SECTION 23 30 00

HVAC AIR DISTRIBUTION

PART 1 - GENERAL

1.1 SUMMARY

A. Related Documents: Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

B. Work Included:

1. HVAC Ductwork
2. Air Duct Accessories
3. HVAC Fans
4. Air Terminal Units
5. Air Outlets and Inlets
6. Wall Louvers

C. Related Sections:

1. Section 01 91 13 -- General Commissioning Requirements
2. Section 23 00 10 – HVAC General Requirements
3. Section 23 05 00 – Common Work Results for HVAC
4. Section 23 05 48 – Vibration and Seismic Controls for HVAC Equipment and Piping
5. Section 23 05 53 – Identification for HVAC Piping and Equipment
6. Section 23 07 00 – HVAC Insulation
7. Section 23 05 93 – Testing, Adjusting, and Balancing for HVAC
8. Section 23 70 00 – Central HVAC Equipment
9. Section 23 80 00 – Decentralized HVAC Equipment

1.2 REFERENCES:

A. General: The following standards or codes form a part of this specification to the extent indicated by the reference thereto.

B. Air Movement and Comfort Association (AMCA):

Bulletin 210, Standard Test Code for Air Moving Devices

Standard 511, Air Performance and Water Penetration

C. American Society for Testing and Materials (ASTM):

ASTM A 525 General Requirements for Steel Sheet, Zinc Coated (Galvanized) By the Hot-Dip Process

ASTM A 527 Steel Sheet, Zinc Coated (Galvanized) By the Hot-Dip Process, Lock-Forming Quality

ASTM E 84 Standard Test Method for Surface Burning Characteristics of Building Materials

ASTM C 411 Standard Test Method for Hot-Surface Performance of High-Temperature Thermal Insulation

D. Underwriters Laboratories, Inc. (UL)

Standard 723 Tests for Surface Burning Characteristics of Building Materials

E. Sheet Metal and Air Conditioning Contractors' Association (SMACNA)

Duct Construction Standards (Latest Edition)

HVAC Air Duct Leakage Test Manual (Latest Edition)

F. National Fire Protection Association (NFPA):

1. Standard 90A – Standard for the Installation of Air Conditioning and Ventilating Systems
2. Standard 90B – Standard for the installation of Warm Air Heating and Air Conditioning Systems
3. Standard 96 – Standard for the Installation of Equipment for the Removal of Smoke and Grease – Laden Vapors from Commercial Cooking Equipment
4. Standard 255 – Method of Test of Surface Burning Characteristics of Building Materials

G. California Department of Health Services

Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers

1.3 DEFINITIONS:

A. Duct Sizes: Sizes shown on Drawings are actual sheet metal dimensions. For acoustically lined ducts, sizes indicated are actual sheet metal sizes allowing for 1" thick acoustic lining. For double wall ductwork, sizes indicated are inside dimensions.

B. Low Pressure Ductwork: Static pressure rating less than 2" w.g. and velocities less than 2000 fpm.

C. Medium Pressure Ductwork: Static pressure rating less than 6" w.g. and velocities greater than 2000 fpm and all ductwork upstream of VAV boxes.

D. High Pressure Ductwork: Static pressure rating over 6” w.g. and velocities greater than 2000 fpm.

1.4 COMMISSIONING OF HVAC SYSTEMS:

A. The Contractor shall provide contact information to the Commissioning Agent indicated in Division 1 for all major items of Equipment.

B. Provide additional submittal copy of major equipment for Commissioning Agent specified in Division 1.

1.5 SUBMITTALS:

A. Submit shop drawings, product data and samples in accordance with Division 1 and Section 23 00 10.

B. Shop drawings, diagrams, catalog data and such other data necessary to fully describe and substantiate compliance with these specifications shall be submitted for all equipment and materials marked with notation set forth in Section 23 00 10.

C. Operation and maintenance data shall be submitted in accordance with Division1, for all items of equipment and materials marked with notation set forth in Section 23 01 00.

D. All fans for use with Variable Frequency Drives (VFD) shall have critical speed and multiples of critical speed indicated on each submittal.

1.6 SPARE PARTS

A. Each filter grille shall be provided with 3 sets of filters. At end of construction each unit shall be provided with a clean filter and one set shall be turned over to the Owner as spares.

PART 2 - PRODUCTS

2.1 HVAC DUCTWORK

A. Materials:

1. Sheet Metal Ducts: Trademarked galvanized steel, lock forming quality, having zinc coating of 0.90 ounces per square foot for each side (G90, ASTM A653 and A653M).
2. All ductwork without external insulation, exposed to view in finished, non-utility spaces shall have paint-grip or galvaneal coating to accept field painting.
3. Fasteners: Use rivets and bolts throughout; sheet metal screws may be used on low pressure ducts.
4. Sealants: United McGill “United Duct Sealer” or equal. Water and fire resistant when dry, compatible with mating materials. Where sealants are used on exposed

ductwork, composition shall be designed to prevent bleed-through of finish paint, or sealant shall be pre-painted with a coating impervious to bleed-through. For field applications within the weatherproofing system, all adhesives and sealants shall comply with the requirements of the California Health Services Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers.

5. All duct and accessory materials shall have a composite flame spread rating not exceeding 25, and a smoke developed rating not exceeding 50 as tested under procedure ASTM E-84-75, NFPA 255 and UL 723. Duct coverings and linings shall not flame, glow, smolder or smoke when tested in accordance with ASTM C411.

B. Fabrication:

1. All ductwork shall conform accurately to the dimensions indicated on plans and shall be fabricated and installed in accordance with ASHRAE Guide and Data Books and SMACNA Duct Construction Standards, except that sheet metal gauges and zinc coating shall not be lighter than specified under this Section.
2. All rectangular sheet metal ducts over 18” wide shall be cross-broken for rigidity.
3. Reinforcing angles, stiffeners and tie-rods for all sheet metal ducts shall be provided where required to prevent sagging, buckling, and vibration in accordance with the latest SMACNA Duct Construction Standards Publication. Reinforcing for flat oval duct shall be provided as specified for rectangular duct in accordance with the latest SMACNA Duct Construction Standards Publication.
4. Lap metal ducts in direction of air flow. Hammer down edges and slips to leave smooth interior surface.
5. Where square elbows are indicated on the Drawings, curved elbows may be used provided the centerline radius is not less than 1-1/2 times the width of duct and as space allows.
6. Provide turning vanes in all square elbows. Provide air foil type turning vanes on all ducts more than 24” wide. Mitered round elbows (2-piece) shall not be used unless specifically indicated. Mitered round elbows shall have airfoil turning vanes.
7. Transitions shall be made with a slope ratio of 4:1, except at equipment divergence and convergence shall not exceed a slope ratio of 3:1.
8. All duct joints and seams shall be mechanically tight, and sealed with sealant or gaskets to provide a substantially airtight system.
9. All duct liners shall be installed using fasteners in strict accordance with SMACNA Duct Construction Standards. Fastener pins shall be clinched pin type or welded pin type. The use of adhesive type pins is not acceptable. All liners shall have transverse edges coated with adhesive, all corners lapped and butted or folded.
10. Duct liners at fan discharges shall be lapped on outside of fan discharge flange or shall have metal nosing on leading edge. Fastening pin length shall be equal to liner thickness.

11. Provide easements where low pressure ductwork conflicts with piping and structure. Where easement exceeds 10% duct area, split into two ducts maintaining original duct area.
12. Plenums and Casings (Site Fabricated Units) [S]: Construct of galvanized steel panels joined by standing seams on outside of casing. Rivet or bolt all seams and joints on approximately 6" centers and seal with sealant. Reinforce with steel angles and provide diagonal bracing. Access doors shall be 36" x 18" with frame welded to plenum, three brass hinges and three brass tension fasteners operable from either side of door.
13. All radiused elbows shall have centerline radius (R = 1.5 D), and shall be stamped or pressed smooth radius or minimum five gore type. Adjustable gore type fittings are not acceptable.
14. All locking regulator shall be Rossi Everlock, Elgen Super Standoff, or Windgate Sure-Loc HD, unless noted otherwise.

C. Low Pressure Ducts:

1. Sheet Metal Gauges:

a. Rectangular Ducts:

Max. Dimen., In.	Min. Gauge
Up to 30	24
31 to 54	22
55 to 84	20
85 and Over	18

b. Round Ducts:

Duct Diameter, In.	Min. Gauge
Up to 24	26
25 to 30	24
31 to 36	22
37 to 50	20
51 to 60	18
61 to 84	16

D. Medium and High Pressure Ducts:

1. Sheet Metal Gauges:

a. Rectangular Ducts:

Max. Dimen., In.	Min. Gauge
Up to 18	22
19 to 48	20
49 to 72	18
73 to 96	16
97 to 144	14

b. Round Ducts (Factory Made With Spiral Lock Seams equal to United McGill):

Duct Diameter, In.	Min. Gauge
Up to 26	24
28 to 36	22
38 to 50	20
51 to 60	18
61 and Over	16

2.

2. Fittings shall be minimum 20 gauge on flat oval, but not less than 2 gauges heavier than ductwork in which it is installed on round and flat oval. Fittings for duct sizes 5" round and below may be minimum 24 gauge.
3. All take-offs shall be full body pre-manufactured 45° conical lateral type or alternate pre-manufactured fitting with equivalent loss coefficient. The use of field-installed or factory lateral taps or manifolds is not acceptable.
4. All elbows shall have centerline radius (R = 1.5 D), and shall be stamped or pressed smooth radius or minimum five gore type. Adjustable gore type fittings are not acceptable.

2.2 AIR DUCT ACCESSORIES

A. Sound traps [S] shall be rectangular or tubular model of size and performance as indicated. Outer casing shall be galvanized steel with lock formed or continuously welded seams and rated to withstand 10" of water pressure. Interior baffles shall be perforated galvanized steel backed by acoustical filler made from inorganic, moisture proof fiberglass material compressed to prevent settling.

B. Access Doors:

1. Doors for low pressure rectangular ductwork shall be galvanized steel, 20 gauge rigid type, 12" X 16" minimum size unless noted otherwise, except where size of duct will not accommodate this size, they shall be as large as possible. Door shall have gasket, two hinges, and two compression latches with outside and inside handles. Provide insulated doors where installed in insulated ductwork.
2. Doors for round or flat-oval low, medium or high pressure ductwork shall be a complete factory mounted, duct section/access door assembly constructed of minimum 20 gauge galvanized steel. Access door shall match within two inches the diameter of duct and shall be complete with gasket, insulated door with handle, compression clips and chain retainer.

C. Gravity dampers shall be Airline type CBD counter balanced back draft damper constructed of felt edged aluminum blades. Set to open at .10" H2O. Maximum leakage rate shall be 20 cfm/ft2 at 1.0 inch water gauge when tested in accordance with AMCA 500D.

D. Dampers:

1. General:

    a. Fabricate of galvanized steel.
    b. Where manual dampers occur behind or above finished portions of hard ceilings or walls, a remote cable operated damper by Young Regulator Co. shall be provided.
    c. Where dampers are located in accessible spaces, operators shall be locking type quadrant operators. Quadrant operators shall be installed on 1-1/2" high 4 bend galvanized steel bracket so that duct insulation may be extended and sealed under the quadrant operator.
    d. End of damper rod on each damper shall be grooved to show damper position.

E. Manual Volume Dampers shall be Ruskin model MD35, opposed blade multi-louver single blade for dampers under 11" nominal construction 16 gauge minimum with molded synthetic or stainless steel bearings, galvanized channel iron frame and maximum blade width of 8 inches. Axles shall be positively locked into blades to prevent slippage or loosening. Damper blades shall be interlocking type with linkage, control shaft, and standoff locking regulator ,Rossi Everlock, Elgen Super Standoff, or Windgate Sure-Loc HD.

F. Rectangular branch take-off connections from mains shall be made using 45 degree entry fittings per SMACNA 1995 figure 2-6. Grille and register connections to mains shall be made using 45 degree entry fittings where space allows. Where diffuser, register or grille is located too close to the main, air deflectors shall be used. Air deflectors shall be factory fabricated. Adjustable deflectors shall be complete with worm gear operator when behind grilles, an extension rod and concealed regulator when above plaster ceilings, or self-locking lever type regulator when accessible. Locking regulator shall be Rossi Everlock, Elgen Super Standoff, or Windgate Sure-Loc HD.

G. Instrument Test Holes: Holes, with patches, in ducts and plenums shall be provided where directed or necessary for using pitot tubes for taking air measurements for balancing the air systems. At locations where ducts or plenums are insulated and on all medium and high pressure ductwork die cast collars with threaded neoprene caps shall be provided.

H. Apparatus Connections: At points where sheet metal connections are made to fans or where ducts of dissimilar metal are connected, provide a flexible connection of neoprene coated canvas of sufficient length to eliminate transmission of vibration. Flexible connections shall be securely fastened and air tight.

I. Duct Sleeves: All ducts shall have sleeved openings 1" larger than the overall duct dimensions framed in place when the wall is constructed and 1/4" larger when floors are poured. Space between duct or duct insulation and sleeve shall be tightly filled with mineral fiber rope insulation and sealed. All duct penetrations through corridor walls, floors not requiring fire dampers and walls indicated to be smoke partitions shall be

sealed with U.L. approved firestopping sealant. In fire partitions or floors requiring fire dampers, the duct sleeve shall be sized to match the fire damper frame with all voids packed tight with mineral fiber rope. All penetrations through draftstop partitions shall be sealed to maintain the integrity of the partition. Flanges, constructed of 20 gauge galvanized sheet metal, not less than 3" wide, shall be installed at each opening in finished areas.

J. Prefabricated curbs shall be provided where ductwork above roof penetrates roof surface, sized to match ductwork and duct supports. Curbs shall be insulated type, 12 inches high complete with mounting flange and integral cant strip where acceptable to roofing manufacturer. Outer shell shall be mitered and welded continuously to form a rigid leakproof shell; inner shell shall be solid metal similarly constructed. Wood nailing strips shall be bolted to top of curb shell to provide means for securing flashing material to the curb. Curb shall be constructed of galvanized steel. Ductwork and insulation cover shall be counterflashed to the curb. Curb sidewalls shall be fully insulated to minimum R-5. Top of curb shall be gasketed for airtight fit of rooftop unit.

K. High Efficiency Take Offs (HETOs) [S] shall be 24 gauge G90 galvanized steel, welded and riveted construction. Each fitting shall have conical bell-mouth duct fitting, locking groove, insulation guard, adjustable damper with 3/8" square shaft, u-bolt, nylon bushings, and standoff locking regulator (Rossi Everlock, Elgen Super Standoff, or Windgate Sure-Loc HD).

L. All wire mesh, woven metal fabric, bird screens, and similar items shall be constructed from corrosion resistant, galvanized steel or aluminum.

M. Duct Smoke Detectors: The air duct smoke detector shall be of the photoelectronic type, with sampling and exhaust tubes of the proper dimensions, insect screen, and shall incorporate an air-tight smoke chamber in compliance with UL 268A standard for smoke detectors for duct applications. The detector enclosures shall be equipped with an integral mounting base capable of accommodating either photoelectronic or ionization detector heads and shall be capable of local testing via a magnetic switch. Detector housing cover shall be clear polycarbonate. The detector shall operate at air velocities of 300 feet per minute to 4000 feet per minute. The unit shall operate on 120 volts AC and be complete with one (1) Form A (NO) and two (2) Form C (DPDT) 2 amp rated contacts. Standby current shall be 15 milliamps. Alarm current shall be 20 milliamps. A remote trouble/alarm lamp, piezo horn (85dB) and keyed switch reset test station shall be provided with each air unit.

2.3 HVAC FANS [S] [O/M]

A. Roof fans shall be equal to Greenheck of model indicated, roof or sidewall vent type, power exhaust fans having backward curved composite, aluminum, or steel blade centrifugal fan, directly or belt connected as indicated to motor in fully enclosed air cooled motor compartment, outside of exhaust air stream. Fan and motor housing shall be aluminum. Provide electronically commutated motors (ECM) for all fans unless

otherwise noted. ECM motor shall be suitable for connection to DDC system specified in 23 09 00 where required. All ECM motors shall be complete with means to adjust the speed of the fan either through the DDC system or at the fan. All ECM motors shall be speed controllable down to 20% of full speed (80% turndown). ECM motor shall be a minimum of 85% efficient at all speeds. Each fan shall be complete with bird screen and motor (gravity) operated dampers. Each fan shall be tested and rated in accordance with AMCA Standard #210. Each fan motor shall be factory wired to a terminal strip mounted in a junction box attached inside the motor housing. A weather resistant switch or disconnect, with thermal overload, shall be provided in wiring between the terminal strip and motor connection. All motor operated damper actuators shall be coordinated to operate off the same voltage as the associated fan.

B. Centrifugal fans shall be equal to Greenheck Vent Set with centrifugal fan wheel direct connected to motor. Fan and motor shall be mounted on a common base. Fan wheel shall be steel. Rubber in shear type vibration isolators shall be provided for entire unit. Motors shall be open drip proof sleeve bearing type.

C. Ceiling exhaust fans shall be equal to Greenheck complete with aluminum inlet grille with white finish coat, twin wheeled power unit with shaded pole motor, acoustic line steel housing with integrally wired junction box and disconnects for fan motor, (solid state variable speed controller with positive off,) and backdraft damper in discharge outlet.

D. All motor operated dampers shall be Class 1A with maximum leakage rate of 4 cfm/ft2 at 1.0 inch water gauge when tested in accordance with AMCA 500D.

E. Prefabricated curbs shall be insulated type, 12-14 inches high complete with mounting flange, integral cant strip and rack or flange to support dampers. Outer shell shall be mitered and welded continuously to form a rigid leakproof shell, inner shell shall be solid metal similarly constructed. Wood nailing strips shall be bolted to top of curb shell to provide means for securing flashing material to the curb. Curb shall be constructed of (aluminum) (galvanized steel). Curb sidewalls shall be fully insulated to minimum R-5. Top of curb shall be gasketed for airtight fit of rooftop unit.

F. See PART 1 for spare parts requirements.
1.

2.4 AIR OUTLETS AND INLETS [S]:

A. Acceptable Manufacturers:

1. Standard Products: Price, Metal Industries, Krueger, Tuttle and Bailey, and Titus.

B. General:

1. All devices shall be commercial grade and shall be constructed of steel or aluminum as indicated on the drawings.

2. Manufacturer shall certify cataloged performance and ensure correct application of each air device to provide air pattern, velocity, pressure drop and sound characteristics NC suitable for space installed. Shop drawings shall include a fully itemized list of each devices air quantity, size, accessories, border style, pressure drop, throw ft, and sound level NC. Inclusion of the manufacturers catalog data is not acceptable. Shop Drawings without this information will not be reviewed.
3. All devices located in ceilings shall have white baked enamel finish. Devices at other locations shall have prime finish suitable for painting or anodized aluminum unless noted otherwise.
4. Maximum air outlet noise level shall not exceed NC35.
5. Provide sponge rubber seal around edges of all supply registers and grilles.

C. Registers and Grilles:

1. Return and exhaust registers shall be aluminum, unless noted otherwise, complete with 45 degree fixed airfoil vanes at not more than 1/2 inch centers. Provide 1 or 1-1/4 inch margin, 1/8 inch beveled frame with concealed screw holes. Damper shall be opposed blade face operated type with removable key. Units on watertight ducts shall be all polished stainless steel or aluminum with baked enamel finish, including damper, linkage, core and frame.
2. Return or exhaust registers (floor mounted) shall be extruded aluminum linear grille with 0° fixed deflection grille bars. Grille bars shall be spaced at not more than 7/16 inches on center. Grille shall be complete with 1” margin frame with countersunk screw holes. Damper shall be factory mounted opposed blade face operated type with removable key.
3. Return Filter grilles shall be heavy duty aluminum with fixed horizontal blades spaced at 1/2" centers and set 45°. Blades shall run parallel to the long dimension of the grille. The mounting frame shall be designed to accept a standard one-inch filter media.

    a. The border shall be mounted to the filter frame with 1/4 turn quick-release fasteners. Filter shall be accessible from the face to allow easy cleaning or replacement. Filter efficiency shall be MERV-8 and the filter type shall be pleated.
4. Supply Registers:

    a. Sidewall supply registers shall be aluminum complete with removable, reversible double deflection core and fixed horizontal or longitudinal deflecting vanes at not more than 1/3 inch centers. Provide 1 or 1-1/4 inch margin frame 1/8 inch beveled frame or 3/16 to 1/4 inch curved frame with concealed screw holes. Damper shall be opposed blade face operated type with removable key. Units shall be provided with core removal tools which shall be turned over to the Owner. Front row of deflection blades shall be horizontal.

5. Grilles shall be as specified for registers except without opposed blade dampers.

6. All registers and grilles installed in a wall shall be provided with front blades parallel to the floor. Those installed in the ceiling shall have front blades parallel to the long dimension.

2.5 WALL LOUVERS [S]:

A. Louvers shall be stationary, stormproof units constructed of (16 gauge galvanized steel) complete with 1/2" mesh matching bird screen in removable frame and extended sill. Blades shall be "S" or "K" shape spaced 3 1/4" - 4" O.C. Finish shall be baked enamel, color as selected by Architect. Pressure drop shall not exceed 0.10 inch H_2O at 700 fpm and water penetration shall not exceed 0.01 oz./sq. ft. at 500 fpm when tested in accordance with AMCA Standard 511, and shall be licensed to bear the AMCA seal. All project louvers shall be provided under this Section. See Architectural Drawings for louvers not shown on Mechanical Drawings, at gables, elevator vents, smoke vents and similar areas.

PART 3 - EXECUTION

3.1 INSTALLATION:

A. Duct clearance and lengths shall be established from measurements taken at the job site before any ducts are fabricated.

B. Provide openings in ductwork where required to accommodate thermometers and controllers. Provide pitot tube openings where required for testing and balancing of system. Where exhaust ducts are installed within a chase or shaft, pitot tube shall extend to the outside of the chase or shaft and be capped.

C. Locate ducts with sufficient space around equipment to allow normal passage, and operating and maintenance activity.

D. Locate all ductwork to align with the ceiling grid where connections are to be made to Diffusers, Registers and Grilles. Field verify exact grid location before installing ductwork.

E. Locate all Diffusers, Registers and Grilles as indicated on plans and in accordance with the Reflected Ceiling Plans, if provided.

F. Provide low loss factory fabricated fittings for all round take-off connections to low velocity rectangular ducts.

G. Install duct accessory items in accordance with manufacturers printed instructions.

H. Install volume, smoke and fire dampers where shown on plans.

I. Manual volume dampers shall be installed at all branch connections, divided flow branches, and end-of-run diffuser/register connections for low pressure supply, return, and exhaust duct systems. Manual volume dampers shall be installed within 3 feet of the main duct.

J. Provide access doors at all automatic dampers, thermostats and at all other points requiring inspection or servicing. Labeling shall be as specified for equipment nameplates under Section 23 05 53.

K. Connection of horizontal ducts to rooftop exhaust fans shall be made using radiused elbows or mitered elbows with turning vanes. Duct transitions shall be as hereinbefore specified.

L. Ductwork installed or stored on site shall be protected such that open ends are covered to prevent construction dust and debris and other foreign matter from being introduced into the duct systems. If at any time during construction, dust or debris is discovered within the duct systems or ducts openings are observed to be unprotected, the Contractor will be responsible for properly cleaning all duct systems in accordance with NADCA procedures for the respective type of ductwork.

M. Grille, Register and Diffuser Installation:

1. Boots to diffusers shall fit airtight to diffuser necks and diffusers shall be securely fastened thereto.
2. Where grilles are installed at walls or ceilings, the duct shall be fastened securely to the masonry or panel at each side of the opening and the grille shall be securely fastened snug against the masonry or panel.
3. If flanged grille frames are used on exposed ducts, runout shall be same size as outside dimension of flange and full depth of register assembly.
4. Unless otherwise indicated in the Contract Documents, sidewall grilles and registers to be installed high shall be installed within 6 inches of the ceiling or nearest overhead projection. Unless otherwise indicated in the Contract Documents, sidewall registers and or grilles to be installed low shall be installed within 6 inches of the floor, but shall be coordinated with cove or base molding. Sidewall registers shall also be coordinated with the block coursing where applicable.

N. Patching: Where existing control, monitoring or other penetrating devices are removed from ductwork, the opening shall be patched to match thickness, type and finish of existing ductwork, and sealed airtight.

3.2 DUCT CLEANING:

A. Clean new supply, return, and exhaust duct systems before testing, adjusting, and balancing.

B. Use service openings for entry and inspection.

1. Create new openings and install access panels appropriate for duct static-pressure class if required for cleaning access. Provide insulated panels for insulated or lined duct. Patch duct as recommended by duct manufacturer. Comply with paragraph "Air Duct Accessories" in this Section for access panels and doors.
2. Disconnect and reconnect flexible ducts as needed for cleaning and inspection.
3. Remove and reinstall ceiling to gain access during the cleaning process.

C. Particulate Collection and Odor Control:

1. When venting vacuuming system inside the building, use HEPA filtration with 99.97 percent collection efficiency for 0.3-micron-size (or larger) particles.
2. When venting vacuuming system to outdoors, use filter to collect debris removed from HVAC system, and locate exhaust downwind and away from air intakes and other points of entry into building.

D. Clean the following components by removing surface contaminants and deposits:

1. Air outlets and inlets registers and grilles..
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, actuators, and turning vanes except in ceiling plenums and mechanical equipment rooms.
6. Supply-air ducts, dampers, actuators, and turning vanes.
7. Dedicated exhaust and ventilation components and makeup air systems.

E. 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 ducts or duct accessories.
4. Clean fibrous-glass duct with HEPA vacuuming equipment; do not permit duct to get wet. Replace fibrous-glass duct that is damaged, deteriorated, or delaminated or that has friable material, mold, or fungus growth.
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.
6. Provide drainage and cleanup for wash-down procedures.

7. Antimicrobial Agents and Coatings: Apply EPA-registered antimicrobial agents if fungus is present. Apply antimicrobial agents according to manufacturer's written instructions after removal of surface deposits and debris.

F. Source-Removal Cleaning Methods: The HVAC system shall be cleaned using source-removal mechanical cleaning methods designed to extract contaminants from within the HVAC system and to safely remove these contaminants from the facility. No cleaning method, or combination of methods, shall be used that could potentially damage components of the HVAC system or negatively alter the integrity of the system.

1. Use continuously operating vacuum-collection devices to keep each section being cleaned under negative pressure.
2. Cleaning methods that require mechanical agitation devices to dislodge debris that is adhered to interior surfaces of HVAC system components shall be equipped to safely remove these devices. Cleaning methods shall not damage the integrity of HVAC system components or damage porous surface materials such as duct and plenum liners.

G. Cleaning Mineral-Fiber Insulation Components:

1. Fibrous-glass thermal or acoustical insulation elements present in equipment or ductwork shall be thoroughly cleaned with HEPA vacuuming equipment while the HVAC system is under constant negative pressure and shall not be permitted to get wet according to NADCA ACR 2006.
2. Cleaning methods used shall not cause damage to fibrous-glass components and will render the system capable of passing the HVAC System Cleanliness Tests (see NADCA ACR 2006).
3. Fibrous materials that become wet shall be discarded and replaced.

H. Duct System Cleanliness Tests:

1. Visually inspect duct system to ensure that no visible contaminants are present.
2. Test sections of metal duct system, chosen randomly by Owner, for cleanliness according to "Vacuum Test" in NADCA ACR, "Assessment, Cleaning and Restoration of HVAC Systems."
3. Acceptable Cleanliness Level: Net weight of debris collected on the filter media shall not exceed 0.75 mg/100 sq. cm.
4. Duct system will be considered defective if it does not pass tests and inspections.
5. Prepare and submit test and inspection reports.

3.3 DUCT SCHEDULE:

A. All ductwork shall be fabricated, installed, sealed, and tested in accordance with the schedule below. All testing shall be in accordance with the latest edition of the SMACNA HVAC Air Duct Leakage Test Manual.

1. Testing shall be conducted and the results approved by the Architect/Engineer prior to the application of insulation.

2. The Architect/Engineer shall be notified one week prior to conducting the test. Unless specifically waived, the Engineer and Owner reserve the right to witness the test. Final, signed and dated test results shall be documented as outlined in SMACNA HVAC Air Duct Leakage Test Manual and submitted to the Architect/Engineer.

B. Supply Ductwork

1. Medium pressure (to include all ductwork upstream of VAV boxes):

   a. Pressure Class: Positive 6" w.g.
   b. Seal Class: A
   c. Leakage Class for Round Duct: 3
   d. Leakage Class for Rectangular Duct: 6
   e. Testing Requirement: 100%

2. Low pressure duct downstream of VAV boxes:

   a. Pressure Class: Positive 2" w.g.
   b. Seal Class: A
   c. Leakage Class for Round Duct: 12
   d. Leakage Class for Rectangular Duct: 12
   e. Testing Requirement: 25%

3. Low pressure duct connected to air handling units, energy recovery units, and rooftop air conditioning units/heat pumps in excess of 5 tons:

   a. Pressure Class: Positive 3" w.g.
   b. Seal Class: A
   c. Leakage Class for Round Duct: 6
   d. Leakage Class for Rectangular Duct: 6
   e. Testing Requirement: 25%

4. Low pressure duct connected to cabinet unit heaters, fan coil units, and heat pumps - 5 tons or less:

   a. Pressure Class: Positive 2" w.g.
   b. Seal Class: A
   c. Leakage Class for Round Duct: 12
   d. Leakage Class for Rectangular Duct: 12
   e. Testing Requirement: N/A

5. Ductwork connected to equipment not listed above:

   a. Pressure Class: Positive 2" w.g.
   b. Seal Class: A
   c. Leakage Class for Round Duct: 12
   d. Leakage Class for Rectangular Duct: 12

e. Testing Requirement: N/A

C. Return Ductwork:

1. Ductwork located outdoors:

a. Pressure Class: Negative 2” w.g.
b. Seal Class: A
c. Leakage Class for Round Duct: 6
d. Leakage Class for Rectangular Duct: 6
e. Testing Requirement: 100%

2. Ductwork located in unconditioned spaces or fully ducted systems located above ceiling:

a. Pressure Class: Negative 2” w.g.
b. Seal Class: A
c. Leakage Class for Round Duct: 12
d. Leakage Class for Rectangular Duct: 12
e. Testing Requirement: 10%

3. Ductwork exposed in conditioned spaces or installed in ceiling return plenums:

a. Pressure Class: Negative 2” w.g.
b. Seal Class: A
c. Leakage Class for Round Duct: 24
d. Leakage Class for Rectangular Duct: 24
e. Testing Requirement: N/A

4. Ductwork connected to cabinet unit heaters, fan coil units, or heat pumps – 5 tons or less:

a. Pressure Class: Negative 2” w.g.
b. Seal Class: A
c. Leakage Class for Round Duct: 12
d. Leakage Class for Rectangular Duct: 12
e. Testing Requirement: N/A

5. Ductwork connected to equipment not listed above:

a. Pressure Class: Negative 2” w.g.
b. Seal Class: A
c. Leakage Class for Round Duct: 12
d. Leakage Class for Rectangular Duct: 12
e. Testing Requirement: N/A

D. Exhaust Ductwork:

1. Negative pressure general exhaust:

    a. Pressure Class: Negative 2” w.g.
    b. Seal Class: A
    c. Leakage Class for Round Duct: 12
    d. Leakage Class for Rectangular Duct: 12
    e. Testing Requirement: N/A

2. Positive pressure general exhaust:

    a. Pressure Class: Positive 2” w.g.
    b. Seal Class: A
    c. Leakage Class for Round Duct: 12
    d. Leakage Class for Rectangular Duct: 12
    e. Testing Requirement: 10%

3. Fume exhaust:

    a. Pressure Class: Negative 6” w.g.
    b. Seal Class: Welded
    c. Leakage Class for Round Duct: 3
    d. Leakage Class for Rectangular Duct: 3
    e. Testing Requirement: 100%

4. Watertight and dishwasher hood exhaust:

    a. Pressure Class: Negative 2” w.g.
    b. Seal Class: Welded
    c. Leakage Class for Round Duct: 3
    d. Leakage Class for Rectangular Duct: 3
    e. Testing Requirement: N/A

5. Grease Duct:

    a. Pressure Class: Negative 2” w.g.
    b. Seal Class: Welded
    c. Leakage Class for Round Duct: 3
    d. Leakage Class for Rectangular Duct: 3
    e. Testing Requirement: 100% Light test (or other test approved by the Code Official in accordance with local and state codes).

3.4 FANS:

A. Coordinate roof opening and locations with structural system.

END OF SECTION 23 30 00