

SECTION 23 7313 - PACKAGED (MODULAR) AIR HANDLING UNITS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Outdoor and/or indoor modular air handling units and components as scheduled and shown on drawings.

1.2 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Specification Book Division 01 Sections, apply to this section.

1.3 REFERENCES

- A. AMCA 99 – Standard Handbook
- B. AMCA 210 – Laboratory Methods of Testing Fans for Rating Purposes
- C. AMCA 500 – Test Methods for Louvers, Dampers, and Shutters
- D. AMCA 611-95 – Methods of Testing Airflow Measurement Stations for Rating
- E. ANSI/AFBMA 9 – Load Ratings and Fatigue Life for Ball Bearings
- F. ANSI/UL 900 – Test Performance of Air Filter Units
- G. AHRI 260 – Sound Rating of Ducted Air Moving and Conditioning Equipment
- H. AHRI 410 – Forced-Circulation Air Cooling and Air Heating Coils
- I. ANSI/AHRI 430 – Performance Rating of Central-Station Air Handling Units
- J. ASHRAE 52.1/52.2 – Method of Testing General Ventilation Air Cleaning Devices for Removal Efficiency by Particle Size
- K. ASHRAE 62 – Ventilation for Acceptable Indoor Air Quality
- L. ASHRAE 90.1 – Energy Standard for Buildings Except Low-Rise Residential Buildings
- M. ASTM-C 1338 – Standard Test Method for Determining Fungi Resistance of Insulation Material and Facings.
- N. NFPA 70 – National Electric Code (conductors, equipment and raceways)
- O. NFPA 90A – Installation of Air Conditioning and Ventilation Systems

- P. SMACNA – HVAC Duct Construction Standards
- Q. UL-181 – Mold Growth and Humidity Test
- R. UL-1995 – Standard for Safety for Heating and Cooling Equipment

1.4 QUALITY ASSURANCE

- A. Manufacturer shall have a minimum of 25 years of experience in designing, manufacturing, and servicing air-handling units.
- B. The design indicated on the schedules and shown on the drawings is based upon the products of the named manufacturer. Alternate equipment manufacturers are acceptable if equipment meets scheduled performance requirements and dimensional requirements.
- C. ARI Compliance:
 - 1. Comply with ARI 203/110 and ARI 303/110 for testing and rating energy efficiencies for RTUs.
 - 2. Comply with ARI 270 for testing and rating sound performance for RTUs.
- D. ASHRAE Compliance:
 - 1. Comply with applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."
- E. ASHRAE/IESNA 90.1 Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."
- F. NFPA Compliance: Comply with NFPA 90A and NFPA 90B.
- G. UL Compliance: Comply with UL 1995.
- H. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- I. Comply with FM Global requirements for fans and blowers, motors and VFD's, and for monitoring and diagnosis of vibration in rotating machinery.

1.5 COORDINATION

- A. If equipment is supplied by a manufacturer other than the one named, coordinate with the General Contractor and affected subcontractors to ensure the specified performance is met. This coordination shall include (but is not limited to) the following:
 - 1. Structural supports for units.
 - 2. Size and location of concrete bases/housekeeping pads
 - 3. Location of roof curbs, unit supports and roof penetrations
 - 4. Ductwork sizes and connection locations
 - 5. Piping size and connection/header locations
 - 6. Interference with existing or planned ductwork, piping and wiring
 - 7. Electrical power requirements and wire/conduit and over current protection sizes.

8. Trap height requirements

- B. The Mechanical Contractor shall be responsible for costs incurred by the General Contractor, Subcontractors, and Consulting Engineers to accommodate units furnished by a manufacturer other than manufacturer named as basis of design.

1.6 RATINGS AND CERTIFICATIONS

- A. Air Handling Unit safety: ETL or UL 1995
- B. Air Handling Unit energy use: ASHRAE 90.1
- C. Fans: AMCA 210
- D. Air Coils: AHRI 410
- E. Air Handling Unit certification program: ANSI/AHRI 430
- F. Filter media: ANSI/UL 900 listed Class I or Class II
- G. Control wiring: NEC codes & ETL requirements
- H. Motors: Federally mandated Energy Policy Act (EPACT).
- I. Airflow Monitoring Stations: AMCA 611-95

1.7 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Design outdoor units/supports to comply with project wind performance requirements, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

1. Wind-Restraint Performance:

- a. **Basic Wind Speed: Refer to structural drawings.**
- b. **Building Classification Category: [I] [II] [III] [IV].**
- c. **Minimum XX lb/sq. ft multiplied by the maximum area of the mechanical component projected on a vertical plane that is normal to the wind direction, and 45 degrees either side of normal.**

1.8 SUBMITTAL DOCUMENTATION REQUIRED

A. **[LEED Submittals:**

- 1. **Product Data for Credit EA 4: Documentation indicating that equipment and refrigerants comply.**
- 2. **Product Data for Prerequisite IEQ 1: Documentation indicating that units comply with ASHRAE 62.1, Section 5 - "Systems and Equipment."**

- B. Delegated-Design Submittal: For unit supports indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Design Calculations: Calculate requirements for selecting vibration isolators and for designing vibration isolation bases.
 2. If outdoor, roof mounted unit, detail mounting, securing, and flashing of roof curb to roof structure. Indicate coordinating requirements with roof membrane system.
 3. Wind-Restraint Details (if unit subject to wind): Detail fabrication and attachment of wind restraints and snubbers. Show anchorage details and indicate quantity, diameter, and depth of penetration of anchors.
- C. Coordination Drawings: Plans and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
1. Structural members to which packaged air handling units will be attached.
 2. Roof openings
 3. Roof curbs and flashing.
- D. Manufacturer Wind Loading Qualification Certification: Submit certification that specified equipment will withstand wind forces identified in "Performance Requirements" Article and in Section 23 0550 "Vibration Isolation."
1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculations.
 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of wind force and locate and describe mounting and anchorage provisions.
 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- E. Furnish fan performance ratings and fan curves with specified operating point clearly plotted.
- F. Furnish drawings indicating unit dimensions, required clearances, field connection locations, wiring diagrams, shipping drawings, and curb drawings.
- G. Furnish performance report showing unit level performance data including: fan(s), motor(s), coil(s) and other functional components. Performance report shall also include unit casing performance.
- H. Furnish operation and maintenance data, including instructions for lubrication, filter replacement, motor and drive replacement, and condensate pan cleaning; spare parts lists, and wiring diagrams.
- I. Adjust and report performance ratings for the proper altitude of operation.
- J. Report air-handling unit performance ratings in accordance with ANSI/AHRI-430 (static pressure, airflow, fan speed, and fan brake horsepower).
- K. Report static pressure profiles by component section.
- L. Report coil ratings in accordance with AHRI-410 (capacities and pressure drops).
- M. Report unweighted octave band AHU sound power for inlets and outlets rated in accordance with AHRI Standard 260. Provide eight data points, the first for the octave centered at 63 Hz, and the eighth centered at 8,000 Hz. Manufacturer shall not use sound estimates based on bare fan data (AMCA ratings), nor use calculations like the substitution method based on AHRI 260 tests of other AHU products. Provide data for inlets and outlets

as scheduled. Report unweighted casing radiated sound power over the same 8 octave bands in accordance with ISO 9614 Parts 1&2 and ANSI S12.12.

- N. Airflow measuring device performance shall be certified and rated in accordance with AMCA-611. Report data in accordance with AMCA-611. Provide AMCA Certified Rating Seal for Airflow Measurement Performance.
- O. Report panel deflection at +/-8 w.g., stated in terms of 'L/X' where 'L' is the casing panel length and 'X' is a constant provided by the AHU manufacturer.
- P. Report casing leakage rate at +/-8" w.g., specified in terms of percentage of design airflow.
- Q. Report weight loads and distributions by component section.
- R. Report product data for filter media, filter performance data, filter assembly, and filter frames.
- S. Report electrical requirements for power supply wiring including wiring diagrams for interlock and control wiring, clearly indicating factory-installed and field-installed wiring.
- T. Report motor electrical characteristics.
- U. Operation and Maintenance Data: For units to include in emergency, operation, and maintenance manuals.
- V. Northwestern University Maintenance Requirement Forms, see Division 01.

1.9 DELIVERY, STORAGE AND HANDLING

- A. Comply with ASHRAE 62, Section 5 (mold and corrosion resistant casings, filters upstream of wetted surfaces, and drain pan design).
- B. Comply with ASHRAE 62, Section 7 (practices to be followed during construction and startup). Protect equipment from moisture by appropriate in-transit and on-site procedures.
- C. Follow manufacturer's recommendations for handling, unloading and storage.
- D. Protect, pack, and secure loose-shipped items within the air-handling units. Include detailed packing list of loose-shipped items, including illustrations and instructions for application.
- E. Protect, pack and secure controls devices, motor control devices and other electronic equipment. Do not store electronic equipment in wet or damp areas even when they are sealed and secured.
- F. Enclose and protect control panels, electronic, and variable frequency drives. Do not store equipment in wet or damp areas even when they are sealed and secured.
- G. Seal openings to protect against damage during shipping, handling and storage.
- H. Wrap indoor units with a tight sealing membrane. Wrapping membrane shall cover entire AHU during shipping and storage. Cover equipment, regardless of size or shape. Alternatively AHU must be tarped for shipment and storage.

- I. Wrap equipment, including electrical components, for protection against rain, snow, wind, dirt, sun fading, road salt/chemicals, rust and corrosion. Keep equipment clean and dry.
- J. Tarp outdoor units to protect against rain and road debris during shipping.
- K. Clearly mark AHU sections with unit tag number, segment sequence number, and direction of airflow. Securely affix safety-warning labels.

1.10 EXTRA MATERIALS

- A. Provide one set of filters for balancing, and one additional set for final turnover to owner.
- B. Provide one extra set of fan belts, in addition to the factory-installed set.

1.11 SPECIAL WARRANTY

- A. Five (5) years, see Division 01.

1.12 SYSTEM STARTUP

- 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.
- B. Comply with manufacturer's start-up requirements to ensure safe and correct operation and integrity of warranty.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on schedule as JCI/York Solutions, or comparable product by one of the following:
 - 1. Buffalo Air Handling.
 - 2. Daikin.
 - 3. HuntAir.
 - 4. Temtrol.
 - 5. Airflow Equipment.

2.2 GENERAL DESCRIPTION/REQUIREMENTS

- A. Air-handling units are to be designed and built to meet the performance detailed in this submittal and as called for on the drawings.
- B. Units will be complete with fans, motors, motor controls, coils, dampers, access doors and other components/options, as shown on product drawings, wiring diagrams, and as described in performance specifications.**
- C. Fans and drives will be balanced to limit vibration at operating speeds.

- D. Unit will ship in one (1) piece whenever possible. Shipping splits will be provided when necessary. Lifting lugs will be provided where required for proper lifting.
- E. Unit casing and frame will be factory insulated.
- F. Units will be ETL labeled.

2.3 UNIT CASING

- A. Unit shall be specifically designed for specific indoor or outdoor application.
- B. Unit casing will consist of a structural frame with insulated roof, wall, and floor panels, with panels fabricated from minimum 16 gauge, G-90, galvanized steel. Construction shall be bolted standing seam type.
- C. Removal of wall panels will not affect structural integrity of units.
- D. Unit casing will be insulated with spray injected foam to achieve thermal resistance of minimum of R13 hr-ft²-°F/BTU. Insulation application will meet the requirements of NFPA 90A.
- E. Unit base shall be minimum 2.5" welded structural steel channel construction with full walk-on G-90 galvanized steel floors in all sections. No paint is permitted.
- F. Unit will conform to ASHRAE Standard 111 Class 6 for casing leakage no more than 1% of design airflow at 1.25 times design static pressure up to a maximum of +8 inches w.g. in positive pressure sections and -8 inches w.g. in negative pressure sections.
- G. Wall panels and access doors will deflect no more than L/240 when subjected to 1.5 times design static pressure up to a maximum of +8 inches w.g. in positive pressure sections and -8 inches w.g. in negative pressure sections. 'L' is the panel-span length and 'L/240' is the deflection at panel midpoint.
- H. Access sections shall be 24" minimum and shall have access doors on both sides.
- I. Unit will have double wall, 2" insulated panels for walls, roof, and floor. Exterior skin will be galvanized sheet steel as described above. Individual segments will have galvanized solid sheet steel interior liner except for fan sections, which shall be perforated.
 - 1. Panels with perforated liners will have 1" of minimum 3 lb/ft³ fiberglass board insulation, faced to prevent fiber erosion, and 1" of foam insulation. Exterior skin will be galvanized sheet steel. Interior liner will be perforated galvanized. Minimum perforated panel thermal resistance will be R11 hr-ft²-°F/BTU.
- J. For outdoor units, roofs will be double-sloped with a longitudinal peak and a minimum pitch of 1/4" per foot.
 - 1. Roof snow-loads capacity will be at least 50 lb/ft².
 - 2. Roof overhangs unit perimeter by 1-1/2".
- K. Floor panels will be double wall construction, designed to provide at most L/240 deflection when subjected to a 300 lb. load at mid-span.
- L. Double wall access doors will be provided on sections as shown on product drawings.

1. Stainless steel hinges permit a 180° door swing.
2. Access door will be of the same material type as exterior/interior casing.
3. Access door latches will use a roller cam latching mechanism.

M. View ports will be single pane Plexiglas.

N. Drain pans will comply with the guidelines of ASHRAE 62, and are to be minimum 16 gauge, Type 304 stainless steel.

1. Drain pans will be double sloped at least 1/8" per foot, and have no horizontal surfaces.
2. Drain connection material will be the same as drain pan.
3. Drain pans will drain to one point and to be insulated double bottom type.
4. Drain connections will be welded to drain pans
5. Drain pans will have at least 1" clearance between pan and coil supports.

O. *Optional pipe chases will be furnished, as shown on drawings.*

- 1. *Pipe chases will be constructed in the same manner as units.***
- 2. *Pipe chase doors will be provided, as shown on drawings.***
- 3. *Pipe chases will have the same base rail options as units.***

2.4 FANS

A. Refer to Section 23 3400 "Fans."

1. Blank off Panels — Each Multiple Fan section to be provided with one fan blank-off panel to enable manual isolation of fan for servicing.
2. Fan Options — The following options will be available for multiple fans:
 - a. Piezometer Ring: Airflow station will be factory installed in each fan inlet. Tubing will be manifolded so that the measurement is representative of all fans in the array. The device will have a measurement accuracy of $\pm 5\%$.
 - b. Backdraft Damper: Backdraft dampers will be available for automatic isolation of individual fans.

2.5 ELECTRICAL MOTORS

A. Refer to Section 23 0513 "Motors."

2.6 FAN MOTOR DISCONNECTS

- A. Fan motor disconnects will be provided with unit, as shown in performance specifications.
- B. Disconnect will be housed in a NEMA 3R enclosure, and will be mounted on the primary access side of segment.
- C. Disconnect will be suitable for use as an OSHA lockout/tagout disconnect when applied in accordance with part IV, Department of Labor OSHA 29 CFR Part 1910, Control of Hazardous Energy Source (lockout/tagout): Final Rule.
- D. Disconnect handles can be padlocked in the "off" position with up to three padlocks. Switch mechanism can be directly padlocked in the "off" position when door is open.

- E. Disconnects will be provided with an integral ground lug.
 - 1. 16A to 100A disconnects will have two (2) #14 ground wires.
 - 2. 200A to 400A disconnects will have one (1) #6-250 ground wire.

2.7 ACROSS-THE-LINE FAN MOTOR STARTERS

- A. Constant speed motor starters will be furnished (shipped loose) or provided (factory mounted and wired to motor) with units, as shown in submittal documents.
- B. For outdoor units, motor starters will be housed in a dedicated, weather resistant compartment.
 - 1. Shipped loose starters and starters provided on units without single point power will be housed in a NEMA 3R enclosure.
 - 2. Weatherproof compartments will be provided on units with single point power.
- C. Motor starter panels will include:
 - 1. Main power block
 - 2. Motor contactor(s)
 - 3. Individual short circuit and overload protection
 - 4. 120 volt control power transformer with primary and secondary protection
 - 5. 5 point terminal strip for field connections
 - 6. Main power disconnect
 - 7. Hand-Off-Auto switch

2.8 FAN VARIABLE FREQUENCY DRIVES

- A. Refer to Section 23 0514 "Variable Frequency Drives (VFD)."
- B. Variable frequency drives will be furnished (shipped loose) or provided (factory mounted and wired to motor) with units, as shown in submittal documents.
- C. For outdoor units, VFDs will be housed in a dedicated, weather resistant compartment.
 - 1. Shipped loose VFDs and VFDs provided on units without single point power will be housed in a NEMA 3R enclosure.
 - 2. Weatherproof compartments will be provided on units with single point power.
- D. VFDs furnished or provided with units will be programmed and started by a drive factory authorized and trained technician.

2.9 HEATING AND COOLING COILS

- A. Refer to Section 23 8216 "Coils."
- B. Cooling coil segments will have a full-width IAQ drain pan that extends at least 6" downstream of the last coil in the section.
- C. Coils will be removable from the side of unit, via removable AHU panels. No more than one panel must be removed to remove a coil.

- D. Coils will have frames constructed of galvanized steel. Casing channels will be free-draining and do not block fin area.
- E. Cooling coils with finned height greater than 48" will have an intermediate drain pan with downspout to drain condensate to main drain pan. Intermediate drain pan material will match coil frame material.
- F. Coil segment door clearances will allow for at least 2-inches of field installed piping insulation.
- G. Coil bulkheads and blank-offs will prevent air from bypassing coils.
- H. Coil segment casing to accommodate full-face or reduced-face coils will be provided. Provide face and bypass coil segments with factory installed bypass damper
- I. Coil connections will be extended through unit casing.
- J. Water and glycol coils will have a 1/4" FPT plugged vent or drain tap on each connection that is accessible from outside the unit.
- K. Spool shaped coil grommets will be provided to insulate and seal coil penetrations.

2.10 FILTERS

- A. Refer to Section 23 4114 "Filters."
- B. Filter segments will be provided, as shown on product drawings. Filter tracks/frames will be an integral part of the unit.
- C. Filter types, nominal sizes, efficiencies, and performance characteristics will be as shown in drawing schedules.
- D. Filter access will be provided via access doors on filter segments or adjacent segments as required by filter loading scheme. See product drawings for details.
- E. Performance of installed HEPA filtration systems is certified via a DOP test and classified as UL Class 1 when tested in accordance with UL Standard 586.
- F. Flush mounted, factory installed differential pressure gauge on the drive side of unit to measure pressure drop across filters will be provided

2.11 DAMPERS

- A. Refer to Section 23 3314 if smoke dampers are required, Section 23 3314 if isolation dampers are required, or Division 25 if control dampers are required.**
- B. Dampers will be factory installed.**
- C. Dampers will have airfoil blades with extruded vinyl edge seals and flexible metal compressible jamb seals.
- D. Dampers will have a maximum leakage rate of 4 CFM/square foot at 1" w.g. and comply with ASHRAE 90.1.

- E. Maximum damper torque requirement will be 7 in. lbs./ft².
- F. Damper blades will be parallel acting unless submitted otherwise.
- G. Damper blades will be galvanized steel or aluminum.

2.12 AIR FLOW MONITORING STATIONS

- A. ***Optional airflow monitoring stations will be provided on air inlets, as shown in performance specifications.***
- B. ***Airflow monitoring stations will bear the AMCA Certified Ratings Seal for Airflow Measurement Performance.***
- C. ***Airflow monitoring station dampers will comply with leakage rates per ASHRAE 90.1.***
- D. ***Airflow monitoring stations will be accurate within 5% of actual airflow between 350 FPM and 4000 FPM free area velocity.***
- E. ***Outdoor air intake openings with air flow monitoring stations will have rain louver.***
 - 1. ***Louver will be a wind-driven rain penetration class A louver.***
 - 2. ***Louver effectiveness ratio will be 100% at the following conditions:***
 - a. ***Wind velocity, 29 mph into louver.***
 - b. ***Rain fall rate, 3 in./hr.***
 - c. ***Free area air velocity, 1500 FPM.***

2.13 DIFFUSERS

- A. ***Diffuser segments will be provided, as shown on product drawings.***
- B. ***Perforated steel diffuser plates will be installed between fans and downstream components when required to ensure proper velocity profiles across downstream components.***

2.14 ROOF CURBS

- A. Roof curbs for roof mounted units will be furnished, as shown on product drawings.
- B. Roof curbs will be galvanized steel and support the perimeter of units, including pipe chases.
- C. Roof curbs will have a wood nailing strip.
- D. Roof curbs will be shipped loose for installation prior to unit installation.

2.15 APPURTENANCES

- A. Safety grates capable of supporting a 300 lb. center load will be provided over bottom openings, as scheduled.

- B. Formed [**Welded structural**] steel base rails suitable for rigging and lifting will be provided, as shown on product drawings.
- C. Lifting lugs will be provided where required for proper lifting.

2.16 FINISHES

- A. External unit surfaces will be factory cleaned prior to finishing or shipping.
- B. Unpainted air-handling units constructed of galvanized steel will pass the ASTM B-117 test for 220-hour salt spray solution (5%) without any sign of red rust.

2.17 HUMIDIFIERS

- A. Refer to Section 23 8413 Humidification Equipment.

2.18 TESTS AND INSPECTIONS

- A. Fan skid(s) will be run-balanced at specified speed to insure smooth, operation.
 - 1. Constant volume fan assemblies will be balanced at design RPM.
 - 2. Variable volume fan assemblies will be balanced from 10% to 100% of design RPM.
 - 3. Filter-in measurements will be taken in horizontal and vertical axes on drive and opposite-drive sides of fan shafts.
 - 4. Constant speed fan vibration limits: filter-in measurements will not exceed 4 mils.
 - 5. Variable speed fan vibration limits: filter-in measurements will not exceed 7 mils.
- B. Unit wiring with voltage greater than 30VAC will be hipot tested prior to shipping.

2.19 OTHER UNIT FEATURES/REQUIREMENTS:

- A. ***Provide all required framing, safing, supports, etc., for all components to be installed in the unit, including (but not limited to): Fans, dampers, coils, piping, humidifier grids, attenuators, heat exchangers, etc.***
- B. ***Stainless steel coil raising structures inside unit if required for proper cooling coil drain trapping and/or steam condensate trapping/drainage.***
- C. ***Humidifier control valves, strainers and valves shall be outside the airstream.***
- D. ***Do not locate humidifiers upstream of fan sections. The preferred location for humidifier sections are downstream of the fans.***
- E. ***Humidifiers shall be located 18" downstream of heating coils and a minimum of 3' upstream of cooling coils.***

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install equipment per industry standards, applicable codes, and manufacturer's instructions.
- B. Do not use AHU's for temporary heating, cooling or ventilation prior to complete inspection and startup performed per this specification.
- C. Install AHU's on a concrete pad, roof curb, or structural steel base, as shown on drawings.
- D. Install AHU's with manufacturer's recommended clearances for access, coil pull, and fan removal.
- E. Provide one complete set of filters for testing, balancing, and commissioning. Provide second complete set of filters at time of transfer to owner.
- F. Install AHU's plumb and level. Connect piping and ductwork according to manufacturer's instructions.
- G. Install pipe chases per manufacturer's instructions.
- H. Insulate plumbing associated with drain pan drains and connections.
- I. Install insulation on all staggered coil piping connections, both internal and external to the unit.

3.2 FIELD QUALITY CONTROL

- A. Store per AHU manufacturer's written recommendations. Store AHUs indoors in a warm, clean, dry place where units will be protected from weather, construction traffic, dirt, dust, water and moisture. If units will be stored for more than 6 months, follow manufacturer's instruction for long-term storage.
- B. Rig and lift units according manufacturer's instructions.

3.3 AHU INSPECTION

- A. Hire manufacturer's factory-trained and factory-employed service technician to perform an inspection of unit and installation prior to startup. Technician shall inspect and verify the following as a minimum:
 - 1. Damage of any kind
 - 2. Level installation of unit
 - 3. Proper reassembly and sealing of unit segments at shipping splits.
 - 4. Tight seal around perimeter of unit at the roof curb
 - 5. Installation of shipped-loose parts, including filters, air hoods, bird screens and mist eliminators.
 - 6. Completion and tightness of electrical, ductwork and piping
 - 7. Tight seals around wiring, conduit and piping penetrations through AHU casing.
 - 8. Supply of electricity from the building's permanent source
 - 9. Integrity of condensate trap for positive or negative pressure operation
 - 10. Condensate traps charged with water

11. Removal of shipping bolts and shipping restraints
12. Sealing of pipe chase floor(s) at penetration locations.
13. Tightness and full motion range of damper linkages (operate manually)
14. Complete installation of control system including end devices and wiring
15. Cleanliness of AHU interior and connecting ductwork
16. Proper service and access clearances
17. Proper installation of filters
18. Filter gauge set to zero

- B. Resolve any non-compliant items prior to unit start-up.

3.4 INSPECTION AND ADJUSTMENT: AHU FAN ASSEMBLY

- A. Hire the manufacturer's factory-trained and factory-employed service technician perform an inspection of the AHU fan assembly subsequent to general AHU inspection and prior to startup. Technician shall inspect and verify the following as a minimum:

1. Fan isolation base and thrust restraint alignment
2. Tight set screws on pulleys, bearings and fan
3. Tight fan bearing bolts
4. Tight fan and motor sheaves
5. Tight motor base and mounting bolts
6. Blower wheel tight and aligned to fan shaft
7. Sheave alignment and belt tension
8. Fan discharge alignment with discharge opening
9. Fan bearing lubrication
10. Free rotation of moving components (rotate manually)

3.5 STARTUP SERVICE and OWNER TRAINING

- A. Manufacturer's factory-trained and factory-employed service technician shall startup AHUs. Technician shall perform the following steps as a minimum:

1. Energize the unit disconnect switch
2. Verify correct voltage, phases and cycles
3. Energize fan motor briefly ("bump") and verify correct direction of rotation.
4. Re-check damper operation; verify that unit cannot and will not operate with all dampers in the closed position.
5. Energize fan motors and verify that motor FLA is within manufacturer's tolerance of nameplate FLA for each phase.

- B. Provide a minimum of 8 hours of training for owner's personnel by manufacturer's factory-trained and factory-employed service technician. Training shall include AHU controls, motor starters, VFD's, and AHU's.

- C. Training shall include startup and shutdown procedures as well as regular operation and maintenance requirements.

- D. If AHU is provided with a factory-mounted variable frequency drive (VFD), hire the VFD manufacturer's factory-trained and factory-employed service technician to inspect, test, adjust, program and start the VFD. Ensure that critical resonant frequencies are programmed as 'skip frequencies' in the VFD controller.

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- E. Submit a startup report summarizing any problems found and remedies performed.

3.6 FIELD PERFORMANCE VERIFICATION

- A. Leakage: Pressurize casing to maximum operating static pressure (up to +/-8" w.g.) and measure leakage. If leakage exceeds 1% of design airflow, seal leakage points with a permanent solution. Repeat test. If the AHU still does not pass, contact the manufacturer to seal unit.
- B. Submit a field test report with testing data recorded. Include description of corrective actions taken.

3.7 CLEANING

- A. Clean unit interior prior to operating. Remove tools, debris, dust and dirt.
- B. Clean exterior prior to transfer to owner.

3.8 DOCUMENTATION

- A. Provide Installation Instruction Manual, & Startup checklist in the supply fan section of each unit.
- B. Provide six copies of Spare Parts Manual for owner's project system manual.

END OF SECTION 23 7323

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