PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Casing construction.

B. Fan section.

C. Coil section.

D. Filter and air cleaner section.

E. Damper section.

F. Airflow measurement.

G. Total energy recovery wheel section.

H. Access section.

1.02 DEFINITIONS

A. Low Pressure: Greater than 1 inch w.c. and less than or equal to 4 inches w.c. internal positive or negative pressure.

B. Medium Pressure: Greater than 4 inches w.c. and less than 10 inches w.c. internal positive or negative pressure.

C. High Pressure: Greater than or equal to 10 inches w.c. internal positive or negative pressure.

1.03 REFERENCE STANDARDS

A. ABMA STD 9 - Load Ratings and Fatigue Life for Ball Bearings; 2015.

B. ABMA STD 11 - Load Ratings and Fatigue Life for Roller Bearings; 1990 (Reapproved 2008).

C. ACGIH - Ultraviolet Radiation, TLV Physical Agents; 2010, 7th edition.

D. AHRI 260 - Sound Rating of Ducted Air Moving and Conditioning Equipment; 2011.

E. AHRI 410 - Standard for Forced-Circulation Air-Cooling and Air-Heating Coils; 2001 (R2011).

F. AHRI 430 (I-P) - Performance Rating of Central Station Air-Handling Units; 2014.

G. AHRI 1060 I-P - Performance Rating of Air-to-Air Heat Exchangers for Energy Recovery Ventilation Equipment; 2011.

H. AMCA (DIR) - [Directory of] Products Licensed Under AMCA International Certified Ratings Program; http://www.amca.org/certified/search/company.aspx.

I. AMCA 99 - Standards Handbook; 2010.

J. AMCA 210 - Laboratory Methods of Testing Fans for Certified Aerodynamic Performance Rating; 2007.

K. AMCA 300 - Reverberant Room Method for Sound Testing of Fans; 2014.

L. AMCA 301 - Methods for Calculating Fan Sound Ratings from Laboratory Test Data; 2014.

M. AMCA 500-D - Laboratory Methods of Testing Dampers for Rating; 2012.

N. AMCA 500-L - Laboratory Methods of Testing Louvers for Rating; 2012.

O. AMCA 611 - Certified Ratings Program for Airflow Measurement Stations; 2010.

P. ASHRAE Std 52.2 - Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size; 2012, with 2015 amendments.

Q. ASHRAE Std 62.1 - Laboratory Method of Testing to Determine the Sound Power in a Duct; 2013.

R. ASHRAE Std 90.1 - Energy Standard for Buildings Except Low-Rise Residential Buildings; 2013, Including All Addenda.

S. ASTM B177/B177M - Standard Guide for Engineering Chromium Electroplating; 2011.

T. ASTM E477 - Standard Test Method for Measuring Acoustical and Airflow Performance of Duct Liner Materials and Prefabricated Silencers; 2013.

U. CGA 3.2 - Industrial and Commercial Gas-Fired Package Furnaces; Current Edition, Including All Amendments.

V. NEMA MG 1 - Motors and Generators; 2014.

W. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

X. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems; 2015.

Y. SMACNA (DCS) - HVAC Duct Construction Standards Metal and Flexible; 2005.

Z. UL (DIR) - Online Certifications Directory; current listings at database.ul.com.

AA. UL 153 - Portable Electric Luminaries; Current Edition, Including All Revisions.

BB. UL 181 - Standard for Factory-Made Air Ducts and Air Connectors; current edition, including all revisions.

CC. UL 508 - Industrial Control Equipment; Underwriters Laboratories Inc; Current Edition, Including All Revisions.

DD. UL 1598 - Luminaires; Current Edition, Including All Revisions.

EE. UL 1812 - Ducted Heat Recovery Ventilators; Current Edition, Including All Revisions.

FF. UL 1995 - Heating and Cooling Equipment; Current Edition, Including All Revisions.

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination: Coordinate the installation with size, location and installation of service utilities.

B. Coordinate the work with other trades for installation of roof mounted air handling units on roof curbs.

C. Preinstallation Meeting: Conduct a preinstallation meeting one week prior to the start of the work of this section; require attendance by all affected installers.

D. Sequencing: Ensure that utility connections are achieved in an orderly and expeditious manner.

1.05 SUBMITTALS

A. Product Data:

1. Published Literature: Indicate dimensions, weights, capacities, ratings, gages and finishes of materials, and electrical characteristics and connection requirements.
2. Filters: Data for filter media, filter performance data, filter assembly, and filter frames.
3. Fans: Performance and fan curves with specified operating point clearly plotted, power, RPM.
4. Sound Power Level Data: Certified fan outlet, inlet, and casing radiation at rated capacity. For variable speed fans, provide sound ratings at 100, 80 and 60 percent of maximum rpm.

5. Electrical Requirements: Power supply wiring including wiring diagrams for interlock and control wiring, clearly indicating factory-installed and field-installed wiring.
6. Certified coil performance ratings with system operating conditions indicated.
7. Motor ratings and electrical characteristics plus motor and fan accessories.
8. Provide short circuit current rating of units with factory mounted starter or variable frequency drive.
9. Dampers, including housings, linkages, and operators.
10. Total pressure drop for the unit with itemized pressure drop per module. At a minimum, provide line items for the following:

    a) External static pressure loss.
    b) Unit inlet and outlet opening losses.
    c) Internal filter, coil, and casing losses.
    d) Pressure drop per module.

B. Sustainable Design Documentation: Submit manufacturer's product data on refrigerant used, showing compliance with specified requirements.

C. Shop Drawings: Indicate assembly, unit dimensions, weight loading, required clearances, construction details, field connection details, and electrical characteristics and connection requirements.

D. Specimen Warranty: Submit sample of manufacturer's warranty.

E. Executed Warranty: Submit documentation of final executed warranty completed in Owner's name and registered with manufacturer.

F. Manufacturer's Instructions: Include installation instructions.

G. Maintenance Data: Include instructions for lubrication, filter replacement, motor and drive replacement, spare parts lists, and wiring diagrams.

H. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.

1. Extra Fan Belts: One set for each unit.
2. Extra Filters: One set for each unit.

I. Product certificates signed by manufacturers of central-station air-handling units certifying that their products comply with specified requirements.

1.06 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience.

B. NFPA Compliance: Central-station air-handling units and components shall be designed, fabricated, and installed in compliance with NFPA Standard 90A "Standard for the Installation of Air Conditioning and Ventilating Systems."

C. UL Compliance: Electric coils, along with the complete central-station air-handling unit, shall be listed and labeled by Underwriters' Laboratories.

D. Nationally Recognized Tested Laboratory and NEMA Compliance (NRTL): Electric coils, along with the complete central-station air-handling unit shall be listed and labeled by a NRTL. The term "NRTL" shall be as defined in OSHA Regulation 1910.7.

E. AHRI Certification: Central-station air-handling units and their components shall be factory tested in accordance with the applicable portions of AHRI 430 - Standard for Central-Station Air-Handling Units and shall be listed and bear the label of the Air-Conditioning and Refrigeration Institute.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Shipping Requirements: Each air handling unit and/or air handling unit section, top, bottom and sides, shall be covered with Shrinkfast or equal shrink wrap prior to shipment to protect interior surfaces and components from debris, dirt and moisture damage during shipping and storage.

1. Reference Manufacturer/Model Number: Shrinkfast / R10CCU 10HUV
2. Part Number: Q44R
3. Description: 20' x 100', 10 Mil reinforced poly wrap with scrim.

B. Accept products on site in factory-fabricated protective containers, with factory-installed shipping skids and lifting lugs. Follow manufacturer's written instructions for rigging. Inspect for damage. Replace damaged units or components.

C. Store in clean dry place off the ground and protect from weather, physical damage, and construction traffic. Handle carefully to avoid damage to components, enclosures, and finish. Replace any sections that experience internal water damage due to lack of protection.

D. Do not operate units until ductwork is clean, filters are in place, bearings lubricated, and fan has been test run under observation.

1.08 SPARE PARTS

A. General: Furnish to Owner, with receipt, the following spare parts for each air-handling unit.

1. If HVAC equipment is used during the construction period, Contractor shall provide one set of filters (if system is designed to include pre-filters and after-filters, provide only pre-filters) when the unit is started and replace filters when needed, but not less than every month. On the day of

substantial completion, the Contractor shall clean the unit and provide a new set of filters at each location in the unit.

2. Furnish one additional gasket for each sectional joint of each central-station air-handling unit.

PART 2 - PRODUCTS AND MATERIALS

2.01 MANUFACTURERS

A. Aaon, Inc.

B. Airtherm Mfg. Co.

C. Air Zone Industries, Inc.

D. Carrier Air Conditioning.

E. Daikin Applied.

F. Dunham-Bush, Inc.

G. Johnson Controls Inc./ York International Corporation.

2.02 MANUFACTURED UNITS

A. General Description: Factory assembled, consisting of fans, motor and drive assembly, coils, plenums, filters, and drip pans.

B. Types: Central-station air-handling units included in this project are of the following types:

1. Draw-through.

C. Motor: Refer to Division 23 Section "Common Motor Requirements for HVAC Equipment."

1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so that the driven load will not require the motor to operate in the service factor range.

D. Electrical Components: Refer to Division 26 Sections.

2.03 CASING CONSTRUCTION

A. Full Perimeter Base Rail:

1. Construct of galvanized steel.
2. Provide base rail of sufficient height to raise unit for external trapping of condensate drain pans.

B. Casing:

1. Construct of one piece, insulated, double wall panels.
2. Provide mid-span, no through metal, internal thermal break.
3. Construct outer panels of galvanized steel and inner panels of galvanized steel.
4. Casing Air Pressure Performance Requirements:

    a) Able to withstand up to 4 inches w.g. positive or negative static pressure.

5. Medium and high-pressure units shall be constructed with additional bracing and supports. Units rated at 5.5 inches w.g. and higher shall be connected to accessories sections with double-thickness neoprene-coated flexible connection.

C. Access Doors:

1. Construction, thermal and air pressure performance same as casing.
2. Provide surface mounted handles on hinged, swing doors.

D. Unit Flooring: Construct with sufficient strength to support expected people and equipment loads associated with maintenance activities.

E. Casing Leakage: Seal joints and provide airtight access doors so that air leakage does not exceed one percent of design flow at the specified casing pressure.

F. Insulation:

1. Insulation: Comply with NFPA Standard 90A "Standard for the Installation of Air Conditioning and Ventilating Systems," for insulation.

    a) Type:

        1) Coated, glass-fiber insulation having a minimum density of 1-1/2 pcf.
        2) Foam injection.

    b) Thickness: 2 inch.
    c) Minimum R-Value: R-13.
    d) Completely fill panel cavities in each direction to prevent voids and settling.
    e) Location and Application: Factory applied with adhesive and mechanical fasteners to the internal surface of section panels downstream from and including the cooling coil section.

G. Drain Pan Construction:

1. Single-Wall Drain Pans: Formed sections of stainless steel. Fabricate pans in sizes and shapes to collect condensate from cooling coils (including coil piping connections and return bends) when units are operating at the maximum cataloged face velocity across the cooling coil. Insulate bottom

and sides of drain pans. Comply with ASHRAE Std 62.1 for indoor air quality and sufficiently size to collect all condensate.

2. Slope in two planes to promote positive drainage and eliminate stagnate water conditions.
3. Locate outlet of sufficient diameter at lowest point of pan to prevent overflow at normal operating conditions.
4. Provide threaded drain connections constructed of drain pan material, extended sufficient distance beyond the base to accommodate field installed, condensate drain trapping.
5. Drain connections: Both ends of the pan.
6. Pan top surface coating: Elastomeric compound.
7. Units with stacked coils shall have an intermediate drain pan or a drain trough to collect condensate from top coil.

H. Bottom Duct Connections: Provide steel or aluminum walking grate on structural supports where connections are located in sections accessible by personnel for maintenance.

I. Marine Lights:

1. Provide factory mounted, water and dust resistant LED fixture(s) in all accessible sections with the following characteristics:

a) Non-ferrous metal housing.
b) Glass or polycarbonate lens.
c) Factory wired to a switch within factory provided service module.
d) Instant on white light with minimum 8000 hour service life.

J. Finish:

1. Indoor Units:

a) Provide exterior, galvanized steel panels with painted surface complying with ASTM B177/B177M.
b) Color: Manufacturer's standard color.

2.04 FAN ARRAY SECTION

A. Performance — Fans shall conform to AMCA test standards, 205 (fan efficiency grade), 210 (air performance) and 300 (sound performance) and shall bear the AMCA certified ratings seal for both sound and air, and fan efficiency grade (FEG). Sound certification shall apply to both inlet and outlet sound power levels.

B. Construction — Fans shall be housed and incorporate a non-overloading type backward inclined airfoil blade wheel or centrifugal plenum wheel, heavy-gauge galvanized G90 steel frame, and front panel. The front panel shall have a removable inlet cone designed for smooth airflow transition into the wheel. The motor base shall be designed to ensure proper alignment of the fan wheel, motor and inlet cone.

The design shall also ensure the structural integrity of the base to minimize vibration.

1. The fan array shall consist of multiple fan and motor ”cubes” or “cells”, spaced in the air way tunnel cross section to provide a uniform air flow and velocity profile across the entire air way tunnel cross section and components contained therein.
2. The fan cube dimensions must be variable, such that each fan rests in an identically sized cube or cell, and in a spacing such that the array dimensions fill a minimum of 90% of the cross sectional area of the AHU air way tunnel.

C. Wheel — Wheels shall be constructed of non-overloading extruded airfoil shaped blades. Airfoil blades shall be continuously welded. The entire wheel shall be constructed of aluminum to reduce weight and vibration. Blades shall be extruded aluminum. Wheel hubs shall be machined aluminum. Aluminum fan wheels shall not require a finish coating. Wheels shall be attached to the motor shaft using taper lock bushings. The wheel and fan inlet shall be matched and have precise running tolerances for maximum performance and operating efficiency.

D. Finish and Coating — Fans shall be constructed of corrosion resistant galvanized steel. Aluminum components shall be unpainted.

E. Motors — Motors shall meet or exceed EISA 2007 (The Energy Independence and Security ACT of 2007) efficiencies. Motors shall be NEMA rated, 720, 900 1200, 1800 or 3600 RPM in 60 Hz, Open Drip Proof (ODP) or Totally Enclosed Fan Cooled (TEFC) with a 1.15 service factor. Motors shall include permanently sealed (L10-400,000 hr) bearings and shaft grounding rings to protect the motor bearings from electrical discharge machining due to stray shaft currents.

F. Fan Balancing — All fans prior to shipment shall be run tested at the specified operating speed. Each fan shall be dynamically balanced as a complete unit in accordance with ANSI/AMCA 204-96 “Balance Quality and Vibration Levels for Fans” to a minimum Fan Application Category BV-3, Balance Quality Grade G6.3. Balance readings shall be taken electronically in the axial, vertical and horizontal directions. Records of each fan balance shall be maintained and a written copy shall be available upon request.

G. Fan Isolation:

1. Blank off Panels — Each Multiple Fan section to be provided with fan blank-off panels to enable manual isolation of fan for servicing. Quantity of panels shall equal number of fans on a single VFD.

H. Fan airflow measurement:

1. Piezometer Ring: Rings shall be factory installed in each fan inlet. The device shall have a measurement accuracy of ± 5%. Tubing shall be field installed along with corresponding air flow monitoring station by DDC

controls contractor so that the measurement is representative of all fans in the array.

I. Fan Array Motor Control (common VFD operation with Array split into two banks)

1. All fan motors shall be factory-wired to individual manual motor protection (MMP) device which shall consist of a motor overload relay with adjustable current rating and an on-off disconnect switch (one per motor) for power isolation. Field wiring of MMPs to fan motors shall not be permitted.
2. MMPs shall be contained in a single control panel (MMP panel) and shall be mounted on the exterior wall panel of the fan array section.
3. MMP panel shall have a single point of connection for input power wiring and shall feed power to individual MMP's through a common bus bar. Independent wiring of input power to individual MMP's shall not be permitted.
4. All VFDs shall be operated together from a single control point so that all fan motors operate together. Independent control of VFDs and fan motors shall not be permitted.
5. Contractor shall set VFD maximum speed if fan design maximum is above 60HZ.

2.05 COIL SECTION

A. Testing Requirements: The following factory tests are required:

1. Coil Performance Tests: Cooling and heating coils, except sprayed surface coils, shall be factory tested for rating in accordance with AHRI 410 - Standard for Forced-Circulation Air-Cooling and Air-Heating Coils.

B. Coil Pressure Ratings:

1. Water Coils: Design for 200 psi working pressure at 325 F, and pressure test at 300 psi under water.

C. Coil Sections: Common or individually insulated, galvanized steel casings for heating and cooling coils. Coil section shall be designed and constructed to facilitate removal of coil for maintenance and replacement and to assure full air flow through coils.

D. Casing: Provide access to both sides of coils. Enclose coils with headers and return bends exposed outside casing. Slide coils into casing through removable end panel with blank off sheets and sealing collars at connection penetrations.

E. Drain Pans: 24 inch downstream of coil and down spouts for cooling coil banks more than one coil high.

F. Eliminators: Three break of galvanized steel, mounted over drain pan.

G. Fabrication:

1. Tubes: 5/8 inch OD seamless copper expanded into fins, brazed joints.
2. Fins: Aluminum or copper, constructed from flat plate with belled collars for tubes. Fins shall be bonded to tubes by mechanically expanding copper tubes.
    a) Thickness: Minimum 0.006 inches.
    b) Spacing: Maximum 12 fins per inch.
3. Casing: Die formed channel frame of galvanized steel.
4. Water Coil Turbulators: Bronze, spring-type.

H. Water Heating Coils:

1. Headers: Cast iron, seamless copper tube, or prime coated steel pipe with brazed joints.
2. Configuration: Drainable, with threaded plugs for drain and vent; serpentine type.

I. Water Cooling Coils:

1. Headers: Cast iron, seamless copper tube, or prime coated steel pipe with brazed joints.
2. Configuration: Drainable, with threaded plugs for drain and vent; threaded plugs in return bends and in headers opposite each tube.

2.06 FILTER AND AIR CLEANER SECTION

A. General:

1. Provide filter sections with filter racks, minimum of one access door for filter removal, and filter block-offs to prevent air bypass.
2. Filters shall comply with NFPA Standard 90A "Standard for the Installation of Air Conditioning and Ventilating Systems."
3. Filter Section: Cabinet material and finish shall match the air-handling unit cabinet, with filter media holding frames arranged for flat or angular orientation. Section shall have access doors on both sides of the unit.
4. Refer to Division 23 Section "Particulate Air Filtration" for air filters required for air-handling units.

B. Refer to Particulate Air Filtration spec section for additional requirements.

C. Differential Pressure Gage:

1. Provide factory installed dial type differential pressure gage, flush mounted with casing outer wall, and fully piped to both sides of each filter to indicate status.
2. Maintain plus/minus 5 percent accuracy within operating limits of 20 degrees F to 120 degrees F.

2.07 DAMPER SECTION

A. General: Dampers and their operators shall comply with performance requirements specified in Division 23 Section "Instrumentation and Control Devices for HVAC."

B. Mixing Boxes: Parallel-blade dampers in a reinforced, galvanized steel cabinet. Damper blades shall be galvanized steel mechanically fastened to steel operating rod. Connect operating rods for each set of dampers together with a common linkage and interconnect linkages so dampers operated simultaneously and in the opposite direction (one opens when the other closes).

C. Damper Blades:

1. Double-skin airfoil design with metal, compressible jamb seals and extruded-vinyl blade-edge seals on each blade.
2. Self-lubricating stainless steel or synthetic sleeve bearings.
3. Comply with ASHRAE Std 90.1 for rated maximum leakage rate.
4. Provide leakage testing and pressure ratings in compliance with AMCA 500-D test methods.
5. Arrange in parallel or opposed-blade configuration.

2.08 TOTAL ENERGY RECOVERY WHEEL SECTION

A. Certified in accordance with AHRI 1060 I-P and UL 1812 for mechanical, electrical, and fire safety.

B. Wheel Construction:

1. Dessicant Properties:

a) Factory coated.
b) Washable using standard detergent or alkaline based coil cleaner.
c) Resistant to high levels of humidity.

2. Construct housing of stainless steel, aluminum, or galvanized steel.
3. Factory set adjustable diameter seals and self-adjusting perimeter seals.
4. Permanently sealed and lubricated wheel bearings.
5. Motor:

a) Thermally protected.
b) Factory mounted.

C. Maintenance and Access Features:

1. Access doors upstream and downstream of the wheel cassette.
2. Removable wheel segments to facilitate maintenance and cleaning.
3. Adequate space for cleaning, service, and maintenance.

D. Controls:

1. Wheel Control: Damper control of recovery capacity to 40 percent of initial total recovery capacity.
2. Frost Prevention Control: Provide outside air bypass, return air preheat, or variable speed.

2.09 ACCESS SECTION

A. Provide where indicated on the Drawings to allow for inspection, cleaning, and maintenance of field installed components.

B. Construct access doors same as previously specified within this Section.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine areas and conditions under which air handling units are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.02 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Support floor-mounted units on concrete equipment bases using housed spring isolators. Secure units to anchor bolts installed in concrete equipment base.

C. Arrange installation of units to provide access space around air-handling units for service and maintenance.

D. Bolt sections together with gaskets.

E. Isolate fan section with flexible duct connections.

F. Install flexible duct connections between fan inlet and discharge ductwork and air handling unit sections. Ensure that metal bands of connectors are parallel with minimum one inch flex between ductwork and fan while running.

G. Install assembled unit on vibration isolators. Install isolated fans with resilient mountings and flexible electrical leads. Install restraining snubbers as indicated. Refer to Section 230548. Adjust snubbers to prevent tension in flexible connectors when fan is operating.

H. Provide fixed sheaves required for final air balance.

I. Make connections to coils with unions or flanges.

J. Piping installation requirements are specified in other Division 23 sections. The Drawings indicate the general arrangement of piping, valves, fittings, and specialties. The following are specific connection requirements:

1. Arrange piping installations adjacent to units to allow unit servicing and maintenance.
2. Route unit condensate drain piping to location shown on the plan or, if not shown, to the nearest equipment or floor drain. Provide trap at connection to drain pan with depth as noted on the drawings and install cleanouts at changes in direction. Size condensate drain piping in accordance with local code and as shown on the drawings.

K. Duct installations and connections are specified in other Division 23 sections. Make final duct connections with flexible connections.

L. Electrical Connections: The following requirements apply:

1. Electrical power wiring is specified in Division 26.
2. Temperature control wiring and interlock wiring is specified in Division 23 section "Direct-Digital Control for HVAC."

M. Grounding: Connect unit components to ground in accordance with the National Electrical Code.

N. Hydronic Coils:

1. Hydronic Coils: Connect water supply to leaving air side of coil (counterflow arrangement).
2. Provide shut-off valve on supply line and lockshield balancing valve with memory stop on return line.
3. Locate water supply at bottom of supply header and return water connection at top.
4. Provide manual air vents at high points complete with stop valve.
5. Ensure water coils are drainable and provide drain connection at low points.

O. Insulate Coil Headers Located Outside Air Flow as Specified for Piping: Refer to Section "HVAC Insulation" for additional requirements.

P. Field-wire each factory provided control for field installation.

3.03 EQUIPMENT BASES

A. Construct concrete equipment pads in accordance with Section "Common Work Results for HVAC."

3.04 ADJUSTING, CLEANING, AND PROTECTING

A. Adjust water coil flow, with control valves to full coil flow, to indicated gpm.

B. Adjust damper linkages for proper damper operation.

C. Clean the entire unit including cabinet interiors just prior to substantial completion to remove foreign material and construction dirt and dust. Vacuum clean fan wheel, fan cabinet, intake plenum cabinet, heat exchange surfaces, cooling/heating coil sections, filter sections, access sections, etc.

3.05 FIELD QUALITY CONTROL

A. Vibration Analysis:

1. Measure vibration levels with an FFT (Fast Fourier Transformation) analyzer.
2. Characteristics:
    a) Frequency Response Range: 5 Hz thru 10 KHz (300 thru 600,000 cpm).
    b) Capability to use a Hanning window.
    c) Capacity to perform ensemble averaging.
    d) Auto-ranging frequency amplitude.
    e) Minimum amplitude accuracy over the selected frequency range of plus/minus 20 percent or plus/minus 1.5 dB.
3. Use accelerometer, stud-mounted to collect data.
4. Ensure the mass of the accelerometer and its mounting have minimal influence on the frequency response of the system over the selected measurement range.

B. Final Acceptance Requirements:

1. Use dial indicator gages to demonstrate fan and motor are aligned.
2. Verify conformance to specifications using vibration analysis.
3. Maximum Vibration Levels:
    a) 0.075 inch per second at 1 times run speed and at fan/blade frequency.
    b) 0.04 inch per second at other multiples of run speed.

3.06 SYSTEM STARTUP

A. Final Checks Before Start-Up: Perform the following operations and checks before start-up:

1. Remove shipping, blocking, and bracing.
2. Verify unit is secure on mountings and supporting devices and that connections for piping, ductwork, and electrical are complete. Verify proper thermal overload protection is installed in motors, starters, and disconnects.
3. Perform cleaning and adjusting specified in this Section.
4. Disconnect fan drive from motor and verify proper motor rotation direction and verify fan wheel free rotation and smooth bearings operations. Reconnect fan drive system, align belts, and install belt guards.

5. Lubricate bearings, pulleys, belts, and other moving parts with factory-recommended lubricants.
6. Set zone dampers to full open for each zone.
7. Set face-and-bypass dampers to full face flow.
8. Set outside-air and return-air mixing dampers to minimum outside-air setting.
9. Comb coil fins for parallel orientation.
10. Install clean filters. Do not operate air handling unit without pre-filters installed.
11. Verify manual and automatic volume control, and fire and smoke dampers in connected ductwork systems are in the full-open position.
12. Disable automatic temperature control operators.

B. Provide manufacturer's field representative to observe and approve systems startup.

C. Prepare and start equipment and systems in accordance with manufacturers' instructions and recommendations.

D. Adjust for proper operation within manufacturer's published tolerances.

E. Energize motor, verify proper operation of motor, drive system, and fan wheel. Adjust fan to indicated RPM.

1. Replace fan and motor pulleys as required to achieve design conditions.
2. Measure and record motor electrical values for voltage and amperage.
3. Shut unit down and reconnect automatic temperature control operators.
4. Refer to Division 23 Section "Testing, Adjusting, and Balancing for HVAC" for procedures for air-handling-system testing, adjusting, and balancing.

3.07 CLOSEOUT ACTIVITIES

A. At a time mutually agreed upon between the Owner and Contractor, provide the services of a factory trained and authorized representative to train Owner's designated personnel on the operation and maintenance of the equipment provided under this section.

B. Demonstration: Demonstrate operation of system to Owner's personnel.

1. Use operation and maintenance data as reference during demonstration.
2. Conduct walking tour of project.
3. Briefly describe function, operation, and maintenance of each component.

C. Training: Train Owner's personnel on operation and maintenance of system.

1. Use operation and maintenance manual as training reference, supplemented with additional training materials as required.
2. Provide minimum of four hours of training.
3. Instructor: Manufacturer's training personnel.

4. Location: At project site.

D. Certification: Contractor shall submit to the Engineer a certification letter stating that the Owner's designated representative has been trained as specified herein. Letter shall include date, time, attendees and subject of training. The certification letter shall be signed by the Contractor and the Owner's representative indicating agreement that the training has been provided.

E. Schedule: Schedule training with Owner with at least 7 days' advance notice.

END OF SECTION

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