SECTION 15810
DUCTWORK

PART 1 - GENERAL

1.01 PROVISIONS INCLUDED

A. The general provisions of the Contract, including General and Supplementary Conditions, and Division 1 General Requirements, apply to work specified in this Section.

B. Requirements of Section 15050, “Basic Mechanical Materials and Methods” apply to work specified in this Section.

1.02 SUMMARY

A. This Section specifies ducts, plenums and casings for heating, ventilating, and air conditioning systems in pressure classes from minus 2 inches to plus 10 inches water gage.

B. Work installed but not furnished under this section:
1. Installation of control dampers furnished by Section 15910 “Control Systems”.
2. Installation of smoke detectors furnished by Division 16.

C. Related Work Specified in Other Sections:
1. Fire-resistant sealants for use around duct penetrations and fire damper installations in fire rated floors, partitions, and walls: Section 07840, “Firestopping”.
2. Access panels and doors for access to concealed ducts: Section 08310, “Access Doors.”
3. Flexible duct materials, dampers, duct-mounted access panels and doors, turning vanes, sound attenuatons and other accessories: Section 15820, “Duct Accessories”.
4. Duct insulation: Section 15080, “Mechanical Insulation”.
5. Automatic temperature control devices installed in ducts: Section 15910, “Control Systems”.
6. Testing, adjusting, and balancing of ductwork: Section 15950, “Testing, Adjusting and Balancing”.

1.03 REFERENCED STANDARDS

A. Sheet Metal and Air Conditioning Contractor's Association (SMACNA) 1995 “Hvac Duct Construction Standards, Metal and Flexible” 2nd Edition.

B Sheet Metal and Air Conditioning Contractor's Association (SMACNA) 1975 “Accepted Industry Practise for Industrial Duct Construction.”

C. Sheet Metal and Air Conditioning Contractor's Association (SMACNA) 1998 “Seismic Restraint Manual – Guidelines for Mechanical Systems” 2nd Edition.

1.04 DEFINITIONS

A. Thermal Conductivity and Apparent Thermal Conductivity (k-Value): As defined in ASTM C 168. These values are the result of the formula Btu x in./h x sq. ft. x deg. F.

B. Seams: A seam is defined as joining of two longitudinally (in the direction of airflow) oriented edges of duct surface material occurring between two joints. All other duct surface connections made on the perimeter are deemed to be joints.

C. Joints: Joints include girth joints; branch and subbranch intersections; so-called duct collar tap-ins; fitting subsections; louver and air terminal connections to ducts; access door and access panel frames and jambs; duct, plenum, and casing abutments to building structures.

1.05 SYSTEM DESCRIPTION

A. The duct system design, as indicated, has been used to select and size air moving and distribution equipment and other components of the air system. Changes to the layout or configuration of duct system must be specifically approved in writing by Architect. Accompany requests for layout modifications with calculations showing that proposed layout will provide original design results without increasing system total pressure.

B. Design and obtain approval from authority with jurisdiction over seismic restraint hangers and support for ductwork.

1.06 SUBMITTALS

A. Product Data: Manufacturer's illustrated product literature, including details of construction, dimensions of individual components, profiles, and finishes for the following items:
   1. Sound Attenuators
   2. Ductwork, Shop Standards
   3. Duct Liner.
   4. Sealing Materials.

B. Fabrication, assembly, and installation details, including plans, elevations, sections, details of components, and attachments to other work. Include copy of SMACNA Tables and Figure numbers and configurations marked to identify which are to be used. After review, of fabrication details, submit duct fabrication drawings. (Duct fabrication drawings will not be reviewed prior to review of fabrication details.)

C. Duct fabrication drawings from duct fabrication shop, drawn to a scale not smaller than 1/4 inch equals 1 foot, on drawing sheets same size as the Contract Drawings, detailing:
   1. Duct layout, indicating pressure classifications, gauges and sizes in plan view.
   2. Fittings.
   3. Reinforcement and spacing.
   4. Seam and joint construction.
   5. Penetrations through fire-rated and other partitions.
   6. Terminal unit, coil, and humidifier installations.

7. Hangers and supports, including methods for building attachment, vibration isolation, seismic restraint, and duct attachment.

D. Licensed Engineer,s hanger and support drawings specified in the "Quality Assurance Article" below.

E. Perform tests specified in "Field Quality Control". Modify mock-up construction and perform additional tests as required to achieve specified minimum acceptable results.

F. Quality Assurance Submittals: Coordination drawings for ductwork installation in accordance with Section 01310, "Project Management and Coordination".

G. Closeout Submittals: Submit record drawings including duct systems routing, fitting details, reinforcing, support, installed accessories and devices in accordance and with Section 01770, "Closeout Procedures and Submittals".

1.07 QUALITY ASSURANCE

A. Licensed Engineer: Prepare hanger and support design drawings, and calculations for seismic restraint of ductwork. Include seal and signature of Registered Engineer, licensed in the State of Maine, certifying compliance with BOCA Mechanical code.

B. NFPA Compliance: Comply with the following NFPA Standards:

1. NFPA 90A, "Standard for the Installation of Air Conditioning and Ventilating Systems."

2. NFPA 90B, "Standard for the Installation of Warm Air Heating and Air Conditioning Systems."

C. UL Compliance: UL listed and labeled as complying with UL 181, Class 1 for fibrous glass duct.

D. Acoustic performance certificates as specified for factory-fabricated casings.

1. Indicate sound absorption coefficients in each octave band when tested according to ASTM C 423.

2. Indicate airborne sound transmission losses when tested according to ASTM E 90.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Deliver sealant 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. Store and handle sealant materials in compliance with manufacturer's recommendations.

C. Deliver and store stainless steel sheets with mill-applied adhesive protective paper, maintained through fabrication and installation.

D. Deliver shop-fabricated and factory-fabricated casings, accessories and purchased accessories with protective crating and covering.

1.09 SEQUENCING AND SCHEDULING

A. Coordinate installation of roof curbs, equipment supports, and roof penetrations.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

Subject to compliance with requirements, provide products of one of the following:

A. Transverse Duct Connectors:
   1. Ductmate
   2. TDC
   3. United McGill

B. Duct Liner:
   1. Knauf Fiber Glass
   2. Owens Corning
   3. Schuller International, Inc.

C. Duct Sealant
   1. Hardcast.
   2. United McGill.

2.02 DUCT MATERIALS

A. Sheet Metal, General: Provide sheet metal in thicknesses indicated, packaged and marked as specified in ASTM A 700.

B. Galvanized Sheet Steel: Lock-forming quality, ASTM A 527, Coating Designation G 90. Provide mill phosphatized finish for surfaces of ducts exposed to view.

C. Reinforcement Shapes and Plates: Unless otherwise indicated, provide galvanized steel reinforcement where installed on galvanized sheet metal ducts; compatible materials for all other 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.

2.03 DUCT LINER

A. Materials: ASTM C 1071, Type II, with coated surface exposed to airstream to prevent erosion of glass fibers.

   1. Thickness: 1-1/2 inch.

2. Density: 1-1/2 pounds per cu. Ft..

3. Thermal Performance: "K-Factor" equal to 0.28 or better, at a mean temperature of 75 deg F.

4. Fire Hazard Classification: Flame spread rating of not more than 25 without evidence of continued progressive combustion and a smoke developed rating of no higher than 50, when tested in accordance with ASTM C 411.

5. Liner Adhesive: Comply with NFPA Standard 90A and ASTM C 916.

6. Mechanical Fasteners: Galvanized steel, suitable for adhesive attachment, mechanical attachment, or welding attachment to duct. Provide fasteners that do not damage the liner when applied as recommended by the manufacturer, that do not cause leakage in the duct, and will indefinitely sustain a 50-pound tensile dead load test perpendicular to the duct wall.
   a. Fastener Pin Length: As required for thickness of insulation, and without projecting more than 1/8 inch into the airstream.
   b. Adhesive For Attachment of Mechanical Fasteners: Comply with the "Fire Hazard Classification" of duct liner system.

2.04 SEALING MATERIALS

A. Joint and Seam Sealant: All purpose industrial grade indoor/outdoor, water based sealant complying with ASTM C 731, ASTM C 732 and ASTM D 2202; formulated with a minimum of 63 percent solids.

1. Sealant for exterior applications shall have a service temperature of -30° F to 175° F; ultraviolet ray and ozone resistant.

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

2.05 HANGERS AND SUPPORTS

A. Building Attachments: Concrete inserts, powder actuated fasteners, or structural steel fasteners appropriate for building materials. Do not use powder actuated concrete fasteners for lightweight aggregate concretes or for slabs less than 4 inches thick.

B. Hangers: Galvanized, sheet steel, or round, threaded steel rod.

1. Hangers Installed In Corrosive Atmospheres: Electro galvanized, all-thread rod or hot-dipped-galvanized rods with threads painted after installation.

2. Straps and Rod Sizes: Comply with SMACNA "HVAC Duct Construction Standards - Metal and Flexible," 1995 Edition, for sheet steel width and gage and steel rod diameters.

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

D. Trapeze and Riser Supports: Steel shapes conforming to ASTM A 36/A 36M.

1. Supports for galvanized steel ducts: Hot-dipped-galvanized steel shapes and plates.

2. Supports for stainless steel ducts: Stainless steel support materials.

3. For aluminum ducts: Aluminum support materials, except where materials are electrolytically separated from ductwork.

2.06 PRESSURE CLASSIFICATIONS

A. Static Pressure Classifications: Except where otherwise indicated, construct duct systems to the following pressure classifications.

1. Classify as industrial duct and construct the following work for minimum of 6 inch wg static pressure negative, Seal Class A, Leakage Class 6 for rectangular ductwork and Class 3 for round ductwork as recommended in SMACNA Round Industrial Duct Construction Standards First Edition, and HVAC Air Duct Leakage Test Standards.
   a. Ductwork for future general lab exhaust
   b. Future fume hood exhaust
   c. Existing building exhaust
   d. Ductwork associated with future energy recovery exhaust.

2. Classify as medium pressure and construct all supply ductwork for minimum of 6 inch wg static pressure positive, seal class A, Leakage Class 6 for rectangular ductwork and Class 3 for round ductwork fully compliant with SMACNA HVAC Duct Construction Standards, 1985 Edition, except that button punch snaplocks and pocket locks are not permitted.

2.07 DUCT FABRICATION

A. General: Except as otherwise indicated, fabricate ducts, elbows, transitions, offsets, branch connections and other construction with galvanized sheet steel, in accordance with SMACNA 1995 “HVAC Duct Construction Standards - Metal and Flexible,” 2nd Edition. Comply with the requirements for metal thickness, reinforcing types and intervals, tie rod applications, and joint types and intervals.

1. Fabricate rectangular ducts in lengths appropriate to reinforcement and rigidity class required for pressure classification.

2. Provide materials that are free from visual imperfections such as pitting, seam marks, roller marks, stains, and discolorations.

B. Duct dimensions indicated on Drawings are inside clear dimensions.

C. Crossbreaking or Cross Beading: Crossbreak or cross bead duct sides that are 19 inches and larger and are 20 gage or less, with more than 10 sq. ft. of unbraced panel area, as indicated in

1995 SMACNA "HVAC Duct Construction Standards-Metal and Flexible, 2nd Edition," unless they are lined or externally insulated.

2.08 SHOP APPLICATION OF LINER IN RECTANGULAR DUCTS AND CASINGS

A. Adhere a single layer of indicated thickness of duct liner with 90 percent coverage of adhesive at liner contact surface area. Multiple layers of insulation to achieve indicated thickness are prohibited. Liner to be encase in a mylar or Tedlar film to eliminate errosion and contaimination of the air stream, additional acoustic spacer to be provided between the film and perforated inner liner.

B. Apply adhesive to liner facing in direction of airflow not receiving metal nosing.

C. Butt transverse joints without gaps and coat joint with adhesive.

D. Fold and compress liner in corners of rectangular ducts or cut and fit to assure butted edge overlapping.

E. Do not apply liners in rectangular ducts with longitudinal joints, except at corners of ducts, unless the size of the duct and standard liner product dimensions make longitudinal joints necessary.

F. Apply an adhesive coating on longitudinal seams in ducts exceeding 2,500 FPM air velocity.

G. Secure insulation liner, film and acoustic spacer with perforated sheet metal liner of same gage specified for duct, secured to ducts with mechanical fasteners that maintain metal liner distance from duct without compressing insulation. Sheet metal liner perforations: 3/32-inch-diameter, with an overall open area of 23 percent.

H. Terminate liner with duct buildouts installed in ducts to attach dampers, turning vane assemblies, and other devices. Fabricated buildouts (metal hat sections) or other buildout means are optional; when used, secure buildouts to the duct wall with bolts, screws, rivets, or welds. Terminate liner at fire dampers at connection to fire damper sleeve.

PART 3 - EXECUTION

3.01 DUCT INSTALLATION, GENERAL

A. Install metal ducts and fittings in accordance with 1995 SMACNA "HVAC Duct Construction Standards - Metal and Flexible," 2nd Edition.

B. Duct System Pressure Class: Construct and install each duct system for the specific duct pressure classification indicated.

C. Install ducts with the fewest possible joints.

D. Install fabricated fittings for all changes in direction, changes in size and shape, and connections.

E. Install couplings tight to duct wall surface with a minim of projections into duct .

F. Install ducts, unless otherwise indicated, vertically and horizontally, parallel and perpendicular to building lines; avoid diagonal runs.

G. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.

H. Install ducts with at least 1-inch plus allowance for insulation thickness.

I. The design intent is to conceal ducts from view in finished spaces. Arrange ductwork to be sufficiently above ceiling construction or behind wall construction to allow this to occur. Do not encase horizontal runs in solid partitions, unless as specifically indicated.

J. Coordinate layout with suspended ceiling, fire suppression systems, and lighting layouts and similar finished work.

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

L. Non-Fire-Rated Partition 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 gage as duct. Overlap opening on four sides by at least 1-1/2 inches.

M. Fire-Rated Partition Renetrations: Where ducts pass through fire-rated partitions and walls, install appropriately rated fire damper and sleeve.

N. Install gesketed air tight blank off panels in supply and exhaust ductwork at take off locations shown.

O. Clean dust and debris from each section as it is installed. Clean external surfaces of foreign substances that might deteriorate metal or interface with painting or insulating of casings. Cover openings with polyethylene film or other covering to prevent entrance of moisture, dust and debris during construction.

P. Maintain temporarily closed openings in ductwork until permanently closed by duct connections, equipment installation, and completion of similar work. Remove temporary polyethylene film or other covering as duct construction proceedes

Q. Arrange ductwork installed for future utilization in a manner to allow clear and straight forward extension for connection to future work.

3.02 DUCT LINER

A. Install lining of specified type and thickness in accordance with requirements and recommendations of the “SMACNA Hvac Duct Construction Standards.”

B. Increase sheet metal ductwork in each dimension to incorporate thickness of lining material and provide an internal clear duct dimension as shown.

C. Line ductwork where shown.

3.03 SEAM AND JOINT SEALING

A. General: Seal duct seams and joints in accordance with pressure class indicated and as described in SMACA "HVAC Duct Construction Standards-Metal and Flexible."

B. Pressure Classification Less than 2 Inches Water Gage: Transverse joints only.

C. Seal externally insulated ducts prior to insulation installation.

3.04 HANGING AND SUPPORTING

A. Install metal duct with support systems indicated in SMACNA "HVAC Duct Construction Standards-Metal and Flexible," Tables 4-1 through 4-3 and Figures 4-1 through 4-8.

B. Support horizontal ducts within 2 feet of each elbow and within 4 feet of each branch intersection.

C. Support vertical ducts at a maximum interval of 16 feet and at each floor.

D. Upper attachments to structures shall have an allowable load not exceeding one-fourth the failure (proof test) load.

E. Install powder actuated concrete fasteners after concrete is placed and completely cured.

3.05 CONNECTIONS

A. Equipment Connections: Connect equipment with flexible connectors in accordance with Section 15820," Duct Accessories."

B. Branch, Diffuser, Register, Grille, and Terminal Unit Connections: Comply with SMACNA "HVAC Duct Construction Standards-Metal and Standard," 1995 Edition.

3.06 FIELD QUALITY CONTROL

A. The Owner's Testing Agency will perform, record, and report leakage tests.

B. Remake leaking joints as required and apply sealants to achieve specified maximum allowable leakage.

3.07 FIELD QUALITY CONTROL

A. Test all supply, return and exhaust ductwork during installation and before application of any exterior insulation or enclosing of ductwork, in accordance with SMACNA "HVAC Air Duct Leakage Test Manual".

1. Disassemble, reassemble, and seal segments of the systems as required to accommodate leakage testing, and as required for compliance with test requirements.

2. Conduct tests at static pressures equal to maximum design pressure of system or section being tested. If pressure classifications are not indicated, test entire system at maximum system design pressure. Do not pressurize systems above maximum design operating pressure. Give seven days' advance notice for testing.

3. Remake leaking joints and retest until leakage is less than maximum allowable leakage.

3.08 ADJUSTING AND CLEANING

A. Refer to Section 15950, "Testing, Adjusting, and Balancing" for requirements and procedures for adjusting and balancing air systems.

B. After completing installation, including outlet fittings and devices, inspect the system. Vacuum ducts prior to final acceptance to remove dust and debris.

END OF SECTION 15810