SECTION 23 30 00
DUCTWORK AND ACCESSORIES

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. Provide all materials and equipment, tools, labor and supervision required to fabricate and install sheetmetal ductwork, fittings, dampers, and accessories as required for a complete, operating air distribution system. The scope of work includes the following systems:

1. Fabrication and installation of supply and return air ductwork for packaged rooftop air conditioning units serving the office areas, corridors, and support spaces, including VAV terminals, fan-powered terminals diffusers, and grilles;
2. New exhaust air system including ductwork and fans to serve the new toilet rooms and lanitor's closets.
3. Fabrication and installation of supply and return air ductwork for packaged rooftop air conditioning units (RTU) serving the TKDs/TKFs and electrical Infrastructure rooms
4. New exhaust air systems including ductwork and fans to serve the new battery rooms.

B. All systems are shown on the drawings, with material and installation specifications listed below.

C. Provide supporting and hanging devices necessary to attach entire HVAC system including ductwork and equipment, and to prevent vibration. In general, support all ductwork from secondary structural steel attached to the building structure. Connect hanger rods to suitable supports using beam clamps or inserts. Do not use caddie clips for any duct supports.

D. Provide vertical and horizontal supports as required by codes to meet minimum applicable seismic resistance standards. Ductwork shall be free from vibration under all conditions of operation.

1.2 RELATED SECTIONS

A. Section 23 05 29 – Supports and Anchors

B. Section 23 07 00 - Insulation

1.3 REFERENCES

A. SMACNA HVAC Duct Construction Standards (Metal and Flexible)

B. NFPA 90A – Standard for the Installation of Air Conditioning and Ventilating Systems

C. NFPA 75 – Standard for the Protection of Electric Computer/Data Processing Equipment

D. ARI 880 – Industry Standard for Air Terminals

1.4 GENERAL

A. Section 23 00 10 – Mechanical Requirements, is an integral part of this section. Requirements and work indicated in 23 00 10 are not repeated in this Section.

1.5 QUALITY ASSURANCE

A. All ductwork shall be delivered to the job site in a clean condition, with all fittings and all section ends securely covered with polyethylene. The ductwork shall remain covered until

installation, and a thorough cleaning of each section of ductwork shall be performed as it is installed.

B. Comply with manufacturer's instructions for installation of fire and smoke dampers.

1.6 SUBMITTALS

A. Submit shop drawings for all ductwork systems layout, and product data for all material, sealants, hangers and supports, fabrication, dampers, registers, diffusers, grilles, fans, fan coil units, and specialties as specified in Section 23 00 10.

1. For material and equipment, list sizes, ratings, performance, controls, dimensions and weights, supplier, and connection and installation requirements.
2. Provide scale drawing (min ¼" = 1') of duct layout, coordinated with electrical and other trades to avoid interferences. Electronic files of the design layout will be made available for use by the Contractor to create coordination drawings.
3. Provide damper schedule.
4. Provide installation, operation, and maintenance manuals, including list of recommended spare parts (where applicable) for mechanical specialties.

PART 2 - PRODUCTS

2.1 SHEET METAL MATERIALS

A. Comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods, unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

B. Galvanized Sheet Steel: Lock-forming quality; complying with G90 commercial coating in accordance with ASTM 527; ducts shall have mill-phosphatized finish for surfaces exposed to view.

C. Aluminum Sheets: Comply with ASTM B 209 (ASTM B 209M) Alloy 303, H14 temper; with mill finish for concealed ducts, and standard, one-side bright finish for duct surfaces exposed to view. Used at humidifier manifold as shown and detailed on the drawings.

D. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts.

E. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

2.2 SEALANT MATERIALS

A. Joint and Seam Sealants, General: The term "sealant" is not limited to materials of adhesive or mastic nature but includes tapes and combinations of open-weave fabric strips and mastics.

B. Joint and Seam Tape: 2 inches wide; glass-fiber-reinforced fabric.

C. Tape Sealing System: Woven-fiber tape impregnated with gypsum mineral compound and modified acrylic/silicone activator to react exothermically with tape to form hard, durable, airtight seal.

D. Water-Based Joint and Seam Sealant: Flexible, adhesive sealant, resistant to UV light when cured, UL 723 listed, and complying with NFPA requirements for Class 1 ducts.

E. Solvent-Based Joint and Seam Sealant: One-part, nonsag, solvent-release-curing, polymerized butyl sealant formulated with a minimum of 75 percent solids.

F. Flanged Joint Mastic: One-part, acid-curing, silicone, elastomeric joint sealant complying with ASTM C 920, Type S, Grade NS, Class 25, Use O.

G. Flange Gaskets: Butyl rubber or EPDM polymer with polyisobutylene plasticizer.

2.3 HANGERS AND SUPPORTS

A. Building Attachments: Structural-steel fasteners appropriate for construction materials to which hangers are being attached.

B. Hanger Materials: Galvanized sheet steel or threaded steel rod.

1. Hangers Installed in Corrosive Atmospheres: Electro-galvanized, all-thread rods or galvanized rods with threads painted with zinc-chromate primer after installation.
2. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for steel sheet width and thickness and for steel rod diameters.
3. Galvanized-steel straps attached to aluminum ducts shall have contact surfaces painted with zinc-chromate primer.

C. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.

2.4 RECTANGULAR DUCT FABRICATION

A. Fabricate ducts, elbows, transitions, offsets, branch connections, and other construction according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" and complying 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 class.
2. Deflection: Duct systems shall not exceed deflection limits according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible."

B. Transverse Joints: Prefabricated slide-on joints and components constructed using manufacturer's guidelines for material thickness, reinforcement size and spacing, and joint reinforcement.

1. Manufacturers:
   a. Ductmate Industries, Inc.
   b. Nexus Inc.
   c. Ward Industries, Inc.

C. Formed-On Flanges: Construct according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible," Figure 1-4, using corner, bolt, cleat, and gasket details.

1. Manufacturers:
   a. Ductmate Industries, Inc.
   b. Lockformer.
2. Duct Size: Maximum 30 inches wide and up to 2-inch wg pressure class.
3. Longitudinal Seams: Pittsburgh lock sealed with noncuring polymer sealant.

D. 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 nonbraced panel area unless ducts are lined.

2.5 ROUND DUCT AND FITTING FABRICATION

A. Diameter as applied to flat-oval ducts in this Article is the diameter of a round duct with a circumference equal to the perimeter of a given size of flat-oval duct.

B. Round, Longitudinal- and Spiral Lock-Seam Ducts: Fabricate supply ducts of galvanized steel according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible."

C. Duct Joints:

1. Ducts up to 20 Inches in Diameter: Interior, center-beaded slip coupling, sealed before and after fastening, attached with sheet metal screws.
2. Ducts 21 to 72 Inches in Diameter: Three-piece, gasketed, flanged joint consisting of two internal flanges with sealant and one external closure band with gasket.
3. Ducts Larger Than 72 Inches in Diameter: Companion angle flanged joints per SMACNA "HVAC Duct Construction Standards--Metal and Flexible," Figure 3-2.
4. Round Ducts: Prefabricated connection system consisting of double-lipped, EPDM rubber gasket. Manufacture ducts according to connection system manufacturer's tolerances.
    a. Manufacturers:
        1) Ductmate Industries, Inc.
        2) Lindab Inc.

D. 90-Degree Tees and Laterals and Conical Tees: Fabricate to comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible," with metal thicknesses specified for longitudinal-seam straight ducts.

E. Diverging-Flow Fittings: Fabricate with reduced entrance to branch taps and with no excess material projecting from fitting onto branch tap entrance.

F. Fabricate elbows using die-formed, gored, pleated, or mitered construction. Bend radius of die-formed, gored, and pleated elbows shall be 1-1/2 times duct diameter.

2.6 FLEXIBLE DUCTWORK AND FLEXIBLE CONNECTIONS

A. Flexible ductwork for HVAC systems, connected to insulated duct shall also be insulated and shall be a Class 1 air duct in accordance with UL 181, with 1-1/2”, ¾ lb. Density fiberglass insulation and an aluminized reinforced vapor barrier.

B. Flexible connections to fans and air handling units shall be neoprene-coated fibrous glass fire retardant fabric, by Ventfabrics or Durodyne. Entire unit shall be a Class 1 connector in accordance with UL 181. Secure flexible connections tightly to fan units with metal bands. Bands shall be same material as duct construction.

2.7 FIRE DAMPERS

A. Furnish install automatic fire (UL555) rated dampers at penetrations of fire rated walls as shown on plans. Refer to architectural drawings for ratings. All penetrations require 1½ -hour or 3-hour rated dampers (to match design).

B. Fire dampers shall be SMACNA Type B, with blades out of the air stream, and shall be constructed with minimum 0.034” thick roll formed galvanized steel frame and interlocking blades. Provide factory or field installed galvanized steel sleeve for each damper not installed within a duct. Dampers shall be equal to Ruskin Model IBD.

C. Fire dampers located within ductwork shall be dynamically rated.

D. Dampers shall be rated for UL555, and shall include a replaceable 165°F fusible link.

2.8 COMBINATION FIRE/SMOKE DAMPERS

A. Provide single or multiple blade combination fire/smoke (UL555/555S) rated dampers for installation as shown on plans. Wiring to Fire Alarm Control Panel provided under Division 28.

B. Damper frames shall be constructed of 16 gauge galvanized sheet metal and shall have flanges for duct mounting. Damper blades should not exceed 6" in width. Blades shall be suitable for high velocity performance. Damper bearings shall be stainless steel.

C. Dampers shall be rated for UL555/555S, Leakage Class 1, +250^{o}F.

D. Seals shall provide tight closing, low leakage damper. Submit leakage and flow characteristic charts for approval. 48" x 48" damper section shall have leakage less than 8 cfm/sf at 4" WG differential pressure. Dampers shall be Ruskin FSD60-EFL or equal.

E. Damper Operators shall be electric/electronic, fail-safe, and matched to dampers for torque requirements. Operators shall have external adjustable stops to limit stroke in both directions. Operators shall be spring return electric actuator, 120 V/ 1 phase AC.

2.9 VOLUME DAMPERS

A. Provide manually adjustable volume dampers, with extended mount indicating and locking quadrants at each take-off to register, grille or diffuser (not all are shown on drawings).

B. Dampers shall be ½" smaller in both dimensions or 1" smaller diameter than size of duct in which they are installed: e.g. use 23-1/2" by 23-1/2" damper for 24" square duct. Dampers larger than 12" in height shall be opposed multi-blade.

C. Damper blades shall be two gauges heavier than adjoining ductwork, and shall be riveted to supporting rods. Hem over edges parallel to rods. Brackets shall be galvanized metal, secured to ductwork with sheet metal screw with locking quadrant arms (see seal class section for additional requirements). Provide 2" handle extension for all dampers on externally insulated ductwork.

D. Note: All required volume dampers may not be indicated on drawings but dampers shall be provided as necessary for system balancing.

2.10 DIFFUSERS, REGISTERS, AND GRILLES

A. Provide aluminum diffusers and registers for supply, return, transfer, and exhaust air for the data center and infrastructure rooms. Diffusers and registers shall be of size, type and design shown on drawings. Acceptable manufacturers shall be Tuttle & Bailey, Krueger, or Titus.

1. Equipment shall be tested and rated per ASHRAE 70.
2. Equipment shall handle air quantities at operating velocities with maximum diffusion within space, without objectionable air movement or noise. Maximum NC rating for any occupied space is 35.

2.11 IN-LINE EXHAUST FANS

A. Provide in-line, direct drive exhaust fans as scheduled on the drawings and as specified herein.

B. Fan types shall be as manufactured by Greenheck, Loren Cook Co. or Carnes Company, Inc.

C. The fan wheel, housing, and frame shall be constructed of aluminum,.

D. Provide each fan with gravity backdraft damper, belt guard and factory-mounted disconnect switch.

E. Damper: Gravity operated, parallel blade, integral backdraft damper.
   1. Blades: Die formed sheet aluminum
   2. Frame: Extruded aluminum, with waterproof, felt blade seals.
   3. Linkage: Non-ferrous metals, connecting blades to counter weight.

F. The fans shall be UL-Listed for electrical components and AMCA Rated as noted above.

G. Furnish disconnect switch.

H. Furnish duct collars on intake and discharge.

I. Furnish removable access panels.

2.12 DUCT LINER

A. Fibrous-Glass Duct Liner: Comply with ASTM C 1071, NFPA 90A, or NFPA 90B; and with NAIMA AH124, "Fibrous Glass Duct Liner Standard."
   1. Manufacturers: Subject to compliance with requirements, provide products by the manufacturer specified:
      a. CertainTeed Corporation; Insulation Group.
      b. Johns Manville.
      c. Knauf Insulation.
      d. Owens Corning.
      e. Substitutions: Under provisions of Section 23 00 10.
      f. Maximum Thermal Conductivity:
         1) Type I, Flexible: 0.27 Btu x in./h x sq. ft. x deg F (0.039 W/m x K) at 75 deg F (24 deg C) mean temperature.
         2) Type II, Rigid: 0.23 Btu x in./h x sq. ft. x deg F (0.033 W/m x K) at 75 deg F (24 deg C) mean temperature.
   2. Antimicrobial Erosion-Resistant Coating: Apply to the surface of the liner that will form the interior surface of the duct to act as a moisture repellent and erosion-resistant coating. Antimicrobial compound shall be tested for efficacy by an NRTL and registered by trh EPA for use in HVAC systems.
   3. Water-Based Liner Adhesive: Comply with NFPA 90A or NFPA 90B and with ASTM C 916.
      a. For indoor applications, use adhesive that has a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24)

B. Flexible Elastomeric Duct Liner: Preformed, cellular, closed-cell, sheet materials complying with ASTM C 534, Type II, Grade 1; and with NFPA 90A or NFPA 90B.
   1. Basis-of-Design Product: Subject to compliance with requirements provide the product indicated on the Drawings or the first listed manufacturer or product below. Subject to compliance with requirements a comparable product by one of the others listed may be acceptable:
   2. Manufacturers: Subject to compliance with requirements, provide products by the manufacturer specified:
      a. Aeroflex USA Inc.
      b. Armacell LLC.
      c. Rubatex International, LLC
      d. Substitutions: Under provisions of Section 23 00 10.
   3. 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.
   4. Liner Adhesive: As recommended by insulation manufacturer and complying with NFPA 90A or NFPA 90B.
      a. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

C. Insulation Pins and Washers:

1. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, [0.106-inch- (2.6-mm-)] [0.135-inch- (3.5-mm-)] diameter shank, length to suit depth of insulation indicated with integral 1-1/2-inch (38-mm) galvanized carbon-steel washer.
2. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch- (0.41-mm-) thick aluminum; with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches (38 mm) in diameter.

D. Shop Application of Duct Liner: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-19, "Flexible Duct Liner Installation."

1. Adhere a single layer of indicated thickness of duct liner with at least 90 percent adhesive coverage at liner contact surface area. Attaining indicated thickness with multiple layers of duct liner is prohibited.
2. Apply adhesive to transverse edges of liner facing upstream that do not receive metal nosing.
3. Butt transverse joints without gaps, and coat joint with adhesive.
4. Fold and compress liner in corners of rectangular ducts or cut and fit to ensure butted-edge overlapping.
5. Do not apply liner in rectangular ducts with longitudinal joints, except at corners of ducts, unless duct size and dimensions of standard liner make longitudinal joints necessary.
6. Apply adhesive coating on longitudinal seams in ducts with air velocity of 2500 fpm (12.7 m/s).
7. Secure liner with mechanical fasteners 4 inches (100 mm) from corners and at intervals not exceeding 12 inches (300 mm) transversely; at 3 inches (75 mm) from transverse joints and at intervals not exceeding 18 inches (450 mm) longitudinally.
8. Secure transversely oriented liner edges facing the airstream with metal nosings that have either channel or "Z" profiles or are integrally formed from duct wall. Fabricate edge facings at the following locations:
   a. Fan discharges.
   b. Intervals of lined duct preceding unlined duct.
   c. Upstream edges of transverse joints in ducts where air velocities are higher than 2500 fpm or where indicated.
9. Terminate ducts with buildouts attached to fire-damper sleeves, dampers, turning vane assemblies, or other devices. Fabricated buildouts (metal hat sections) or other buildout means are optional; when used; secure buildouts to duct walls with bolts, screws, rivets, or welds.

PART 3 - EXECUTION

3.1 DUCT APPLICATIONS

A. Static-Pressure Classes: Unless otherwise indicated, construct ducts according to the following:

1. Supply Ducts: 2-inch wg.(downstream of Air terminal Units).
2. Supply Ducts (before Air Terminal Units): 4-inch wg.
3. Return Ducts (Negative Pressure): 1-inch wg.
4. Exhaust Ducts (Negative Pressure): 1-inch wg.

B. Ducts shall be galvanized steel.

3.2 INSTALLATION

A. Construct and install ducts according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible," unless otherwise indicated.

B. Make changes in duct size with tapered connections as required by SMACNA. Changes shall NOT exceed 30° from line of air flow. Take-off to the diffusers shall be 45° leading edge type or bellmouth type. Branch fittings shall be as detailed on the drawings.

C. Seal all joints and seams. Apply sealant to male end connectors before insertion, and afterward to cover entire joint and sheet metal screws.

D. Exposed ductwork shall have the joints and seams sealed in a professional and clean manner to create a professional appearance.

E. Electrical Equipment Spaces: Route ducts to avoid passing through transformer vaults and electrical equipment spaces and enclosures.

F. Non-Fire-Rated Partition Penetrations: Where ducts pass through interior partitions and exterior walls and are exposed to view, conceal spaces between construction openings and ducts or duct insulation with sheet metal flanges of same metal thickness as ducts. Overlap openings on 4 sides by at least 1-1/2 inches.

G. Fire-Rated Partition Penetrations: Where ducts pass through interior partitions and exterior walls, install appropriately rated fire dampers, sleeves, and firestopping sealant.

H. Supports for ductwork and equipment shall be galvanized unless specified otherwise.

I. Connect supply and return air ducts to RTU, fan coil units and fans to ductwork using flexible connections. Support ductwork independently from units. Where RTU is rigidly mounted and fans are isolated within the units, flexible connections to ducts are not required.

J. Make transverse joints, field connections, collar attachments and flexible connections to ducts and equipment with sheet metal screws or bolts and nuts. Do not use rivets and staples.

K. Elbows and bends for rectangular ducts shall have centerline radius of 1.5 times duct width wherever possible. Turning vanes and mitered elbows are not allowed for supply air ductwork, but may be used for transfer and exhaust air ductwork.

L. Provide proper pressure and leakage-rated, gasketed, duct mounted access panels/doors. In insulated ducts, access doors shall be insulated double wall. Gauges of door materials, number of hinges, number and type of door locks shall be as required by the SMACNA Duct Construction Standards. Unhinged doors shall be chained to frame with a minimum length of 6” to prevent loss of door. Door metal shall be the same as the attached duct material. For high temperature ducts, door assembly shall be rated for 2300°F. The minimum sizes are:

1. Fire dampers – 12” x 12” minimum.
2. Suction and discharge sides of inline fans – 24” x 24” minimum.
3. At locations indicated on drawings, or specified elsewhere – 12” x 12” minimum.

M. Provide supports for flexible ductwork at manufacturer’s recommended intervals. Sag shall not exceed ½” per foot of spacing between supports. Ducts shall not exceed 6 feet long and shall be used for straight run only, no offsets or turns.

N. Insulate all ductwork in accordance with Section 230700.

3.3 INTEGRATED SYSTEMS TESTING

A. Provide support for Integrated Systems Testing (Commissioning Level 5) in addition to and after successful completion of Acceptance Testing (Level 4). Provide for three12-hour days for air systems (fans, dampers, controls).

END OF SECTION