SECTION 23 31 00

HVAC DUCTS AND CASINGS

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:

1. Duct Materials.
2. Insulated flexible ducts.
3. Single wall spiral round ducts.
4. Single wall spiral flat oval ducts.
5. Transverse duct connection system.
6. Casings.
7. Ductwork fabrication.
8. Kitchen hood exhaust ductwork fabrication.
9. Duct cleaning.

B. Related Sections:

1. Division 03 - Cast-In-Place Concrete: Product requirements for concrete for placement by this section.
2. Division 09 - Painting and Coating: Execution requirements for Weld priming, weather resistant, paint or coating specified by this section.
3. Division 11 - Foodservice Equipment: Product requirements for kitchen range hoods for placement by this section.
4. Division 23 - Hangers and Supports for HVAC and Plumbing Piping and Equipment: Product requirements for hangers, supports and sleeves for placement by this section.
5. Division 23 - Air Duct Accessories: Product requirements for duct accessories for placement by this section.

1.02 REFERENCES

A. ASTM International:

1. ASTM A36/A36M - Standard Specification for Carbon Structural Steel.
2. ASTM A90/A90M - Standard Test Method for Weight Mass of Coating on Iron and Steel Articles with Zinc or Zinc-Alloy Coatings.
3. ASTM A167 - Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip.
4. ASTM A568/A568M - Standard Specification for Steel, Sheet, Carbon, and High-Strength, Low-Alloy, Hot-Rolled and Cold-Rolled, General Requirements for.
5. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
6. ASTM A1008/A1008M - Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability.
7. ASTM A1011/A1011M - Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability.
8. ASTM B209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
9. ASTM C14 - Standard Specification for Concrete Sewer, Storm Drain, and Culvert Pipe.
10. ASTM C443 - Standard Specification for Joints for Circular Concrete Sewer and Culvert Pipe, Using Rubber Gaskets.
11. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.

B. California Mechanical Code

1. CMC – State of California Mechanical Code

C. National Fire Protection Association:

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.
3. NFPA 96 - Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations.

D. Sheet Metal and Air Conditioning Contractors:

1. SMACNA 1995 1st Edition. - Fibrous Glass Duct Construction Standards.
2. SMACNA 1995 1st Edition. - HVAC Air Duct Leakage Test Manual.
3. SMACNA 1995 1st Edition. - HVAC Duct Construction Standard – Metal and Flexible.

E. Underwriters Laboratories Inc.:

1. UL 181 - Factory-Made Air Ducts and Connectors.

1.03 PERFORMANCE REQUIREMENTS

A. Variation of duct configuration or sizes other than those of equivalent or lower loss coefficient is not permitted except by written permission. Size round ducts installed in place of rectangular ducts in accordance with ASHRAE table of equivalent rectangular and round ducts.

1.04 SUBMITTALS

A. Division 01 - Submittal Procedures: Submittal procedures.

B. Shop Drawings: Submit duct fabrication drawings, drawn to scale not smaller than 1/4 inch equals 1 foot, on drawing sheets same size as Contract Documents, indicating:

1. Fabrication, assembly, and installation details, including plans, elevations, sections, details of components, and attachments to other work.
2. Duct layout, indicating pressure classifications and sizes in plan view. For exhaust duct systems, indicate classification of materials handled as defined in this section.
3. Fittings.
4. Reinforcing details and spacing.
5. Seam and joint construction details.
6. Penetrations through fire rated and other walls.
7. Terminal unit, coil, and humidifier installations.
8. Hangers and supports, including methods for building attachment, vibration isolation, and duct attachment.
9. Equipment service clearance, access panels and door swings.

C. Product Data: Submit data for duct materials, duct liner and duct connectors.

D. Test Reports: Indicate pressure tests performed. Include date; section tested, test pressure, and leakage rate, following SMACNA HVAC Air Duct Leakage Test Manual.

1.05 CLOSEOUT SUBMITTALS

A. Division 01 - Execution and Closeout Requirements: Closeout procedures.

B. Project Record Documents: Record actual locations of ducts and duct fittings. Record changes in fitting location and type. Show additional fittings used.

1.06 QUALITY ASSURANCE

A. Perform Work in accordance with SMACNA - HVAC Duct Construction Standards - Metal and flexible.

B. Construct ductwork to NFPA 90A and NFPA 96 standards.

C. Maintain one copy of each document on site.

1.07 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.

B. Installer: Company specializing in performing Work of this section with minimum three years documented experience approved by manufacturer.

1.08 PRE-INSTALLATION MEETINGS

A. Division 01 - Administrative Requirements: Pre-installation meeting.

B. Convene minimum three weeks prior to commencing work of this section.

1.09 ENVIRONMENTAL REQUIREMENTS

A. Division 01 - Product Requirements.

B. Do not install duct sealant when temperatures are less than those recommended by sealant manufacturers.

C. Maintain temperatures during and after installation of duct sealant.

1.10 FIELD MEASUREMENTS

A. Verify field measurements prior to fabrication.

1.11 WARRANTY

A. Division 01 - Execution and Closeout Requirements: Product warranties and product bonds.

PART 2 PRODUCTS

2.01 DUCT MATERIALS

A. Galvanized Steel Ducts: ASTM A653/A653M galvanized steel sheet, lock-forming quality, having G90 zinc coating of in conformance with ASTM A90/A90M.

B. Steel Ducts: ASTM A1008/A1008M, ASTM A1011/A1011M, ASTM A568/A568M.

C. Aluminum Ducts: ASTM B209; aluminum sheet, alloy 3003-H14. Aluminum Connectors and Bar Stock: Alloy 6061-T6 or of equivalent strength.

D. Stainless Steel Ducts: ASTM A167, Type 304 or 316.

E. Fasteners: Rivets, bolts, or sheet metal screws.

F. Hanger Rod: ASTM A36/A36M; steel, galvanized; threaded both ends, threaded one end, or continuously threaded.

2.02 INSULATED FLEXIBLE DUCTS

A. Manufacturers:

1. Casco
2. Glass Flex
3. Glen Flex
4. Substitutions: Division 01 - Product Requirements.

B. Product Description: Flexible duct shall consist of an exterior reinforced laminated vapor barrier, 1-1/2 inch thick fiberglass insulation (K = .25 @ 75 degrees F), encapsulated spring steel wire helix and impervious, smooth, non-perforated interior vinyl liner. Individual lengths of flexible ducts shall contain factory fabricated steel connection collars. Flexible fiberglass duct shall meet the requirements of NFPA No. 90A and UL 181.

1. Pressure Rating: 10 inches wg positive and 1.0 inches wg negative.
2. Maximum Velocity: 4000 fpm.
3. Temperature Range: -10 degrees F to 160 degrees F.
4. Furnish each flexible duct section with integral clamping devices for connection to round or oval fittings.
5. Join each flexible duct section to main trunk duct through sheet metal fittings. Construct fittings of galvanized steel and equip with factory installed volume damper having positive locking regulator. Provide fittings installed in lined ductwork with insulation guard.
6. Flexible ducts shall be supported at or near mid-length with 2 inch wide, 28 gage steel hanger collar, attached to the structure with an approved duct hanger. Installation shall minimize sharp radius turns or offsets. The maximum length connecting to terminal outlets shall be 7 feet and minimum length of 5 feet.

2.03 SINGLE WALL SPIRAL ROUND DUCTS

A. Manufacturers:

1. McGill Airflow Corporation
2. Semco Incorporated
3. Tangent Air Corp
4. Spiral Mfg. Co., Inc.
5. Substitutions: Division 01 - Product Requirements.
6. ECO Duct Products, Inc.

B. Product Description: UL 181, Class 1, round spiral lock seam duct constructed of galvanized steel.

C. Duct Coating for Underground Ducts: Polyvinyl chloride plastic, 4 mil thick on the outside. Temperature range: minus 30 degrees F to 200 degrees F.

D. Construct duct with the following minimum gages:

Diameter	Gauge
3 inches to 14 inches	26
15 inches to 23 inches	24
24 inches to 37 inches	22
38 inches to 50 inches	20
52 inches to 84 inches	18

E. Construct fittings with the following minimum gages:

Diameter	Gauge
3 inches to 14 inches	24
15 inches to 23 inches	22
24 inches to 37 inches	20
38 inches to 50 inches	20
52 inches to 60 inches	18
62 inches to 84 inches	16

2.04 CASINGS

A. Fabricate casings in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible and construct for operating pressures indicated.

B. Reinforce access door frames with steel angles tied to horizontal and vertical plenum supporting angles. Furnish hinged access doors where indicated or required for access to equipment for cleaning and inspection. Furnish clear wire glass observation ports, minimum 6 x 6 inch size.

C. Fabricate acoustic casings with reinforcing turned inward. Furnish 16 gage back facing and 22 gage perforated front facing with 3/32 inch diameter holes on 5/32 inch centers. Construct panels 3 inches thick packed with 4.5 lb. /cu ft minimum glass fiber media, on inverted channels of 16 gage.

2.05 RECTANGULAR DUCTWORK FABRICATION

A. Low Pressure Duct Construction Schedule: (2 inch" S.P. and below). Include all return, exhaust, supply branches and ductwork downstream of terminal units.

Duct Dimension (Inches)	Material Gauges	Construction of Transverse Joints, Bracing and Reinforcing
0 to 12	26	Hemmed S slip spaced not more than 10' apart
13 to 30	24	Ductmate Jr.**, or 1" G lock spaced not more than 10' apart
31 to 42	22	Ductmate Jr.**, spaced not more than 5' apart
43 to 54	22	Ductmate**, spaced not more than 4' apart
55 to 60	20	Ductmate**, spaced not more than 4' apart
61 to 84	20	Ductmate**, spaced not more than 4' apart
85 and up	18	Ductmate**, spaced not more than 4' apart. Provide intermediate bracing for low pressure ductwork 85" and larger

Note: * Based on maximum of 2.0" WG.
**The Lockformer Company TDC or approved equal

1. Provide intermediate bracing for low pressure ductwork 85 inches and larger.
2. All ducts over 18 inches in either dimension shall be stiffened with beads on 24 through 20 gage. Cross break on 18 and 16 gauge. Longitudinal seams shall be Pittsburgh locks Snap-Lock shall be limited to 12 inch maximum width of ducts.

B. High Pressure Duct Construction Schedule: (2-1/4" S.P. and above). Include all supply ducts on the roof, vertical supply ducts, and horizontal main supply ducts upstream of terminal units.

Duct Dimension (Inches)	*Material	Construction of Transverse
0 to 30	22	Ductmate**, or 1" G lock spaced not more than 4' apart
31 to 42	20	Ductmate**, spaced not more than 4' apart
43 to 54	20	Ductmate**, spaced not more than 4' apart
55 to 60	18	Ductmate**, spaced not more than 4' apart 2"x2"x18 ga angle reinforcing located midway between joints
61 to 84	18	Ductmate**, spaced not more than 4' apart 22"x22"x18 ga angle reinforcing located midway between joints
85 and up	18	Ductmate**, spaced not more than 4' apart 22"x22"x18 ga angle reinforcing located midway between joints

Note: * Based on max. of 5.0" W.G.
** or approved equal

1. Tie rods up to 36 inch, 1/4 inch diameter, over 36 inch", 3/8 inch diameter. All ducts over 18 inch either dimension are stiffened with beads on 24 through 18 gauge.
2. All high pressure ducts shall have Pittsburgh lock longitudinal seams.

C. Strap hanger shall be per CMC 2007, Table 6.2A & 6.2C (for round duct) and as required by CMC/UMC and SMACNA 1995 1st Edition guidelines.

D. Elbows shall be radius or short radius with vanes, type RE 1 and RE 3 in the SMACNA manual. Mitered elbows with turning vanes and other types shall not be used. Construct vanes per pages A.41 and A.43 of the SMACNA manual, Fig 2.3.

E. Divided flow branches shall be per SMACNA 1995 1st Edition, manual figure 2-5, type 1 or type 4A or 4B and type 3.

F. Branch connections per SMACNA manual figure 2-6; 45-degree entry shall only be used where airflow in branch is less than 25% of total airflow in main duct.

G. Offsets shall be SMACNA manual figure 2-7, type 1, concentric trans, eccentric trans and type 3.

H. Transitions shall be used on connections to air handling units and plenums.

I. Provide Ductmate and Ductmate, Jr. and TDC with all required material including metal cleats, corner bolts and nuts, angles, clips and gaskets, all installed in accordance with manufacturer's recommendations and supervision.

J. Quadrant volume damper blades in fittings shall be two gauges heavier than the fittings.

K. Longitudinal Seams: Pittsburgh lock sealed with noncuring polymer sealant. Button punch snap lock seams are not acceptable and shall not be used.

L. Provide drive slip or equivalent flat seams for ducts exposed in the conditioned space or where necessary due to space limitations.

M. 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 non-braced panel area unless ducts are lined.

N. Increase duct sizes gradually, not exceeding 15 degrees divergence wherever possible; maximum 30 degrees divergence upstream of equipment and 45 degrees convergence downstream.

O. Provide standard 45-degree lateral wye takeoffs. When space does not allow 45-degree lateral wye takeoff, use 90-degree conical tee connections.

2.06 KITCHEN HOOD AND DISHWASHER EXHAUST DUCTWORK FABRICATION

A. Fabricate in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible and NFPA 96.

B. Kitchen hood exhaust ducts having an area of 4 sf or less shall be #16 gauge and all ducts having an area greater than 4 sf shall be #14 gauge carbon steel, all with a continuous slope grease tight weld for seams and joints. Use 18 gauge 304 stainless steel minimum, when exposed duct is used. Provide access openings for duct cleaning as required by SMACNA “HVAC Duct Construction Standards”, NFPA 96 “ Removal of Smoke and Grease laden Vapors from Commercial cooking Equipment” and California Mechanical Code.

C. Moisture laden air system: Duct construction, joint method and duct sealant must be waterproof. Ducts shall slope back to hoods.

D. Dishwasher ducts, pot sink hood and exhaust ducts:

1. Concealed: Type 316L stainless steel.
2. Exposed: Type 316, stainless steel with finish to match kitchen equipment and range hood.
3. Weld and flange seams and joints.
4. Screw and silicone seal connection to hood.

2.07 ROUND DUCT AND FITTING FABRICATION

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

B. 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: ECO Products

C. 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.

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

E. Fabricate elbows using 5-gored construction. Bend radius of gored elbows shall be 1-1/2 times duct diameter where possible. Short radius adjustable elbow is acceptable for low pressure ductwork. Unless elbow construction type is indicated, fabricate elbows as follows:

1. Welded- Radius Elbow and Number of Pieces: Welded construction complying with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible," for grease duct and welded stainless steel systems.

2. Round Elbows 8 Inches and Less in Diameter: Fabricate adjustable gored long radius elbows for 45- and 90-degree elbows. Fabricate nonstandard bend-angle configurations or nonstandard diameter elbows with gored construction adjustable long radius.
3. Round Elbows 9 through 14 Inches in Diameter: Fabricate adjustable gored long radius elbows for 45,and 90 degrees. Fabricate nonstandard bend-angle configurations or nonstandard diameter elbows with gored construction. Fabricate 90 degrees elbows with minimum of 5 pieces.
4. Round Elbows Larger Than 14 Inches in Diameter and All Flat-Oval Elbows: Fabricate gored elbows unless space restrictions require mitered elbows.
5. Die-Formed Elbows for Sizes through 8 Inches in Diameter and All Pressures 0.040 inch thick (20 ga) with 2-piece welded construction.
6. Round Gored-Elbow Metal Thickness: Same as non-elbow fittings specified above.

PART 3 EXECUTION

3.01 EXAMINATION

A. Division 01 - Administrative Requirements: Coordination and project conditions.

B. Verify sizes of equipment connections before fabricating transitions.

3.02 INSTALLATION

A. Install and seal ducts in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible, as required in this section.

B. During construction, install temporary closures of metal or taped polyethylene on open ductwork to prevent construction dust from entering ductwork system.

C. Use beaded sleeve couplings for joining round duct and flexible ducts.

D. Install duct hangers and supports in accordance with Division 23.

E. Use double nuts and lock washers on threaded rod supports.

F. Set plenum doors 6 to 12 inches above floor. Arrange door swing so fan static pressure holds door in closed position.

G. Casings: Install floor mounted casings on 4 inch high concrete curbs. Refer to Division 03. At floor, rivet panels on 8 inch centers to angles. Where floors are acoustically insulated, furnish liner of 18 gage galvanized expanded metal mesh supported at 12 inch centers, turned up 12 inches at sides with sheet metal shields.

H. Install kitchen range hoods in accordance with NFPA 96.

I. Install residue traps in kitchen hood exhaust ducts at base of vertical risers with provisions for clean out.

J. Kitchen hood exhaust ducts: Use stainless steel for ductwork exposed to view and stainless steel or carbon steel where ducts are concealed.

3.03 INSTALLATION OF METAL DUCTWORK

A. General: Assemble and install ductwork in accordance with recognized industry practices which will achieve air-tight (5% total system leakage) and noiseless (no objectionable noise) systems capable of performing each indicated service. Install each run with a minimum number of joints. Align ductwork accurately at connections, within 1/8 inch misalignment tolerance and with internal surfaces smooth. Support ducts rigidly

with suitable ties, braces, hangers and anchors of type which will hold ducts true-to-shape and to prevent buckling. Support vertical ducts at every floor.

B. Field Fabrication: Complete fabrication of work at project as necessary to match shop fabricated work and accommodate installation requirements.

C. Routing: Locate ductwork runs, except as otherwise indicated, vertically and horizontally and avoid diagonal runs wherever possible. Locate runs as indicated by diagrams, details and notations or, if not otherwise indicated, run ductwork in shortest route which does not obstruct useable space or block access for servicing building and its equipment. Hold ducts close to walls, overhead construction, column, and other structural and permanent enclosure elements of building. Limit clearance to 1/2 inch where furring is shown for enclosure or concealment of ducts, but allow for insulation thickness, if any. Where possible, locate insulated ductwork for 1 inch clearance outside of insulation. Wherever possible in finished and occupied spaces, conceal ductwork from view, by locating in mechanical shafts, hollow wall construction or above suspended ceilings. Do not encase horizontal runs in solid partitions, except as specifically shown. Coordinate layout with suspended ceiling and lighting layouts and similar finished work or as dictated by Developer Design/Builder coordination.

D. Coordination: Coordinate duct installations with installation of accessories, dampers, coil frames, equipment, controls and other associated work of ductwork system.

E. Seal the clips, Snaplock seams and joints or connections of the metal supply, return and exhaust ducts and the grilled and diffuser seal ductwork with water based duct sealant manufactured by Design Polymetrics 1010, hard cast or equal. Sealing of Pittsburgh seams is required. Seal duct work to meet required duct pressure testing.

F. Install access doors to open against system air pressure, with latches operable from either side, except outside only where duct is too small for person to enter.

G. Coordinate with other work, including ductwork, as necessary to interface installation of ductwork accessories properly with other work.

H. Round ducts shall be used to the maximum extent possible. As duct size increases, flat oval shall be considered. Rectangular ducts shall be limited to areas of space restriction with a maximum aspect ratio of 2:1. If due to a structural clearance constraint, duct aspect ratio can be increased and/or duct cross section reduced if upstream transition has included angles of 60 degrees or less and downstream transition has included angles of 30 degrees or less.

I. Ducts exposed outside to elements shall constructed to shed rainwater. Slope the flat top of rectangular ductwork so rainwater will not stand on top of duct. It is acceptable to cross break the top of the duct provided that no puddle is created.

J. Except for connection of terminal discharge duct to air outlets, 90 degree taps shall not be used unless space prohibits the use of low loss fittings. Takeoff feeding terminals shall be conical branch; 45 wye, conical branch; low loss tee; bell mouth, or branch with a loss coefficient equivalent to that for the conical branch. The slopes of transitions shall be approximately one to five, and no abrupt changes or offsets of any kind in the duct system shall be permitted.

K. Install round ducts in lengths not less than 12 feet unless interrupted by fittings.

L. Install ducts with fewest possible joints.

M. Install fabricated fittings for changes in directions, size, and shape and for connections.

N. Install couplings tight to duct wall surface with a minimum of projections into duct. Secure couplings with sheet metal screws. Install screws at intervals of 12 inches, with a minimum of 3 screws in each coupling.

O. Install ducts vertically and horizontally and parallel and perpendicular to building lines; avoid diagonal runs in ducts that would be over 12 feet in length.

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

Q. Install ducts with a clearance of 2 inch on each side, plus allowance for insulation thickness.

R. Conceal ducts from view in finished spaces. Do not encase horizontal runs in solid partitions unless specifically indicated.

S. Coordinate layout with suspended ceiling, fire- and smoke-control dampers, lighting layouts, and similar finished work.

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

U. Stainless steel ducts shall be welded joints and fittings except for connection to air valves and fume hoods shall be flanged.

V. Install heavy volume dampers at all main supply, return and exhaust duct branch connections. Heavy volume dampers shall be Pottorff Series 400 AF with handle, or approved equal.

W. Duct hangers shall be attached to horizontal slabs with steel angle clips secured with inserts, strapped to vertical walls, bolted to beams and joists, as per SMACNA guidelines, or as approved by the County's Representative.

X. All ducts and equipment shall be blown out prior to operating.

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

Z. 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.

AA. Fire-Rated Partition Penetrations: Where ducts pass through interior partitions and exterior walls, install appropriately rated fire dampers or combination fire/smoke dampers, sleeves.

BB. Install ducts with hangers and braces designed to withstand, without damage to equipment, seismic force required by California building codes.

CC. Protect duct interiors from the elements and foreign materials until building is enclosed. Follow SMACNA's "Duct Cleanliness for New Construction."

DD. Do not paint interiors of metal ducts.

EE. Protect duct openings from damage and prevent entrance of foreign materials.

3.04 INSTALLATION OF FLEXIBLE DUCTS

A. Maximum length: For any duct run using flexible ductwork, do not exceed 7'- 0" extended length.

B. Installation: Install in accordance with Section III of SMACNA's "HVAC Duct Construction Standards, Metal and Flexible", 1995 edition.

C. Bends in flexible ducts shall have a radius of not less than 1.5 times the internal diameters wherever possible.

3.05 EQUIPMENT CONNECTIONS

A. General: Connect metal ductwork to equipment as indicated. Provide flexible connection for each ductwork connection to equipment mounted on vibration isolators, and/or equipment containing rotary machinery. Provide access doors as indicated. Provide sheet metal cover for flexible connection exposed to weather.

3.06 HANGING AND SUPPORTING

A. Support horizontal ducts within 24 inches of each elbow and within 48 inches of each branch intersection.

B. Support vertical ducts at maximum intervals of 16 feet and at each floor.

C. Install upper attachments to structures with an allowable load not exceeding limitations as determined by Developer/Design Builder.

D. Install concrete inserts before placing concrete.

E. Install drilled in concrete anchors after concrete is placed and completely cured.

F. Powder-actuated concrete fasteners are acceptable provided they meet the limitations as determined by Developer/Design Builder. Submit for approval.

3.07 INTERFACE WITH OTHER PRODUCTS

A. Install openings in ductwork where required to accommodate thermometers and controllers. Install pitot tube openings for testing of systems. Install pitot tube complete with metal can with spring device or screw to prevent air leakage. Where openings are provided in insulated ductwork, install insulation material inside metal ring.

B. Connect diffusers or light troffer boots to low pressure ducts directly or with 5 to 7 feet maximum length of flexible duct held in place with strap or clamp. Do not use flexible duct on moisture laden air systems.

C. Connect air terminal units to supply ducts directly with at least one duct size larger than air terminal connection.

3.08 CLEANING NEW SYSTEM

A. Division 01 - Execution and Closeout Requirements: Final cleaning.

B. If the ductwork system is maintained in a clean state during the installation the following is not required. If in the opinion of the Building's Representative the ductwork system is dirty the following shall be complied with.

C. Mark position of dampers and air-directional mechanical devices before cleaning, and perform cleaning before air balancing.

D. Use service openings, as required, for physical and mechanical entry and for inspection.

1. Create other openings to comply with duct standards.
2. Disconnect flexible ducts as needed for cleaning and inspection.
3. Remove and reinstall ceiling sections to gain access during the cleaning process.

E. Vent vacuuming system to the outside. Include filtration to contain debris removed from HVAC systems, and locate exhaust down wind and away from air intakes and other points of entry into building.

F. Clean the following metal duct systems by removing surface contaminants and deposits:

1. Air outlets and inlets (registers, grilles, and diffusers).
2. Supply, return, and exhaust fans including fan housings, plenums (except ceiling supply and return plenums), scrolls, blades or vanes, shafts, baffles, dampers, and drive assemblies.
3. Air-handling unit internal surfaces and components including mixing box, coil section, air wash systems, spray eliminators, condensate drain pans, humidifiers and dehumidifiers, filters and filter sections, and condensate collectors and drains.
4. Coils and related components.
5. Return-air ducts, dampers, and actuators except in ceiling plenums and mechanical equipment rooms.
6. Supply-air ducts, dampers, actuators, and turning vanes.

G. Cleaning Requirements:

1. Interior surfaces of all supply ductwork shall be cleaned of dust and dirt at the fabrication shop during fabrication.
2. Supply Ductwork shall be sealed to protect interior surfaces prior to being shipped and handled.
3. Seals and wrapping shall be removed on job site at time of installation.
4. Seal open duct ends during at the end of each day.

H. Mechanical Cleaning Methodology:

1. Clean metal duct systems using mechanical cleaning methods that extract contaminants from within duct systems and remove contaminants from building.
2. Use vacuum-collection devices that are operated continuously during cleaning. Connect vacuum device to downstream end of duct sections so areas being cleaned are under negative pressure.
3. Use mechanical agitation to dislodge debris adhered to interior duct surfaces without damaging integrity of metal ducts, duct liner, or duct accessories.
4. Clean fibrous-glass duct liner with HEPA vacuuming equipment; do not permit duct liner to get wet.
5. Clean coils and coil drain pans according to NADCA 1992. Keep drain pan operational. Rinse coils with clean water to remove latent residues and cleaning materials; comb and straighten fins.

I. Cleanliness Verification:

1. Visually inspect metal ducts for contaminants.
2. Where contaminants are discovered, re-clean and re-inspect ducts.

3.09 SCHEDULES

A. Static-Pressure Classes: Construct ducts according to the following:

1. Supply Ducts (Exterior Installation): 6-inch wg.
2. Supply Ducts before Air Terminal Units (VAV Boxes or Air Valves): 4-inch wg.
3. Supply Ducts after Air Terminal Units (VAV Boxes or Air Valves): 2-inch wg.
4. Supply Ducts (In Mechanical Equipment Rooms, Roof and Risers): 6-inch wg.
5. Return Ducts (Negative Pressure): 2-inch wg.
6. General Exhaust Ducts (Negative Pressure): 2-inch wg.
7. Vertical risers shall be constructed to a minimum of 4-inch wg, regardless of type.

END OF SECTION