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BuildingName
The Description of the Project
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SPECIFICATION DIVISION 23

NUMBER SECTION DESCRIPTION

DIVISION 23
SECTION 237323 - CUSTOM AIR HANDLING UNITS

END OF CONTENTS TABLE

DIVISION 23
SECTION 237323 - CUSTOM AIR HANDLING UNITS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Custom built-up supply and return/exhaust air handling units.
2. Factory and field testing of custom air handling units.

1.2 RELATED DOCUMENTS

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

B. Related Sections:

1. Section 220500: Common Work Results for Mechanical.
2. Section 220513: Motors.
3. Section 220548: Vibration Control
4. Section 238216: Coils and Drain Pans
5. Section 233400: Fans
6. Section 234000: HVAC Air Cleaning Devices.
7. Section 233300: Air Duct Accessories and RGDs
8. Section 230900: Mechanical Systems Control
9. Section 230593: Testing, Adjusting, and Balancing.
10. Division 26: Electrical.

1.3 QUALITY ASSURANCE

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

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

1. ANSI/AHRI Standard 430 - Performance Rating of Central Station Air-Handling Units.
2. ANSI/AHRI Standard 260 - Sound Rating of Ducted Air Moving and Conditioning Equipment.
3. ASHRAE Standard 111 - Measurement, Testing, Adjusting and Balancing of Building Heating, Ventilation and Air-Conditioning Systems
4. NFPA 70 - National Electric Code.
5. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems

1.4 DELIVERY, STORAGE, AND HANDLING

A. Manufacturer shall provide shipping protection to insure that the interior and exterior of each unit is completely protected from dirt or weather. Duct and pipe openings shall be covered with sealed sheet metal, plastic or other durable means to ensure unit cleanliness is maintained.

B. Support coil headers independently during transport to prevent potential damage from vibration.

C. Restrain fans and other components to prevent damage during shipping.

1.5 ADMINISTRATIVE REQUIREMENTS

A. Provide a qualified service technician from the Manufacturer's staff to supervise installation and reconnection of unit sections and to perform start-up, testing and training as detailed in part 3.

1.6 SUBMITTALS

A. Submit the following product data for approval, for each unit:

1. Overall unit dimensions, weight, and center of gravity.
2. Ductwork connections including sizes, locations, and methods of connecting to mating ductwork.
3. Piping connections including size, material types, and dimensioned locations for each service.
4. Detail methods of sealing inner and outer walls at locations of pipe penetrations.
5. Locations and sizes of access doors.
6. Details of access door handles, latching mechanisms, hinges, and vision panels.
7. Locations of interior light fixtures and light switches.
8. Locations of electric power convenience receptacles.
9. Dimensions, weights and centers of gravity for each section when units will be shipped in multiple sections.
10. Cabinet material, metal thickness, finishes, insulation and accessories.
11. Details of vibration isolation bases including selections for vibration isolation springs.
12. Details of fan discharge flexible duct connector where required.
13. Details of motor and belt guards.
14. Motor ratings, electrical characteristics, and motor accessories.
15. Sound power data for the entire air-handling unit for each octave band at the following locations: At unit inlet, at unit discharge, and transmitted sound.
16. Factory testing procedure.
17. Factory test results.
18. Field test results.

1.7 WARRANTY

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

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturers:

1. Buffalo Air Handling.
2. TMI Custom Air Systems.
3. Nortek Air Solutions - Governair Division.
4. Mafna Air Conditioning, Inc.
5. Air Flow Equipment.
6. Air Enterprises
7. Nortek Air Solutions - Ventrol Division.
8. Ingenia Technologies
9. ClimateCraft
10. Johnson Controls Inc/York - York Custom

2.2 GENERAL

A. Provide factory fabricated, double-wall air handling units with components and equipment as scheduled and detailed on Drawings.

B. Components shall be fabricated in major sections at the Manufacturer's factory and shall carry the Manufacturer's nameplate. Sections, after having framework completely installed on their base structures, shall be final assembled at factory into one-piece for testing and to ensure that sections will fit together properly when reassembled in the field.

C. Provide units of height, width, and length indicated, and that comply with project weight and spatial limitations.

1. Weight, spatial, and dimensional limitations shall also apply to individual sections, including to facilitate unit rigging and installation.

D. Provide a minimum of four lifting lugs per separately shipped section, of adequate strength to allow rigging without damage.

E. Manufacturer shall supply gasketing, sealant, and installation instructions.

F. Manufacturer shall provide touch-up paint(s) for use after field assembly.

G. Touch up all galvanized surfaces damaged from welding or other fabrication operations with zinc rich paint, minimum 65 percent metallic zinc by weight.

2.3 COMPONENTS- GENERAL REQUIREMENTS

A. Provide all components integral to the air handling unit including, but not limited to, the following. These components shall comply with Related Sections and any additional requirements of this Section.

1. Motors
2. Vibration Isolation
3. Coils and Drain Pans
4. Fans and Accessories
5. Air Filters

6. Sheet Metal Accessories
7. Dampers (as specified in Controls section)
8. Energy Recovery Wheels/Heat Exchangers
9. Sound Attenuators

2.4 MANUFACTURING

A. Casings shall be manufactured only after panel components (structural members, facing sheets and insulation) have been thoroughly cleaned of mill grease, dirt and oxidation.

1. Interior and exterior of panel system shall be thoroughly protected from contamination from the manufacturing process through start-up procedures and acceptance.
2. Internal components (fans, coils, air filter frames, equipment and piping) shall arrive from their respective manufacturing facilities free of grease and dirt.

B. In general, products such as sealants and gaskets, used within the unit, shall be non-petroleum based products, with no outgassing characteristics.

C. Equip, prepare, identify and match-mark individual shipping sections so that field reassembly and installation can be performed without reworking, interchanging, adjusting, springing, drilling new bolt holes, etc. All supplemental supplies necessary to assemble the unit shall be provided by the Manufacturer.

2.5 UNIT HOUSING

A. Performance

1. Maximum U-Value: 0.07
   a. Minimum insulation density (fiber glass): 3 lbs/sq. ft.
2. Under normal operating conditions there shall be no condensation on the exterior at 100 deg F db/74 deg F wb ambient.
3. Maximum deflection of walls shall be L/250 at plus or minus 10 in. w.c. (L = span in inches.).
4. Maximum deflection of roof and floor shall be L/250 at design loading. (L = span in inches).
   a. Minimum floor design load: 150 lbs/sq. ft.
   b. Minimum roof design load: 75 lbs/sq. ft. plus snow load for exterior unit.
5. Outdoor design conditions
   a. Minimum wind load: 120 mph.
   b. Minimum snow load: 50 lbs/sq. ft., or per applicable codes, whichever is greater.
6. Minimum sound transmission loss

Octave Band (Hz)	DB Reduction--XX	
30--250	42--500	40--1000
46--2000	53--4000	52--8000

B. Construction

1. Materials
   a. Exterior of unit: Galvanized steel (G-90), aluminum, or stainless steel

b. Interior of unit: Solid galvanized steel (G-90) or aluminum

2. Minimum Panel Thickness: 4 inches. Minimum 2-inch panel construction with a foam insulation core that meets all the requirements of this specification, including sound transmission loss, is also permitted. Foam insulation shall be UL Class 1 rated.
3. Minimum Gauge: The following are minimum gauges. Heavier gauges may be required to meet the performance deflections and/or sound transmission loss specified, or to allow for proper welding:
   a. Roof interior and exterior: steel 16 ga. or aluminum 0.09” (0.040" aluminum for foam core insulated panels).
   b. Wall interior and exterior: steel 16 ga. or aluminum 0.09” (0.040" aluminum for foam core insulated panels).
   c. Floor interior: steel 10 gauge smooth or 1/8” checker plate or aluminum 1/8” checker plate.
   d. Floor exterior (bottom/underliner): steel 20 gauge or aluminum 0.063” (0.040" aluminum for foam core insulated panels).
   e. Partition walls: steel 16 ga. or aluminum 0.09” (0.040" aluminum for foam core insulated panels)
   f. Safing at cooling coils: stainless steel 18 ga. or aluminum 0.071”.
   g. Safing all other: steel 18 ga. or aluminum 0.071”.

4. Openings and penetrations
   a. On any piping subject to sweating, including condensate drains, piping penetrations shall be sleeved.
      1) Sleeve shall extend fully from interior to exterior of unit.
      2) Sleeve shall be continuously welded or seamless, rolled (round), and sealed airtight to unit.
      3) Manufacturer shall provide seals on the interior and exterior to seal between sleeve and piping. Seal performance shall ensure passage of factory leak testing yet provide ease of coil replacement if needed.
   b. All non-sweating piping or conduit penetrations shall be sealed airtight.
   c. At openings, cover exposed edges of insulation with structural steel angles and seal edges.
   d. Protect exposed fastener ends with plastic caps.
   e. Floor penetrations shall incorporate a minimum 1 in. high waterproof dam fabricated of steel angle iron or equivalent, seal welded to floor.
   f. For units located outside, no penetrations shall be made through the roof.
5. For units located outside, slope roof to prevent standing water.
6. Unit shipping sections shall be fabricated to have air and water tight connections. Seals between sections shall consist of 1/4 in. thick by minimum 1-1/2 in. wide neoprene gaskets and continuous caulking on contact surfaces.

C. Floor/Base Frame

1. Floor shall be continuously welded between mating sections and along wall edges to form a watertight surface. Watertight floor shall not be used as part of a coil drain pan system. Provide sleeves for any piping penetrating the unit; if through the floor, continuously weld to waterproof the floor.
2. Floor shall be min. 4 in. thick, insulated with 3-lb./cu. ft. density fiberglass (or 4 in. of U.L. Class 1 foam insulation of equivalent or better R-value), sealed airtight in place by solid galvanized or aluminum underliner.
3. Fabricate base frame of welded structural steel or aluminum members as required to accommodate drain outlet height requirements for proper drain pan trapping, and around the entire unit and under major internal equipment such that all components are completely supported by the factory installed base frame.

D. Ductwork Connections

1. Provide flanged connections with flanges extending a minimum of 2 in. past the outside wall of the unit.
2. For fans discharging directly at the unit casing, provide flexible duct connector internal to the unit.

E. Paint

1. Prior to assembly, prime coat all non-galvanized ferrous metal parts with two coats of lead-free prime paint.
   a. Quick-drying, rust-inhibitive, alkyd-based primer; total dry film thickness of not less than 1.3 mils.
   b. Paint: Benjamin Moore IronClad Alkyd Low Luster Metal and Wood Enamel C163, or equivalent.
2. For interior units, finish paint the same surfaces with two coats of enamel paint of a different color.
   a. Low-luster (eggshell), acrylic-latex, interior enamel; total dry film thickness of not less than 2.6 mils.
   b. Paint: Benjamin Moore Super Spec Latex Eggshell Enamel 274 or equivalent.
3. For exterior units, finish paint the same surfaces with two coats of enamel paint of a different color.
   a. Semi-gloss, alkyd, exterior enamel; total dry film thickness of not less than 2.6 mils.
   b. Paint: Benjamin Moore IronClad Alkyd Low Luster Metal and Wood Enamel 163 or equivalent.
4. Prepare surfaces per paint manufacturer’s recommendations before painting.

F. Sealants:

1. Provide sealant that is non-toxic, including outgassing during curing period.
2. Sealant shall be warranted to maintain the leak-test performance for 25 years.

G. Access Doors and Panels

1. Access doors and panels shall be of same construction as unit housing, including insulation.
2. Doors shall be minimum 24 in. wide. Provide doors that are the full height of the unit, maximum 6’ high.

3. Each access door and panel shall be equipped with continuous gaskets and shall fit in the door frame in a manner to guarantee the same leakage criteria as the unit casing.
4. Each access door shall be mounted with stainless steel,cast aluminum, or fiberglass reinforced nylon (Klima-flex or similar) hinges and hardware. Provide a minimum of two handles per door, operable from either side.
5. Access doors in positive pressure sections shall open inward. Access doors in negative pressure sections shall open outward.
6. Each door shall contain a non-fogging thermal window of double pane safety glass. Coordinate height of window with housekeeping pads, base frame and isolators to ensure that location is at approximate eye level when standing outside of unit. Each window shall be a minimum 12 in. by 12 in., properly sealed to prevent condensation and to operate safely against positive or negative pressure.
7. Each access door shall have a built-in static pressure probe port.
   a. Ventlock Model 699 by Ventfabrics, Inc.
8. Removable access panels shall be provided in unit sections where components contained are larger than door opening and where access to components for cleaning and maintenance is required.

H. Outside and exhaust air openings

1. Outside air and exhaust openings shall be furnished with 25 mesh, galvanized steel or aluminum bird screen. Rain hood velocities shall not exceed 1,000 FPM.

I. Louvers

1. Provide louvers as shown and scheduled on Drawings. Louver airstream shall not entrain water or snow.
2. Louvers shall be self-draining.

2.6 COMPONENTS

A. Mixing Box Section

1. The outside and return airstreams shall be directed into each other in a mixing box by parallel blade damper assemblies oriented to facilitate mixing of the airstreams.
2. Outside and exhaust air openings shall not be on the same side of the unit in order to minimize recirculation, if air is exhausted at the unit.

B. Dampers

1. Provide dampers as specified in Related Section Mechanical Systems Controls.
2. In addition to the requirements in Mechanical Systems Controls, dampers designated as smoke dampers shall be labeled in accordance with the latest editions of UL 555S.

C. Filters

1. Provide filters and filter gauges of types as shown and scheduled on Drawings and as specified in Related Section.

2. Provide hinged primary filter frames where indicated, complying to the following:
    a. Primary filters shall be mounted on vertically hinged non-racking frames that are completely independent of the secondary filter frame. Frames shall swing away from the secondary filter frame in a door-like manner to allow secondary filter removal without removing the primary filters.
    b. Provide multiple hinged frames. Primary filter frames shall be no wider than 2 ft. Frames shall swing out on an arc of 90 degrees, or to the degree required to allow the secondary filters to be easily removed, whichever is greater.
    c. Frame hinges shall be continuous piano type.
    d. The primary filter frames shall be supported by galvanized structural steel support members. Arrange frame and support system relative to the secondary filters to provide a gap long enough to allow accurate measurement of static pressure between the two filter types with a static pressure tap.
    e. Frames shall be gasketed on all four sides. Provide spring type tension fasteners and latching system to lock and seal the hinged frames to the support members. Lock system shall be operable without tools.
    f. Primary filter frame and support system shall meet or exceed all of the performance requirements of the Related Section "Air Filters." Provide all accessories required by that section.

F. Coils and drain pans

1. Provide preheat, energy recovery, heating, cooling coils and associated drain pans as shown and scheduled on Drawings and as specified in Related Sections.
2. Provide drain pans and drain connections for the following sections: cooling coils, humidifiers, and energy-recovery coils or wheels.
3. All coil assemblies shall be safed on top and bottom and at all coil splits.
4. Drain pans shall be sloped in a minimum of 2 planes to eliminate standing water and shall be stainless steel construction. Drain pans shall be constructed of adequate downstream length to collect any condensate that blows off the coil at air velocities up to the design air flow rate or 500 FPM, whichever is greater.
5. Insulate drains pans, including intermediate drain pans, to prevent sweating.
6. Each coil section shall be removable without disruption to other unit components or coils. Fasten coil assemblies with bolts or screws; per manufacturer's recommendations, (welds or rivets are not acceptable). Provide coil tracks in assembly frame for removal of coil assemblies from housing.
7. Provide an individual access panel for each (stacked) coil section, to allow removal of a coil section without disrupting operation of coil sections located above or below the section being serviced. Example: a 3 coil high by 2 coil wide assembly shall have 3 access panels provided per side, for a total of 6.

8. Extend coil connections to the outside of the air handling unit casing to allow field connections. Extend vents and drains to the outside of the casing only when there is inadequate space inside the air handler to install them in a location that permits operation, including connection of a garden hose.
9. Label coil inlet, outlet, vent and drain piping connections with labels applied outside the casing. Vent or drain valves located inside units shall have labels inside the unit.

G. Diffuser Plate

1. If air velocity across the cooling coil varies by more than 15 percent, provide a perforated, aluminum, sectionally-removable diffuser plate immediately upstream of the cooling coil section (plus or minus 6 in.). Diffuser plate shall completely cover cooling coil section and shall be rigid, vibration, and deflection free.

H. Fans and Accessories

1. Provide fans and accessories as shown and scheduled on Drawings and as specified in Related Section. Fans shall be backward inclined or air foil type. Provide fan array per Section 233400 when fan array is scheduled on the drawings.

I. Trolley Beams

1. Provide fan sections with trolley beams where shown on the Drawings. Design and fabricate the unit structural members and housing to support the weight of the trolley beam fully loaded with the weight of the fan motor, trolley hoist, and chain. Trolley beams shall be centered on access doors or on removable component access panels, which shall be centered on fan motor or component. Beams shall be mounted to the ceiling and shall extend continuously from interior wall to interior wall. Trolley hoists and chain shall be provided "by others" in the future as needed. For motors 10 HP or less, the use of Unistrut or similar type support channel is acceptable and support does not need to be centered on the door. Unit manufacturer shall size the support channel to meet the load.

J. Sound Attenuators

1. Provide sound attenuators where shown integral to air handling unit, as scheduled on Drawings and as specified in Related Section.

2.7 ELECTRICAL AND TEMPERATURE CONTROL WIRING

1. Provide a junction box on the outside of the fan section casing for single point connection of external power wiring to each unit fan motor.
2. Provide EMT metal conduits and wiring between the junction boxes and the motor(s). Final connections to motors shall be 1/2 in. minimum flexible metal conduit with steel fittings.
3. For each unit section that has an access door, provide a minimum of one 120V vapor proof marine light with an LED lamp suitable for use in enclosed fixtures.

4. Provide a single light switch with red pilot light adjacent to the latch side of the fan section door. This switch shall activate all internal lights in the air handler. For units with more than one air tunnel (side by side or stacked), provide a single light switch per air tunnel. Pilot light shall be "on" when associated light fixture is "on". Provide one weatherproof, GFCI duplex convenience receptacle mounted centrally on the outside of unit, on the side with the most doors.
5. Provide a junction box on the outside of the unit for single point connection of external power wiring to the unit's lights and receptacle. Provide EMT conduit and wiring between the junction box, switches, associated lights and receptacle. Provide flexible conduit "whips" with wiring at section splits, for reconnection of the lighting circuit by the Electrical Contractor after sections are assembled.
6. Provide all electrical components in accordance with NFPA 70 (NEC) and Division 26 requirements. Indoor electrical enclosures shall be rated NEMA 1. Outdoor electrical enclosures shall be rated NEMA 3R.
7. Power and temperature control wiring shall be run in conduit.
   a. Run power and control wire in separate conduits.

2.8 SOURCE QUALITY CONTROL

A. Assemble and factory test each unit prior to shipping. Correct deficiencies in unit performance at the factory prior to shipping. University representatives shall witness testing and shall be notified of factory testing dates at least four (4) weeks in advance. Associated travel expenses for witnessing tests shall be paid for by the University.

B. Testing shall comply with ASHRAE Standard 111. Submit proposed test procedure to the University representative for approval, detailing methods, equipment, and techniques to be employed for each specific test. Equipment will not be considered approved until written approval of testing procedures is attained. Testing must also be in accordance with Quality Assurance Standards section.

C. At the conclusion of factory testing, a formal written report of results shall be submitted to the University Representative for approval.

D. Factory test each air handling unit as follows:

1. Verify that the airflow rate is within the range of 100 percent to 110 percent of scheduled CFM requirements when operating at scheduled design total static pressure and fan brake horsepower.
2. Airflow measuring devices shall be installed in ducts returning to or leaving the unit. These devices shall be installed per manufacturer's recommendations. External static pressure to the unit shall be simulated using a combination of ducts and dampers and must be equal to or greater than the scheduled external static pressure. Tests shall prove design airflow and static capability of the assembled unit.

3. Perform leakage tests to validate that the unit casing leakage is less than 1/2 percent of the scheduled design airflow (CFM) at 10 in. w.c.
    a. Positive Pressure Test: Duct openings in the positive pressure section shall be sealed. The CFM of the test fan shall be read using an approved airflow measuring device. When the static pressure developed by the test fan reaches 10 in., the fan CFM shall be read and this CFM shall be considered the casing leakage.
    b. Negative Pressure Test: Duct openings in the negative pressure section shall be sealed. The CFM of the test fan shall be read using an approved airflow measuring device. When the static pressure developed by the test fan reaches 10 in., the fan CFM shall be read and this CFM shall be considered the casing leakage.
4. Both the leakage and the airflow tests shall meet the required acceptance criterion without the use of temporary sealant at any permanent panel joints. Temporary sealing methods identical to those applied in field shall be used at the shipping splits to simulate "as installed" conditions.
5. Sound Test: System sound levels shall be measured at eight (8) octave bands at the scheduled design operating conditions. Airborne sound levels at openings shall be read in the test ductwork 5 ft. from openings. Transmitted sound levels shall be read 5 ft. from outside of fan sections or components, on all sides and on top.
    a. Readings shall be taken at all outside, return, exhaust and supply air openings.
6. Amp draw, HP and RPM readings shall be measured for each motor at scheduled design operating conditions.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Use spreader bars with lifting cables and hoist sections from lifting lugs, to prevent cable damage to sections.

B. Rig individual sections under direct supervision of Unit Manufacturer's Representative.

C. Install on concrete housekeeping pad. Coordinate final pad size and location in field.

D. When indicated, install units on steel supports. Coordinate final location and placement of steel supports and ductwork connections in field.

E. Secure the unit to the housekeeping pad or steel supports with suitable anchors bolted through the unit's base rail. Prior to anchoring, level unit in all directions with stainless steel shims.

F. Shipping splits requiring field reconnection shall be made under the direct supervision of unit Manufacturer's Representative. Provide labor to reconnect utilities, piping, conduits and sheet metal sections of the unit. Openings to ductwork and piping shall remain protected and covered until unit assembly. Immediately after unit assembly, restore all factory protection. Maintain protection after assembly until just prior to final acceptance by Owner.

G. Make piping and duct connections, install filters and unit accessories, and complete all work required to place the unit into service. Connect vents and drains to non-ferrous coil headers with bronze or brass fittings.

3.2 START-UP

A. Provide a qualified service technician from the Manufacturer's staff to perform unit start-up. This start-up service shall be provided prior to commissioning activities, and prior to any temporary use.

3.3 TEMPORARY USE OF AIR HANDLING UNITS

A. Thoroughly clean unit of all grease, dirt, dust, etc.

B. Prior to placement into temporary service:

1. Perform manufacturer's pre-start protocol.
2. Perform commissioning activities.

C. Perform all manufacturer's required routine maintenance procedures during temporary service. Continuously maintain a log of such procedures. Store log at unit during temporary use period and include log as part of the final O&M manual.

D. While operating the air handler for temporary use, install a complete set of filters in the air handling unit of the same quality and efficiency as the specified permanent filters for the project.

E. Provide temporary filters, minimum MERV 8, to protect all ductwork and building contents when unit is operated during construction. Filters shall have an equal or better performance rating than primary filters specified for permanent use in order to prevent construction dirt infiltration into the air handling unit systems.

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

3.4 FIELD QUALITY CONTROL

A. Units shall undergo air and water balance and vibration testing per Related Section Testing, Adjusting and Balancing.

B. Each unit shall be field tested. Deficiencies related to manufacture or installation shall be corrected without cost to Owner.

1. The unit Manufacturer shall correct and pay for the repair of deficiencies found during testing, except for leaks found at unit section joints, which shall be the responsibility of the Contractor to repair.

2. Perform leakage tests after reassembly of unit sections to validate that the unit casing leakage is less than 1/2 percent of the scheduled design air flow (CFM) at 10 in. w.c.
   a. Positive Pressure Test: Duct openings in the positive pressure section shall be sealed. The CFM of the test fan shall be read using an approved airflow measuring device. When the static pressure developed by the test fan reaches 10 in., the fan CFM shall be read and this CFM shall be considered the casing leakage.
   b. Negative Pressure Test: Duct openings in the negative pressure section shall be sealed. The CFM of the test fan shall be read using an approved airflow measuring device. When the static pressure developed by the test fan reaches 10 in., the fan CFM shall be read and this CFM shall be considered the casing leakage.
   c. At the conclusion of field tests, a formal written report of results shall be submitted to the University Representative for approval.

3.5 COMMISSIONING

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

3.6 ADJUSTING, CLEANING, PROTECTION

A. After unit has completed any temporary service and just prior to final acceptance by Owner, contractor shall:

1. Thoroughly clean unit of all grease, dirt, dust, etc., lubricate bearings, align and tighten belts, and perform manufacturer's pre-start protocol
2. Install a new, complete set of filters.
3. Perform all commissioning activities, even if previously performed to ready for temporary service.
4. Touch up damaged galvanized surfaces with zinc rich paint, minimum 65 percent metallic zinc by weight.
5. Touch up damaged painted surfaces with manufacturer provided touch-up paint.

3.7 OWNER TRAINING

A. Provide a qualified service technician from the Manufacturer's staff to provide training.

B. Train Owner's maintenance personnel on start-up and shutdown, trouble-shooting, servicing and preventative maintenance procedures, minimum of 2 hours or 1 hour per unit if multiple units were supplied. Review the data contained in the Operating and Maintenance Manuals with Owner's personnel.

C. Schedule training with Owner through the Project Construction Manager with at least seven (7) days prior notice. Training and start up services are separate functions - training shall not be combined with startup services.

END OF SECTION 237323