SECTION 15831
FANS AND VENTS

PART 1 - GENERAL

1.1 APPLICABLE REQUIREMENTS

A. All work to be furnished and installed under this section shall comply with all the requirements of General Conditions, Supplemental Conditions, Division 1 - General Requirements, Section 15050 - Basic Materials and Methods, and other Sections in Division 15 specified herein.

1.2 SCOPE

A. All work to be furnished and installed under this Section shall comply with all the requirements of Division 1, and shall include, but not necessarily be limited to, the following:

1. Spun Aluminum and Steel Housed Centrifugal Exhaust Fans
   a. General Duty Spun Aluminum Exhaust fan
   b. Upblast Spun Exhaust Fan for high temperature kitchen exhaust

2. Small Cabinet Fans (Ceiling Mounted)

3. Gravity roof vents

1.3 RELATED WORK SPECIFIED ELSEWHERE

A. Section 15050: Basic Materials and Methods

B. Section 15080: Mechanical Insulation

C. Section 15880: Air Distribution

D. Section 15900: Controls and Instrumentation

E. Section 15990: Testing, Adjusting and Balancing

F. Division 16: Electrical

1.4 QUALITY ASSURANCE

A. Manufacturer's Qualifications: Provide air handling units that are the standard product of an equipment manufacturer regularly engaged in the production of such units who issues complete catalog information on such products. Units shall not be fabricated by the Contractor.

B. Certifications: Provide certified ratings of units based on tests performed in accordance with ARI 430, "Central-Station Air Handling Units."

C. Codes and Standards: Provide air handling units conforming to the requirements of the latest addition of the following:

1. Air Movement and Control Association (AMCA):
   a. 99 standards Handbook
   b. 210 Laboratory Methods of Testing Fans for Rating [Unit shall bear AMCA Certified Rating Seal]

c. 300 Reverberant Room Method for Sound Testing of Fans [Unit shall bear AMCA Certified Rating Seal]
d. 301 Methods for Calculating Fan Sound Ratings from Laboratory Test Data
e. 500 Test Method for Louvers, Dampers, and Shutters

2. American National Standards Institute (ANSI):
   a. 9 Load Ratings and Fatigue Life for Ball Bearings
   b. 11 Load Ratings and Fatigue Life for Roller Bearings
   c. 900 Test Performance of Air Filter Units

3. Air-Conditioning and Refrigeration Institute (ARI):
   a. 350 Sound Rating of Non-Ducted Indoor Air-Conditioning Equipment
   b. 410 Forced-Circulation Air-Cooling and Air-Heating Coils
   c. 430 Central-Station Air-Handling Units
   d. 440 Room Fan-Coil Air-Conditioners

4. American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE):
   a. 15 Safety Code for Mechanical Refrigeration

5. National Electrical Manufacturers Association (NEMA): Except for motors, provide electrical components required as part of air handling units, which comply with NEMA Standards.

6. National Fire Protection Association (NFPA): Provide air handling unit internal insulation having flame spread rating not higher than 25 and smoke developed rating not higher than 50:
   a. 70 National electrical Code
   b. 90A Standard for the Installation of Air Conditioning and Ventilating Systems
   c. 90B Standard for the Installation of Warm Air Heating and Air Conditioning Systems

7. Sheet Metal and Air Conditioning Contractors' National Association, Inc. (SMACNA): Comply with applicable SMACNA standards including "HVAC Duct Construction Standards - Metal and Flexible."

8. Underwriters Laboratories, Inc. (UL): Except for motors, provide electrical components required as part of air handling units, which have been listed and labeled by UL.

1.5 SUBMITTALS

A. Product Data: Submit manufacturer's technical product data for air handling units showing dimensions, weights, capacities, ratings, fan performance with operating point clearly indicated, motor electrical characteristics, and finishes of materials, installation instructions, sound and vibration test report, and bearing life calculations.

B. Shop Drawings: Submit shop drawings showing unit dimensions, weight loadings, required clearances, field connection details and methods of support. Draw to a scale of 1/4" per one foot. Include field fabricated mixing boxes, dampers and duct connections.

C. Maintenance Data: Submit maintenance instructions, including instructions for lubrication, filter replacement, motor and drive replacement, and spare parts lists. Include this data, product data, shop drawings, and wiring diagrams in operating and maintenance manuals.

1.6 ENVIRONMENTAL REQUIREMENTS

A. Do not operate units for any purpose, temporary or permanent, until ductwork is clean, filters are in place, bearings lubricated, and fan has been test run under observation.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver unit to the site in containers with manufacturer's stamp or label affixed.

B. Store and protect equipment and products against dirt, water, chemical, and mechanical damage. Do not install damaged unit - remove from project site.

1.8 WARRANTY

A. Provide one-year (12 months) warranty. The warranty shall include parts, labor, travel costs, and living expenses incurred by the manufacturer to provide factory authorized service.

1.9 SAFETY PROVISIONS

A. Provide all open drives and fan wheels subject to maintenance and potential entanglement with protective guards or screens meeting OSHA requirements.

PART 2 - PRODUCTS

2.1 GENERAL FAN REQUIREMENTS

A. Construction, Rating and Testing: Provide fans constructed and factory tested in accordance with the Air Moving and Conditioning Association. All fan wheels shall be statically and dynamically balanced. Size and capacity as indicated on the Drawings. Provide extended bearing lubrication fittings where necessary to assure accessibility of all lubrication points.

B. Motors and Drives: Provide premium efficiency drip-proof motors with temperature rise not greater than 40 degrees C above ambient temperature. Provide belt drive assembly capable of 150% of the motor rated horsepower on one less than the total number of belts, for belt drives with two or more belts. All drives shall have adjustable sheaves to allow adjustment of ±20%. Provide two speed, two winding motors where indicated on schedules.

C. Accessories: Provide, as indicated on the Drawings and specified in other paragraphs of this Section, all related accessories to match the fan section, including access sections, diffusion sections, transition sections, flexible connections, vibration eliminators, and belt guards.

D. Submissions: For shop drawings include complete dimensional and physical data, CFM, SP, HP, discharge arrangement, rotation, class, base details, and fan curves.

2.2 SPUN ALUMINUM AND STEEL HOUSED CENTRIFUGAL EXHAUST FANS

A. Manufacturer: Cook, Greenheck, or Penn.

B. General Duty Spun Aluminum Exhaust Fan

1. Belt-drive: Spun aluminum exhaust fans shall be belt driven type.
   a. Description: Fan shall be a spun aluminum, roof mounted, belt driven, downblast centrifugal exhaust ventilator.
   b. Certifications: Fan shall be manufactured at an ISO 9001 certified facility. Fan shall be listed by Underwriters Laboratories (UL 705) and UL listed for Canada (cUL 705). Fan shall bear the AMCA certified ratings seal for sound and air performance.
   c. Construction: Fan shall be of bolted and welded construction utilizing corrosion resistant fasteners. The spun aluminum structural components shall be constructed of minimum 16 gauge marine alloy aluminum, bolted to a rigid aluminum support structure. The aluminum base shall have continuously welded curb cap corners for

maximum leak protection. The discharge baffle shall have a rolled bead for added strength. A two piece top cap shall have stainless steel quick release latches to provide access into the motor compartment without the use of tools. An integral conduit chase shall be provided through the curb cap and into the motor compartment to facilitate wiring connections. The motor, bearings and drives shall be mounted on a minimum 14 gauge steel power assembly, isolated from the unit structure with rubber vibration isolators. These components shall be enclosed in a weather tight compartment, separated from the exhaust airstream. Lifting lugs shall be provided to help prevent damage from improper lifting. Unit shall bear an engraved aluminum nameplate. Nameplate shall indicate design CFM, static pressure and maximum fan RPM. Unit shall be shipped in ISTA Certified Transit Tested Packaging.

d. Wheel: Wheel shall be centrifugal backward inclined, constructed of 100 percent aluminum, including a precision machined cast aluminum hub. Wheel inlet shall overlap an aerodynamic aluminum inlet cone to provide maximum performance and efficiency. Wheel shall be balanced in accordance with AMCA Standard 204-96, Balance Quality and Vibration Levels for Fans.

e. Motor: Motor shall be heavy duty type with permanently lubricated sealed ball bearings and furnished at the specified voltage, phase and enclosure.

f. Bearings: Bearings shall be designed and individually tested specifically for use in air handling applications. Construction shall be heavy duty regreasable ball type in a cast iron pillowblock housing selected for a minimum L50 life in excess of 200,000 hours at maximum cataloged operating speed.

g. Belts and Drives: Belts shall be oil and heat resistant, non-static type. Drives shall be precision machined cast iron type, keyed and securely attached to the wheel and motor shafts. Drives shall be sized for 150 percent of the installed motor horsepower. The variable pitch motor drive must be factory set to the specified fan RPM.

C. Upblast Spun Aluminum Exhaust Fan for Kitchen Exhaust

1. Belt-drive: Spun aluminum exhaust fans shall be belt driven type.

a. Description: Fan shall be a spun aluminum, roof mounted, belt driven, upblast centrifugal exhaust ventilator.

b. Certifications: Fan shall be manufactured at an ISO 9001 certified facility. Fan shall be listed by Underwriters Laboratories a(UL 762) and UL listed for Canada (cUL 762). Fan shall bear the AMCA Certified Ratings Seal for Sound and Air Performance.

c. Construction: The fan shall be of bolted and welded construction utilizing corrosion resistant fasteners. The spun aluminum structural components shall be constructed of minimum 16 gauge marine alloy aluminum, bolted to a rigid aluminum support structure. The aluminum base shall have a one piece inlet spinning and continuously welded curb cap corners for maximum leak protection. The windband shall have a rolled bead for added strength. A two piece top cap shall have stainless steel quick release latches to provide access into the motor compartment without the use of tools. An external wiring compartment with integral conduit chase shall be provided into the motor compartment to facilitate wiring connections. The motor, bearings and drives shall be mounted on a minimum 14 gauge steel power assembly. These components shall be enclosed in a weather tight compartment, separated from the exhaust airstream. A one inch thick three pound density foil back heat shield shall be utilized to protect the motor and drive components from excessive heat. Lifting lugs shall be provided to help prevent damage from improper lifting. Unit shall bear an engraved aluminum nameplate. Nameplate shall indicate design CFM, static pressure and maximum fan RPM. Unit shall be shipped in ISTA certified transit tested packaging.

d. Wheel: Wheel shall be centrifugal backward inclined, constructed of 100 percent aluminum, including a precision machined cast aluminum hub. Wheel inlet shall overlap an aerodynamic aluminum inlet cone to provide maximum performance and efficiency. Wheel shall be balanced in accordance with AMCA Standard 204-96, Balance Quality and Vibration Levels for Fans.

e. Motor: Motor shall be heavy duty type with permanently lubricated sealed ball bearings and furnished at the specified voltage, phase and enclosure.

f. Bearings: Bearings shall be designed and individually tested specifically for use in air handling applications. Construction shall be heavy duty regreasable ball type in a cast iron pillowblock housing selected for a minimum L50 life in excess of 200,000 hours at maximum cataloged operating speed.

g. Belts and Drives: belts shall be oil and heat resistant, non-static type. Drives shall be precision machined cast iron type, keyed and securely attached to the wheel and motor shafts. Drives shall be sized for 150 percent of the installed motor horsepower. The variable pitch motor drive must be factory set to the specified fan RPM.

2.3 SMALL CABINET FANS (CEILING MOUNTED)

A. Ceiling mounted exhaust fans:

1. Manufacturer: Cook, Penn, Greenheck

a. Certifications: Fan shall be manufactured by an ISO 9001 certified company. Fan shall be listed by Underwriters Laboratories (UL 705) and UL listed for Canada (cUL 705). Fan shall bear the AMCA Certified Ratings seal for sound and air performance.

b. Construction:

1) (Model GC-220-960) Fan housing shall be minimum 20 gauge galvanized steel and acoustically insulated. Blower and motor assembly shall be mounted to a minimum 14 gauge reinforcing channel and shall be easily removable from the housing. Motor shall be mounted on vibration isolators. Unit shall be supplied with integral wiring box and disconnect receptacle shall be standard. Discharge position shall be convertible from right angle to straight through by moving interchangeable panels. The outlet duct collar shall include a reinforced aluminum damper with continuous aluminum hinge rod and nylon bushings. To accommodate different ceiling thickness, an adjustable prepunched mounting bracket shall be provided. A powder painted white steel grille shall be provided as standard. Unit shall be shipped in ISTA Certified Transit Tested Packaging.

2) (Model GC-122-184) Fan wheel housing and integral outlet duct collar shall be injection molded from a specially engineered resin exceeding UL requirements for smoke and heat generation. The outlet duct shall have provision for an aluminum backdraft damper with continuous aluminum hinge rod. The inlet box shall be minimum 22 gauge galvanized steel. Motor shall be isolation mounted to a one piece galvanized stamped steel integral motor mount/inlet. A field wiring compartment with disconnect receptacle shall be standard. To accommodate different ceiling thickness, an adjustable prepunched mounting bracket shall be provided. A deluxe aluminum grille shall be provided. Unit shall be designed with provision for field conversion from ceiling to inline. Unit shall be shipped in ISTA certified transit tested packaging.

c. Wheel:

1) Wheel shall be centrifugal forward curved type, constructed of galvanized steel for Models GC 220-960, injection molded of polypropylene resin for Models GC 122-184. Wheel shall be balanced in accordance with AMCA Standard 204-96, balance quality and vibration levels for fans.

d. Motor: Shall be open drip proof type with permanently lubricated sealed bearings, thermal overload protection and disconnect plug. Motor shall be furnished at the specified voltage.

2.4 GRAVITY ROOF VENT

A. General: Roof vent to be Greenheck, Cook, or Penn.

B. Type: Based on scheduled vent on drawings.

C. Sizing: Pressure drop less than or equal to 0.125"w.g.

D. Required Accessories: roof curb, backdraft damper, birdscreen, and removable hood.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Coordinate motor starters with control contractor and Div. 16.

C. Examine site to verify if site is ready to receive work. Provide layout drawings of air handlers and fan locations to electrical installer.

D. Install unit on roof curbs.

E. Install 3" flexible duct connection at inlets and outlets of units.

F. Control installers shall install all wiring associated with control signals into the fan starters.

G. Electrical installer shall install all line voltage power wiring and conduit. Coordinate with Division 16 work.

3.2 MANUFACTURER'S START-UP SERVICES

A. The manufacturer shall provide start-up service in the form of a factory trained service technician. The service technician shall verify correct installation, verify unit mounting, verify fan rotation, verify spring isolator adjustments, verify control wiring, verify power wiring, start-up the fans, and check for proper operation. The service technician shall provide final adjustments to meet the specified performance requirements. Fully staffed parts and service personnel shall be within four hours travel from the job site.

END OF SECTION 15831

SECTION 15880
AIR DISTRIBUTION

PART 1 - GENERAL

1.1 APPLICABLE REQUIREMENTS

A. All work to be furnished and installed under this Section shall comply with all the requirements of General Conditions, Supplemental Conditions, Division 1 - General Requirements, and Section 15050 - Basic Materials and Methods, and other Sections in Division 15 specified herein.

1.2 SCOPE

A. All work to be furnished and installed under this Section shall include, but not necessarily be limited to, the following applicable items:

1. Ductwork - Rigid, Flexible and Fabric
2. Chimneys, Stacks and Flue Vents
3. Ductwork Specialties
4. Flexible Connections
5. Sealants, Adhesives and Tapes
6. Flashings
7. Bird Screens
8. Duct Access Panels and Doors
9. Backdraft Dampers
10. Louvers
11. Diffusers, Grilles, and Registers
12. Radiant Heaters

1.3 RELATED WORK SPECIFIED ELSEWHERE

A. Section 15050: Basic Materials and Methods

B. Section 15080: Mechanical Insulation

C. Section 15900: Controls and Instrumentation

D. Section 15990: Testing, Adjusting and Balancing

E. Division 16: Electrical

1.4 QUALITY ASSURANCE

A. Codes and Standards: Provide products conforming to the requirements of the following:

1. ARI 885-98 "Procedure for Estimating Occupied Space Sound Levels in the Application of Air Terminal and Air Outlets."

2. AMCA-210 - Laboratory Methods of Testing Fans for Rating Purposes.

3. ANSI S1.23 - Designation of Sound Power Emitted by Machinery and Equipment.

4. ASC-A7001 - Standard for Duct Sealants.

5. ASTM A167 - Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip. Type 304 or 304 stainless steel.

6. ASTM A525 - Standard Specification for General Requirements for Steel Sheet, Zinc-Coated (Galvanized) Hot-Dip Process. G90 zinc-coated.

7. ASTM A527/A527M - Standard Specification for Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process, Lock-Forming Quality.

8. TIMA AAC-101 - Standard for fiberglass duct liner with erosion proof facing.

9. UL 181 - Factory-Made Air Ducts and Connections, Class 1.

B. Conform to NFPA 90A "Standards for the Installation of Air Conditioning and Ventilating Systems".

C. Provide and construct ductwork systems in conformance with the latest editions of the following documents:

1. SMACNA "HVAC Duct Construction Standards-Metal and Flexible - 1995" (HDCS)

2. SMACNA "Accepted Industry Practice for Industrial Duct Construction" for duct pressures above +5" W.G. positive pressure or below -5" W.G. negative pressure. Where differences exist between SMACNA and the prevailing building code, the gauge or construction method of the submitted ductwork shall be the more stringent of the two standards.

3. ASHRAE Systems and Equipment Handbook "Duct Construction" chapter.

4. ASHRAE Fundamentals Handbook "Duct Design" chapter.

D. Alternatives: The SMACNA standards and publications referenced in this Section of the specifications establish ductwork construction requirements.

1. Alternatives to these standards and publications may be submitted. Approval will be based on demonstration that such alternatives are equivalent and satisfy the functional requirements described in the referenced standards.

2. Such demonstration shall include evidence that the alternatives proposed were tested in accordance with SMACNA procedures and with test results certified by an independent testing laboratory.

E. All ductwork and equipment shall be seismically supported and braced per the SMACNA "Seismic Restraint Manual: Guidelines for Mechanical Systems".

F. Flame/Smoke Rating: All materials, including sealants and adhesives, exposed within plenums shall have a flame-spread index of 25 or less, and smoke developed index of 50 or less, as tested by ASTM E84 (NFPA 255) method.

1.5 SUBMITTALS

A. Prior to construction, submit for approval on all materials and equipment:

1. Ductwork – Rigid and Flexible
2. Ductwork Specialties
3. Flexible Connections
4. Sealants, Adhesives and Tapes
5. Flashings
6. Bird Screens
7. Duct Access Panels and Doors
8. Backdraft Dampers
9. Louvers
10. Radiant Heaters
11. Diffusers, Grilles, and Registers
12. SMACNA "HVAC Duct Construction Standards - Metal and Flexible"

B. Shop Drawings: Provide shop drawings of sheet metal ductwork and plenums as follows:

1. Draw to a scale not less than ⅛" to one foot, with sheet sizes equal to Contract Drawings.
2. Show duct sizes, where possible use even duct sizes.
3. Show fitting details.
4. Show coordination with lighting fixtures, fire dampers, smoke dampers, piping, diffusers, grilles, registers, fans, major electrical runs, cable trays and bus ducts.

C. Shop Drawings: Provide shop drawings for field erected mechanical equipment:

1. Draw to a scale of ½" to one foot, with sheet sizes equal to Contract Drawings.
2. Show plan, sections, elevations and details of all joints and enclosures.
3. Detail access doors and hardware.
4. Detail coil, damper, humidifier, filter and fan installations.
5. Show access space for electrical components that are part of the equipment provided and/or installed such as power and control panels on humidifiers. This shall be coordinated with

Division 16 and NEC.

D. Certifications: Provide a duct schedule, certified by an officer of the sheet metal fabrication subcontractor, that the ductwork conforms to SMACNA standards, and for each sheet metal system furnished on the project include:

1. System name.

2. Duct material.

3. Duct gauge.

4. SMACNA rectangular reinforcement number.

5. SMACNA intermediate reinforcement number.

6. SMACNA transverse reinforcement number.

7. Rod diameter and type.

8. Sealant type.

9. Attachment method.

10. Duct system design pressure.

E. Construction IAQ Management Plan: Collaborate with the general contractor to submit and implement an IAQ Management Plan for the construction process meeting the requirements of the SMACNA IAQ Guidelines. This plan should address the protection of the ventilation system components during construction and cleanup of contaminated components after construction is complete. SMACNA IAQ Guideline recommends control measures in five areas. The IAQ Management Plan should address how compliance has been achieved in these required five areas as follows:

1. HVAC Protection
   a. Shutdown of return side of existing HVAC system in areas effected by heavy construction.
   b. Provision of temporary filters if existing or new systems must remain operational during construction.
   c. Dampering of supply and returns and sealing of openings in areas subject to construction dust.

2. Source Control
   a. How will reduction of contaminants be reduced at the source?
   b. What steps will be taken to employ low emitting products and sealants.
   c. How will air handling equipment be cycled off when not needed.

3. Pathway Interruption
   a. Describe how the construction space will be ventilated as required to dilute contaminants.
   b. Describe how occupied spaces adjacent to construction areas will be kept at positive pressure relative to spaces under construction.

4. Housekeeping: Describe how the following housekeeping objectives will be implemented:
   a. Reduction of dust generated by work will be suppressed.

b. Maintaining a frequent cleaning frequency for dust and particulates.
c. Remove spills or excess applications of solvent-containing products as soon as possible.
d. Remove accumulated water and keep work areas as dry as possible.
e. Protect insulation materials from exposure to moisture.

5. Scheduling: Describe how overlap of construction activity and ongoing building occupancy activities will be minimized.

F. Field Manual: Submit one copy of the SMACNA "HVAC Duct Construction Standards - Metal and Flexible". Maintain a second copy on the project site.

G. Any ductwork installed without prior approval by the specifier, shall be replaced at the expense of the contractor.

H. The contractor must comply with the enclosed specification in its entirety. If on inspections, the specifier finds changes have been made without prior approval, the contractor will make the applicable changes to comply with this specification, at the contractor's expense.

I. At the discretion of the specifier, sheet metal gauges, and reinforcing may be checked at various times to verify all duct construction is in compliance.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver products to the site in containers with manufacturer's stamp or label affixed.

B. Store and protect products against dirt, water, chemical, and mechanical damage. Do not install damaged components. Remove damaged products from project site.

PART 2 - PRODUCTS

2.1 DUCTWORK

A. All interior ducts shall be constructed with G-60 or better galvanized steel (ASTM 527) LFQ, chem treat. Exterior ductwork or duct exposed to high humidity conditions shall be G-90 or better galvanized steel LFQ, chem treated. Construct all ducts and plenum of gauges, and with joints, bracing, reinforcing, and other construction details in accordance with the latest construction standards previously listed. Metals shall be manufactured by United States Steel, Kaiser, Rolok or equal.

B. Duct dimensions indicated on Drawings are net, inside, clear dimensions. For internally lined ducts, add lining thickness to determine metal duct dimensions.

C. Ducts shall be constructed of material gauges and reinforcement per SMACNA pressurization classifications to meet 150% of the pressure requirements for external static pressure scheduled on drawings for the fans serving each system. Where differences exist between SMACNA and the prevailing building code, the gauge or construction method of the submitted ductwork shall be the more stringent of the two standards. See also Part III Execution for matrix of requirements.

D. All ductwork, fittings, grilles/diffuser, etc, shall be constructed of aluminum or stainless steel in, and around, magnetically/electrically sensitive rooms. Refer to all construction documents for location of these critical rooms.

2.2 DUCTWORK FABRICATION

A. Joints – Sealing

1. Duct tape is not allowed. Rolled elastomeric duct sealants are not allowed.

2. Solvent-based and oil-based sealants are not allowed indoors.

3. Seal all transverse joints - this includes mechanical joints similar to Ductmate on all supply, return, exhaust and outside air intake ducts.

4. All sealant systems for outdoor application to be suitable for use in exposure to water. Vulcum 801 and 351.

5. All sealant systems for indoor application to be meet VOC limits as specified in South Coast Air Quality Management District Rule #1168 limiting VOC's to 100 g/l. Sealants by Hardcast, Ductmate, Mon-Eco Industries, United McGill or equal, as recommended for ductwork application.

6. Water-Based Joint and Seam Sealant: Flexible, adhesive sealant, suitable for high velocity and high pressure applications, UL 181B-M listed, UL 723 classified, and complying with NFPA requirements for Class 1 ducts.
   a. Outdoor Application: Not permitted where subject to moisture exposure.
   b. Indoor Application: Hardcast Iron Grip, Ductmate PROseal, Mon-Eco EZ Seal 44-44, or equal.

7. Two-Part Tape Sealing System: Woven-fiber tape impregnated with gypsum mineral compound and modified acrylic/silicone activator to react exothermally with tape to form hard, durable airtight seal. Hardcast Two Part II, McGill Uni-Cast, or equal.

B. Joints - Rectangular Ducts

1. Slip drive joints, standard seams, flanges or welding as required by SMACNA HVAC Duct Construction Standards for system static pressure. Ductmate, MEX Industries, or equal are acceptable joint methods, but must be sealed as described previously. Transverse joints shall be constructed per Figure 1-4 for types T-8 through T-25. T-1 and T-5 slip joints are NOT allowed. Joint T-2, T-3, T-6 and T-7 reinforced slip joints are allowed below 2" static pressures.

C. Joints – Round

1. Exposed Ductwork: Slip drive and sheet metal screws.

2. Concealed Ductwork: Sheet metal screws.

D. Elbows

1. Construct long radius elbows with centerline not less than 1.5 times the duct width. Shorter radius elbows may be used where required to fit in restricted spaces, or as shown. Provide single thickness turning vanes on all short rectangular radius elbows less than 25" wide. Provide double thickness turning vanes for short rectangular radius elbows 25" wide and greater. Number of vanes per SMACNA. Elbows with square throat and radius heel are NOT allowed.

E. Transitions

1. Construct transitions with minimum slope of 1 to 5 ratio and in conformance to SMACNA.

F. Branch Connections

1. Provide 45° entry boots or radius taps for rectangular duct take-offs and conical or bellmouth taps for round duct take-offs. Straight 90° taps are not allowed, except where round take-off duct size equals round branch duct size. Provide volume dampers at take-offs for balancing if not specifically noted as provided at outlet or inlet. Provide insulation guards at transitions to lined ductwork.

2.3 RECTANGULAR DUCTWORK

A. Construct rectangular ductwork to meet all functional criteria defined in Section VII, of the SMACNA "HVAC Duct Construction Standards Metal and Flexible" 1995 Edition. This shall be subsequently referred to as the SMACNA Manual. All ductwork must comply with all local, code requirements. Ductwork shall be constructed of galvanized steel. Diagonally cross break all panels on ducts 30 inches wide and larger, or bead using automatic bead machine with beads at 12 inches on center or less. All connections shall utilize 45° boot take-offs. Bullhead tees and straight taps are not permitted. All ductwork shall be aluminum or stainless steel in, and around, magnetically/electrically sensitive rooms.

2.4 ROUND DUCTWORK

A. Round and oval ductwork shall be constructed to SMACNA round ductwork requirements of galvanized sheet steel. Spiral lock seams, only, to 50" diameter. Larger than 50" may be welded longitudinal or spiral lock seam. Lap or snap lock seams are not permitted for round ductwork of any size. Provide beaded sleeve joints or flanges with gasket joints. Elbows shall be 5-gore mitered and welded. All elbows shall be long radius type with centerline radius to duct diameter of 1.5, exceptions will only be allowed at restricted space locations. All connections shall utilize welded conical tees, aluminum conical fitting with damper by Flexmaster #CBD, or 45° boot take-offs by Flexmaster #STOD. Spin-in type or other types of butt tees, bullhead tees or straight taps are not permitted. Flat oval shall be utilized in space-restricted areas. All ductwork shall be aluminum or stainless steel in, and around, magnetically/electrically sensitive rooms.

2.5 FLEXIBLE DUCTWORK

A. Flexible one-inch thick insulated round ductwork may be utilized where shown on the Drawings and at the last seven (7') feet to each air outlet and inlet, unless shown otherwise on the plans. Maximum of only one 90° bend in any length. No intermediate joints are allowed. Connect each end with stainless steel screw operated drawbands. Support duct to maintain smooth shape without sagging. Casco Silent Flex II, JP Lamborn type LPR or approved equal.

B. Flexible aluminum ductwork for use in magnetic/electrically sensitive room environments, such as MRI rooms, in low pressure systems with static pressure at or below 2" w.g. positive pressure shall be a trilaminate of aluminized foil with aluminum helix with exterior 1" aluminum jacket fiberglass insulation. Flexmaster #TL-V or approved equal.

2.6 KITCHEN GREASE EXHAUST DUCTWORK

A. Grease exhaust ducts for Type I hoods shall be constructed of 16 gauge steel or 0.044" stainless steel with liquid tight welded or brazed joints in accordance with the mechanical code. Provide bolted access doors at each elbow and at the base of each riser sized to allow proper cleaning. Use long or short radius elbows. Do not use turning vanes or square elbows. All joints in vertical riser to

be water tight to prevent leakage of condensation. Ducts exposed to outside atmosphere to be protected against corrosion as required by code. Ducts to be galvanized, painted with non-corrosive paint or insulated.

B. As an alternate method to enclosing the duct in a rated shaft enclosure - furnish and install on the exhaust duct, a 2 hour fire blanket wrap. See Section 15080 Insulation for specification.

2.7 DUCTWORK SPECIALTIES

A. Volume and Splitter Dampers: Galvanized sheet metal blade and frame with Ventfabrics Inc., Ventlok operating hardware. For accessible dampers, provide #641 self -locking dial regulators and #644 self-locking dial regulators for insulated ductwork, #637 square end bearing, and #635 spring end bearing, as applicable. For inaccessible dampers, provide #666 or #677 concealed locking damper regulator with bearings as above. For static pressures above 3" W.G., provide #640 HiVel dial regulator and #609 HiVel end bearing for accessible dampers. Regulators shall extend to and through ceiling with neatly installed hardware at the finished ceiling. For inaccessible dampers requiring adjustment through diffusers use Young Regulator, Bowden cable control system.

B. Multi-louver Volume Dampers: 16 gauge galvanized steel frame. Opposed, 6" wide, 16 gauge galvanized steel blades. Concealed linkage in frame. Ruskin #CD35/OBD or equal.

C. Flexible Connections: Provide flexible connectors at the discharge and inlet of fans, air handlers, rotating mechanical equipment, and where shown on the Drawings for proper vibration isolation. Neoprene impregnated glass cloth with 24 gauge galvanized metal frame. Neoprene-only connectors are <u>not</u> allowed. Minimum dimensions - 3" metal, 3" fabric, 3" metal. Ventfabrics #Ventglas or approved equal by Duro Dyne, Q Industries, consolidated Kinetics, Ductmate Proflex or Elgen.

D. Ducts through roof shall be 16 gauge (or minimum of 2 gauges heavier than attaching ductwork), flashed and counterflashed, and provided with storm collars to secure a watertight construction.

E. Bird Screens: 14 gauge, ½", galvanized wire mesh, set in a galvanized steel frame, screw set.

2.8 DUCT ACCESS PANELS AND DOORS

A. In sheet metal work, hollow core double construction of same or heavier gauge material as duct in which installed. Use no door smaller than 12" by 12" for simple manual access or smaller than 24" by 24" where personnel must pass through infrequently. Use 24" by 60" minimum for filters and more frequent maintenance. Use Ventlok or approved hinges and latches on all doors; 100 Series hinges and latches on low pressure system doors up to 18 " maximum dimension, 200 Series on larger low pressure system doors and 333 Series on high pressure systems. Construct doors up to 18 " maximum dimension with one inch overlap fit and gasket with ¾" by ⅛" sponge rubber, fit larger doors against 1½" by ⅛" flat stock or angle frame and gasket with ¾" by ⅛" sponge rubber or felt. Door swing to be opposite airflow. CESCO, Vent Products, Air Balance, Ductmate Sandwich or equal. Access doors smaller than 12" x 12" can be used for visual inspection of dampers, etc. on small ductwork less than 12" wide but must be of maximum size that will fit on duct with 6" x 6" as minimum size. All access doors smaller than 12" x 12" must be approved by Engineer for the specific application prior to ordering.

2.9 BACKDRAFT DAMPERS

A. Damper Types:

1. Heavy Duty Backdraft Dampers: Provide counterweight type complete with frame, end bearings, counterbalance assembly, blades, and linkage. Pressure drop to be no more than

0.24"w.g. at 1000 fpm. Install at outside air intakes, exhaust outlets, and where shown on Drawings. Pacific Air Products #PRD-100AL, Ruskin #CBD2, NCA, or equal by Swartout, American Warming or Vent Products.

2. Nonmetallic Backdraft Damper: Provide complete with 16ga frame, neoprene coated fiberglass blades, galvanized expanded metal grill. Ruskin NMS2.

B. Application Requirements:

1. Generator Discharge Damper: Heavy Duty Backdraft Damper. Size at no more than 1000 fpm velocity.

2. Outside Air Intakes except where a control damper is required – Heavy Duty Backdraft Damper.

2.10 LOUVERS

A. Louvers are generally to be provided under Division 10. Where louvers are not covered on architectural plans and specifications, contractor is to provide under the following specification:

1. Louvers to be 6" deep, 35° drainable fixed blade design, constructed of galvanized steel or extruded aluminum, or as specified on the plans.

2. Frames to be constructed of 6" deep channel.

3. Provide with ½" x ½" galvanized mesh birdscreen mounted on backside of louver.

4. Finish/color per architect/engineer's review.

5. Manufacturer: Ruskin ELF6375DXH, American Warming, Industrial Louver.

2.11 DIFFUSERS, GRILLES AND REGISTERS

A. All diffusers, grilles, and registers shall be selected to provide proper air distribution for the intended occupant application. All supply air devices shall be selected to provide a maximum air velocity of 50 fpm at three feet above the floor, unless otherwise noted. Manufacturer's representative shall carefully review Architectural and Mechanical drawings and ensure diffuser/grille/register selections will provide proper air distribution at NC 30 or less. Manufacturer at no additional expense to the Owner shall replace diffusers, grilles, and registers not providing proper distribution or excessive noise at scheduled airflow.

B. All frames shall be selected to fit the ceiling type. Verify with Architectural Drawing. Each diffuser, grille and register shall be individually capable of balancing via duct mounted balancing dampers.

C. Sizes, capacities and patterns shall be as shown on the Drawings. Manufacturer: Titus, Krueger, or Price.

2.12 DUCT SMOKE DETECTORS (DSD)

A. Duct mounted photoelectric smoke detector. One required for each heating or cooling system supplying air in excess of 2,000 cfm, for systems serving more than one occupancy type, and for control of each combination fire/smoke damper when not controlled by Div. 16 area wide detection system. Coordinate with Div 16. work and electrical installer for power to smoke detector. Detector shall be mounted in the supply air ductwork downstream of the air handler and filters, or upstream of combination dampers. Coordinate with control installer to assure that detector shall shut down the

air-moving equipment when smoke is detected and close associated damper actuator(s). Sensor shall be selected to operate with air velocity rating from 100 to 4000 fpm. Provide with metal sampling tube. Provide remote test and reset station at ceiling or as otherwise indicated. Duct smoke detector shall be installed in compliance with the applicable mechanical or building code. Coordinate with Section 15900 and 15990 work. System Sensor #DH100LP series or approved equal.

2.13 ELECTRIC RADIANT HEATERS

A. Requirements

1. Electric infra-red space heaters shall be supplied and installed in accordance with the manufacturers certified installation instructions and governing codes.

2. Heaters shall be design certified by the Canadian Standards Association Int'l and bear the C.S.A. Seals of Certification for the United States and Canada. Certified to UL Standard number 1278 and Canadian Standard number 46-M1988-ELECTRIC AIR HEATERS.

3. The quartz tubing shall be opaque in color allowing maximum radiant heat transfer.

4. Heaters radiant efficiency shall be 76% min.

5. The manufacturer shall have a min. of 35 years of manufacturing experience producing electric radiant heaters.

B. Construction

1. The heater reflector shall be constructed of specular polished aluminum.

2. The emitter tubing shall be ½" I.D. drawn quartz with high temperature ceramic and caps.

3. The heater body shall be powder-coated steel.

4. The protective grill shall be bright zinc coated.

5. Optional factory supplied mounting brackets shall accommodate for sidewall or ceiling mounting. Refer to drawings.

C. Acceptable manufacturers are Re-verber-ray or approved equal.

PART 3 - EXECUTION

3.1 DUCTWORK AND SPECIALTIES INSTALLATION

A. Ductwork is generally diagrammatically indicated and shall be generally installed as indicated. Do not scale Drawings for exact location of ducts. Install ducts to best suit field conditions and cooperate with other trades. Do not penetrate Structural members without consent of Architect or Structural Engineer. Check with Structural drawings prior to locating any penetrations. Duct sizes are indicated as net inside dimensions on the Drawings. The indicated dimensions shall be altered at the job site for the purpose of avoiding interferences and clearance difficulties to other dimensions producing the same air handling characteristics, provided such altered dimensions are approved by the Architect. Ducts shall be constructed in accordance with the latest edition of codes and standards identified in Part 1 and as shown on the Drawings.

1. Clean and pretreat surfaces before application of sealant. Conform to the manufacturer's cleaning procedures. Install sealants in conformance with manufacturer's instructions.

2. Vertical ducts or horizontal ductwork penetrating fire rated ceilings, roofs, walls and floors shall be fire separated with UL listed and labeled fire dampers. Provide additional fire dampers indicated on the Drawings and as otherwise required by the CBC and building inspector. Provide approved firestopping between damper frames and firewalls. Install fire dampers in accordance with NFPA Standards, requirements of the State Fire Marshal, and applicable codes. Ensure that fire dampers are installed in the open position.

3. Provide 16 gauge metal sleeve with 1" clearance and pack space around ducts through walls tight with fiberglass, and seal with Schuller Duxseal or approved 3M fire proof caulking, as required. For exposed ducts through walls, provide flat, sheet metal escutcheon to conceal fiberglass and wall opening.

4. Grilles, Registers and Diffusers: Install flush, squared, tightly sealed, and entirely covering sheet metal ductwork and gaskets. Thread sheet metal mounting screws tightly into sheet metal. All frames shall be selected to fit the ceiling type. Verify with Architectural Drawing. Each diffuser, grille and register shall be individually capable of balancing via duct mounted balancing dampers. Duct connections shall fit securely to necks or collars behind face area. Provide all necessary transition pieces and duct collars to make connections from ductwork to neck sizes. Where ducts connect directly to necks or collars provide a minimum straight duct section of two times the duct diameter to the last elbow. Where minimum straight duct sections are not physically possible provide sheet metal plenum sized for approximately 500 fpm air velocity with duct tapped directly to side of plenum. Where building walls, floors and ceilings form portions of duct or plenum, provide gasketed angles or channels at junction points, securely bolted and sealed to building structure.

5. Install turning vanes in all mitered elbows in all ducts, so that tips are parallel with the sides of the ducts. Vanes shall be single thickness type. Tips of acoustical turning vanes on outside radius shall be flush with acoustical lining.

6. Provide flexible connections to completely isolate fans from direct contact with all sheet metal work.

7. Provide access panels or doors, as required, for access to valves, controllers, fire dampers and humidifier dispersion tubes. Access doors required in Product Conveying Vapor/Moisture Ductwork (see applicable paragraph above) shall not be installed in the bottom of the duct or in a manner to allow leaks.

8. Volume Dampers: Provide manual volume dampers in all low-pressure supply return and exhaust branch ductwork to grilles, diffusers, and inlet and outlet openings to facilitate balancing of systems. These are to be provided as part of contract whether shown on plans or not. Where ceilings are not accessible, provide access door or remote damper operator.

9. Splitters and splitter dampers shall not be installed in medium or low-pressure supply ductwork to VAV systems.

B. Hangers and Supports: Securely fasten all ductwork to the building construction by means of hangers, supports, guides, anchors, and sway braces to maintain duct alignment, to prevent sagging, and to prevent noise and excessive strain on ductwork due to movement under operating conditions.

1. Maximum spacing between hangers shall not exceed eight (8) feet.

2. Adequately mount and anchor all material and equipment as required. Include lateral bracing as required to prevent horizontal, seismic movement. Refer to CBC and architectural Drawings for seismic requirements.

3. Do not support ductwork from fans or any other pieces of equipment.

4. Powder driver fasteners shall not be used to support rectangular ducts of 40" maximum dimension. Powder driven fasteners shall not be allowed in existing facilities where electronic equipment is located.

5. Support round duct, 30" and larger, with two hangers at each support point.

6. Hangers and supports shall conform to SMACNA section "Hangers and Supports". Nail inserts, hangers and supports to formwork before slabs are poured. Cut off or remove nails, strap-ends and other projections, flush with concrete after forms are removed.

7. Support vertical ducts, passing through floors with two continuous angles screwed to the duct and bearing to the floor and conforming to SMACNA section "Riser Support-From Floor". Blocking or shimming ducts will not be permitted.

C. Other:

1. Fans: Align fans, motors, and drives. Install fans to render bearings accessible for lubrication without dismantling fans or ducts. Provide extended bearing boilers as required. Mount all fans on vibration isolators as specified.

2. Insulation: Properly and neatly apply insulation on all material and equipment and apparatus, as specified, including all fittings. Apply insulation over clean, dry surfaces, with adjoining sections firmly butted together and canvas smoothly pasted over. When vapor barriers are specified, install continuous overall external surfaces of the entire system.

3. Duct Sizing: Where duct sizes are not specifically shown on the plans or must be modified due to physical limitations, main ducts may be sized at a maximum velocity of 1,500 fpm. Branch ducts may be sized at a maximum 0.08" sp friction per 100 feet. Transfer/make-up air ducts may be sized at a maximum velocity of 500 fpm or 0.06" sp friction per 100 feet, whichever provides the larger duct.

3.2 STAINLESS STEEL DUCTWORK

A. For installations serving moisture, vapor, or fume exhaust.

1. For connections to hoods or equipment provide minimum 12" length flanged and bolted stainless steel spool piece connection.

2. All fittings shall be long radius. Round elbows shall be minimum 5 gore.

3. Slope horizontal ductwork back toward source connected equipment minimum 1% slope so that moisture and liquids may drain back toward equipment.

4. Low point "traps" in the ductwork shall be fitted with a low point drain valve, ½" welded connection, stainless steel piping and valve.

5. All welding to be completed by certified welders experienced in 316 grade stainless.

3.3 CONSTRUCTION AND SEALING CRITERIA

A. 15880 – Unless called out otherwise on drawings the pressure classification of ductwork shall be as follows:

Duct system:	Location	Working pressure	Build to SMACNA pressure class	Build to SMACNA seal class:
Low press Supply Air	Downstream of air terminal units to grilles, registers or diffusers.	low pressure	+1" wc	B
Low press Supply Air	From AHU to grilles, registers or diffusers.	low pressure	+1" wc	B
Low press Return air	From return grilles to AHU	Low pressure	-1" wc	B
Transfer air	From grille to grille, or acoustic boots or "z" bends	Low pressure	+0.5" wc	C
General exhaust	From grille to exhaust fan	-1" wc	-2" wc	B
General exhaust	From exhaust fan to discharge at ambient	+1" wc	+2" wc	B
Washroom exhaust	From grille to exhaust fan	-1" wc	-2" wc	B
Washroom exhaust	From exhaust fan to discharge at ambient	+1" wc	+2" wc	B
Type I Kitchen Hood vapor/ low temp, and dishwash exhaust	From Hood or equipment to exhaust fan	-1" wc	-2" wc	A, or welded. Refer to specification
Gravity type boiler vent	From boiler connection to ambient discharge	Low pressure	+1"	Seal per boiler vent mfg. installation recommendations
Pressure type boiler vent	From boiler connection to ambient discharge	N/A	N/A	Seal per boiler vent mfg. installation recommendations

B. 15880 – The default leakage classification of ductwork is as follows:

Duct working press. class:	Low pressure - +/- 0.5"wc	+/-1" – +/-3"	+/-4" – +/-10" wc
SMACNA Seal Class	C	B	A
Sealing Applicable	Transverse joints only	Transverse and longitudinal Joints	Joints, seams, and all wall penetrations
Rectangular sheet metal SMACNA Leakage Class	24	12	6
Round sheet metal SMACNA Leakage Class	12	6	3

3.4 MANDATORY CALIFORNIA DUCTWORK TESTING

A. All duct systems shall be sealed to a leakage rate not to exceed 6% of the fan flow if the duct systems are:

1. Connected to a constant volume, single zone system, air conditioners, heat pumps or furnaces, and

2. Serve less than 5,000 square feet of floor area, and

3. Have more than 25% duct surface area located in one or more of the following places:
   a. Outdoors, or
   b. In a space directly under a floor where the U-factor of the roof is greater than the U-factor of the ceiling, or
   c. In a space directly under a roof with fixed vents or openings to the outside or unconditioned spaces, or
   d. In an unconditioned crawlspace, or
   e. In other unconditioned spaces.

4. The leakage rate shall be confirmed through field verification and diagnostic testing in accordance with procedures set forth in the Nonresidential ACM Manual.

3.5 SEISMIC REQUIREMENTS

A. All HVAC equipment and machinery shall be anchored to withstand forces generated by earthquake motions. As a minimum, equipment and equipment frames shall be designed to withstand a force of 100% of the weight of the equipment and frame acting at its center of gravity. Anchorage of the equipment and/or frame to the structure shall be for a force of four times gravity also acting at the center of gravity.

B. Piping and ductwork connecting to equipment shall be seismically braced per SMACNA "Seismic Restraint Manual: Guidelines for Mechanical Systems".

C. The seismic calculations shall be the responsibility of contractor.

3.6 EQUIPMENT

A. Install equipment as shown on plans and in accordance with manufacturer's installation recommendations.

3.7 SUPPLY DIFFUSER AND REGISTER LOCATIONS

A. Coordinate location of supply outlets with ceiling mounted smoke detectors. Locate outlets or outlet distribution so as to prevent airflow from inhibiting the operation of smoke detectors. Locate ceiling outlets a minimum of 3'-0" from smoke detectors.

3.8 PAINTING

A. Where the interior surfaces of ductwork are visible through the blades of supply outlets, return inlets, and exhaust inlets - paint the interior visible surfaces with one coat of flat black paint.

3.9 FIELD QUALITY CONTROL

A. Do not insulate or conceal ductwork before inspection by Owner's Representative, Architect or Engineer. If ductwork is insulated and concealed prior this inspection the Contractor shall remove insulation and ceiling to permit inspection at no additional cost to the Owner. The Contractor shall replace the insulation and ceiling after final inspection at no additional cost to the Owner.

B. Ductwork Deflection Criteria:

1. Maximum inward and/or outward deflection at sheetmetal panels shall be ¾" under maximum static pressure operating conditions. Additional intermediate stiffening angles shall be installed where deflections exceed ¾".

2. Maximum inward and/or outward deflection at sheetmetal elbows and joints shall be ¼" under maximum static pressure operating conditions. Additional stiffening angles shall be installed where deflections exceed ¼".

C. Acceptance of duct systems shall be contingent upon conformance with the requirements specified in Section 15990 "Testing, Adjusting and Balancing".

3.10 ADJUSTING AND CLEANING

A. Clean the inside of plenums, casings, enclosures, fans, and accessible ductwork before starting fans. Blowout coils and condensate piping with compressed air. Install a clean set of filters in each system prior to testing and balancing. Proceed with testing and balancing. All dampers shall be locked in place.

END OF SECTION 15880