

## SECTION 233113 - DUCTWORK

## PART 1 - GENERAL

## 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. Refer to Section 012100 "Allowances".
- C. Related Sections include the following:
  - 1. Division 8 for Access Doors
  - 2. Division 23 Section "Common Work Results for Mechanical"
  - 3. Division 23 Section "Mechanical Insulation"
  - 4. Division 23 Section "Air Terminals"
  - 5. Division 23 Section "Diffusers, Registers, and Grilles."
  - 6. Division 23 Control Section
  - 7. Division 23 Section "Testing, Adjusting, and Balancing".

## 1.2 SUMMARY

- A. This Section includes metal ducts and accessories for heating, ventilating, and air-conditioning systems.

## 1.3 SYSTEM DESCRIPTION

- A. Drawings show the general layout of ductwork and accessories but do not show all required fittings and offsets that may be necessary to connect ducts to equipment, diffusers, grilles, etc., and to coordinate with other trades. Fabricate ductwork based on field measurements. Provide all necessary fittings and offsets. Coordinate with other trades for space available and relative location of HVAC equipment and accessories on ceiling grid. Duct sizes on the drawings are inside dimensions, which may be altered by Contractor to other dimensions with the same air handling characteristics where necessary to avoid interferences and clearance difficulties.
- B. The contractor must comply with the enclosed specification in its entirety. If on inspections, the engineer finds changes have been made without prior written approval, the contractor will make the applicable changes to comply with this specification, at the contractor's expense.
- C. At the discretion of the engineer, sheet metal gauges, and reinforcing may be randomly checked to verify all duct construction is in compliance.

## 1.4 SUBMITTALS

- A. Ductwork:
  - 1. Material, gage, type of joints, sealing materials, and reinforcing for each duct size range, including sketches or SMACNA plate numbers for joints, method of fabrication and reinforcing.

2. Fabrication, assembly, and installation, including plans, elevations, sections, components, and attachments to other work.
3. Duct layout indicating pressure classifications and sizes on plans.
4. Fittings.
5. Reinforcement and spacing.
6. Seam and joint construction.
7. Penetrations through fire-rated and other partitions.
8. Terminal unit, coil, and related installations.
9. Hangers and supports, including methods for building attachment

B. Ductwork Specialties Product Data; provide for the following:

1. Sealant
2. Duct Liner
3. Duct-mounted access doors and panels.
4. Flexible ducts.
5. Manual-volume dampers: Damper manufacturer's printed application and performance data including pressure, velocity and temperature limitations shall be submitted for approval.
6. Fire & smoke dampers: Provide complete submittal information (including installation instructions) and the manufacturer's certification of compliance with these specifications for approval prior to bidding. Contractor shall include damper manufacturer's Installation Instructions as part of the submittal. These instructions shall describe the applicable requirements for damper sleeve thickness, retaining angles, and methods of attachment, duct-to-sleeve connections, preparation of wall or floor openings, and all other requirements to provide an installation equivalent to that tested by the damper manufacturer during the UL Standard 555 qualification procedures. Contractor shall detail any proposed installations that deviate from these manufacturer's instructions and explain the needed deviations.

C. Record Drawings: Indicate actual routing, fitting details, reinforcement, support, and installed accessories and devices.

#### 1.5 APPLICABLE PUBLICATIONS

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.
- B. National Fire Protection Association (NFPA):
  1. 90A: Standard for the Installation of Air Conditioning and Ventilating Systems
- C. Sheet Metal and Air Conditioning Contractors National Association (SMACNA):
  1. 3rd Edition: 2005 HVAC Duct Construction Standards, Metal and Flexible

#### 1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver sealant and fire stopping materials to site in original unopened containers or bundles with labels indicating manufacturer, product name and designation, color, expiration period for use, pot life, curing time, and mixing instructions for multi-component materials.
- B. Deliver, store and handle materials according to manufacturer's written recommendations.

- C. All ductwork, equipment, and fittings delivered and stored on the job site must be capped to prevent the entry of moisture, construction dust or other debris.

## PART 2 - PRODUCTS

### 2.1 SHEET METAL MATERIALS

- A. SMACNA: Gages of materials, fabrication, reinforcement, sealing requirements, installation, and method of supporting ductwork shall be in accordance with the following SMACNA manuals. Conform to the applicable requirements of NFPA 90A, 91, 96, and 101.
- B. Galvanized, Sheet Steel, normal service: Lock-forming quality; ASTM A653, G60 or G90 as indicated.
- C. Reinforcement Shapes and Plates: Galvanized steel reinforcement where installed on galvanized, sheet metal ducts; compatible materials for aluminum and stainless-steel ducts.
- D. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for 36-inch length or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

### 2.2 RECTANGULAR DUCT FABRICATION

- A. General: Fabricate ducts, elbows, transitions, offsets, branch connections, and other construction with sheet steel, according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible." Comply with requirements for metal thickness, reinforcing types and intervals, tie-rod applications, and joint types and intervals.
  - 1. Lengths: Fabricate rectangular ducts in lengths appropriate to reinforcement and rigidity class required for pressure classification.
  - 2. Materials: Free from visual imperfections such as pitting, seam marks, roller marks, stains, and discolorations.
  - 3. Maximum allowable deflection for transverse joints and intermediate reinforcements will not exceed 0.250 inch.
  - 4. Longitudinal Seams: Pittsburgh lock shall be used on all longitudinal seams. Snap-lock seams are not acceptable.
  - 5. If SMACNA seal class A or B is specified, the longitudinal seam shall be sealed from the inside.
- B. Slide-on Transverse Joint Connectors: Prefabricated slide-on transverse duct connectors and components will be accepted. Duct constructed using prefabricated systems will refer to the manufacturer guidelines for sheet gauge, intermediate reinforcement size and spacing, and proper joint reinforcement(s). Approved connection systems: Ductmate Industries: or W.D.C.I.
- C. Cross Breaking or Cross Beading: Cross break or cross bead duct sides 19 inches and larger and 0.0359 inch thick or less, with more than 10 sq. ft. of un-braced panel area, unless ducts are lined. All large ducts must be braced as required to prevent drumming.
- D. Fittings per SMACNA acceptable, specific fittings requirements below:
  - 1. Fig. 2-3 Rectangular Elbows: Type RE2 square throat with vanes, Type RE1 radius, or Type RE5 dual radius.
  - 2. Vane support in elbows: Fig 2-4. Turning vanes shall be Harper double wall turning vanes fabricated from the same material as the duct. Mounting rails shall have friction insert tabs that align the vanes automatically. Tab spacing shall be as specified in Figure 2-3 of the 1995

SMACNA Manual, "HVAC Duct Construction Standards, Metal & Flexible" Second Edition standard. Rail systems with non-standard tab spacing shall not be accepted. Due to tensile loading, vanes shall be capable of supporting 250 pounds when secured according to the manufacturer's instructions.

3. Fig. 2-5 Rectangular Divided Flow Branches: Type 1, Type 2, Type 4A, or 4B.
4. Fig. 2-6 Branch Connections: 45-degree entry, 45-degree lead-in, bell-mouth or spin-in (single diffuser supply only).
5. Fig. 2-7 Offsets and Transitions. Use gradual offsets as shown, 90-degree offsets shall be avoided.

### 2.3 ROUND DUCT FABRICATION

- A. Fabricate supply ducts of galvanized steel according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" latest edition.
- B. Round ducts shall be as follows:
  1. Shall be longitudinal Grooved Seam Flat lock (RL-5 seam) at 2-inch wg construction.
  2. Snap lock seams *shall not* be used for this project.
- C. Round Joints: Interior slip coupling beaded at center and fastened to duct with screws shall be used to join ducts. Seal joint with an approved sealing compound, continuously applied around joint prior to assembling and after fastening, making certain that majority of sealant resides on interior of the joint.

### 2.4 SEALANT MATERIALS

- A. Joint Sealant/Mastic: Shall be flexible, water-based, adhesive sealant designed for use in all pressure duct systems. After curing, it shall be resistant to ultraviolet light and shall prevent the entry of water, air and moisture into the duct system. Sealer shall be UL 723 and UL 181 listed and meet NFPA 90A requirements.
  1. Maximum 5 flame spread and 0 smoke-developed (ASTM E-84 Tunnel Test).
  2. Generally provide liquid sealant for low clearance slip joints and heavy, permanently elastic, mastic type where clearances are larger.
  3. Resistance to mold, mildew and water: Excellent
  4. Color: Gray
  5. Duct sealant/mastic shall meet requirement for "LEED IEQ Credit 4.1: Low Emitting Materials: Adhesive and Sealant". ITW TACC Miracle Kingco water-based sealants, or approved equal.
- B. Flange Gasket: A butyl rubber gasket which complies with UL Standard 181 and 723 testing and meets Mil-C 18969B and TTS-S-001657. This material, in addition to the above, shall not contain vegetable oils, fish oils, or any other type vehicle that will support fungal and/or bacterial growth. Approved: Ductmate 440 Butyl gasket tape.

### 2.5 HANGERS AND SUPPORTS

- A. Building Attachments: Fasteners appropriate for building materials. Provide per SMACNA Fig's. 4-1, 4-2, and 4-3.
  1. Sheet Metal Screws, Machine Bolts and Nuts: Same material as duct, unless otherwise specified.
  2. Concrete Inserts: Steel or malleable iron, galvanized; continuously slotted or individual inserts conforming with MSS SP-58, Types 18 & 19, Class A-B.
  3. C Clamps: Fee & Mason Co.'s 255L with locking nut, and 255S with retaining strap.

4. Metal Deck Ceiling Bolts: B-Line Systems, Inc.'s Fig. B3019.
  5. Welding Studs: Erico Fastening Systems, capacitor discharge, low carbon steel, copper flashed.
  6. Structural (carbon) Steel Shapes and Steel Plates: ASTM A36, shop primed.
  7. Machine Bolt Expansion Anchors: Non-caulking single unit type: FS FF-S-325, Group II, Type 2, Class 2, Style 1; Non-caulking double unit type: FS FF-S-325, Group II, Type 2, Class 2, Style 2; Self-drilling type: FS FF-S-325, Group III, Types 1 and 2.
- B. Hanger Materials: Sheet steel or round, threaded steel rod. Straps and Rod Sizes: Comply with SMACNA for sheet steel width and thickness and for steel rod diameters.
1. Duct Attachments: Strap hangers, angles, trapezes, and rods per SMACNA Fig. 4-4. Wire supports are not permitted.
  2. Riser Supports: SMACNA Fig 4-7 and Fig 4-9.
  3. Wall Supports: SMACNA Figs. 4-8.
  4. HVAC Unit Suspension: SMACNA Fig. 4-10.
  5. Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.
  6. Trapeze and Riser Supports: Steel shapes complying with ASTM A36/A36M.
- C. Dissimilar Metals: Separate dissimilar metals used for ductwork with 12 oz vinyl coated woven fiberglass duct connector fabric, such as Duro Dyne's Glasseal. No separation is required between screws or rivets and the materials in which they are inserted.

## 2.6 FITTINGS

- A. Tees, Laterals, and Conical Tees: Use 45 degree; fabricate to comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible," with metal thicknesses specified for longitudinal seam straight duct.
- B. Diverging-Flow Fittings: Fabricate with a reduced entrance to branch taps with no excess material projecting from body onto branch tap entrance.
- C. Elbows: Diameters 3 through 8 inches shall be two-section die stamped; all others shall be gored construction, maximum 18 degree angle, with all seams continuously welded or standing seam. Coat galvanized areas of fittings damaged by welding with corrosion resistant aluminum paint or galvanized repair compound.

## 2.7 MANUAL-VOLUME DAMPERS

- A. Manual balancing dampers meeting the following specifications shall be furnished and installed on all branch ducts and where shown on plans. Testing and ratings to be in accordance with AMCA Standard 500-D.
- B. Single-Blade Rectangular Dampers shall consist of: an 18 ga. galvanized steel frame with 3-1/2 in. depth; blades fabricated from 20 ga. galvanized steel; integral 1/2 in. dia axles. Damper suitable for pressures to 1.0 in. wg, velocities to 2000 fpm and temperatures to 180°F. Basis of design is Greenheck model MBD-10.
- C. Multi-Blade Rectangular Dampers shall consist of: a 16 ga. galvanized steel hat channel frame with 5 in. depth; triple V type blades fabricated from 16 ga. galvanized steel; 1/2 in. dia. plated steel axles; external (out of the airstream) blade-to-blade linkage. Damper suitable for pressures to 4.0 in. w.g. (996 Pa), velocities to 2000 fpm and temperatures to 180°F. Basis of design is Greenheck model MBD15.

- D. Round dampers shall consist of: a 20 ga. galvanized steel frame with 6 in. depth; blades fabricated from 20 ga. galvanized steel; 3/8 in. square plated steel axles turning in acetal bearings. Damper suitable for pressures to 1.0 in. wg, velocities to 2000 fpm and temperatures to 180°F. Basis of design is Greenheck model MBDR50.

## 2.8 DUCT LINER

### A. Liner Thickness:

1. General duty: 1 inch (R4.2)

### B. Flexible Elastomeric

1. Basis-of-Design Product: Subject to compliance with requirements, provide Armacell LLC; AP Armaflex, or a comparable product by one of the following:
  - a. Aeroflex USA Inc.; Aeroceel.
  - b. RBX Corporation; Insul-Sheet 1800
2. Armaflex: All ducts, where shown on the drawings, shall be lined with thick AP/Armaflex SA duct liner, or approved equal. The liner shall meet the requirements of NFPA 90A and UL 181.
  - a. Temperature Range: -40F to 180F.
  - b. Thermal conductivity: 0.27 @ 75°F (24°C) mean temp (ASTM C 518).
  - c. Water vapor transmission: less than 0.08 (1.16 x 10<sup>-13</sup>) (ASTM E 96, Procedure A)
  - d. Water vapor transmission: less than 0.2% by volume (ASTM C 209)
  - e. Microbial growth: none (ASTM C 1071), ASTM G21- fungal), ASTM G22 – bacterial).
  - f. Erosion Resistance: Does not break away, flake off or show evidence of delamination at velocities of 6,000ft./min. (ASTM C 1071)
  - g. Surface-Burning Characteristics: Maximum flame-spread index of 25 and maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.
  - h. Liner Adhesive: As recommended by insulation manufacturer and complying with NFPA 90A. Duct liner adhesive sealants shall meet requirement for “LEED IEQ Credit 4.1: Low Emitting Materials: Adhesive and Sealant”.
  - i. Comply with ASTM C 534, Type II, Grade 1, for sheet materials.
  - j. Provide product recognized under Underwriters Laboratories "UL 94 - Plastic Component Classification" and listed in Factory Mutual "FM Approval Guide."

## 2.9 FIRE DAMPERS

### A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Air Balance Inc.
2. Cesco Products
3. Greenheck Fan Corporation.
4. METALAIRE, Inc.
5. Nailor Industries Inc.
6. Prefco
7. Ruskin Company.

### B. Type: Static; rated and labeled according to UL 555S by an NRTL.

### C. Fire Rating: 1-1/2 hours.

- D. Frame: Curtain type with blades outside airstream except when located behind grille where blades may be inside airstream; fabricated with roll-formed, 0.034-inch- 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 thick, as indicated, and of length to suit application.
  - 2. Exception: Omit sleeve where damper-frame width permits direct attachment of perimeter mounting angles on each side of wall or floor; thickness of damper frame must comply with sleeve requirements.
- F. Mounting Orientation: Vertical or horizontal as indicated.
- G. Blades: Roll-formed, interlocking, 0.034-inch- thick, galvanized sheet steel. In place of interlocking blades, use full-length, 0.034-inch- thick, galvanized-steel blade connectors.
- H. Horizontal Dampers: Include blade lock and stainless-steel closure spring.
- I. Heat-Responsive Device: Replaceable, 165 deg F rated, fusible links.
- J. General: Labeled to UL 555C; comply with construction details for tested floor- and roof-ceiling assemblies as indicated in UL's "Fire Resistance Directory." The basis of design is Greenheck Model CRD-2. Frames and Blades: in Galvanized steel (in gauges required by UL listing R-13446). Blade Insulation: non-asbestos U.L. Listed refractory insulation. Provide U.L. approved thermal blanket at diffusers. Volume Adjustment: UL-labeled, fusible volume-control adjustment. The heat responsive device shall have a temperature rating of 165 °F. 350 °F.

## 2.10 FIRE/SMOKE DAMPERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Air Balance Inc.
  - 2. Cesco Products
  - 3. Greenheck Fan Corporation.
  - 4. METALAIRE, Inc.
  - 5. Nailor Industries Inc.
  - 6. Prefco
  - 7. Ruskin Company.
- B. General Requirements: Label according to UL 555S by an NRTL.
- C. Frame: Hat-shaped, 0.094-inch- thick, galvanized sheet steel, with interlocking, gusseted or mechanically attached corners and mounting flange.
- D. Blades: 3V, horizontal, interlocking, 0.034-inch- thick, galvanized sheet steel.
- E. Leakage: not less than Class II.
- F. Fire/Smoke Dampers: Heat-Responsive Device: Replaceable, 165 deg F rated, fusible links.
- G. Elevated Temperature Rating: 350°F.
- H. Rated pressure and velocity to exceed design airflow conditions.

- I. Mounting Sleeve: Factory-installed, 0.039-inch- thick, galvanized sheet steel; length to suit wall or floor application with factory-furnished silicone caulking.
- J. Actuators: factory-mounted, electric, two-position action. The actuator shall be externally sleeve mounted or side-plate externally mounted. Actuators and accessories shall be wired to a single junction box for single-point wiring installation.
- K. Smoke Detector: Integral, factory wired for single-point connection. Provide built-in or separate test switch.

#### 2.11 DUCT-MOUNTED ACCESS DOORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Ductmate Industries, Inc.
  - 2. Greenheck Fan Corporation.
  - 3. McGill Air Flow LLC.
  - 4. Nailor Industries Inc.
  - 5. Cesco
  - 6. Buckley
- B. Duct-Mounted Access Doors: Fabricate access panels according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 2-10, "Duct Access Doors and Panels," and 2-11, "Access Panels - Round Duct."
  - 1. Door:
    - a. Double wall, rectangular; rated for up to 4.5" static pressure.
    - b. Door panel filled with 1" fiberglass insulation; ¾ lb. density.
    - c. Hinges and Latches: 1-by-1-inch continuous piano hinge and cam latches.
    - d. Fabricate doors airtight and suitable for duct pressure class.
  - 2. Frame: Galvanized sheet steel, with bend-over tabs.
  - 3. Provide 1/8" thick neoprene gaskets.
  - 4. Number of Hinges and Locks: Access Doors Less Than 12 Inches Square: No hinges and two cam locks. Access Doors up to 24 Inches Square: One hinge and cam locks.

#### 2.12 FLEXIBLE DUCTS

- A. General: Comply with UL 181, Class 0 Or 1. Flame Spread: Less than 25; Smoke Developed: Less than 50.
- B. All products shall be certified by Greenguard Environmental Institute; independent testing of products for emissions of respirable particles and Volatile Organic Compounds (VOC's), including formaldehyde and other specific product-related pollutants. Greenguard provides independent, third-party certification of IAQ performance. Certification is based upon criteria used by EPA, OSHA and WHO.
- C. Rated Positive Pressure: 10" w.g. per UL-181. Maximum negative pressure: ¾".
- D. Flexible Ducts, Insulated: Factory-fabricated, insulated, round duct, with an outer jacket enclosing 1-1/2-inch- thick (R = 6.0), glass-fiber insulation around a continuous inner liner.
  - 1. Thickness: 1", R4.2, Basis of Design: Atco #80



2. Reinforcement: Steel-wire helix encapsulated in inner liner.
  3. Outer Jacket: Polyethylene film.
  4. Inner Liner: Polyethylene film.
- E. Flexible Duct Clamps: Stainless-steel band with cadmium-plated hex screw to tighten band with a worm-gear action, in sizes 3 to 18 inches to suit duct size.
- F. Hangers shall be band type, 1" wide minimum.

## PART 3 - EXECUTION

### 3.1 MATERIALS

- A. Hangers, accessories, and dampers shall be same material as parent duct.
- B. All ducts shall be G60 galvanized steel.

### 3.2 DUCT CLASSIFICATIONS AND SEALING

- A. Static-Pressure Classifications: Unless otherwise indicated, construct ducts to the following:
  1. Supply duct upstream of VAV terminal units: 3 in. w.g.
  2. Supply Ducts downstream of VAV terminal units: 2-inch wg.
  3. Return Ducts: 2-inch wg, negative pressure.
  4. Exhaust Ducts: 2-inch wg, negative pressure.
- B. Seam And Joint Sealing
  1. General: Seal duct seams and joints according to the duct pressure class indicated and as described in SMACNA's "HVAC Duct Construction Standards--Metal and Flexible."
  2. Seal to SMACNA Class A; all joints, longitudinal and transverse seams, and connections in ductwork shall be securely fastened and sealed with welds, gaskets, or duct sealant. Exceptions:
    - a. Continuously welded and locking-type longitudinal joints and seams on ducts operating at less than 2 in. wg pressure classification.
    - b. Exposed exhaust or return ducts operating at less than 2 in. wg pressure classification.
    - c. Exposed supply ducts in the space that the duct serves.
  3. Seal externally insulated ducts before insulation installation.

### 3.3 DUCT INSTALLATION, GENERAL

- A. Construct and install each duct system for the specific duct pressure classification indicated.
- B. Properly seam, brace, stiffen, support and render ducts mechanically airtight. Adjust ducts to suit job conditions. Dimensions may be changed as approved, if cross sectional area is maintained.
- C. Install ducts in lengths not less than 12 feet, unless interrupted by fittings. Install ducts with fewest possible joints.
- D. Install fabricated fittings for changes in directions, changes in size and shape, and connections.

- E. Install couplings tight to duct wall surface with a minimum of projections into duct.
- F. Install ductwork to allow maximum headroom. Install ducts, unless otherwise indicated, vertically and horizontally, parallel and perpendicular to building lines; avoid diagonal runs. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.
- G. Install ducts with a clearance of 1 inch, plus allowance for insulation thickness.
- H. Conceal ducts from view in finished spaces. Do not encase horizontal runs in solid partitions, unless specifically indicated.
- I. Coordinate layout with suspended ceiling, lighting layouts, and similar finished work.

### 3.4 DUCT PENETRATIONS

- A. Fire or Smoke Rated Penetrations not requiring a fire and/or smoke damper: Where ducts pass through walls, floors, or partitions that are required to have a fire resistance rating and fire dampers are not required, the opening in the construction around the duct shall be as follows:
  - 1. Not exceeding a 1" average clearance on all sides.
  - 2. Filled solid with firestopping material as specified in Section 230500.
- B. Fire-Rated Penetrations – Fire Damper: Provide fire damper as specified under Duct Accessories paragraph.
- C. Smoke-Rated Penetrations – Smoke Damper: Provide smoke damper as specified under Duct Accessories paragraph.
- D. Non-Fire-Rated Exposed Penetrations: Where ducts pass through interior partitions and exterior walls, and are exposed to view, conceal space between construction opening and duct or duct insulation with sheet metal flanges of same metal thickness as duct. Overlap opening on four sides by at least 1-1/2 inches.
- E. Non-Fire-Rated Concealed Penetrations: Provide insulation infill and acoustical sealant around gaps. Tightly seal to prevent sound transmission. Neatly finish.
- F. Mechanical room floor penetrations: Provide 4-inch high concrete curbs or other sealing method to prevent leakage from mechanical room into floor penetration.
- G. Flexible air ducts or connectors shall not pass through any wall, floor, or ceiling.

### 3.5 HANGING AND SUPPORTING

- A. Install duct with support systems indicated in SMACNA's "HVAC Duct Construction Standards--Metal and Flexible."
  - 1. Support horizontal ducts within 24 inches of each elbow and within 48 inches of each branch intersection.
  - 2. Support horizontal ducts at a maximum interval of 10 feet.
  - 3. Support vertical ducts at a maximum interval of 16 feet and at each floor.
  - 4. Secure upper hanger attachments to structural steel or steel bar joists wherever possible.
  - 5. Do not use drive-on beam clamps, flat bars or bent rods, as upper hanger attachments.

6. Do not attach hangers to steel decks which are not to receive concrete fill.
7. Do not attach hangers to pre-cast concrete planks less than 2-3/4 inches thick.
8. Avoid damage to reinforcing members in concrete construction.
9. Metallic fasteners installed with electrically operated or powder driven tools may be used as upper hanger attachments, in accordance with the SMACNA Manual, with the following exceptions:
  - a. Do not use powder driven drive pins or expansion nails.
  - b. Do not attach powder driven or welded studs to structural steel less than 3/16 inch thick.
  - c. Do not support a load, in excess of 250 lbs from any single welded or powder driven stud.
  - d. Do not use powder driven fasteners in pre-cast concrete.
10. Install upper attachments to structures with an allowable load not exceeding one-fourth of failure (proof-test) load.

### 3.6 FLEXIBLE DUCT

- A. Provide in accordance with manufacturer's and Air Diffusion Council recommendations.
- B. Flexible ducts shall be supported at manufacturer's recommended intervals, but at no greater distance than 5 feet. Maximum permissible sag is 1/2" per foot of spacing between supports.
- C. Install duct fully extended; do not install in the compressed state or use excess lengths.
- D. Avoid bending ducts across sharp corners or incidental contact with metal fixtures, pipes, conduits, or hot equipment. Radius at centerline shall not be less than one duct diameter.
- E. Hanger or saddle material in contact with the duct shall be at least 1-1/2" wide.
- F. Provide at least 2 duct diameters of straight duct at the entrance to register, grilles, and diffusers.

### 3.7 DUCT ACCESSORIES INSTALLATION

- A. Install duct accessories according to applicable details shown in SMACNA's "HVAC Duct Construction Standards--Metal and Flexible".
- B. Provide duct transitions, offsets and connections to dampers, coils, and other equipment in accordance with SMACNA Standards
- C. Each register, grille, or diffuser shall have a means of air flow adjustment. Provide volume damper in branch duct if not furnished with the RGD.
- D. Adjust operable devices for proper action.
- E. Perform the following as directed by the controls contractor:
  1. Installation of:
    - a. Automatic control dampers.
    - b. Smoke detectors.
    - c. Necessary blank off plates.
  2. Access doors where indicated and as required.

- F. Install duct access panels for access components that require servicing.
1. Install duct access panels to allow access to interior of ducts for cleaning, inspecting, adjusting, and maintaining per equipment manufacturers' requirements.
  2. Install access panels on side of duct where adequate clearance is available.
  3. Locate panel upstream and/or downstream as recommended by manufacturer.
- G. Fire Damper Installation
1. Examine areas to receive dampers. Notify the Engineer of conditions that would adversely affect installation or subsequent utilization of dampers. Do not proceed with installation until unsatisfactory conditions are corrected
  2. Install dampers in accordance with manufacturer's UL Installation Instructions, labeling, and NFPA 90A at locations indicated on the drawings. Any damper installation that is not in accordance with the manufacturer's UL Installation Instructions must be approved prior to installation.
  3. Dampers must be accessible to allow inspection, adjustment, and replacement of components. The sheet metal contractor shall furnish any access doors in ductwork or plenums required to provide this access. The general contractor shall furnish any access doors required in walls, ceilings, or other general building construction.
  4. Install dampers square and free from racking.
  5. The installing contractor shall provide and install bracing for multiple section assemblies to support assembly weight and to hold against system pressure.
  6. Do not compress or stretch the damper frame into the duct or opening.
  7. Attach multiple damper section assemblies together in accordance with manufacturer's instructions. Install support mullions as reinforcement between assemblies as required.
  8. Handle dampers using the frame or sleeve. Do not lift or move dampers using blades, actuator or jackshaft.
- H. Fire/Smoke Damper Installation: The contractor shall coordinate all smoke damper installation, wiring, and checkout to ensure that these dampers function properly and that they respond to the proper fire alarm system general, zone, and/or detector trips. The contractor shall immediately report any discrepancies to the engineer no less than two weeks prior to inspection by the code authority having jurisdiction.

### 3.8 DUCT LINER INSTALLATIONS

- A. All portions of duct designated to receive duct liner shall be completely covered with duct liner. All joints shall be neatly butted and there shall be no interruptions or gaps. Duct liner shall be installed with the printed air stream surface treatment exposed to the air stream.
- B. Duct liner shall be adhered to the sheet metal with 90% (minimum) coverage of adhesive complying with the requirements of ASTM C 916.
- C. All transverse edges that are not to receive sheet metal nosing shall be coated. Longitudinal joints shall occur at the corners of ducts. If duct size and standard duct liner product dimensions make exposed longitudinal joints necessary, such joints shall be coated with adhesive designated for duct liner application and which meets the requirements of ASTM C 916. Such joints shall be additionally secured with mechanical fasteners in accordance with NAIMA FGDLS, or SMACNA HVAC DCS as if they were transverse joints.
- D. Duct liner shall be additionally secured with mechanical fasteners complying with the requirements NAIMA FGDLS or SMACNA HVAC DCS and of the correct type for the duct liner being installed. Fasteners may be either weld-secured or impact-driven, and shall be installed perpendicular to the duct surface. Mechanical fasteners shall not compress the insulation more than 1/8" based on nominal

insulation thickness. Fastener spacing with respect to interior duct dimensions shall be in accordance with NAIMA FGDLS or SMACNA HVAC DCS. Fastener heads or washers shall have a minimum area of 0.75 in<sup>2</sup>, with beveled or cupped edges to prevent their cutting into the duct liner.

- E. Where air velocities exceed 4000 fpm, metal nosing (either channel or "zee" profile) shall be installed on upstream edges of liner duct sections.
- F. Metal nosing shall be securely installed over transverse liner edges facing the airstream at fan discharge and at any point where lined duct is preceded by unlined duct.
- G. Duct liner in roll form shall be folded and compressed in the corners of rectangular duct sections, or shall be cut and fit to assure a lapped, compressed corner joint.
- H. Duct liner in sheet form shall be cut and fit to assure tight, over-lapped corner joints. Top pieces of liner shall be supported at the edges by the side pieces.
- I. Any damage to the air stream surface must be repaired by coating the damaged area with adhesive or coating designed for duct liner application. Adhesive or coating shall meet requirements of ASTM C916.

### 3.9 FIELD QUALITY CONTROL

- A. HVAC systems shall not be operated during construction.
- B. Upon completion of installation duct systems and before HVAC system start-up, visually inspect the ductwork proper installation
- C. Cover supply openings with filter media prior to system start-up to catch any loose material that may remain inside the ductwork. Turn the HVAC system on and allow it to run until steady state operation is reached. Remove the temporary filter media from supply openings and, along with it, any loose material blown downstream and caught by the filter media.
- D. All ductwork shall be provided with temporary enclosures to keep the HVAC system free of dust and construction debris. The HVAC system includes any interior surface of the facility's air distribution system for conditioned spaces and/or occupied zones. This includes the entire duct from the points where the air enters the system to the points where the air is discharged from the system.
  - 1. Confirm that the duct system is free from construction debris. Check all registers, grilles, and diffusers to ensure that they are clean and free from construction debris.
  - 2. If no contaminants are evident through visual inspection, the HVAC system shall be considered clean; however, the Owner reserves the right to further verify system cleanliness through Surface Comparison Testing or the NADCA vacuum test specified in the NADCA standards. If visible contaminants are evident through visual inspection, those portions of the system where contaminants are visible shall be cleaned and subjected to re-inspection for cleanliness.
  - 3. If cleaning is required, the procedures of the National Air Duct Cleaners Association (NADCA) General Specifications for the Cleaning of Commercial HVAC Systems (free download) shall be followed. Costs of this work shall be borne by Division 23.
- E. Check all filters in accordance with their manufacturer's instructions. Use specified grade of filters at all times that system is operating.

END OF SECTION 233113