PART 1 - GENERAL

1.01 GENERAL

The Bidding and Contract Requirements, Division 1 - General Requirements, Section 15010 - General Provisions and Section 15050 - Basic Materials and Methods shall apply to this section.

1.02 SCOPE

The work covered under this section of the specifications shall include furnishing and installing the ductwork, accessories, associated items and all necessary connections to outlets, inlets and equipment required for a complete system as shown on the drawings and hereinafter specified.

1.03 QUALITY ASSURANCE

A. Galvanized sheet metal shall meet the requirements of ASTM A653 and A924 standards.

B. Ductwork and duct accessories shall meet the requirements and recommendations of SMACNA standards, SMACNA Duct Cleanliness for New Construction (Advanced Level), UL-181 standard and ASHRAE recommendations.

C. The installation of ductwork and duct accessories shall comply with NFPA standard 90A and state and local codes.

1.04 SUBMITTALS

Provide shop drawings on ductwork materials and accessories as described in Section 15010 - 1.04. Shop drawings are not required for duct layouts.

PART 2 - PRODUCTS

2.01 DUCTWORK SYSTEM CLASSIFICATION

For determination of ductwork construction criteria, all ductwork systems shall be classified as either low or medium pressure according to the following velocities or pressures. In all cases the higher of the two values shall be used to determine the system classification unless other overriding considerations are established on the drawings or in the specifications. A ductwork system is defined as, the complete run of a supply, return, exhaust, or intake air system, each classified individually.

A. Ductwork systems with any portion having an average cross-sectional velocity up to and including 2000 FPM and not exceeding 2” w.g. maximum static pressure at any
point in the system shall be classified as low pressure.

B. Ductwork systems with any portion having an average cross-sectional velocity exceeding 2000 FPM or exceeding 2” w.g. maximum static pressure at any point in the system shall be classified as medium pressure.

C. All Variable Air Volume (VAV) supply air duct systems and all air duct systems outside exposed to weather regardless of velocity and pressure conditions are classified as medium pressure and shall be constructed in compliance with SMACNA’s three (3) inch pressure classification, formerly ‘High Pressure Duct Construction Standard.’ Joints and seams shall be sealed as described in this specification.

2.02 DUCT MATERIALS

A. All ductwork, housings, dampers, access doors and all other duct related accessories shall be formed from galvanized steel sheets unless otherwise noted.

B. All angles used for reinforcement, support, hanging and other construction uses shall be galvanized steel and shall be equal to that used for ductwork. Galvanized angle iron shall be used where required by SMACNA standards.

2.03 DUCTWORK CONSTRUCTION

A. The low pressure ductwork as defined in Article 2.01 shall be constructed in accordance with the one (1) inch pressure classification, as described in SMACNA’s “HVAC Duct Construction Standards – Metal and Flexible”.

B. Ductwork classified as other than low pressure shall be constructed in accordance with the three (3) inch pressure classification, as described in SMACNA’s “HVAC Duct Construction Standards – Metal and Flexible”.

C. Duct sizes are shown on the drawings in inches. The dimensions given establish the free or unobstructed area required on the inside of the duct. In case a duct size is not shown the dimensions shall be requested from the Architect.

D. The ductwork shall be fabricated from field measurements to avoid conflict with beams, columns, pipes and other obstructions. Where necessary to avoid obstructions, the ductwork shall be transformed, divided or moved to one side as long as the free area is not reduced and such changes meet the approval of the Architect.

E. The minimum thickness of the sheet metal shall be either as described in SMACNA’s “HVAC Duct Construction Standards – Metal and Flexible” or as shown in the following table:
DUCT CONSTRUCTION MINIMUM SHEET METAL GAUGES

RECTANGULAR DUCTS

<table>
<thead>
<tr>
<th>Maximum side (inches)</th>
<th>Steel (Minimum Galvanized Sheet Gauge)</th>
<th>Aluminum (Minimum B &amp; S Gauge)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thru 12&quot;</td>
<td>26 (0.022 inches)</td>
<td>24 (0.020 inches)</td>
</tr>
<tr>
<td>13&quot; - 30&quot;</td>
<td>24 (0.028 inches)</td>
<td>22 (0.025 inches)</td>
</tr>
<tr>
<td>31&quot; - 54&quot;</td>
<td>22 (0.034 inches)</td>
<td>20 (0.032 inches)</td>
</tr>
<tr>
<td>55&quot; - 84&quot;</td>
<td>20 (0.040 inches)</td>
<td>18 (0.040 inches)</td>
</tr>
<tr>
<td>Over 84&quot;</td>
<td>18 (0.052 inches)</td>
<td>16 (0.051 inches)</td>
</tr>
</tbody>
</table>

ROUND DUCTS

<table>
<thead>
<tr>
<th>Diameter (inches)</th>
<th>SPIRAL SEAM DUCT Steel (Minimum Galvanized Sheet Gauge)</th>
<th>LONGITUDINAL SEAM DUCT Steel (Minimum Galvanized Sheet Gauge)</th>
<th>FITTINGS Steel (Minimum Galvanized Sheet Gauge)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thru 12&quot;</td>
<td>28 (0.019 in.)</td>
<td>26 (0.022 in.)</td>
<td>26 (0.022 in.)</td>
</tr>
<tr>
<td>13&quot; - 18&quot;</td>
<td>26 (0.022 in.)</td>
<td>24 (0.028 in.)</td>
<td>24 (0.028 in.)</td>
</tr>
<tr>
<td>19&quot; - 28&quot;</td>
<td>24 (0.028 in.)</td>
<td>22 (0.034 in.)</td>
<td>22 (0.034 in.)</td>
</tr>
<tr>
<td>29&quot; - 36&quot;</td>
<td>22 (0.034 in.)</td>
<td>20 (0.040 in.)</td>
<td>20 (0.040 in.)</td>
</tr>
<tr>
<td>37&quot; - 52&quot;</td>
<td>20 (0.040 in.)</td>
<td>18 (0.052 in.)</td>
<td>18 (0.052 in.)</td>
</tr>
</tbody>
</table>

F. When required, heavier ductwork shall be installed to meet the requirements of the UL Fire Resistance Index.

G. Where indicated on the drawings or where insufficient space is available for round ductwork, flat oval ductwork may be used. The conversion from round duct sizes to flat oval should be made on an equivalent pressure loss basis, not on an equal cross-sectional area. The flat oval ducts shall be constructed in accordance with current SMACNA standards.

H. Rectangular Duct Section Connections - Shall be as described in the SMACNA Standards. Contractor may use zero leakage four corner bolted companion angle transverse joint as manufactured by DUCTMATE INDUSTRIES, INC. or LOCKFORMER. Joint shall be constructed of galvanized steel with bolting corner pieces, roll formed double wall mating angles, gasketing, mastic sealer and snap-on flange cover cleats.

2.04 FLEXIBLE DUCTWORK

A. Where shown on the drawings provide flexible ductwork between branch ducts and terminals or air outlets. It shall be of a low or medium pressure to match duct system.
served.

B. Ductwork

1. Insulated flexible ductwork shall be factory pre-insulated duct composed of a corrosion-resistant reinforcing wire or band helix permanently bonded and enclosed in polyester film, covered with 1 1/2", 3/4 pound density fiberglass insulation blanket sheathed in a vapor barrier of aluminum polyester film laminated to glass mesh, elastomer back coated. The flexible duct shall be rated for a minimum working velocity of 2000 fpm, shall be listed by Underwriters Laboratories under their UL-181 standards as a Class 1 air duct material and shall comply with NFPA standard No. 90A.

2. Taps for flexible ductwork shall be high efficiency gasketed air-tite type with manual damper

C. The maximum length of flexible duct connection shall be ten feet.

D. Flexible ductwork shall not be used for return air or exhaust air ductwork.

2.05 DUCT ACCESS DOORS

A. Duct Access Doors shall be provided in both the low and medium pressure duct systems as shown on the contract drawings and as specified.

B. Access doors shall be constructed as shown in SMACNA standards for the appropriate pressure classification. Door shall be the same gauge and material as the duct. All access doors shall be hinged, except where a removable type is required.

C. The minimum size of all access doors shall be 20" x 14" except where the duct is less than 16", in which case one dimension shall be 20" and the other 2" less than the duct width.

D. Access doors shall be provided in the following locations: At the linkage side of automatic dampers; at the manual volume control dampers; fire dampers; and any other service, balance or control device requiring periodic maintenance.

2.06 FLEXIBLE CONNECTIONS AT FAN

A. Flexible connections shall be provided at the inlet and outlet connection for each fan, between ductwork and inlet and outlet collars.

B. Each flexible connection shall be designed to allow one inch of free movement and shall be completely air tight and shall have sewed and cemented seams.
C. Flexible connections for low-pressure ductwork shall be in accordance with SMACNA standards. Material shall be neoprene coated glass fabric, 30 oz. per square yard.

D. Flexible connections for medium pressure ductwork shall be the same as for low pressure except additional reinforcing shall be provided as required by the operating pressure of the system.

E. Flexible connections to any roof mounted equipment shall not be exposed to the elements. Flexible connections shall be located inside the building just below the roofline. For side discharge units the flexible connection shall be located inside the building just inside the wall.

2.07 TURNING VANES

A. Any square elbow ductwork 18 inches or over in width shall require turning vanes of galvanized steel.

B. Vanes for Low and Medium Pressure Systems: Shall be as shown in SMACNA standards for appropriate pressure classification.

C. Vane lengths shall not exceed 36" for low-pressure systems or 48" for medium pressure systems. Where greater lengths are required, separate banked sections shall be provided.

2.08 FIRE, SMOKE AND CEILING DAMPERS.

A. Fire dampers, also known as flame retarding or primary dampers, may be of the individual folded blade type, the continuous folded stainless steel one piece curtain type, the pivoted single blade type or the pivoted multi-blade type, providing they bear a UL label for the complete assembly. Dampers shall be sized so that folded or open blades do not restrict the duct free area given by the duct dimensions. Dampers shall have a positive lock in the closed position. Fusible links shall be UL listed and marked 160°F.

B. Ceiling dampers, also known as radiation shielding or secondary dampers, may be of the single blade spring loaded guillotine type, the continuous folded stainless steel one piece curtain type or the folded approved fire retardant fabric type provided they bear a UL label for the complete assembly. Single protected pivoted blade type ceiling damper constructed in accordance with the requirements of specific UL ceiling assemblies and SMACNA standards and subject to field acceptance may be used where permitted by the conditions of the specific UL ceiling assembly used. Dampers shall be sized so that folded or open blades do not restrict the duct free area given by the duct dimensions. Dampers shall have a positive lock in the closed position. Fusible links shall be UL listed and marked 160°F.

C. Smoke dampers shall meet the requirements of NFPA 90A & 92A and UL555. Smoke dampers shall be UL Class I smoke damper, normally open and automatically operated by a 120 volt, electric actuator. Provide airfoil style blades.
Elevated temperature rating shall be 350°F. Smoke damper shall operate upon activation of smoke detector and re-settable by a locally mounted momentary contact switch.

D. All dampers shall be installed in sleeves a minimum of two gauges heavier than the connecting ductwork unless noted otherwise. Sleeves shall be mounted within and secured to wall, floor, ceiling or other structural penetration. Dampers shall be positioned only as permitted in the UL listing. Connecting ductwork shall be joined to the sleeve so that in the event of damage to the duct system it will break away leaving the fire damper and sleeve intact in the structural penetration. When necessary to avoid obstructions and after acceptance by the Architect, damper dimensions may be different from the connecting ductwork providing the required free area is maintained and 15° maximum transitions are used.

E. Provide UL listed, photoelectric, 120 volt smoke detector for use with smoke damper and 120 volt, reset switch, (normally on, momentary off) mounted within sight of the damper and detector. This switch shall reset the damper and the detector. Smoke detectors shall be rated for air velocities of 500 to 4000 fpm and have integral, auxiliary contacts for “ALARM” and “TROUBLE” annunciation to the fire alarm system.

2.09 MANUAL VOLUME CONTROL DAMPERS

Manual Volume Control Dampers in ducts not exceeding 12” on the longest side shall be as shown in SMACNA Duct Standards. For ducts over 12”, dampers of the opposed multi-blade type shall be used. Dampers shall be galvanized steel, swivel end bearings at one end of the blade, and quadrant with level and lock-screw at the opposite end. Multi-blade dampers shall have steel washers at ends of damper rods with self-aligning blade interconnecting hardware.

2.10 COATED DUCT LINER

A. Duct Liner: Low-Pressure Ductwork

1. All plenums and transfer ducts shall receive duct liner. Supply air ductwork shall receive duct liner from the fan discharge to 20 feet downstream from the fan discharge or as otherwise shown. Return air duct work shall receive duct liner from the fan suction to 20 feet upstream from the fan suction or as otherwise shown. All supply air discharge ductwork from fan coil units shall receive duct liner.

2. Duct liner shall be designed for use as an acoustical and thermal insulation for sheet metal heating and cooling ducts and plenums. The duct liner shall have a density of 1.5 pounds per cubic foot a "K" factor not to exceed .24 @ 50°F mean temperature and a minimum NRC rating of .75. The minimum duct liner thickness shall be 1 inch.

3. Duct liner shall be designed for use as an acoustical and thermal insulation for sheet metal heating and cooling ducts and plenums. The duct liner shall
have a density of 1.5 pounds per cubic foot a "K" factor not to exceed .24 @ 50°F mean temperature and a minimum NRC rating of .75. The minimum duct liner thickness shall be 1 inch.

4. Duct liner air stream surface shall be coated with an immobilized, EPA-registered antimicrobial agent so it will not support microbial growth. Duct liner shall be Johns Manville Linacoustic RC. Duct liners with similar characteristics will be considered as long as all aspects of the specifications are met.

B. Duct Liner: Medium Velocity

1. All rectangular supply/return air duct and all air duct outside exposed to weather shall receive duct liner. Rectangular supply air duct shall receive duct liner from the fan discharge to 20 feet downstream from the discharge or as otherwise shown. Return air duct work shall receive duct liner from the fan suction to 20 feet upstream from the fan suction or as otherwise shown.

2. Duct liner shall be designed for use as an acoustical and thermal insulation for sheet metal heating and cooling ducts. The duct liner shall have a density of 1.5 lbs./cu. ft., a 'K' factor not to exceed .24 @ 50 degrees F mean temperature and a minimum NRC rating of .95. The minimum duct liner thickness shall be 2 inches.

3. Duct liner air stream surface shall be coated with an immobilized, EPA-registered antimicrobial agent so it will not support microbial growth. Duct liner shall be Johns Manville Linacoustic RC. Duct liners with similar characteristics will be considered as long as all aspects of the specifications are met.

PART 3 - EXECUTION

3.01 DUCT INSTALLATION

A. The ductwork, fittings, access doors, flexible connections, turning vanes, hangers and supports, fire dampers, volume dampers and other accessories shall be installed as recommended by SMACNA Duct Construction Standards. Ductwork shall not be supported from bottom chords of bar joists, bridging between bar joists or from metal decks. Ductwork shall be supported from the top chords of bar joists.

B. All necessary allowances and provisions shall be made by this contractor for beams, columns or other obstructions of the building or the work of other contractors, whether or not same is indicated. Where necessary to avoid obstructions, the ducts shall be transformed, divided or moved to one side with the required free area being maintained, all as approved or directed by the Architect.

C. Flexible ducts shall be secured to the metal ductwork, terminal units and supply diffusers by use of a 3/4" minimum width stainless steel drawband pulled tight with an adjusting worm drive type screw. Flexible duct insulation shall be properly sealed.
at connections to maintain vapor seal/barrier.

D. All duct dimensions shown on the drawings are inside clear dimensions. The duct sizes of ducts with duct liner shall be increased accordingly.

3.02 DUCT LINER

Duct Liner Application: Coated duct liner shall be cut to assure overlapped and compressed longitudinal corner joints. Apply liner with coated surface facing the air stream and adhere with 100% coverage of fire retardant adhesive. Coat all exposed leading edges and all transverse joints with fire retardant adhesive. The liner shall be additionally secured with mechanical fasteners which shall compress the duct liner sufficiently to hold it firmly in place as follows:

A. Low Velocity to 2000 FPM: Fasteners shall start within 3" of the upstream transverse edge of liner and 3" from the longitudinal joints and shall be spaced at a maximum of 12" o.c. around the perimeter of the duct, except that they may be a maximum of 12" from a corner break. Elsewhere they shall be a maximum of 18" o.c. except that they shall not be more than 6" from a longitudinal joint of liner nor 12" from a corner break. Coat all exposed joints with a fire retardant adhesive.

B. Medium Velocity from 2000 FPM to 4000 FPM - Fasteners shall start within 3" of the upstream transverse edges of the liner and 3" from the longitudinal joints shall be spaced at a maximum of 6" o.c. around the perimeter of the duct, except that they may be a maximum of 6" from a corner break. Elsewhere they shall be a maximum of 16" o.c. except that they shall not be more than 6" from a longitudinal joint of liner nor 12" from a corner break.

C. In addition to adhesive edge coating of transverse joints, any longitudinal joints shall be similarly coated with adhesive.

3.03 WATERPROOFING DUCTWORK ABOVE ROOF

A. Exposed ductwork shall be waterproofed with a prefabricated self-adhering, sheet-type waterproofing membrane as manufactured by Venture Tape and offered as VentureClad-1579CW series. Additional manufacturers will be considered providing all aspects of the specifications are met.

B. MATERIALS:

1. Prefabricated, Self-Adhering, Sheet-Type Waterproofing Membrane.

   a. Description:

   1) Top Layer: Stucco-embossed, UV-resistant aluminum weathering surface.

   2) Middle Layer: Double layer of high-density polyethylene reinforcement.
3) **Bottom Layer:** Uniform layer of rubberized asphalt adhesive, protected by disposable silicone release paper.

4) **Heat Aging, ASTM D 794:** No visible blistering or deterioration.

5) **Tear Resistance, ASTM D 1424,** Average: 660 grams.

6) **Elongation, ASTM D 412,** Minimum: 450 percent.

7) **Low Temperature Flexibility, 1,000,000 Cycles at -10 Degrees F, 1,200 Cycles at 20 Degrees F:** No cracking.

8) **Water Vapor Transmission, ASTM E 96:** 0.009 perms.

9) **Flame Spread Index, ASTM E 84.0.**

10) **Smoke Density Index, ASTM E 84.5.**

11) **Wind-Driven Rain, SFBC TAS-110-95, 100 mph:** No leakage or failure.

12) **UV Stability:** Excellent.

### C. SURFACE PREPARATION AND APPLICATION.

1. Prepare surfaces in accordance with manufacturer’s instructions.

2. Ensure tops of ducts have sufficient slope to eliminate ponding water.

3. Remove dirt, dust, oil, grease, hand oils, processing lubricants, moisture, frost, and other contaminants that could adversely affect adhesion of waterproofing membrane.

4. Ensure surfaces are clean and dry.

5. Apply membrane to clean, dry, primed metal ductwork and foil-faced rigid insulation boards. Do not apply over wet or nonrigid insulation.

6. Apply membrane in accordance with manufacturer’s air, material, and surface temperature requirements.

7. Apply firm, uniform pressure with hand roller to entire membrane to ensure proper adhesion. Concentrate pressure at seams and on underside of ductwork.

8. Apply membrane to ducts in accordance with manufacturer’s instructions.

9. Apply membrane shingle fashion to shed water over, not against laps.
10. Do not terminate membrane on bottom of duct.

11. Apply minimum 3-inch side laps and minimum 6-inch end laps for ductwork applications.

3.04 DUCT SEALING FOR VARIABLE AIR VOLUME SYSTEMS

A. All supply/return air metal and flexible duct joints shall be sealed with water based brush on duct sealant such as FLEX-GRIP 550 as manufactured by Hardcast, Inc. or UNI-FLEX as manufactured by McGill AirSeal LLC and applied in accordance with the manufacturer's directions.

B. Where zero leakage transverse joints as manufactured by DUCTMATE INDUSTRIES or LOCKFORMER are used to join rectangular duct sections additional sealing is not required at those joints unless leakage is revealed during pressure tests.

3.05 LEAKAGE

A. All low pressure supply, return and outside air ductwork shall be tested and made substantially airtight at static pressure indicated for the system before covering with insulation or concealing in masonry. Substantially airtight shall be construed to mean that no air leakage is noticeable through the senses of feeling or hearing at all duct joints. Supply, return and outside air transverse duct joints shall be sealed a water based brush on duct sealant such as FLEX-GRIP 550 as manufactured by HARDCAST or UNI-FLEX as manufactured by McGill LLC.

B. The entire medium pressure ductwork system, including duct runouts to the variable air volume control units, shall be pressure tested for leakage at three (3) inches ductwork static pressure. Perform leakage tests in accordance with the SMACNA HVAC Duct Leakage Test Manual, using test forms equivalent to those outlined in manual. Tests shall be observed by the Architect, Engineer and owner's representative. A test log shall be maintained by the contractor which will contain the results of systems tested and approval from test observer. Copies of the test log will be included in the operation and maintenance manuals.

3.06 CLEANING/STORAGE

Every effort should be made to ensure the components of the ductwork systems are kept clean and free of dust and debris. Stocked ductwork shall be stored in areas which are away from dust producing operations. Lined ductwork shall be stored in areas which are substantially weather-tight. Should any portion of lined ductwork become water saturated during storage or installation identified sections will be removed and replaced at no additional cost to the owner. As ductwork is being installed any open ductwork shall be temporarily sealed to prevent the ductwork from being contaminated with construction debris or dust. Temporary filter media shall be installed on the return systems of any equipment which is required to be run as a temporary control during the construction period. Temporary filters shall be monitored and changed frequently to ensure the cleanliness of the ducted systems.
After completing installation of ductwork, entire system shall be cleaned of rubbish, plaster, dirt and any other debris. After installation of equipment and connections are made on fan, and before any grilles are installed, entire system shall be blown out with dampers and outlets wide open.

3.07 DUCT SMOKE DETECTORS

Duct smoke detectors shall be furnished under and interconnected between the auxiliary contacts and the fire alarm system by the Division 16 contractor and installed under this section. The duct smoke detectors shall be installed in accordance with the manufacturer's recommendations, NFPA requirements and local fire marshal requirements. Duct smoke detectors shall be mounted to allow full access for service.

3.08 FIRE, SMOKE AND CEILING DAMPERS

A. Provide fire dampers where ducts pass through fire-rated components and where required by the local authority. Install in accordance with local codes, NFPA, SMACNA-FSR and manufacturers requirements.

B. Demonstrate the re-setting of the smoke damper and smoke detector to the Fire Marshal and the owner’s representative.

C. All interlock wiring between the 120 volt power supply and devices listed in this section shall be installed under this section. All wiring shall conform to the requirements of Division 16.