and greater static pressure classification: airfoil blade design, Leakage Classification II, maximum rated airflow rate of at least 3000 fpm.
2. Dampers in ductwork with a 1" wg and less static pressure classification, and in openings: Leakage Classification II, maximum rated airflow rate of at least 2000 fpm.

B. Damper operators shall be factory-installed, power open, spring closed, 24 V AC, and shall be rated for a minimum of 250°F. Damper closure rate shall be 15 seconds minimum and 30 seconds maximum.

C. Dampers in round ductwork up to 18" in diameter shall be the single-blade type. Dampers in round ductwork larger than 18" diameter shall be the multiblade type with connector sleeves. Minimum connector sleeve size shall be 2" larger in each dimension than the duct connection.

D. Dampers in rectangular ductwork and in openings shall be multiblade type. Provide connector sleeves.

E. Manufacturer: Air Balance, Greenheck, Leader, Nailor, National Controlled Air, Prefco, Ruskin, or Safe-Air.

2.15 COMBINATION FIRE/SMOKE DAMPERS

A. Factory-fabricated type, complying with UL 555-2006 and UL 555S-2014 at 250°F and a minimum test pressure differential of 4" wg.

1. 1.5 hour rating, with UL fire and leakage classification markings.
2. Dampers in ductwork with a 2" wg and greater static pressure classification: airfoil blade design, Leakage Classification II, maximum rated airflow rate of at least 3000 fpm.
3. Dampers in ductwork with a 1" wg and less static pressure classification, and in openings: Leakage Classification II, maximum rated airflow rate of at least 2000 fpm.

B. Dampers shall have a 212°F thermal device which will close and lock the damper in the closed position. Damper operators shall be factory installed, power open, spring closed, 24 V AC, and shall be rated for 250°F. Damper closure rate, on smoke mode, shall be 15 seconds minimum and 30 seconds maximum.

C. Dampers in round ductwork up to 18" in diameter shall be the single-blade type. Dampers in round ductwork larger than 18" diameter shall be the multiblade type with connector sleeves. Minimum connector sleeve size shall be 2" larger in each dimension than the duct connection.

D. Dampers in rectangular ductwork and in openings shall be multiblade type. Provide connector sleeves.

E. Manufacturer: Air Balance, Greenheck, Leader, Nailor, National Controlled Air, Prefco, Ruskin, or Safe-Air.

2.16 MANUAL DAMPERS

A. Single blade up to 8" high, opposed multiblade over 8" high; minimum 80% free area based on damper frame outside dimensions.

B. Blades: minimum 16 gauge galvanized steel, or airfoil shape extruded aluminum.

1. Pivot rods: steel, minimum 0.5" diameter or hex, with one rod extended 6" to permit operation of damper from outside the duct.
2. Maximum length 42"; maximum width 8".
3. For low leakage applications: at points of contact provide interlocking or overlapping edges, compressible neoprene or extruded vinyl blade seals, and compressible metal side seals, designed for temperature of -40°F to 180°F at leakage rate specified herein.

C. Frames: galvanized steel bar minimum 2" wide x 12 gauge for dampers 10" high or less, and 3.5" x 0.875", 16 gauge galvanized roll-formed channel with double-thickness edges or 5" x 1" x 0.125" extruded aluminum channel for 11" high and larger.

1. Corner bracing.
2. Full size of duct or opening in which installed.

D. Bearings: bronze sleeve, steel ball type, or Cycoloy 800.

1. Vertically-mounted: thrust bearings.
2. Maximum spacing: 42".

E. Quadrants: cadmium-plated steel, with damper locking device, and damper position indicator.

1. Manufacturer: Arrow Q-38, Duro-Dyne KL-7R, or Ventlok 560.

F. Finish on steel parts: galvanized.

G. Operating linkage: factory-assembled, concealed in frame out of airstream, steel construction.

H. For low leakage applications: leakage when closed shall be less than 4 cfm/ft² at 1" wg differential static pressure based on a 48" damper width.

2.17 CONTROL DAMPERS

A. As specified in Section 238000, Automatic Temperature Controls.

2.18 GRILLES, REGISTERS AND DIFFUSERS

A. General:

1. Selection of grilles, registers and diffusers shall be based on air introduced at a 20°F temperature differential.
2. Grilles and registers with borders shall have felt or rubber gaskets cemented to the back face and holding screws not over 18" on center around the perimeter.
3. Wall-mounted grilles and registers located less than 7' above finished floor shall be heavy duty, impact-resistant type.
4. Diffusers in lay-in ceilings shall lay in a nominal 24" x 24" grid opening and shall be furnished without exposed flanges.
5. Register dampers: gang-operated, opposed-blade type, operated through the face of the register. Operating mechanism shall not project through the register face.
6. Extractors: adjustable through the face of the grille or register.
7. Diffusers shall be complete with straightening vanes, and opposed or rotating blade volume control dampers. Straightening vanes are not required where diffusers are attached to round flexible ductwork. Volume control dampers are not required where single diffusers are served by branch ducts with dampers at take-offs.
8. Internal parts of diffusers shall be designed so they can be adjusted, removed, and assembled without special tools.
9. Diffusers shall have round necks or shall be provided with square-to-round collars where connected to round or flexible duct.
10. Finishes, unless otherwise specified herein:

    a. Steel grilles and registers: white baked enamel.
    b. Diffuser faces and frames: white baked enamel.
    c. Diffusers interior: same as face and frame
    d. T-bar slot diffusers: flat black.

11. Grilles, registers and diffusers shall be provided with frames, borders, and mounting attachments for installation in the actual wall, soffit, and ceiling construction in which installed.

B. Supply Devices:

1. Type S-CF - Square cone face diffuser type, 24" x 24" face, minimum of 3 stamped cones, horizontal/vertical pattern adjustment device, 1-piece construction.

2. Type S-SR - Sidewall supply register, double-deflection type with vertical front blades, horizontal rear blades, and opposed-blade volume damper.
3. Type S-LD - Linear diffuser, extruded aluminum type, with 3 0.5" 0.75" 1" wide slots with integral volume control and pattern adjustment and concealed mounting frame. Finish in baked enamel with white face, and interior components visible after installation finished flat black.

Type	Number of Slots	Slot Width
S-LD-1	2	0.5"
S-LD-2	6	1"

C. Return and Exhaust Devices:

1. Type R-EG - Eggcrate grille, 0.5" x 0.5" x 0.5" fabricated aluminum eggcrate. Where indicated on the Drawings, provide hinged cores or separate hinged mounting frames.
2. Type R-SR - Sidewall register, single-deflection, 35° fixed position, 0.5" on center, horizontal blades with opposed-blade volume damper.

D. Manufacturer, unless otherwise noted: Anemostat, Carnes, Krueger, Metal*Aire, Nailor, E.H. Price, Titus, or Tuttle & Bailey.

2.19 FANS - GENERAL

A. Rated in accordance with AMCA 211-2013 (R2018), AMCA 300-2014, and ASHRAE 51/AMCA 210-2016.

B. Drives:

1. V-belt type, sized for 140% of motor size. Belt drive fans used in smoke control systems shall have 1.5 times the number of belts required for the design duty, minimum 2 belts.
2. Construction: cast iron. Sheaves for drives 5 hp and larger shall have bushed bores.
3. Motor sheaves: fixed pitch once final balancing and commissioning is completed.
4. Companion sheaves: to maintain belts parallel.
5. Temporary motor sheaves for final balancing and commissioning: variable pitch for motors through 25 hp or fan speeds less than 1000 rpm; fixed pitch for motors over 25 hp or fan speeds over 1000 rpm, and for variable frequency drives.

C. Motors: and variable frequency drives: as specified in Section 230010, HVAC General, unless otherwise specified herein.

D. Control circuit transformers: for actuators on fans with 3-phase motors.

E. Wheels and shafts: factory-balanced, both statically and dynamically as an assembly. Fans with variable frequency drives shall be dynamically balanced throughout the complete speed range.

F. Bearings: ball, roller, or taper roller type. Bearings for cabinet fans, centrifugal inline duct fans, propeller fans, and power roof ventilators shall have an L_{10} life of 50000 hours. Other bearings shall have an L_{10} life of 100000 hours. Bearing life shall be calculated based on the peak operating condition indicated on the Drawings.

2.20 FILTERS

A. General:

1. MERV ratings shall be based on ASHRAE 52.2-2017.
2. Filters shall be UL 900-2015 Class 1.

B. Pleated Filters:

1. 2" thick pleated, disposable type. Each filter shall consist of media and enclosing frame. Media shall be self-supported or shall contain a support grid. Initial resistance shall not exceed 0.25" wg based on 500 fpm
2. Filter media shall be reinforced nonwoven cotton fabric type with a minimum MERV rating of 6.
3. The effective filter media shall be not less than 7 ft² of media per ft² of filter face area.
4. Self-supported media shall be capable of maintaining its shape and pleat spacing during normal use. Filters with self-supported media shall maintain functionality if filter frame is damaged.
5. The media support shall be a welded grid with an effective open area of not less than 96%. The welded wire grid shall be bonded to the filter media to eliminate the possibility of media oscillation and media pullaway. The media support grid shall be formed in such a manner that pleats are rounded, allowing total use of filter media.
6. The enclosing frame shall be constructed of rigid, heavy duty, chipboard with diagonal or longitudinal support members bonded to the air entering and air exit side of each pleat to ensure pleat stability. The inside periphery of the enclosing frame shall be bonded to the filter pack.
7. Housings: factory-fabricated of galvanized steel, double-wall insulated type, with tracks for filters, and side access door with seal. Filter enclosing frames and housing shall form an airtight seal.
8. Frame retainers: designed to fit together to form a filter bank with airtight joints. Retainers shall be galvanized steel with gaskets and fasteners.
9. Manufacturer: Airguard DP, American Air Filter Am-Air 300X PerfectPleat, or Farr 30-30.

C. Bag Filters:

1. Supported type, nominal depth 24". Media shall have a minimum MERV rating of 13. Capacity shall be based on 500 fpm.
2. Filter media shall be supported with a corrosion resistant steel wire basket, and shall be synthetic. micro-glass fiber.
3. Housings: factory-fabricated of galvanized steel, double-wall insulated type, with tracks for filters, and side access door with seal. Filter enclosing frames and housing shall form an airtight seal.
4. Frame retainers: designed to fit together to form a filter bank with airtight joints. Retainers shall be galvanized steel with gaskets and fasteners.
5. Manufacturer: Airguard Venti-Pak, American Air Filter DriPak, Pureklean, or Farr Hi-Flo.
6. Manufacturer: American Air Filter Dripak 2000, or Farr HP.

2.21 FILTER PRESSURE GAUGES

A. Differential pressure gauges shall have a range 0" wg to 1" wg. , Gauges shall have 4" dial face, pointer zero adjustment, transmitter with two wire 4-20 mA output and zero and span adjustments for remote monitoring, 1/8 female NPT connections, and mounting accessories.

1. Manufacturer: Dwyer Magnehelic 605.

2.22 ROOF CURBS AND EQUIPMENT SUPPORT RAILS

A. Prefabricated type, 16-gauge aluminum with welded joints, raised cant to match roof deck insulation, and 1.5", 3 pcf fiberglass insulation. Top surfaces shall be level, with construction to fit roof pitch. Minimum height, at the lowest point, shall be 8".

B. Manufacturer: AES Industries, Pate, Penn, Roof Curb Products, Roof Products & Systems, or Thy Curb.

2.23 SIDE TAKEOFF FITTINGS

A. Minimum 26 gauge galvanized steel, designed for minimum pressure drop by an expansion from a rectangular connection to a round duct. The fitting shall include a 1" wide mounting flange with die formed corner clips, prepunched mounting holes, and an adhesive-coated flange gasket. The outlet collar shall be crimped and incorporate a bead.

B. Manufacturer: Crown, Flexmaster, or Design Air.

2.24 SMOKE DETECTORS

A. As specified in Section 238000, Automatic Temperature Controls.

PART 3 - EXECUTION

3.1 SHEET METAL WORK - GENERAL

A. Unless otherwise specified herein or indicated on the Drawings, construct and install sheet metal work in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible, 2005.

B. Workmanship, methods of assembly, joint and seam construction, and sealants for sheet metal work shall be designed for the duct leakage classifications specified in Section 230095, Testing, Adjusting and Balancing.

C. Changes in shape, dimension, or direction shall be made with a maximum transition, offset, or combination thereof of 1 to 7.

D. Except where indicated otherwise on the Drawings, use metal hat sections or standoff brackets in lined ductwork to install dampers, turning vanes or coils. Hat sections or standoff brackets shall be the same height as the lining thickness.

E. Openings in plenum casings for access doors shall be 9" above the floor. Hinge doors to close with plenum pressure.

F. Separate galvanized sheet metal from aluminum or copper with lead or felt gaskets.

G. Provide supplemental stiffening and supports to ducts and apparatus casings to prevent drumming, sagging and to provide a structurally sound assembly.

H. Ductwork and sheet metal seams, joints, penetrations, connections and attachments shall be sealed.

1. Sealants shall be applied in accordance with the manufacturer's recommendations for each specific application.
2. Ductwork failing the leakage tests specified in Section 230095, Testing, Adjusting and Balancing shall be repaired, reworked or rebuilt until satisfactory, before additional ductwork is installed and before ductwork is concealed.

I. Entire air system installation shall be rigid, and free from rattles and air noises. Interior of ducts shall be smooth.

J. Provide angle brackets inside ductwork on both sides to support slip-in electric heating coils in vertical ducts over 24" wide.

K. Provide transitions between different size sections of air handling units.

L. Install duct from shower exhaust grilles grading down to the exhaust grille, without traps or dips.

M. Install uninsulated ductwork exposed in finished areas against the ceiling.

N. Provide offsets, elbows, and transitions to coordinate with other work.

O. Provide transitions to connect ductwork to equipment and coils.

P. Elbows:

1. Elbows in round and flat oval ductwork are specified hereinbefore.
2. Radius elbows in rectangular and square ductwork shall have an inside radius equal to the width of the duct, except where space conditions prohibit, in which case a reduced inside radius with full heel radius is permitted. Where the space conditions require the inside radius to be less than 75% of the duct width, provide multiple splitter vanes inside the elbow.
3. Square (mitered) elbows in rectangular and square ductwork shall contain single-thickness turning vanes and shall be limited to 90° turn applications.
    a. Vanes shall be parallel to airflow.
    b. Vanes exceeding the maximum unsupported length defined by SMACNA shall be divided into multiple sections with intermediate vane rails or shall be braced with tie rods spanning perpendicularly across the leading edges of the vanes. The tie rods shall be welded to the leading edge of each vane.
4. Turns less than 90° in rectangular and square ductwork shall be made with radius type elbows. Mitered elbows are not permitted.

Q. Seal wall and floor penetrations as specified in Section 230010, HVAC General.

R. Internal surfaces of clothes dryer exhaust shall be free of obstructions. Sheet metal screws shall not be used for fastening. Elbows in square and rectangular ductwork shall be radius type without splitter vanes.

S. Instrument test ports: provide where required for measurements.

3.2 AIR DISTRIBUTION SYSTEMS

A. Provide a written construction indoor air quality (IAQ) management plan for use during demolition and construction. Maintain a detailed digital photograph log of the IAQ plan practices followed during construction.

3.3 PLENUM LINING

A. Line AHU AND ERU connections with fibrous nonfibrous plenum lining.

B. Install lining with coated side facing air stream. Adhere lining to inside of plenums with 100% coverage of adhesive. Coat exposed edges and joints with edge sealer. Attach lining and cover to sheet metal plenums with weld or mechanical grip pins 16" on center. Mechanical fasteners shall not compress the lining more than 0.125". Coat field cuts and minor surface damage with edge sealer after lining is installed. Adhere lining to masonry with insulation hangers set in adhesive 12" on center.

C. Cover lining with 0.5" galvanized hardware cloth or galvanized expanded metal.

3.4 DUCT LINING

A. Line 10' downstream of terminal boxes ductwork, at all locations, with duct fibrous lining.

B. Do not install lining within 18" upstream or 30" downstream of electric heating coils. If the box has an electric heating coil, install lined ductwork 10' downstream after 30" from electrical heating coil.

C. Install lining, except where otherwise specified herein, with coated side facing air stream and in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible, 2005. Adhere lining to inside of duct with 100% coverage of adhesive. In addition, weld or mechanical grip pins shall be installed with spacing conforming to SMACNA HVAC Duct Construction Standards - Metal and Flexible, 2005, for velocities over 2500 fpm. Mechanical fasteners shall not compress the lining more than 0.125". Coat exposed edges and joints with edge sealer. Protect leading edges against flaking by 24 gauge galvanized metal protectors. Butt and seal edges of lining together to form a continuous thermal barrier. Coat field cuts and minor surface damage with edge sealer after lining is installed.

3.5 ROUND AND FLAT OVAL DUCTWORK

A. Exposed ductwork shall be parallel to building surfaces and structural members, and shall have seams aligned at joints.

B. Construct a mock-up of exposed ductwork showing typical joints, methods of support, linear diffusers, and fittings for approval by the Architect before fabrication of exposed ductwork.

C. Joints shall be sealed with duct sealer. Duct sealer shall not be visible on the exterior of the ductwork. Sheet metal screws shall not be used for joints in dryer exhaust.

3.6 FLEXIBLE CONNECTIONS

A. Joints and seams shall be sealed airtight.

B. Provide at:

1. Inlet and outlet of fans.
2. Duct connections to air handling units, or on inlet and outlet of fan section only if fan section is separate.
3. Duct connections to engine-generator set radiators.

C. Not required at:

1. Power roof ventilators.
2. Air handling units with internally isolated fan, motor and drive.
3. Fan-powered terminal units with internally isolated fan and drive.

D. Provide a braided copper bridge strap across flexible connections.

3.7 ACCESS PANELS AND ACCESS DOORS

A. Provide access panels of sufficient size and quantity for access to fire dampers, smoke dampers, controls, air measuring stations, coils, duct smoke detectors, and where ductwork covers electrical boxes. Install in appropriate locations to allow cleaning, oiling, inspection, repair and maintenance.

B. Open each to verify that swing space is clear and access into duct or plenum is unobstructed.

3.8 PRESSURE RELIEF DOORS

A. Install vertically with the latch mechanism at the top.

3.9 FLEXIBLE DUCTWORK

A. Install flexible ductwork in a fully extended condition, free of sags and kinks, using the minimum length to make connection. Seal joints as recommended by manufacturer. Maximum length of flexible ducts to diffusers shall be 7'. Maximum length of flexible ducts to terminal units shall be 3'. Use round galvanized duct, same size as flexible duct, for longer runouts.

B. Flexible ductwork shall be fastened to spin-in fittings, collars and transitions by draw bands and duct tape.

C. For diffusers, size same diameter as diffuser neck to which it connects.

D. For terminal units, size as indicated on the terminal unit detail.

E. Where size of flexible duct is different than size of collar, make connection with a sheet metal transition.

3.10 HANGERS AND SUPPORTS

A. Adjust hangers and supports so that loading is uniform.

B. Unless otherwise specified herein or indicated on the Drawings, duct hangers and supports shall be in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible, 2005.

C. Support horizontal ductwork not more than 8' on center. Ductwork shall be directly suspended from or supported by the building structure.

D. Support ductwork associated with Air Handling Units directly from fire resistant rated structural elements of the building.

E. Support round ductwork with straps and hangers as recommended by the manufacturer and SMACNA.

F. Hang horizontal range hood and grill hood exhaust duct with rods secured to the structure and attached to trapeze angles or clips welded to the duct.

G. Support sound attenuators independently of the ductwork.

H. Flat oval ductwork shall be reinforced and supported with trapeze hangers.

I. Where ducts are suspended below ceilings, extend hangers through the ceiling and secure to the structure as specified herein.

J. Support vertical ducts at each floor with a minimum of 2 supports attached to the duct and fastened to the floor or structure.

3.11 FIRE DAMPERS

A. Install within the thickness of the rated construction.

B. Verify accessibility of each fire damper through duct and building access panels, and operation of each fire damper by removing link and operating damper.

3.12 SMOKE DAMPERS

A. Install in accordance with conditions of UL listing.

B. Locate within 24" of the smoke barrier.

C. Install so that blades, when open, are no more than 5° off-axis with airflow.

D. Verify accessibility of each smoke damper through duct and building access panels, and operation of each smoke damper by removing operator and operating damper.

3.13 COMBINATION FIRE/SMOKE DAMPERS

A. Install within the thickness of the rated construction.

B. Install so that blades, when open, are no more than 5° off-axis with airflow.

C. Verify accessibility of each combination fire/smoke damper through duct and building access panels, and operation of each combination fire/smoke damper by removing link and operator and operating damper.

3.14 MANUAL DAMPERS

A. Install dampers in accordance with manufacturer's instructions to operate freely.

B. Provide standoff brackets, sized to clear the insulation thickness, for quadrants installed on insulated ductwork.

3.15 CONTROL DAMPERS

A. Install dampers in accordance with manufacturer's instructions to operate and to obtain leakage rates specified herein. Adjust the damper linkage such that the damper closes before the actuator is fully closed to assure tight closure of the damper.

B. Blank-off and seal around dampers and between dampers and sleeves or frames to eliminate air bypass.

3.16 GRILLES, REGISTERS AND DIFFUSERS

A. Wall return and relief grilles installed above eye level shall be installed with blades angled so the inside of the duct or the adjacent space will not be visible through the grilles.

B. Lengths of linear diffusers indicated on the Drawings are nominal. Coordinate actual lengths required with field conditions and/or the Architectural Drawings.

3.17 FANS - GENERAL

A. Install centrifugal fans with a minimum of 2.5 duct diameters of straight duct at the inlet.

3.18 FILTERS

A. Install filters and media to be used while the building is under construction. Replace during construction as filters and media become loaded. Prior to final inspection, remove these filters and media and replace with new filters and media.

B. Install temporary filter media to protect return air grilles, registers and openings of permanent air handling systems operated while the building is under construction. Media shall be installed to prevent leakage around and bypass of filters.

C. Each bank of activated carbon filter units shall be fitted with a test element to be used for laboratory determination of the degree of saturation of the units. This operation shall be part of the manufacturer's replacement service.

1. Filters shall not be installed in the bank until final inspection.

3.19 FILTER PRESSURE GAUGES

A. Provide a differential pressure gauge, unless otherwise specified herein, across each bank of filters and/or filter housing.

B. Gauges shall be located so as to be visible.

3.20 SIDE TAKEOFF FITTINGS

A. Provide for takeoffs from rectangular ductwork to terminal units.

B. Install 45° takeoff fittings to correspond with direction of airflow.

C. Install concentric takeoff fittings where terminal units are connected to the supply duct loop.

3.21 SMOKE DETECTORS

A. Duct-mounted smoke detectors shall be located as follows:

1. Within 60" of its respective smoke damper with no outlets or inlets between the detectors and damper.
2. Between the smoke damper and any duct opening or connection.
3. In a straight section of duct.
4. To be accessible.

B. Locate remote test and alarm stations near the detector served, and mount approximately 6" below the ceiling.

END OF SECTION 237000