UNIVERSITY OF MICHIGAN
ARCHITECTURE, ENGINEERING AND CONSTRUCTION

ARCHITECTURE & ENGINEERING
326 East Hoover, Mail Stop B
Ann Arbor, MI 48109-1002
Phone: 734-764-3414
Fax: 734-936-3334

Building Name
Edit Custom Properties
P00000000 0000

SPECIFICATION DIVISION 23

NUMBER SECTION DESCRIPTION

DIVISION 23
SECTION 233100 - HVAC DUCTS AND CASINGS

END OF CONTENTS TABLE

DIVISION 23
SECTION 233100 - HVAC DUCTS AND CASINGS

REVISIONS:
2-17-2000: SUBSTANTIALLY REVISED, ADOPTED AS NEW MASTER.

7-29-10 SUBSTANTIAL REVISIONS FOR HVAC MECH. /TECH. TEAM – S. WOLDT

4-2011 FORMAT AND CONTENT REVISED BY MECH/TECH TEAM

2-2012 HANGING DUCT WITH CABLE OR WIRE PROHIBITED, PER HVAC MTT DECISION.

OCT. 2015: ADDED SET DUCT AS APPROVED MFR. D. KARLE PER HVAC MTT.

APRIL 2018: REVISED TO LIST MFR.S FROM PML. R BENEDEK

JUNE 2018: ADDED VENTCON AS APPROVED FOR DUCT CLEANING PER HVAC MTT. D.KARLE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

INCLUDE PARAGRAPH 1.1.A AND B IN EVERY SPECIFICATION SECTION. EDIT RELATED SECTIONS 1.1.B TO MAKE IT PROJECT SPECIFIC.

A. Drawings and general provisions of the Contract, Standard General and Supplementary General Conditions, Division 1 Specification Sections, and other applicable Specification Sections including the Related Sections listed below, apply to this Section.

B. Related Sections:

1. Section 220500: Common Work Results for Mechanical
2. Section 220548: Vibration Control
3. Section 220719: Mechanical Systems Insulation
4. Section 233300: Air Duct Accessories and RGDs
5. Division 26: Electrical.

1.2 SUMMARY

A. Section Includes:

1. Ductwork materials, plenums, construction, , fabrication, and support
2. Galvanized steel ductwork.
3. Polyvinyl chloride coated galvanized steel ductwork (PCD).
4. Stainless steel ductwork.
5. Round and flat oval ductwork.
6. Reinforcing and supports.
7. Flexible duct.
8. Flexible nonmetallic duct.

9. Special ductwork construction including exhaust plenums; perchloric acid ductwork system; double-wall ductwork; and exhaust stacks.
10. Custom fabricated canopy hoods.
11. Double-walled panels, plenums, and duct at outside air intake plenums.
12. Blank-off panels for unused louver areas.
13. Dryer vent ductwork.
14. Bellmouth connections.
15. Duct sealants.
16. Duct cleaning and disinfecting
17. Ductwork sealing, inspection, and leakage testing.

1.3 QUALITY ASSURANCE

A. Manufacturers and Products: The products and manufacturers specified in this Section establish the standard of quality for the Work. Subject to compliance with all requirements, provide specified products from the manufacturers named in Part 2.

B. Reference Standards: Products in this section shall be built, tested, and installed in compliance with the following quality assurance standards; latest editions, unless noted otherwise.

C. ASTM A653 / A653M Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.

D. ASTM A 666 – Standard Specification for Austenitic Stainless Steel Sheet, Strip, Plate, And Flat Bar.

E. ASTM B 209 & 209M – Standard Specification for Aluminum and Aluminum Alloy Sheet and Plate.

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

G. NFPA 90B – Standard for the Installation Of Warm Air Heating and Air Conditioning Systems.

H. NFPA 91 – Standard for Exhaust Systems for Conveying of Materials.

I. NFPA 92A – Standard for Smoke Control Systems.

J. NFPA 92B – Standard for Smoke Management Systems.

K. NFPA 96 – Standard for Ventilation Control of Cooking Operations.

L. NFPA 99 – Standard for Health Care Facilities.

M. SMACNA – All standards.

N. AWS - All applicable standards.

O. UL 181, 181A, & B – Factory-made Air Ducts and Connectors and Closure Systems.

P. UL 760 – Standard for Exhaust Hoods For Commercial Cooking Equipment.

Q. UL 723 – Standard for Surface Burning Characteristics of Building Materials.

R. Air Diffusion Council – Flexible Duct Performance and Installation Standards.

S. National Air Duct Cleaners Association (NADCA).

1.4 SUBMITTALS

A. Provide the following information and product data:

1. Project specific duct fabrication schedule including materials, methods of installation, and location of fitting types. Indicate the metal gauge and reinforcement method intended for each pressure classification and size of duct.
2. Construction details for double wall duct and panels, plenums, stacks, canopy hoods, etc.
3. Double wall duct and panel fill material
4. Hangers and supports
5. Duct fittings
6. Turning vanes
7. Duct sealant
8. Flexible duct
9. Dryer duct and fittings

1.5 WARRANTY

A. Provide a complete parts and labor warranty for a minimum of one year from the date of Substantial Completion.

PART 2 - PRODUCTS

2.1 GENERAL

A. Provided duct and fittings of G90 galvanized steel unless otherwise indicated.

B. Constructed duct and fittings in compliance with SMACNA standards and recommendations and per the additional requirements indicated.

C. Duct dimensions indicated on drawings are inside dimensions. The sheet metal dimensions shall be increased an equivalent amount to accommodate internal liner where liner is required.

D. Drawings are diagrammatic and indicate the arrangement of the principal apparatus, ductwork, and piping, and shall be followed as closely as possible. All the required offsets, rises, drops, fittings and accessories are not indicated on the drawings, but shall be provided as required for a complete system. Carefully investigate structure, finish conditions, and the work of other sections affecting sheet metal work, including work associated with testing, adjusting and balancing, in order to arrange all items accordingly. Provide best possible arrangement to provide maximum headroom and maintenance clearances.

E. In addition to sheet metal ductwork specified herein, provide, or install as furnished by other sections, accessories and devices including, but not limited to, smoke detectors, plenums, canopy hoods, control dampers, and blank-off panels at unused louver areas.

F. Provide intake and exhaust plenums attached to louvers.

G. Alternate Joining Methods: As an alternate to SMACNA joining methods, Contractor may propose proprietary joining systems with performance equivalent to SMACNA for Owner's approval.

IMPORTANT: INCLUDE THE DUCT APPLICATION SCHEDULE ON DRAWINGS AND EDIT APPROPRIATELY FOR SPECIFIC PROJECTS. SEE U-M STANDARD DETAILS FOR SAMPLE SCHEDULE, CONSTRUCTED FOR USE WITH THIS SPECIFICATION.

H. Refer to Drawings for ductwork construction and application schedule.

2.2 DUCTWORK MATERIALS AND FABRICATION

A. General Ductwork Fabrication Requirements:

1. Provide fittings, branches, inlets and outlets in such a manner that air turbulence is reduced to a minimum.
2. Turns:
   a. Use radius type elbows wherever possible. Where it is not possible to install a 1.5 times width to centerline radius elbow (full radius elbow), use lesser radii configurations, with 'radius-proportional' splitter vanes permanently installed within. No radius shall be less than 1.0 times width. Provide square elbows of equivalent pressure drop in rectangular ducts where radius elbows will not fit or where specifically noted on drawings. Elbows shall be installed with vanes in accordance with Related Section "Sheet Metal Accessories." Stamped elbows may be used up to and including a diameter of 12 in.
3. Transitions:
   a. Limit transition angles (for each side) to 15 degrees diverging and 30 degrees converging.
4. Take-Off Fittings:
   a. For take-offs carrying more than 25 percent of duct main, provide an increasing branch elbow with an inside radius equal to branch duct width. Size branch and main at elbow for equal velocity.
   b. For take-offs carrying 25 percent or less of duct main, provide flanged increased area branch take-off (45 degree entry, "shoe" type) or 45 degree lateral wye takeoffs. Conical fittings shall be used for spiral, round, and oval ductwork.
   c. For take-offs directly to side outlet for register or grille, provide an increased area tap. For take-offs directly to diffusers see appropriate SMACNA figures.
   d. Acceptable take-off fitting manufacturers:
      1) Sheet Metal Connectors, Inc.
      2) United Sheet Metal.
      3) McGill AirFlow LLC.
      4) Set Duct.
      5) Tangent.
      6) Flexmaster.
      7) SEMCO Incorporated.
      8) Sheet Metal Connectors, Inc.
5. Crossbreak or bead rectangular ductwork.

6. Rectangular duct longitudinal seams shall be Pittsburgh lock 3/8 in. minimum pocket.
7. Bolts and Fasteners
   a. Carbon steel, zinc coated per ASTM A153 for G-90 and stainless steel for aluminum and stainless steel ducts.
8. Welding Materials
   a. Refer to SMACNA "Guidelines for Welding Sheet Metal" for applicable requirements.

B. Galvanized Steel Ductwork:

1. Minimum steel rectangular duct gage shall be as follows:
   a. Ducts through 12 in. wide: 24 Gage
   b. Ducts 13 in. through 30 in. wide: 22 Gage.
   c. Ducts 31 in. through 84 in. wide: 20 Gage.
   d. Ducts 84 in. and larger: 18 Gage
2. ASTM A653, A924 mill galvanized steel sheet, 1.25 oz per sq. ft. zinc coating on each side in conformance with coating designation G-90.

C. Galvanized Touch-Up Paint: Inorganic zinc-rich touch up paint containing a minimum of 65 percent metallic zinc by weight for damaged galvanized coating.

1. Acceptable manufacturers/product: Carboline/Carbo-Zinc, Tnemec/Tneme-Zinc.

D. Polyvinyl Chloride Coated Galvanized Steel Ductwork (PCD):

1. Except where noted, comply with Galvanized Steel Ductwork paragraph above. Factory coat interior and exterior with a 4 mil thick coat of fused polyvinyl chloride. Construct and install horizontal ductwork and fittings with longitudinal seam located on top of duct.
2. Screws and rivets that penetrate ducts shall be stainless steel.
3. Cut edges or coating damage shall be touched up to match the 4 mil thick coat of fused polyvinyl chloride.
4. Acceptable Manufacturers: Set Duct, Tangent, United McGill, Foremost, Semco

E. Stainless Steel Ductwork

CONSIDER IF THE LESS EXPENSIVE 304 STAINLESS STEEL IS SUITABLE FOR YOUR APPLICATION.

1. Minimum stainless steel rectangular duct gauge shall be 18 gauge, for welding.
2. ASTM A167, type 316L.
3. Concealed stainless steel ductwork shall have an ASTM mill rolled No.1 or No.2 D finish.
4. Exposed stainless steel ductwork shall have an ASTM mill rolled No.2 B finish, or as indicated. Welds shall be ground smooth and final brushed with stainless steel wire brushes. Welds on exposed stainless steel ductwork shall be free of stain, burn-through, or discoloration to the satisfaction of the University's Representative/Project Design Engineer.
5. Screws and rivets shall be stainless steel.

F. Round and Flat Oval Ductwork

1. All round and oval duct shall be manufactured of spiral lock seams, with minimum gage per the appropriate SMACNA Tables and per manufacturers recommendations. Ductwork up to 12 in. diameter and 2 in. w.g. can be manufactured with longitudinal lock seams.
2. Tees shall be conical. Laterals shall be straight. Taps through 10 in. diameter in size shall have a machine drawn entrance and fittings shall have longitudinal seams, continuously welded. Both sides of welds shall be primed with zinc chromate. Tap entrances shall be free of weld build-up.
3. Elbows in diameters 2 in. through 10 in. shall be stamped or pleated. Elbows shall be 5 gore for 90 degrees and 3 gore for 45 degrees. Elbows shall have 1.5 times width to centerline radius (full radius elbow).
4. Flanges, access doors and taps into spiral ducts shall be factory fabricated.
5. Field joints in diameters through 48 in. shall be made with 2 in. long slip-fit, sleeve coupling, or flanges. Ductwork 48 in. diameter and over, and for all sizes where disassembly or removal is required, shall be joined with flanges.

G. Reinforcing and Supports

1. Structural steel per ASTM A36; Mill galvanized per ASTM A653, Coating Designation G-90. Equivalent rolled steel structural support systems (such as TDF or TDC) may be used in lieu of mill rolled structural steel. Use double nuts and lock washers on threaded rod supports.
2. Tie-Rods
   a. Maximum tie rod spacing shall be 42 in., unless specifically engineered in accordance with SMACNA Industrial Rectangular Duct Standard.
   b. Minimum tie rod diameter shall be 1/2 in.
   c. Tie Rods shall not be used in any plenum or ducts that require access.
   d. Tie rods shall not be used in any PCD, cage wash, BSL-3 or BSL-4, Vivarium, stainless steel, or ducts carrying lint.
   e. Tie rods shall not be used in any return or exhaust ducts in health care facilities.

2.3 FLEXIBLE DUCT

A. General

1. Flexible duct shall be UL listed, and shall maintain shape when installed. Sagging shall not exceed 1/2 in. per linear foot when installed horizontally.
2. Flexible duct shall not be used where system pressure is greater than plus or minus 2 in. w.g.
3. Insulated flex shall have a gray fire retardant polyethylene outer jacket with an 8 oz. density, 1-1/3 in. thick fiberglass insulation blanket, factory wrapped.
4. Flexible duct used on negative pressure systems shall be specifically rated for negative pressure use.

FLEXIBLE METALLIC DUCT IS SELDOM USED, AND NOT COVERED BELOW.

B. Flexible Nonmetallic Duct

1. Flexible nonmetallic duct shall be constructed of sound transparent foil. Material shall be mechanically locked to the outside helix. Use of adhesives to lock fabric in place is not acceptable. The helix shall be constructed of corrosion resistant galvanized steel, formed and mechanically locked to the duct fabric on the outside to prevent tearing.
2. Flexible fabric duct shall be rated at 6 in. positive pressure and at 4 in. negative pressure.
3. Flexible nonmetallic duct shall be listed UL Class 1.
4. Acceptable manufacturers:
   a. Flexmaster.
   b. Hart & Cooley.
   c. Atco.
   d. Peppertree Air Solutions

2.4 SPECIAL DUCTWORK CONSTRUCTION

A. Ductwork required to be removable shall utilize companion flanges.

B. Ductwork systems serving areas of high process humidity shall be constructed of aluminum, min. thickness of 0.040 in., or 316L stainless steel. Ductwork shall be continuously welded and watertight. Pitch duct to low point drains. Pipe drains to floor drains or utility sinks.

1. Provide in the following areas, and where indicated:
   a. Non-insulated ductwork exposed on roof.
   b. Dishwasher exhaust.
   c. Within 20 feet of a shower area exhaust register/grille.
   d. From sterilizer and glass washer exhaust register/grille, canopy, or equipment connection to main or lateral duct (stainless steel only).

C. Exhaust plenums on roof shall be double wall with 2 in. thick duct liner, G-90 stainless steel solid inner wall (gauge per specified duct minimum standards) and minimum 18 gauge, G-90 stainless steel outer wall.

SEE THE U-M DESIGN GUIDELINE FOR PERCHLORIC ACID SYSTEMS. EDIT PARAGRAPH BELOW ACCORDINGLY.

D. Perchloric Acid Ductwork System.

E. Double Wall Ductwork.

AVOID THE USE OF PERFORATED DOUBLE WALL DUCT DUE TO CONCERNS WITH ABILITY TO CLEAN PROPERLY, INSULATION EROSION, MOLD/FUNGUS GROWTH, AND COST. INDICATE ON DRAWINGS OR IN SPECIFICATION WHERE SOLID DOUBLE WALL AND PERFORATED DOUBLE WALL IS TO BE USED.

1. Solid outer and inner wall, or solid outer wall and perforated inner wall, as indicated.
   a. Outer wall: comply with Galvanized Steel Ductwork paragraph above.
   b. Insulation: 1-in. thick, 3.0 lb. density fiberglass acoustical liner with fire resistant fiber bonding coating and a 1 mil vapor barrier on inside of Tedlar or Mylar.
   c. Inner wall solid: Minimum 18 gauge.

d. Inner wall perforated: Minimum 18 gauge perforated steel, nominal 3/32 in. diameter perforations, overall open area of 23 percent. Tightly secure liner along all seams.

2. Double wall ductwork from a point 10 feet upstream of steam humidifiers to a point 20 feet downstream of humidifiers shall have a solid inner wall.
3. Acceptable manufacturers: McGill AirFlow LLC; Semco, or as approved.

DETAIL THE STACK HEIGHT AND CONSTRUCTION ON DRAWINGS.

F. Exhaust Stacks:

1. Construct stacks from same material as exhaust duct or as indicated on drawings.
2. Stacks shall be self-supporting and constructed for wind velocities at a minimum of 100 MPH from all directions.

2.5 CUSTOM FABRICATED CANOPY HOODS

DETAIL CANOPY CONSTRUCTION ON DRAWINGS.

A. Fabricate from 18 gauge 316L stainless steel, all welded construction, number 2B finish, or from material as indicated on Drawings.

B. Welds shall be ground smooth and final brushed with stainless steel wire brushes. Welds shall be free of stain, burn-through, or discoloration.

C. Provide a continuous turned-up lip forming a trough around the inside perimeter of the hood with separate drain connections consisting of a welded stainless steel nipples, and as indicated on the drawings.

D. Size and configuration of each hood shall be as indicated on the drawings. Coordinate with other trades for lights, fire protection, controls, and other interconnections.

2 1/2 IN. THICK PANELS ARE DESCRIBED BELOW, EDIT TO MAKE PROJECT SPECIFIC.

2.6 DOUBLE-WALLED PANELS, PLENUMS, AND DUCT AT INTAKES AND RELIEFS

A. Double-walled type panels, 2-1/2-in.-thick, constructed from smooth or embossed mill finish G-90 galvanized steel or aluminum facing sheets. Each panel shall contain an integral frame of G-90 galvanized steel or extruded aluminum bonded to the facing sheets to provide a moisture-tight seal at the panel perimeter. Panels shall be load bearing and capable of forming the plenum or duct without the installation of structural members. Join panels together with G-90 galvanized steel or extruded aluminum mullions and fasten with closed end rivets. Make connections to the duct or plenum using a support mullion that is an integral part of the panel and not bolted to or through the panel. Gasket all joining mullions with a double vinyl gasket or a double butyl gasket to provide a permanent air-tight seal. Design panel skins, core density, rib spacing, and mullion spacing to eliminate panel pulsation and to a maximum deflection of 1/200 of any span at design pressure, positive or negative. The overall "U" factor of the panels shall not exceed 0.14 BTU/ft^2/°F.

B. Removable panels shall be the same construction as described above, with double seals around periphery to guarantee tight closure.

C. Access doors shall be constructed as follows:

1. Doors shall be minimum 24 in. wide whenever possible, or widths as indicated on drawings. Provide doors that are the full height of the panel, maximum 5 ft. high.
2. Each access door shall be equipped with continuous double gaskets and shall fit in the door frame in a manner to guarantee tight closure.
3. Hinges and hardware shall be galvanized, stainless steel or aluminum. Outdoor unit hardware shall be stainless steel, or aluminum. Provide at least 2 handles per door, operable from either side.
4. Access doors in positive pressure sections shall open inward, in negative pressure sections shall open outward.
5. Where indicated, provide a glass window in the access door, minimum 6 in. by 6 in. size, located at a height convenient for viewing, sealed to prevent leakage, rated to operate safely against the duct/plenum pressure rating. Provide double pane insulating type glass at all locations connected to outdoors/exterior or exposed to air temperatures below 55F; single pane at other locations.

D. The manufacturer shall have published literature available stating the coefficient of absorption and the sound transmission loss characteristics of the panels system per ASTM C 423 and the sound transmission loss properties per ASTM E 90 and E 413. Published acoustic data shall show the trademark or name of the manufacturer, shall have been verified by a recognized independent testing laboratory, and shall specify the coefficient of acoustic absorption and attenuation by octave band. Submit acoustic performance data in graphic and tabular form as part of the shop drawings. Minimum panel performance for 2-1/2 inch thick panels shall be as follows:

Frequency (Hz)	125	250	500	1000	2000	4000
Transmission Loss (dB)	14	22	28	35	43	48
Absorption Coefficient	0.3	0.7	0.95	0.95	0.95	0.85

E. The duct and plenum systems, in addition to supporting indicated equipment, scheduled maximum operating pressure, and system test pressure, shall sustain a 35 lb. per sq. foot maintenance function load without permanent deformation or damage.

F. Acceptable Manufacturers:

1. McGill Airflow LLC.
2. Semco Mfg Co.
3. Vibro-Acoustics
4. VAW Systems

2.7 BLANK-OFF PANELS FOR UNUSED LOUVER AREAS

A. Provide a minimum 20 gauge, G-90 galvanized or aluminum, insulated sheet metal blank-off panels for unused louver sections. Panels may be of the double-walled or single wall insulated type. For double-walled type panels, the insulation shall have an overall "U" factor of 0.14 BTU/ft²/°F. Insulation for single skin panels shall be of the rigid type and of the thickness as specified for outside air intake ducts located in mechanical rooms in Related Section "Mechanical Systems Insulation," permanently secured to the panel skins. Panels shall have a maximum deflection of 1/200 of any span at wind velocities of up to 100 MPH.

B. Exterior/visible face of blank-off panel shall be cleaned and painted flat black, prior to installation.

THE SPECIFICATION BELOW FOR CLAMP-TOGETHER DRYER VENTING IS INTENDED FOR HEAVY USE CLOTHES DRYER APPLICATIONS SUCH AS RESIDENT HALL LAUNDRY ROOMS WITH MULTIPLE DRYERS WHERE ACCESS TO DISASSEMBLE DUCT FOR PERIODIC CLEANING MAY BE CHALLENGING. FOR SIMPLE DRYER APPLICATIONS, SPECIFYING CONVENTIONAL DUCT MAY BE MORE APPROPRIATE.

2.8 CLOTHES DRYER VENT DUCTWORK

A. Dryer vent duct system shall consist of a clamp-together rigid duct system utilizing single lever reusable clamps at transverse joints.

B. Ductwork and fittings shall be round G-90 galvanized steel, of gauge and construction as recommended by SMACNA for the system's static pressure, minimum 22 gauge.

C. Duct shall be roll formed and continuously laser welded along longitudinal seams with the exception of the 3-in. duct that may be lock formed. Non laser welded elbows, branches, reducers, etc. to have a buffed smooth interior. End connections shall be die-formed rolled edge for use with single lever clamps.

D. All connections and seams shall have gaskets, seals and sealant compatible with the application, not degraded by chemicals with a PH range of 0-14, temperature rating not less than 500°F. Duct leakage shall not exceed SMACNA Class 3 at 5 in. w.g. static pressure.

E. Clamp gaskets shall be PTFE.

F. Include all elbows, fittings, adapters and accessories for a complete installation.

G. Elbows shall be long radius type with centerline radii of 1.5 x diameter whenever space permits. Elbows with centerline radii of 1.0 x diameter in congested spaces: submit for approval. Branch fittings shall be concentric.

H. Approved manufacturer: Nordfab Quick-Fit/ACS, Fenton, MO.

2.9 BELLMOUTH CONNECTIONS

A. Bellmouth fittings shall be constructed to match material requirements as indicated on drawings.

B. Bellmouth shall have a minimum radius of 1 1/2 in. with 1/2 in. flange and 1/2 in. by 1/8 in. thick neoprene gasket.

C. Manufacturers:

1. Buckley Associates.
2. McGill Airflow LLC. Semco.

2.10 DUCT SEALANTS

DETERMINE IF SOLVENT BASED DUCT SEALANT IS APPROPRIATE FOR THE AREA OF WORK AND EDIT THE BELOW ACCORDINGLY. NOTE THAT LEED© TYPICALLY PERMITS SOLVENT BASED DUCT SEALANTS IN WELL-VENTILATED AREAS DURING LOW AMBIENT TEMPERATURES (<40˚F), BUT WATER BASED SEALANTS OTHERWISE.

A. Solvent-based sealants may only be used if the outdoor air temperature will be below 40˚F within 24 hours of applying.

B. Sealant shall be non-asbestos type, and comply with UL and NFPA 90A.

C. Sealant: Water or solvent based elastomeric compound, gun or brush grade, maximum 25 flame spread and 50 smoke developed (dry state) specifically for sealing ductwork. Use products as recommended by manufacturer for low, medium or high-pressure systems.

1. Manufacturers
   a. Hardcast.
   b. McGill Airflow LLC.
   c. Polymer Adhesives.
   d. Ductmate.

D. Tape shall not be used.

E. Gaskets and mastics used for flanged joints shall be compatible for the service of use and per the manufacturer’s recommendations.

2.11 DUCTWORK CLEANING AND DISINFECTING

DETERMINE IF THIS SECTION IS REQUIRED. INSERT AND EDIT THE NADCA SPECIFICATION APPROPRIATELY.

A. When scheduled, the minimum requirements for commercial HVAC system cleaning shall be as described in the National Air Duct Cleaners Association (NADCA) “General Specifications for the Cleaning of Commercial Heating, Ventilation and Air Conditioning Systems.”

B. Approved Cleaning Specialists:

1. Sani-Vac Service
2. Power Vac
3. High Tech Vacuum
4. Aero Filter Inc.
5. Stanley Steemer Great Lakes Inc.
6. Ventcon

PART 3 - EXECUTION

3.1 GENERAL SHEET METAL INSTALLATION

A. Ductwork shall be installed to true alignment, parallel or perpendicular to adjacent building walls, floors and ceilings, to present a neat and workmanlike appearance.

B. Provide necessary offsets and transitions to avoid interference with the building construction, piping, or equipment. Locate ducts with sufficient space around equipment to allow operating and maintenance activities.

C. Bullhead tees and straight tap connections are not acceptable.

D. Provide straight runs of ductwork, upstream and downstream, at equipment, fans, coils, TAU's, LTAUs, and humidifiers per manufacturer's recommendations and as indicated on drawings.

E. Provide flexible connector where ductwork connects to fans, air handling units and other rotating equipment and where indicated on drawings.

F. Repair damaged galvanized surfaces with zinc rich paint.

G. For ductwork mounted outdoors, install duct with slight lateral pitch to prevent water ponding on top of duct.

H. Repair PCD ductwork where coating is damaged or exposed by connections with compatible liquid PVC or per manufacturer's recommendations.

I. Enclose dampers located behind architectural intake or exhaust louvers in a sheet metal collar and seal to building construction.

J. Air volume control on parallel flow branches shall be accomplished with branch dampers; splitter type dampers are not acceptable.

K. Install special equipment items in ductwork systems including, but not limited to: control dampers, thermometers, airflow measuring devices and other related items, according to manufacturer's recommendations.

L. Set plenum doors 6 in. to 12 in. above floor. Arrange door swings so that fan static pressure holds door in closed position.

M. Store duct at least 4 in. above floor on wood pallets or similar devices. Protect duct from odors, dust, moisture, and other debris while stored on or off the jobsite, and when transporting to the jobsite, by tightly covering with plastic.

N. Ductwork openings shall remain protected and covered until just prior to connection. Immediately after assembly, restore all protection to prevent odors, dust, moisture, and other debris from entering ductwork system. Remove any internal labels.

O. Provide required penetrations and sleeves in building structure.

P. Blank-off panels shall be screwed to louver blades and caulked to provide a weather tight seal.

3.2 FLEXIBLE DUCT INSTALLATION

A. Flexible duct runs shall not exceed 5 ft. long. Cut to length so that it is not compressed. Trim ends squarely. Sag shall not exceed 1/2 in. per linear foot when installed horizontally.

B. Provide a minimum of 3 ft. of flexible non-metallic duct at connections to supply, return and exhaust diffusers/grilles, unless otherwise noted.

C. Support at a maximum spacing of 2 ft. using 4 in. wide sheet metal protection saddles at each duct hanger. Flex duct directional changes shall not exceed 45 deg with centerline radius of bend no less than one-half times duct diameter.

D. For connection to supply, return and exhaust diffusers/grilles located in horizontal ceilings, use pre-fabricated 90 degree plastic supports (such as the Flexflow Elbow by Thermaflex), or 90 degree sheet metal elbow fittings.

E. Apply duct sealant to outside surface of collars and secure with metallic draw-band where flexible duct joins other duct or devices.

F. Flexible duct shall not be used to connect terminal units to branch or main ducts.

3.3 DUCTWORK HANGERS AND SUPPORTS

A. Generally, hang and support ductwork per the latest edition of SMACNA. Additionally, adhere to the more specific requirements found in this specification section, the Related Sections, and as indicated on the project drawings.

B. Hanging duct, equipment, or accessories with cables or wires is prohibited.

C. Comply with Related Sections and drawing details regarding hangers, building attachments, fasteners, beam clamps and retaining clips, and as note below.

D. Provide vibration isolation as specified in Related Section.

E. Ductwork shall be supported and anchored to structure so that horizontal ducts are without sag or sway, vertical ducts without buckle and all ducts are free from deformation, collapse or vibration

F. Support un-insulated rectangular ducts in sizes to 36 in. by non-perforated galvanized steel strap or by trapeze hangers. Support insulated rectangular ducts and ducts larger than 36 in. with trapeze hangers.

G. Provide at least one support for each length of duct, with a maximum hanger spacing of 10 feet. Install supports on both ends of duct turns, branch fittings and transitions.

H. Do not hang ductwork from piping, ducts, other trades hangers, existing hangers, or equipment.

I. Single band hangers are not acceptable on ducts greater than 24 in. diameter.

J. Provide supports on each side of any duct mounted equipment or device, including fans, coils, dampers, etc, to permit removal of item without removal of adjacent duct sections.

K. Provide supplemental steel required to support ductwork in shafts, mechanical rooms or on the floor where structural steel is not properly positioned.

L. Beam clamps shall be double sided on ducts over 36 in. by 36 in. Use double sided or single sided beam clamps with retaining clips on all other sizes.

M. Do not modify existing structural steel without approval of U-M project manager and a structural engineer’s review.

N. Provide clamping systems that are compatible with the structural steel system of the building.

O. Use angle iron "V" construction supports or similarly rigid construction for vertical ducting that requires lateral support.

P. Ductwork mounted on roof or otherwise exposed to elements shall be supported with frames constructed of galvanized steel angles and channels, regardless of duct size. Supports shall not rest on top of roof, but shall be firmly attached to roof structure and properly flashed. Ducts that penetrate through the roof shall utilize curbs and shall be counter-flashed. All fasteners shall be galvanized.

Q. Provide angle sway bracing and diagonal cross bracing to the structure to provide support against maximum lateral loads that may be imposed on the ductwork installed downstream of fan discharges and ductwork exposed to wind loads, and any other locations exposed to lateral loads.

3.4 DUCT PAINTING

A. Where the interior of duct is visible through grilles, registers, diffusers or other air diffusion devices, paint the interior flat black. Coordinate work with Architectural Trade.

B. For plenum returns, where equipment and structure above ceiling is visible through return air grilles, provide black sheet metal baffle with turned edges suspended from building construction. Size and position the baffle to prevent restriction of air flow. Where space above ceiling precludes use of a baffle, paint visible building surfaces flat black.

3.5 TEMPORARY USE

A. Develop a plan that assures ductwork is protected during temporary use. Obtain approval of the plan from the Owner’s Representative.

B. Maintain the protection plan until just prior to Owner turn-over.

C. Successfully complete return/negative pressure duct leak testing prior to duct temporary use.

D. Temporary filters shall be provided in return or negative pressure duct to protect ductwork and building contents when any fans are operated during construction. Filters shall have an equal or better performance rating than the air handling unit pre-filters specified for permanent use, but not less than MERV 8, in order to prevent construction dirt infiltration into duct systems. Install filters over grilles, diffusers, and all duct openings. Provide filters over supply grilles, diffusers and duct openings if construction dust and debris will enter when operated for temporary service (e.g. air system cycles off during periods when construction continues). Seal around temporary filters to prevent filter bypass.

E. Continuously maintain all filters and replace when pressure drop exceeds 1 in. w.c., or at manufacturer's recommended change-out pressure drop, whichever is lower.

F. Remove temporary filters and associated materials, and clean any adhesive residue from finished surfaces, at completion of temporary use.

3.6 DUCTWORK SEALING, INSPECTING AND LEAKAGE TESTING

A. Seal, inspect and test prior to insulating or concealing ductwork. Leak test per procedures in the latest edition of SMACNA.

FOR EXPOSED DUCT IN FINISHED AREAS, CONSIDER IMPACT OF SEALANT ON AESTHETICS OF DUCT. POSSIBLE OPTIONS ARE NO SEALANT, WELDED JOINTS, OR BANDS TO COVER THE SEALANT.

B. Seal ductwork to meet the following SMACNA seal classifications:

BELOW DUCT SEAL REQUIREMENTS MEET OR EXCEED ASHRAE 90.1 2007 REQUIREMENTS EXCEPT FOR UNCONDITIONED SPACES. ENGINEER TO REFER TO 90.1 FOR THE DEFINITION OF AN UNCONDITIONED SPACE AND IDENTIFY IF THE PROJECT HAS ANY DUCT RUNNING IN UNCONDITIONED SPACES. IF SO, SPECIFICALLY IDENTIFY WHICH SPACES ARE CONSIDERED UNCONDITIONED AND INDICATE THE REQUIRED SEAL CLASS, MATCHING 90.1 REQUIREMENTS.

1. Pressure class 2 in. w.c. or less (except exhaust or outdoor): Class C (seal transverse joints only.)
2. Exhaust ductwork, pressure class 2 in. w.c. or less: Class B (seal all transverse joints and longitudinal seams).
3. All outdoor ductwork: Class A (seal all transverse joint, longitudinal seams, and duct wall penetrations)
4. All ductwork rated for a pressure greater than 2 in. w.c: Class A (seal all transverse joints, longitudinal seams, and duct wall penetrations).
5. All inaccessible ductwork (duct in shafts, above hard ceilings, and any made inaccessible by work of other trades): Class A.

C. Perform measured leak testing on the following ductwork:

1. All duct sealed to SMACNA Class A.
2. All welded duct.
3. Maximum permissible leakage rate:
   a. SMACNA Leakage Class 3.
   b. Welded Ductwork: Zero leakage.

D. Duct Leakage Testing Procedures:

1. Prior to fabrication and installation, develop and submit for approval a ductwork testing plan, indicating locations of temporary caps, surface area of ductwork test sections, test pressure, leakage class and allowable leakage in cubic feet per minute.
2. Notify the Owner's Representative at least 2 days prior to each test.
3. Provide all blank-off plates, flanges, and safing required to isolate each section of duct to be tested.
4. Provide necessary testing apparatus.
5. For all ducts, pressurize ductwork to the specified pressure class and inspect ductwork for visual and audible leaks, and leaks perceptible to a hand 2 in. from duct. Reseal all perceptible leaks until acceptable to Owner's Representative.
6. After completing visual and audible inspection, conduct measured ductwork leakage tests at the specified pressure class for the duct. Reseal and retest as required until successfully achieving the specified leakage class.
7. Submit leakage test report for approval, using SMACNA or other approved form.

3.7 COMMISSIONING

A. Perform the commissioning activities as outlined in the Division 01 Section Commissioning and other requirements of the Contract Documents.

3.8 DUCTWORK CLEANING

DETERMINE IF THIS SECTION IS REQUIRED. INSERT AND EDIT THE NADCA SPECIFICATION APPROPRIATELY.

A. Clean HVAC system as specified in the National Air Duct Cleaners Association (NADCA) "General Specifications for the Cleaning of Commercial Heating, Ventilation and Air Conditioning Systems."

B. Approved Ductwork Cleaning Specialists: Sani-Vac, Power Vac, High Tec Vacuum, Aero Filters Inc., and Stanley Steemer Great Lakes Inc.

END OF SECTION 233100