

## SECTION 237313 - AIR-HANDLING UNITS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. Section includes insulated, double-wall-casing, air-handling units that are factory assembled using multiple section components as specified, scheduled and/or shown on the drawings.
- B. Related Sections:
  - 1. Section 230513 "Common Motor Requirements for Mechanical Equipment" for fan motor requirements.
  - 2. Section 230548 "Vibration Controls for HVAC" for vibration isolation devices.
  - 3. Section 230550 "Variable Frequency Drives" for separately enclosed VFDs for speed control of three-phase induction motors.
  - 4. Section 233300 "Air Duct Accessories" for dampers and flexible connectors.
  - 5. Section 233350 "HVAC Fans" for air handling unit fans.
  - 6. Section 238216.11 "Hydronic Air Coils" for cooling and heating coils.
  - 7. Section 238216.14 "Electric-Resistance Air Coils" for electric resistance air coils.

#### 1.3 ACTION SUBMITTALS

- A. Product Data: For each air-handling unit, including components provided or furnished as part of the air-handling unit as a single submittal package, even where components are specified in related sections. Refer to related sections for component product data submittal requirements.
  - 1. Unit dimensions and required clearances.
  - 2. Unit components.
  - 3. Casing material, metal thickness, finishes, insulation, and accessories.
  - 4. Casing construction details.
  - 5. Weight loads and distributions by component section.
  - 6. Sound Data:
    - a. Unweighted octave band air-handling unit 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.
    - b. Unweighted casing radiated sound power over the same 8 octave bands in accordance with ISO 9614 Parts 1&2 and ANSI S12.12.
    - c. 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 air-handling unit products.

7. Required clearances, field connection locations, wiring diagrams, shipping drawings, and curb drawings.
  8. Electrical requirements for power supply wiring including wiring diagrams for interlock and control wiring, clearly indicating factory-installed and field-installed wiring.
  9. Static pressure profiles by component section.
  10. Panel deflection at +/- 10-inch wg, stated in terms of 'L/X' where 'L' is the casing panel length and 'X' is a constant provided by the AHU manufacturer.
  11. Casing leakage rate at +/- 10-inch wg, specified in terms of percentage of design airflow.
- B. Air-handling unit plan, elevation and section views shall be provided in a scale no less than 1/4" = 1'-0".

#### 1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For air-handling units to include in emergency, operation, and maintenance manuals.

#### 1.5 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
1. Filters: For each air-handling unit, provide:
    - a. One set of filters at the start of testing, adjusting and balancing (TAB).
    - b. One set of filters for final turnover to owner.
  2. Gaskets: One set(s) for each access door.

#### 1.6 DELIVERY, STORAGE AND HANDLING

- A. Comply with ASHRAE 62.1, Section 7 - "Construction and Startup." Protect equipment from moisture by appropriate in-transit and on-site procedures.
- B. Follow manufacturer's recommendations for handling, unloading and storage.
- C. 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.
- D. 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.
- E. Enclose and protect control panels, electronic devices, and variable frequency drives. Do not store equipment in wet or damp areas even when they are sealed and secured.
- F. Seal openings to protect against damage during shipping, handling and storage.
- G. Wrap indoor units with a tight sealing 8 mil shrink wrap membrane for protection against rain, snow, wind, dirt, sun fading, road salt/chemicals, rust and corrosion during shipping. Wrapping

membrane shall cover entire air-handling unit during shipping and storage. Cover equipment, regardless of size or shape.

- H. Tarp outdoor units with a tight sealing membrane for protection against rain, snow, wind, dirt, sun fading, road salt/chemicals, rust and corrosion during shipping. Tarp shall cover entire air-handling unit during shipping and storage. Cover equipment, regardless of size or shape.
- I. Clearly mark AHU sections with unit tag number, segment sequence number, and direction of airflow. Securely affix safety-warning labels.

#### 1.7 SOURCE QUALITY ASSURANCE

- A. AHRI 430 Certification: Air-handling units and their components shall be factory tested according to AHRI 430 and shall be listed and labeled by AHRI.
- B. AMCA 301 or AHRI 260: Air-handling unit fan sound ratings shall comply with AMCA 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data," or AHRI 260, "Sound Rating of Ducted Air Moving and Conditioning Equipment."
- C. Fan Sound-Power Level Ratings: Comply with AMCA 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data." Test fans according to AMCA 300, "Reverberant Room Method for Sound Testing of Fans." Fans shall bear AMCA-certified sound ratings seal.
- D. Fan Performance Rating: Factory test fan performance for airflow, pressure, power, air density, rotation speed, and efficiency. Rate performance according to AMCA 210, "Laboratory Methods of Testing Fans for Aerodynamic Performance Rating."
- E. Water Coils: Factory tested to 300 psig according to AHRI 410 and ASHRAE 33.

#### 1.8 COORDINATION

- A. If equipment is supplied by a manufacturer other than the basis of design, coordinate with the General Contractor and affected subcontractors to ensure the specified performance is met. 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.

## 1.9 WARRANTY

- A. Manufacturer agrees to repair or replace components of air handling unit that fail in materials or workmanship within specified warranty period. This warrants that all products are free from defects in material and workmanship.
  - 1. One year from date of Substantial Completion.
- B. Warranty work shall be performed by manufacturer's factory-trained and factory-employed technician.
- C. Warranty covers all parts except consumable items (belts, filters, fuses). Include factory-provided controls in the parts warranties.
- D. Parts associated with routine maintenance, such as belts and air filters shall be excluded.
- E. The manufacturer's factory-trained and factory-employed technician shall provide labor warranty for the unit's first operating year.

## PART 2 - PRODUCTS

### 2.1 PERFORMANCE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. NFPA Compliance: Comply with NFPA 90A for design, fabrication, and installation of air-handling units and components.
- C. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."
- D. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."
- E. Structural Performance:
  - 1. Casing Panels: Self-supporting and capable of withstanding positive/negative 10-inch wg internal static pressure, without exceeding a midpoint deflection of 0.0042 inch/inch of panel span.
  - 2. Floor and Roof Panels: Self-supporting and capable of withstanding 300-lb static load at midspan, without exceeding a midpoint deflection of L/240.
  - 3. Roof Panels: Self-supporting and capable of withstanding a static snow load of 30 lb/sq. ft., without exceeding a midpoint deflection of L/240.
  - 4. When two or more air unit/air tunnels are stacked on top of each other, the structural integrity of the base unit(s) shall be sufficient to support the upper operating unit.
- F. Casing Leakage Performance: ASHRAE 111, Class 6 leakage or better at plus or minus 10 inch wg.

- G. Thermal Performance: Condensation shall not form on the casing exterior at a supply air temperature within the unit of 51°F and ambient conditions on the exterior of the unit of 95°F dry bulb and 78°F wet bulb.

## 2.2 MANUFACTURERS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide York/JCI or comparable product by one of the following:
  - 1. JCI/York
  - 2. Temtrol
  - 3. Trane
  - 4. TMI Climate Solutions
  - 5. Carrier
  - 6. Buffalo Air Handling
  - 7. Climate Craft
  - 8. Energy Labs Inc.
- B. Source Limitations: Obtain all air-handling units on the project from single manufacturer.

## 2.3 MATERIALS

- A. Steel:
  - 1. ASTM A 36/A 36M for carbon structural steel.
  - 2. ASTM A 568/A 568M for steel sheet.
- B. Stainless Steel:
  - 1. Manufacturer's standard grade for casing.
  - 2. Type 304, ASTM A 240/A 240M for bare steel exposed to airstream or moisture.
- C. Galvanized Steel: ASTM A386 or ASTM A525.
- D. Aluminum sheet and plate: 3003-H14 alloy, conforming to ASTM B209.
- E. Corrosion-Resistant Coating: Coat with a corrosion-resistant coating capable of withstanding a 2000-hour salt-spray test according to ASTM B 117.
  - 1. Standards:
    - a. ASTM B 117 for salt spray.
    - b. ASTM D 2794 for minimum impact resistance of 100 in-lb.
    - c. ASTM B 3359 for cross hatch adhesion of 5B.
  - 2. Application: Immersion or spray.
  - 3. Thickness: 1 mil.
  - 4. Gloss: Minimum gloss of 60 on a 60-degree meter.
- F. All dissimilar materials are to be properly isolated.

## 2.4 FRAME AND FRAME

- A. Frame: Modular and providing overall structural integrity without reliance on casing panels for structural support.
- B. Base Rail:
  - 1. Material: Type ASTM A36 welded structural steel C-channel, with cross supports spaced at regular intervals and removable lifting lugs.
  - 2. Height: 6-inch.
  - 3. Factory shall provide curb angle welded to the base for outdoor curb mounted units.
  - 4. Factory Finish:
    - a. Provide manufacturer's standard finish
    - b. Factory applied high build (3 to 5 mils) alkyd enamel.
    - c. Coating shall pass ASTM B-117B 2000 hour salt spray test.
    - d. Bead blast all surfaces of base and wipe clean all bare metal before painting.

## 2.5 FLOOR

- A. Floorplate:
  - 1. Material: 20 Gauge Galvanized Steel
  - 2. Floor shall be insulated with 2-inch polyurethane spray foam insulation.
- B. Floor Openings:
  - 1. Provide walk on safety grate attached with screws over all floor openings.
  - 2. Safety grates shall be min 90% open area and support a minimum 400-pound load.
  - 3. Safety grates shall be made of Type IWA welded rod with a cross flow pattern of 1.5" x 4".
  - 4. Grating shall be same material as the floorplate.
  - 5. Safety grates shall be removable to ensure adequate access to the ductwork below.

## 2.6 CASING WALLS

- A. Internal Post Structure: Formed galvanized 16 ga steel C-channel. Structure shall be fully welded.
- B. Casing Joints: Joints shall be mechanically fastened. Fasteners shall not extend from the outside to the inside of the unit. Use angle to fasten and seal walls at corners, floors, and roofs.
- C. Outside Casing Wall:
  - 1. Material: Galvanized minimum 20 gauge thick.
  - 2. Factory Finish:
    - a. Provide manufacturer's standard finish
    - b. After cleaning and pre-treating, apply two-coat, baked-on enamel finish, consisting of polyurethane prime coat and polyester thermosetting topcoat.
    - c. Coating shall pass ASTM B-117 2,000 hour salt spray test.
    - d. Unit shall NOT have manufacturer's logo on exterior of unit.
- D. Inside Casing Wall:

1. Material: Galvanized, minimum 20 gauge thick.
2. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

E. Casing Insulation:

1. Materials: CFC-free injected polyurethane foam insulation, 2.5lbs./cu.ft.
2. Insulation Thickness: 2 inches.
3. Casing Panel R-Value: Minimum R-13.
4. Location: Encased between outside and inside casing.

## 2.7 ROOF

A. Roof: Construction of the roof shall be identical to the wall construction specified.

1. Unit roof for outdoor units shall be sloped a minimum 0.25-in./ft.
2. The roof shall overhang all side and end panels to prevent precipitation drainage from streaming down the unit wall panels. Gutter systems are not acceptable.
3. Roofs less than 12 feet wide shall be sloped to the non-door side of the unit; roofs 12 feet wide and wider shall be peaked in the center and sloped to both sides of the unit.
4. Roof shall be designed to hold a 300lb load for service and maintenance.
5. Outdoor units supplied with non-sloped roofs are not acceptable.
6. Roof system shall be warranted by manufacturer against water penetration for a period of 10 years

## 2.8 ACCESS DOORS

A. Access Doors:

1. Fabrication: Formed and reinforced, double-wall and insulated panels of same materials and thicknesses as wall casing. Thermal break construction.
2. Hinges: A minimum of three ball-bearing hinges or full height stainless-steel piano hinge and two roller cam latches, operable from inside and outside. Rotating knife-edge or "paw" latches are not acceptable. Arrange doors to be opened against pressure.
3. Handles: Glass fiber reinforced, UV rated, padlockable, nylon polyamide.
4. Gasket: EPDM-sponge, applied around entire perimeters of panel frames.
5. Size: Large enough to allow for unobstructed access for inspection and maintenance of air-handling unit's internal components. At least 24 inches wide by full height of unit casing up to a maximum height of 72 inches.

B. Locations and Applications:

1. Access doors with windows shall be provided in each air-handling unit access section and as shown on the drawings.
2. Access panels shall be provided:
  - a. Hydronic coil section, large enough to allow removal of coils.
  - b. Fan section, large enough to allow removal of fan assemblies.

## 2.9 CONDENSATE DRAIN PANS

A. Construction:

1. Full welded 16-gauge stainless-steel sheet.
- B. Drain Connection:
  1. Located at lowest point of pan and sized to prevent overflow. Terminate with threaded nipple on one end of pan.
  2. Minimum Connection Size: NPS 1-1/4.
- C. Slope: Minimum 0.125-in./ft. slope, to comply with ASHRAE 62.1, in at least three planes to collect condensate from cooling coils (including coil piping connections, coil headers, and return bends) and to direct water toward drain connection.
- D. Length: Extend drain pan downstream from entering face of coil for distance to comply with ASHRAE 62.1, minimum 24 inches downstream of leaving face of coil.
- E. Width: Entire width of water producing device. Extend 1-inch beyond headers and U-bends on each side of coil.
- F. Depth: A minimum of 2 inches deep.

#### 2.10 FAN ARRAYS

- A. Refer to Section 233350 "HVAC Fans" for fan product data and additional requirements. HVAC fans shall be provided by the air-handling unit manufacturer.
- B. Description: Factory-fabricated, -assembled, -tested, and -finished, housed multiple direct-driven plenum fans consisting of wheel, fan shaft, motor, drive assembly, and support structure.
- C. Backdraft Damper:
  1. Backdraft dampers shall be provided for automatic isolation of individual fans.
  2. Backflow preventer shall be made from materials consistent with the unit interior.
  3. Backflow preventer shall be designed with a smooth transition to increase fan efficiency and damper to have no adverse system effect on the fan.
  4. Backflow preventer shall be designed to remain open at all times except under the loss of a fan in the array, where the disabled fan backflow preventer will close, while the other fans remain in operation.

#### 2.11 MOTORS

- A. Motor: Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."
  1. NEMA Premium Efficient motors as defined in NEMA MG 1.
  2. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.15.
  3. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in electrical Sections.
  4. Motors shall include a shaft grounding ring.



## 2.12 VARIABLE FREQUENCY DRIVES

- A. Refer to Section 230550 "Variable Frequency Drives" for VFD product data and additional requirements.
  - 1. Variable frequency drives without bypass shall be provided, mounted, and wired by the AHU manufacturer for all air handling units.
  - 2. Variable frequency drive shall serve all fans combined in fan array.
- B. When using variable frequency drives provide input line reactors with three percent impedance mounted externally if not already internal to variable frequency drive.

## 2.13 HYDRONIC AIR COILS

- A. Refer to Section 238216.11 "Hydronic Air Coils" for chilled water coil product data and additional requirements. Hydronic coils shall be provided by the air-handling unit manufacturer.
- B. Fabricate coil section to allow removal and replacement of coil for maintenance and to allow in-place access for service and maintenance of coil(s). Coils shall be removable from the side of the AHU.
- C. Provide coils with a maximum face velocity as scheduled. Face velocity calculations shall be based on the finned area of the coil.
- D. Connections shall be factory piped through the casing wall with a minimum extension beyond the casing exterior of 6 inches. Internal unions shall be provided.
- E. Locate access doors near coil connections to provide minimum clearance of 2 inches for field installed external piping insulation. Space shall allow a minimum of 90 degrees of door swing.

## 2.14 ELECTRIC-RESISTANCE AIR COILS

- A. Refer to Section 238216.14 "Electric-Resistance Air Coils" for electric-resistance coil product data and additional requirements. Electric-resistance air coils shall be provided by the air-handling unit manufacturer.
- B. Fabricate coil section to allow removal and replacement of coil for maintenance and to allow in-place access for service and maintenance of coil(s).
- C. Provide coils with a maximum face velocity as scheduled. Face velocity calculations shall be based on the finned area of the coil.

## 2.15 AIR FILTRATION

- A. Refer to Section 234100 "Particulate Air Filtration" for particulate air filtration product data and additional requirements. Particulate air filtration, filter frames and filter gages shall be provided by the air-handling unit manufacturer.

- B. Mounting Frames: 18 gauge galvanized steel, with gaskets and fasteners; suitable for bolting together into built-up filter banks.
  - 1. Vertically support filters to prevent deflection of horizontal members without interfering with either filter installation or operation.
  - 2. Access: Side.
  - 3. Sealing: Factory-installed, positive-sealing device for each row of filters, to ensure seal between foam gasketed filter elements and to prevent bypass of unfiltered air.
  - 4. The frame shall include filter-centering dimples on each frame wall to facilitate ease of filter installation and assure filter centering against filter sealing flange.
  - 5. Vertically support filters to prevent deflection of horizontal members without interfering with either filter installation or operation.
  - 6. Designed to accommodate standard size filters with the application of the appropriate type fastener.
  - 7. Sized to accommodate the filters scheduled on the drawings.
- C. Filter Gages: Magnehelic diaphragm-type gage with dial and pointer in metal case, vent valves, black figures on white background, and front recalibration adjustment.
  - 1. Install filter gages on filter banks with separate static-pressure taps upstream and downstream from filters.
- D. Accessories: Two 1/8" NPT plugs for duplicate pressure taps, tubing, gage connections, and mounting bracket.

## 2.16 DAMPERS

- A. Refer to Section 233300 "Air Duct Accessories" for damper product data and additional requirements. Dampers shall be provided by the air-handling unit manufacturer. Actuators shall be provided by the BAS provider.
- B. Return-, and Relief-Air Control Dampers:
  - 1. Type: Opposed-blade.
  - 2. Material: Galvanized steel. Provide extruded-aluminum in units with aluminum inside casing wall.
  - 3. Leakage: Class IA.
  - 4. Damper Operators: Comply with requirements in Section 230900 "Building Automation and Temperature Control System."
- C. Backdraft Dampers:
  - 1. Type: Parallel-blade.
  - 2. Material: Galvanized steel. Provide extruded-aluminum in units with aluminum inside casing wall.
  - 3. Damper Operators: Gravity.
- D. Smoke Dampers:
  - 1. Type: Opposed-blade.
  - 2. Material: Galvanized steel. Provide extruded-aluminum in units with aluminum inside casing wall.
  - 3. Leakage: Class I.
  - 4. Damper Motor: Two-position action, as required.

- E. Isolation Dampers:
  - 1. Type: Opposed-blade.
  - 2. Material: Galvanized steel. Provide extruded-aluminum in units with aluminum inside casing wall.
  - 3. Leakage: Class I.
  - 4. Damper Operators: Comply with requirements in Section 230900 "Building Automation and Temperature Control System."

## 2.17 ROOF CURBS

- A. Contractor shall furnish the roof curbs, coordinated with the air-handling unit.
- B. Roof curbs with vibration isolators and wind or seismic restraints are specified in Section 230548 "Vibration and Seismic Controls for HVAC."

## 2.18 INTAKE AND RELIEF AIR OPENINGS

- A. Provide weather hood over all unit intake and relief openings. Match material and finish of casing exterior.
  - 1. Intake openings shall be provided with moisture eliminator.
  - 2. Relief openings shall be provided with 1/4" sq. galvanized mesh birdscreen.
- B. Hoods shall be designed for a gross intake velocity not to exceed 450 FPM. Intake shall be designed to prevent snow or rain from being pulled into the air handling unit.
- C. The leading edge and sides of the hood shall extend 6" below the bottom edge of the damper section covered.
- D. The hood to unit sheet metal joint shall be caulked to prevent water leakage into intake dampers. If hood is shipped as a sub-assembly, the installing contractor shall install and seal with caulking provided by the unit manufacturer.

## 2.19 OUTDOOR AIR AND RELIEF HOODS

- A. Provide manufacturers standard outdoor air and relief hoods of the same material as the exterior casing.

## 2.20 FIELD MOUNTED CONTROLS

- A. Automatic temperature components shall be furnished under Section 230900 "Building Automation and Temperature Control System" and shall be installed by the BAS provider in the field.

## 2.21 PIPING

- A. Factory shall extend all piping connections through casing for field connection.

- B. All piping insulation shall be field applied by the installing Contractor. The unit manufacturer shall pressure test any factory piping. Certification of this test shall be included in the I.O.M. manuals.

## 2.22 ELECTRICAL

### A. General

1. All electrical wiring shall be in conformance with the N.E.C.
2. All wiring shall be 600 volt rated type M1W/TTHN stranded copper, enclosed in 3/4-inch diameter or larger, EMT galvanized conduit. Connections to all fans shall be made with a minimum 3-foot length of 3/4-inch diameter or larger FMC. All junction boxes shall be U.L. approved and gasketed.
3. All wiring shall be routed above access doors and panels and shall be not less than 12" above the unit interior floor.
4. On units that ship in sections, wiring harnesses shall be provided for facilitate field reconnection at section breaks.
5. All permanent and temporary conduit termination points shall be sealed to prevent moisture from entering the conduit.
6. All control and instrument wiring shall be identified with a unique wire number. These numbers shall agree with the numbers shown on the supplier's wiring diagrams. Control circuit wiring shall be permanently identified with wire markers applied within 1" of each terminal and splice.

### B. Power Wiring

1. Unit shall be completely factory wired and shall be arranged to accept the single point connections indicated below. Unit manufacturer shall furnish, install and wire single point power panel (SPPP) with non-fused disconnect on the exterior wall of the unit for each connection to by the electrical contractor.
2. AHU manufacturer shall:
  - a. Provide factory mounted Single Point Power Panel (SPPP) for the following circuits:
    - 1) 3-phase 480-volt power connection for motor circuits (VFD's) and electric heat coil.
    - 2) 1-phase 120-volt power connection for lighting and receptacle circuit.
    - 3) 1-phase 120-volt power connection for control circuit.
  - b. Provide factory mounted and wired Manual Motor Protection (MMP) panel for each fan in the supply fan array and return fan array.
  - c. Furnish and install (set in place) variable frequency drives for the supply fan array and return fan array.
  - d. Provide power wiring from the 480v motor circuit SPPP to the supply fan array variable frequency drive and return fan array variable frequency drive.
  - e. Provide power wiring from the supply fan array variable frequency drive and return fan array variable frequency drive to each fans respective MMP.
  - f. Provide power wiring from the 120v lighting and receptacle circuit SPPP to the lighting and receptacle junction boxes.
3. Electrical contractor shall:
  - a. Provide input power wiring to the 480v SPPP and 120v SPPPs.
4. Lighting and receptacle circuit shall remain functional when motor circuit disconnect is in "OFF" position.

C. Lighting Systems and Receptacles

1. Lights:
  - a. Factory shall provide four foot long two tube T8, 40 Watt, gasketed outdoor grade vapor proof fluorescent with rapid start low temperature electronic ballasts.
  - b. Where four foot light fixtures will not fit, factory shall provide vapor resistant pendant, marine type light fixture with clear globe, metal guard, and 23W compact fluorescent bulb.
  - c. Factory shall provide a wired lighting fixture in each compartment, placed for optimum viewing without obstructing service access.
2. Switches:
  - a. Lights shall be factory wired through light switches with pilot lights at each section access door to a central lighting junction box.
  - b. Lights in separate air handling unit sections shall be independently switched.
  - c. All switches shall be mounted forty-eight (48) inch high.
  - d. If exposed to weather, switches shall be weatherproof with a self-closing cover.
3. Receptacles: Weatherproof duplex 20 amp, 120v GFI receptacles shall be provided at each fan section and factory wired to the central receptacle junction box.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine casing insulation materials and filter media before air-handling unit installation. Reject insulation materials and filter media that are wet, moisture damaged, or mold damaged.
- C. Examine roughing-in for all piping systems and electrical services to verify actual locations of connections before installation.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Roof Curb: Install unit level on roof curb. Secure units to curb.
- B. Unit Support: Install unit level on structural steel supports. Secure units to structural support with anchor bolts.
- C. Comply with requirements for vibration isolation devices specified in Section 230548 "Vibration Controls for HVAC."
- D. Arrange installation of units to provide access space around air-handling units for service and maintenance.
- E. Do not operate fan system until filters are in place.

- F. Do not use AHUs for temporary heating, cooling or ventilation unless approved by the Owner. If approved, do not use prior to complete inspection and startup has been performed per this specification.
  - 1. If AHUs are used during construction, see SMACNA's "IAQ Guidelines for Occupied Buildings under Construction" for procedures to protect HVAC system.
  - 2. Provide additional sets of AHU prefilters, one for every 4 weeks the units are operated for temporary conditioning during construction.
  - 3. Replace temporary filters used during construction with new, clean filters at start of test, adjust and balancing.
- G. Install AHUs with manufacturer's recommended clearances for access, coil pull, and fan removal.
- H. Install filter-gauge, static-pressure taps upstream and downstream of filters. Mount filter gauges on outside of filter compartment in accessible position. Provide filter gauges on each filter bank, installed with separate static-pressure taps upstream and downstream of filters.
- I. Connect duct to air-handling units with flexible connections. Comply with requirements in Section 233300 "Air Duct Accessories."
- J. AHU manufacturer and mechanical contractor shall refer to individual component specifications referenced in this section for installation requirements.

### 3.3 PIPING CONNECTIONS

- A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Where installing piping adjacent to air-handling unit, allow for service and maintenance.
- C. Connect piping to air-handling units mounted on vibration isolators with flexible connectors.
- D. Connect condensate drain pans using NPS 1-1/4, ASTM B 88, Type M copper tubing. Extend to nearest floor or roof drain. Construct deep trap at connection to drain pan and install cleanouts at changes in direction.
  - 1. Insulate plumbing associated with condensate drain pan drains and connections.
- E. Install elastomeric insulation on all internal piping serving staggered coils.

### 3.4 ELECTRICAL CONNECTIONS

- A. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
- B. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

- C. Install electrical devices furnished by manufacturer, but not factory mounted, according to NFPA 70 and NECA 1.
- D. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.
  - 1. Nameplate shall be laminated acrylic or melamine plastic signs with a black background and engraved white letters at least 1/2 inch high.

### 3.5 CONTROL CONNECTIONS

- A. Install control and electrical power wiring to field-mounted control devices.
- B. Connect control wiring according to Section 260523 "Control-Voltage Electrical Power Cables."

### 3.6 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
  - 1. Delivery: Inspect the units for proper storage, check for damage, and complete initial inspection report to be submitted to the Architect. The installing contractor shall coordinate this site visit with the AHU service representative.
  - 2. Assembly: Supervise the work performed by the installing contractor during the rigging and assembly of the unit (s). All tools and labor shall be provided by the installing contractor.
  - 3. Installation: Provide on-site installation specific instructions to the trade contractors regarding piping, electrical, ductwork, and field control wiring connections to the unit. The service representative shall approve all field penetrations to the units, if required.
  - 4. General:
    - a. Check for damage of any kind.
    - b. Confirm level installation of unit.
    - c. Confirm proper reassembly and sealing of unit segments at shipping splits.
    - d. Confirm tight seal around perimeter of unit at the roof curb.
    - e. Check for installation of shipped-loose parts, including filters, air hoods, bird screens and mist eliminators.
    - f. Confirm completion and tightness of electrical, ductwork and piping.
    - g. Confirm tight seals around wiring, conduit and piping penetrations through AHU casing.
    - h. Confirm supply of electricity from the building's permanent source.
    - i. Confirm integrity of condensate trap for positive or negative pressure operation.
    - j. Confirm condensate traps charged with water.
    - k. Confirm removal of shipping bolts and shipping restraints.
    - l. Confirm sealing of pipe chase floor(s) at penetration locations.
    - m. Confirm tightness and full motion range of damper linkages (operate manually).
    - n. Confirm complete installation of control system including end devices and wiring.
    - o. Confirm proper service and access clearances.
    - p. Confirm proper installation of filters.
    - q. Confirm filter gauge set to zero.

- r. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
  - s. Leak Test: After installation, charge coils and test for leaks. Repair leaks and retest until no leaks exist.
  5. Vibration Controls:
    - a. Measure isolator clearance.
    - b. Measure isolator deflection.
    - c. Verify snubber minimum clearances.
  6. Variable Frequency Drives:
    - a. Inspect VFD, wiring, components, connections, and equipment installation. Test and adjust controllers, components, and equipment.
    - b. Test insulation resistance for each VFD element, component, connecting motor supply, feeder, and control circuits.
    - c. Test continuity of each circuit.
    - d. Verify that voltages at VFD locations are within 10 percent of motor nameplate rated voltages. If outside this range for any motor, notify Architect before starting the motor(s).
    - e. Test each motor for proper phase rotation.
    - f. Perform tests according to the Inspection and Test Procedures for Adjustable Speed Drives stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
    - g. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
  7. HVAC Fans:
    - a. Disconnect fan drive from motor, verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearing operation. Reconnect fan drive system, align and adjust belts, and install belt guards.
    - b. Adjust belt tension.
    - c. Adjust damper linkages for proper damper operation.
    - d. Verify lubrication for bearings and other moving parts.
  8. Particulate Air Filtration:
    - a. Check for leakage of unfiltered air while system is operating.
  9. Hydronic Air Coils:
    - a. Straighten bent fins on air coils.
    - b. Clean coils using materials and methods recommended in writing by manufacturers, and clean inside of casings and enclosures to remove dust and debris.
  10. Electric-Resistance Air Coils:
    - a. Operational Test: After electrical circuitry has been energized, operate electric coils to confirm proper unit operation.
- B. Air-handling unit or components will be considered defective if unit or components do not pass tests and inspections.
- C. Prepare test and inspection reports.

### 3.7 STARTUP SERVICE

- A. Engage a factory-authorized service representative to perform startup service.



1. General:
  - a. Complete installation and startup checks according to manufacturer's written instructions.
  - b. Verify that shipping, blocking, and bracing are removed.
  - c. Verify that unit is secure on mountings and supporting devices and that connections to piping, ducts, and electrical systems are complete. Verify that proper thermal-overload protection is installed in motors, controllers, and switches.
  - d. Install new, clean filters.
  - e. Comb coil fins for parallel orientation.
2. Dampers:
  - a. Verify that face-and-bypass dampers provide full face flow.
  - b. Verify that outdoor- and return-air mixing dampers open and close, and maintain minimum outdoor-air setting.
  - c. Verify that control and smoke dampers are in their normal position, and that dampers in distribution duct systems are in fully open position.
3. Variable Frequency Drives:
  - a. The VFD manufacturer's factory-trained and factory-employed service technician shall inspect, test, adjust, program and start the VFD. Ensure that critical resonant frequencies are programmed as 'skip frequencies' in the VFD controller.

B. Starting procedures for air-handling units include the following:

1. Energize motor; verify proper operation of motor, drive system, and fan wheel. Adjust fan to indicated rpm. Replace fan and motor sheaves as required to achieve design conditions.
2. Measure and record motor electrical values for voltage and amperage.
3. Manually operate dampers from fully closed to fully open position and record fan performance.

### 3.8 ADJUSTING

A. Comply with requirements in Section 230593 "Testing, Adjusting, and Balancing for HVAC" for air-handling system testing, adjusting, and balancing.

B. Dampers:

1. Adjust damper linkages for proper damper operation.

C. Vibration Controls:

1. Adjust isolators so they are out of contact during normal operation.

D. Variable Frequency Drives:

1. Program microprocessors for required operational sequences, status indications, alarms, event recording, and display features. Clear events memory after final acceptance testing and prior to Substantial Completion.
2. Set field-adjustable switches, auxiliary relays, time-delay relays, timers, and overload-relay pickup and trip ranges.
3. Adjust the trip settings of instantaneous-only circuit breakers and thermal-magnetic circuit breakers with adjustable, instantaneous trip elements. Initially adjust to 6 times the motor nameplate full-load amperes and attempt to start motors several times, allowing for motor cool-down between starts. If tripping occurs on motor inrush, adjust settings in

increments until motors start without tripping. Do not exceed 8 times the motor full-load amperes (or 11 times for NEMA Premium Efficient motors if required). Where these maximum settings do not allow starting of a motor, notify Architect before increasing settings.

4. Set field-adjustable circuit-breaker trip ranges.
5. Set field-adjustable pressure switches.

### 3.9 CLEANING

- A. After completing system AHU installation and startup service, and after completing TAB of the air-handling unit and air-distribution systems, and prior to acceptance by the Owner, thoroughly clean the outside and particularly the inside of air-handling units to remove all foreign material and construction dirt and dust.
- B. Industrial grade cleaners can be used to remove construction dust. Any sheet metal mil finish or grease can be removed with Freon TF solvent fluorocarbon. All proposed cleaning materials shall have contents identified and approved prior to use.
- C. Install new, clean filters.

### 3.10 DEMONSTRATION

- A. Engage an AHU factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain air-handling units and all components.
- B. If the AHU factory-authorized service representative is not qualified to train on specific components within the air-handling unit, that component's factory-authorized service representative shall also participate in the training.
- C. Training shall include startup and shutdown procedures as well as regular operation and maintenance requirements.

END OF SECTION 237313