

City of Lynchburg  
Procurement Division  
900 Church Street  
Lynchburg, Virginia 24504  
Telephone No.: (434) 455-3970  
Fax No.: (434) 845-0711

**Addendum for Invitation for Bids  
Monument Terrace Building Air Handler & Controls Replacement  
2016-056**

Date: 04/13/2016  
From: Lisa Moss, Buyer VCA  
RE: Addendum No. 1

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This Addendum supplements and amends the original Plans and Specifications and shall be taken into account in preparing proposals and shall become a part of the Contract Documents. The Bidder shall indicate receipt of this Addendum and all previously issued Addenda on the Bid Form.

1. How do you install the new ductwork where it interferes with the existing roof structural steel?  
**Large return and outside air ducts connecting to AHU-1 (shown on drawing ME 1.5) may impinge on existing structural beams, columns, and cross bracing. Modification of duct dimensions is acceptable to avoid structure as long as duct area is maintained and proper duct transitions are used. Submit any duct modification to engineer of record for approval before proceeding with construction of duct.**

**In unavoidable situations, limited structural steel may also pass through return and outside air duct. Submit to engineer of record for approval of any structural member passing through the outside air or return air ducting.**

2. How do you get the new structural steel for the new AHU into the attic space?  
**Refer to Sheet 2.0 Detail 5 Typical MC-Section Splice; Splice locations to be determined by the contractor. Contractor shall provide proposed splice location to the EOR for review. Coordinate locations with MEP requirements.**

3. Where can equipment and material be stored?  
**Equipment and material may be stored in the basement and attic area.**

4. What is the elevator weight capacity?  
**The elevator weight capacity is 2,000 lbs.**

5. What are the working hours?  
**Normal working hours at 7:00 a.m. to 5:p.m. Monday through Friday. Moving of material or equipment through occupied areas and loud or obtrusive operations must be done after hours or on weekends.**

**Successful contractor must conduct a pre-construction meeting that includes building occupants to get input for a detailed construction schedule to be submitted for approval.**

6. What are the construction parking arrangements?  
**The Parking Management Department will be responsible for the administration and monitoring of Construction Permits for on-street parking accommodations for up to (4) vehicles within a one (1) block radius of Monument Terrace Building during normal working hours over the course of the project. Coordination of parking, for the project, will be arranged between the awarded contractor and Parking management during the pre-construction phase of the project.**

**7. THE BID SUBMISSION DATE HAS BEEN EXTENDED: Bids will be received until 3:00 p.m. on May 11, 2016.**

**8. 01 5000-1.02 C3: To what extent do we need to repair/replace the existing light fixtures in the work areas?**

**No repairs or replacement of existing lighting is required unless indicated on the construction documents. Contractor can install temporary additional lighting as needed.**

**9. M0.1 ME1.2-VAV-106,107,108: Where is the electrical power for these units being fed from? Specification Section 237313 has been updated and is attached. It replaces the same specification section in the Project Manual.**

**10. ME1.5-Note 18; What size breakers are required for the supply and return circuits for the new AHU? The smaller return fan circuit has a maximum breaker size of 45 amps and the larger supply fan circuit has a maximum breaker size of 150 amps. These values are based on the MOCP information provided by the basis of design manufacturer.**

**11. Additional site visits will be allowed ONLY by vendors that attended the Mandatory Pre Bid Meeting. These visits are to be arranged with Randy Dalton at 434-455-4407.**

Company Name: \_\_\_\_\_ Address: \_\_\_\_\_ Date: \_\_\_\_\_

Authorized Signature: \_\_\_\_\_ Title: \_\_\_\_\_

Print Name: \_\_\_\_\_ Telephone No.: \_\_\_\_\_ Fax No.: \_\_\_\_\_

## 237313 – MODULAR INDOOR CENTRAL-STATION AIR HANDLING UNITS

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. Section Includes:
  - 1. Variable-air-volume, multizone air-handling units.

#### 1.2 REFERENCES

- A. AMCA Standard 99: Standards Handbook
- B. AMCA /ANSI Standard 204: Balance Quality and Vibration Levels for Fans
- C. AMCA Standard 210: Laboratory Methods of Testing Fans for Ratings
- D. AMCA Standard 300: Reverberant Room Method for Sound Testing of Fans
- E. AMCA Standard 500: Test Methods for Louvers, Dampers and Shutters
- F. ARI Standard 410: Forced-Circulation Air-Cooling and Air-Heating Coil
- G. ASHRAE Standard 52: Gravimetric and Dust Spot Procedures for Testing Air Cleaning Devices Used in General Ventilation for Removing Particulate Matter
- H. ASHRAE/ANSI Standard 111: Practices for Measurement, Testing, Adjusting and Balancing of Building Heating, Ventilation, Air-Conditioning and Refrigeration Systems
- I. UL Standard 1995: Heating and Cooling Equipment
- J. ASTM A-525: Specification for General Requirements for Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process

#### 1.3 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Design seismic-restraint details, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
- B. Seismic Performance: Air-handling units shall withstand the effects of earthquake motions determined according to ASCE/SEI 7 and criteria indicated on the structural (Drawing S001) and other Contract Documents, where applicable.

1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

#### 1.4 SUBMITTALS

A. Product Data: For each air-handling unit indicated.

1. Unit dimensions and weight.
2. Cabinet material, metal thickness, finishes, insulation, and accessories.
3. Fans:
  - a. Certified fan-performance curves with system operating conditions indicated.
  - b. Certified fan-sound power ratings.
  - c. Fan construction and accessories.
  - d. Motor ratings, electrical characteristics, and motor accessories.
4. Certified coil-performance ratings with system operating conditions indicated.
5. Dampers, including housings, linkages, and operators.
6. Filters with performance characteristics.

B. Delegated-Design Submittal: For vibration isolation and seismic restraints 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 external unit seismic restraint.

#### 1.5 INFORMATIONAL SUBMITTALS

A. Seismic Qualification Certificates: For air-handling units, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity 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.

B. Source quality-control reports.

#### 1.6 CLOSEOUT SUBMITTALS

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

1.7 QUALITY ASSURANCE

- 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. ARI Certification: Air-handling units and their components shall be factory tested according to ARI 430, "Central-Station Air-Handling Units," and shall be listed and labeled by ARI.
- D. ASHRAE Compliance: 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. Comply with NFPA 70.

1.8 1.5 COORDINATION

- A. Coordinate sizes and locations of concrete bases with actual equipment provided.
- B. Coordinate sizes and locations of structural-steel support members, if any, with actual equipment provided.

1.9 1.6 EXTRA MATERIALS

- 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: One set(s) for each air-handling unit.
  - 2. Gaskets: One set(s) for each access door.
  - 3. Fan Belts: One set(s) for each air-handling unit fan.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. Basis-of-Design Product: Provide custom (indoor / outdoor) air handling unit as manufactured by Temtrol as the basis-of-design.
1. Temtrol
  2. Governair
  3. Webco
  4. Ventrol
  5. Huntair
  6. Carrier Corporation
  7. McQuay International
  8. Trane; American Standard Inc.
  9. YORK International Corporation.

### 2.2 GENERAL

- A. Furnish and install where shown on the plans, mechanical frame style air handling units specifically designed for OUTDOOR application with construction features as specified below. The units shall be provided and installed in strict accordance with the specifications. All units shall be complete with all components and accessories as specified. Any exceptions must be clearly defined. The contractor shall be responsible for any additional expenses that may occur due to any exception made.
- B. Factory Testing and Quality Control
1. Standard Factory Tests: The fans shall be factory run tested to ensure structural integrity and proper RPM. All electrical circuits shall be tested to ensure correct operation before shipment of unit. Units shall pass quality control and be thoroughly cleaned prior to shipment.
- C. UNIT CONSTRUCTION DESCRIPTION
1. General: Provide factory-fabricated air handling units with capacity as indicated on the schedule. Units shall have overall dimensions as indicated and fit into the space available with adequate clearance for service as determined by the Engineer. Units shall be completely assembled. Multiple sectioned units shall be shipped as a single factory assembled piece (except where shipping limitations prevent) de-mounted into modular sections in the field by the contractor. Units shall be furnished with sufficient gasket and bolts for reassembly in the field by the contractor. Unit manufacturer shall provide certified ratings conforming to the latest edition of AMCA 210, 310, 500 and ARI 410. All electrical components and assemblies shall comply with NEMA standards. Unit internal insulation must have a flame spread rating not over 25 and smoke developed rating no higher than 50

complying with NFPA 90A, "Standard for the Installation of Air Conditioning and Ventilating Systems." Units shall comply with NFPA 70, "National Electrical Code," as applicable for installation and electrical connections of ancillary electrical components of air handling units. Tags and decals to aid in service or indicate caution areas shall be provided. Electrical wiring diagrams shall be attached to the control panel access doors. Operation and maintenance manuals shall be furnished with each unit. Units shall be UL or ETL listed.

- a. Liner materials applied in this location shall have air-stream surface coated with a temperature-resistant coating or faced with a plain or coated fibrous mat or fabric depending on service-air velocity.
2. Rigging Provision – Multiple Piece Units: Units shipped in multiple sections shall be engineered for field assembly. The base frame shall have integral lifting lugs. The lifting lugs shall be fabricated from structural steel with an appropriate rigging hole. Lifting lugs shall be located at the corner of each section (and along the sides if required) and sized to allow rigging and handling of the unit. All gasket and necessary assembly hardware shall ship loose with unit. Junction boxes with a factory supplied numbered terminal strip shall be supplied at each shipping split for reconnection of control wiring.
3. Unit Base - Floor: Unit perimeter base shall be completely welded and fabricated using heavy gauge structural steel tubing. (Note: bolted bases are not acceptable) C-Channel cross supports shall be welded to perimeter base steel tubing and located on maximum 24" centers to provide support for internal components. Base rails shall include lifting lugs welded to perimeter base at the corner of the unit or each section if de-mounted. Entire base frame is to be painted with a phenolic coating for long term corrosion resistance. Internal walk-on floor shall be 16 gauge galvanized steel. The outer sub-floor of the unit shall be made from 20 gauge galvanized steel. The floor cavity shall be spray foam insulated with floor seams gasketed for thermal break and sealed for airtight / watertight construction. Where access is provided to the unit interior, floor openings shall be covered with walk on phenolic coated steel safety grating. Single wall floors with glued and pinned insulation and no sub floor are not acceptable. Base frame shall be attached to the unit at the factory.
4. Unit Casing – The construction of the air handling unit shall consist of a formed 16 gauge galvanized steel exterior casing panels. The air handling unit casing shall be of the "no-through-metal" design. The casing shall incorporate insulating thermal breaks as required so that, when fully assembled, there's no path of continuous unbroken metal to metal conduction from inner to outer surfaces. Provide necessary support to limit casing deflection to L/200 of the narrowest panel dimension. If panels cannot meet this deflection, additional internal reinforcing is required. All panel seams shall be caulked and sealed for an airtight unit. Leakage rates shall be less than 1% at design static pressure or 9" W.C. whichever is greater.
5. Double Wall Liner - Each unit shall have double wall construction with 20 gauge solid galvanized steel in the entire unit.

6. Insulation - Entire unit to be insulated with a full 3" (R12.5) thick non-compressed fiberglass insulation. The insulation shall have an effective thermal conductivity (C) of .24 (BTU in./sq.ft. F°) and a noise reduction coefficient (NRC) of 0.70 / per inch thick (based on a type "A" mounting). The coefficients shall meet or exceed a 3.0 P.C.F. density material rating. Insulation shall meet the erosion requirements of UL 181 facing the air stream and fire hazard classification of 25/50 (per ASTM-84 and UL 723 and CAN/ULC S102-M88) and meet NFPA 90A and 90B. All insulation edges shall be encapsulated within the panel. All perforated sections shall have Micromat® or equal insulation with non-woven mat facing, 5000 fpm rating and non-hygroscopic fibers as manufactured by Johns Manville or approved equal.
7. Access Doors - The unit shall be equipped with a solid double wall insulated (same as the unit casing), hinged access doors as shown on the plans. The doorframe shall be extruded aluminum, foam filled with a built in thermal break barrier and full perimeter gasket. The door hinge assembly shall be completely adjustable die cast stainless steel. There shall be a minimum of two heavy duty handles per door. Provide ETL, UL 1995, and CAL-OSHA approved tool operated safety latch on all fan section access doors.
  - a. Note: If manufacturer cannot provide thermal break door design it must be noted as an exception on the bid.
  - b. Access doors all sections shall be provided with a 10 x 10 dual thermal pane safety glass window.

D. Unit Convenience Features

1. Each section (specified sections) shall be equipped with a vapor- proof 100 watt service light with guard.
2. Lights shall be controlled by one light switch mounted adjacent to the supply air fan access door.

E. FANWALL

1. The Fanwall System shall consist of multiple, direct driven, arrangement 4 plenum fans with fan wheels that are rated and certified with tests and procedures in accordance with AMCA publication 211 and comply with the requirements of the AMCA Certified Ratings Program and constructed per the AMCA requirements for the duty specified, (Class I, II, or III). All fans shall be selected to deliver the specified airflow quantity at the specified operating Total Static Pressure and specified fan/motor speed. The Fanwall array shall be selected to operate at a system Total Static Pressure that does not exceed 90% of the specified fan's peak static pressure producing capability at the specified fan/motor speed. Each fan/motor "cube" shall include a 12 gauge, G 90U Galvanized steel intake wall, 16 gauge spun steel fan inlet funnel, and a 1/4" steel motor support plate rail and structure. The fan intake wall, inlet funnel, and motor support structure shall be powder coated for superior corrosion resistance.

All motors shall be standard foot mounted type, TEFC or TEAO motors selected at the specified operating voltage, RPM, and efficiency as specified or as scheduled elsewhere. Motors shall meet the requirements of NEMA MG-1 Part 30 and 31, section 4.4.2. Motors shall be as manufactured by Baldor, Seimens, or Toshiba as approved for use in multiple fan arrays that operate at varying synchronous speeds as driven by an approved VFD. Steel cased motors and/or ODP motors are not acceptable. Six pole motors, unless specifically called for will not be accepted. All motors shall include permanently sealed bearings and shaft grounding to protect the motor bearings from electrical discharge machining due to stray shaft currents. Each fan/motor assembly shall be dynamically balanced to meet AMCA standard 204-96, category BV-5, to meet or exceed an equivalent Grade G.55, indicating a maximum of .022" per second peak, filter in ( .55mm per second peak, filter in) residual unbalance.

- a. The FWT array shall be provided with acoustical silencers that reduce the bare fan discharge sound power levels by a minimum of 15 db re 10<sup>-12</sup> watts throughout the eight octave bands with center frequencies of 125, 250, 500, 1000, 2000, 4000, and 8000 HZ when compared to the same unit without the silencers. The silencers shall not increase the fan total static pressure, nor shall it increase the airway tunnel length of the Air Handling Unit when compared to the same FWT unit without the silencer array.
  - b. Alternate manufacturers must submit acoustical data for review and approval indicating that the proposed alternate equipment can meet all specified performance requirements without impacting the equipment performance or design features including duct connection location, unit weights, acoustical performance, or specified total fan HP for each FWT array. Proposals submitted which indicate a higher connected fan HP than specified or scheduled will not be accepted.
2. The fan array shall consist of multiple fan and motor "cubes", 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. Wire sizing shall be determined, and installed, in accordance with applicable NEC standards
  3. The Fanwall array shall produce a uniform air flow profile and velocity profile within the airway tunnel of the air handling unit not to exceed the specified cooling coil and/or filter bank face velocity when measured at a point 12" from the intake side of the Fanwall array intake plenum wall, and at a distance of 48" from the discharge side of the Fanwall intake plenum wall.
  4. Each fan/motor assembly shall be removable through a 30" wide, free area, access door located on the **(discharge) (inlet)** side of the fan wall array.
  5. Each fan/motor "cube" will be provided with an individual back-draft damper. HUNTAIR backdraft dampers are made with Heavy Duty 6063-T5 extruded aluminum on the frames and blades and engineered to produce little to no static pressure loss at the designed operating conditions. Seals shall be solid rubber.

Bearings shall be rubber shielded radial ball bearings, permanently lubricated. The vertical blades of the damper open as airflow commences and close when the fan is idle. This is accomplished without the use of mechanical means or weights.

6. Each fan assembly shall be supplied with a complete flow measuring system, Huntair Flow-Cone, which indicates airflow in Cubic Feet per Minute. The flow measuring system shall consist of a flow measuring station and two pressure taps with one high static pressure tap and one low total pressure tap located at the throat of the inlet cone. The flow measuring station shall not obstruct the inlet of the fan and shall have no effect on fan performance (flow or static) or sound power levels. A surface mounted indicator, located on the unit exterior, shall provide a **(digital) (analog)** CFM readout, and/or a **(4-20 ma) (0-10 volt)** output control signal for use in the BAS as specified elsewhere.
7. The manufacturer shall provide a complete spare FWT fan/motor assembly for emergency replacement, one for each type of assembly provided on the project. Manufacturers for alternate, single direct driven fan assembly provided in lieu of the specified Fanwall shall provide a spare motor and fan assembly and a five year, parts and labor warranty for repair and/or replacement at no additional expense to the owner. Such warranty coverage shall include all freight charges for expedited shipment of emergency replacement parts, the cost of any cranes or lifting devices, and any costs associated with air handling unit disassembly and re-assembly, as required, for emergency replacement of any defective fan or motor.

F. FANWALL ELECTRICAL :

1. Provide a complete electrical and control system required to run the Fanwall system including all equipment, material, electrical enclosure, electrical components and electrical labor.
2. Fanwall designs shall be in accordance with specific system requirements. Please see system requirements before electrical design of Fanwall system is to commence.
3. Fanwall Electrical designs shall be in accordance with the NEC, UL 508A, and Local Codes.
4. There shall be a controller provided as an integral part of the fan system electrical panel that automatically reconfigures the number of active fans in the multiple fan array to achieve substantially peak operating efficiency for the fan array at any fan system operating point. System optimization shall be achieved by enabling and disabling fans in the active array while the controller varies the enabled fan operating speeds to achieve substantially peak efficiency at the concurrent system flow and pressure demands of the system. The fan array controller shall also be provided with an interface as indicated or specified that is compatible with the building automation system and which shall allow remote monitoring and/or control of the multiple fan array being interfaced with. The

multiple fan array control panel(s) shall be provided with means to indicate fan and motor status, operating mode, system flow rate and fan total static pressure. Status shall be displayed at the unit control panel and/or at the remote location of the building automation system control panel and interface screens. When specified and/or indicated, the optional communication interface with the BAS system shall be provided by the AHU manufacturer and shall require a single interface point at the multiple fan array system control panel by the project controls contractor.

G. FAN WALL WITH VARIABLE FREQUENCY DRIVE CONTROL:

1. As required by system design, provide Variable Frequency Drive to all motors in the Fanwall array. The Variable Frequency Drive shall be sized accordingly to start and hold all motors in the Fan Wall. Provide short circuit protection of motor circuits through means of using fuses with fused circuit breakers.
2. Provide three phase power distribution wiring and control wiring as required. All three phase power components shall have a rating listed for Short Circuit Current Rating. Provide control wiring and components required for complete operation of fan wall system. System controls, controls components and control wiring shall include but is not limited to Auto mode or manual mode, CFM control mode, or BMS control mode. Controls and control wiring shall include auto start/stop, manual start stop, safety shutdown, smoke shutdown, system alarms and VFD alarms. All control wiring shall be included in VFD enclosure provided with system.
3. As required by system design, provide a Programmable Logic Controller (PLC) to control all functions of the Fanwall array system. The Programmable Logic Controller system will be designed and programmed to control Auto and Manual Functions, provide CFM totalizing, CFM control, optimization control, and all functions required by the fan wall system. Provide an Operator Interface Unit for communication with PLC. Provide BMS communication via BACnet IP, BACnet MSTP, LonWorks or Modbus.
4. The Programmable Logic Controller, Variable Frequency Drives, and all other PLC related equipment shall be mounted in a dedicated enclosure for connection to single point power. The enclosure shall be provided with a main disconnecting means. Provide appropriate cooling of enclosure.
5. As required by system design, each fan assembly shall be supplied with a complete flow measuring system, Huntair Flow-Cone, which indicates airflow in Cubic Feet per Minute. The flow measuring system shall consist of a flow measuring station and two pressure taps with one high static pressure tap and one low total pressure tap located at the throat of the inlet cone. The flow measuring station shall not obstruct the inlet of the fan and shall have no effect on fan performance (flow or static) or sound power levels. A surface mounted indicator, located on the unit exterior, shall provide a **digital** CFM readout, and/or an output control signal for use in the BAS as specified elsewhere.

6. As required by electrical design, when using variable frequency drives provide Input Line reactors with five percent impedance mounted externally if not already internal to variable frequency drive.
7. As required by electrical design, when using variable frequency drives where distance and filtering is an issue, provide output line reactors as required. Size output filter accordingly to manufactures recommendations.

H. SHAFT GROUNDING:

1. As required by system design, when using variable frequency drives provide a shaft grounding system for each AC motor to prevent electrical damage to motor bearings and to extend motor life by safely channeling harmful shaft currents to ground.

I. Variable Frequency Controllers:

1. Description: NEMA ICS 2, IGBT, PWM, VFC; listed and labeled as a complete unit and arranged to provide variable speed of an NEMA MG 1, Design B, 3-phase induction motor by adjusting output voltage and frequency.
2. Output Rating: 3-phase; 6 to 60 Hz, with voltage proportional to frequency throughout voltage range.
3. Unit Operating Requirements:
  - a. Input ac voltage tolerance of 380 to 500 V, plus or minus 10 percent.
  - b. Input frequency tolerance of 50/60 Hz, plus or minus 6 percent.
  - c. Minimum Efficiency: 96 percent at 60 Hz, full load.
  - d. Minimum Displacement Primary-Side Power Factor: 96 percent.
  - e. Overload Capability: 1.1 times the base load current for 60 seconds; 2.0 times the base load current for 3 seconds.
  - f. Starting Torque: 100 percent of rated torque or as indicated.
  - g. Speed Regulation: Plus or minus 1 percent.
4. Isolated control interface to allow controller to follow control signal over an 11:1 speed range.
5. Internal Adjustability Capabilities:
  - a. Minimum Speed: 5 to 25 percent of maximum rpm.
  - b. Maximum Speed: 80 to 100 percent of maximum rpm.
  - c. Acceleration: 2 to a minimum of 22 seconds.
  - d. Deceleration: 2 to a minimum of 22 seconds.
  - e. Current Limit: 50 to a minimum of 110 percent of maximum rating.
6. Self-Protection and Reliability Features:
  - a. Input transient protection by means of surge suppressors.
  - b. Undervoltage and overvoltage trips; inverter overtemperature, overload, and overcurrent trips.

- c. Notch filter to prevent operation of the controller-motor-load combination at a natural frequency of the combination.
  - d. Instantaneous line-to-line and line-to-ground overcurrent trips.
  - e. Loss-of-phase protection.
  - f. Reverse-phase protection.
  - g. Short-circuit protection.
  - h. Motor overtemperature fault.
7. Automatic Reset/Restart: Attempts three restarts after controller fault or on return of power after an interruption and before shutting down for manual reset or fault correction. Bidirectional autospeed search shall be capable of starting into rotating loads spinning in either direction and returning motor to set speed in proper direction, without damage to controller, motor, or load.
  8. Motor Temperature Compensation at Slow Speeds: Adjustable current fall-back based on output frequency for temperature protection of self-cooled, fan-ventilated motors at slow speeds.
  9. Door-mounted LED status lights shall indicate the following conditions:
    - a. Power on.
    - b. Run.
    - c. Overvoltage.
    - d. Line fault.
    - e. Overcurrent.
    - f. External fault.
  10. Panel-Mounted Operator Station: Start-stop and auto-manual selector switches with manual-speed-control potentiometer and elapsed time meter.
  11. Meters or digital readout devices and selector switch, mounted flush in controller door and connected to indicate the following controller parameters:
    - a. Output frequency (Hertz).
    - b. Motor speed (rpm).
    - c. Motor status (running, stop, fault).
    - d. Motor current (amperes).
    - e. Motor torque (percent).
    - f. Fault or alarming status (code).
    - g. Proportional-integral-derivative (PID) feedback signal (percent).
    - h. DC-link voltage (volts direct current).
    - i. Set-point frequency (Hertz).
    - j. Motor output voltage (volts).
  12. Control Signal Interface:
    - a. Remote signal inputs capable of accepting any of the following speed-setting input signals from the control system:
      - 1) 0 to 10-V dc.
      - 2) 0-20 or 4-20 mA.
      - 3) Potentiometer using up/down digital inputs.

- 4) Fixed frequencies using digital inputs.
  - 5) RS485.
  - 6) Keypad display for local hand operation.
- b. Output signal interface with a minimum of 4 analog output signal (0/4-20 mA), which can be programmed to any of the following:
- 1) Output frequency (Hertz).
  - 2) Output current (load).
  - 3) DC-link voltage (volts direct current).
  - 4) Motor torque (percent).
  - 5) Motor speed (rpm).
  - 6) Set-point frequency (Hertz).
- c. Remote indication interface with a minimum of 2 dry circuit relay outputs (120-V ac, 1 A) for remote indication of the following:
- 1) Motor running.
  - 2) Set-point speed reached.
  - 3) Fault and warning indication (overtemperature or overcurrent).
  - 4) High- or low-speed limits reached.
13. Communications: RS485 interface allows VFC to be used with an external system within a multidrop LAN configuration. Interface shall allow all parameter settings of VFC to be programmed via BMS control. Provide capability for VFC to retain these settings within the nonvolatile memory.
14. Accessories:
- a. Devices shall be factory installed in controller enclosure unless otherwise indicated.
  - b. Push-Button Stations, Pilot Lights, and Selector Switches: NEMA ICS 2, heavy-duty type.
  - c. Standard Displays:
    - 1) Output frequency (Hertz).
    - 2) Set-point frequency (Hertz).
    - 3) Motor current (amperes).
    - 4) DC-link voltage (volts direct current).
    - 5) Motor torque (percent).
    - 6) Motor speed (rpm).
    - 7) Motor output voltage (volts).

## 2.3 COIL SECTION

### A. General Requirements for Coil Section:

1. Comply with ARI 410.
2. 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).

3. Coils shall not act as structural component of unit.
4. Seismic Fabrication Requirements: Fabricate coil section, internal mounting frame and attachment to coils, and other coil section components with reinforcement strong enough to withstand seismic forces defined in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment" when coil-mounting frame and air-handling-unit mounting frame are anchored to building structure.
5. Hydronic coil material shall be copper tube and copper fin.

## 2.4 AIR FILTRATION SECTION

- A. Provide filters of the type indicated on the schedule. Factory fabricated filter sections shall be of the same construction and finish as the unit. Face loaded pre and final filters shall have Type 8 frames as manufactured by BLC, FARR or equal. Filter racks over 72" in length shall require an angle center reinforcement support. Side service filter racks shall be fabricated from no less than 16 gauge galvanized steel and include hinged access doors on both sides of the unit or as indicated on unit drawings. Internal blank-offs shall be provided by the air unit manufacturer as required to prevent air bypass around the filters.
  1. Filter Gauge: Each Filter bank shall be furnished with Dwyer Series 2000 filter gauge or equal.
  2. Medium Efficiency MERV 8 Pleated filters – Provide (2" or 4") filters as specified on filter schedule. The filters shall be as manufactured by AAF, FARR or equal. Filters shall be in compliance with ANSI/UL 900 – Test Performance of Air Filters.
  3. High Efficiency MERV 11 Rigid filters - Provide 12" deep filters as specified on the filter schedule. The filters shall be listed as Class II under UL Standard 900. The filters shall be as manufactured by AAF, FARR or equal. Filters shall be in compliance with ANSI/UL 900 – Test Performance of Air Filters.
- B. General Requirements for Air Filtration Section:
  1. Comply with NFPA 90A.
  2. Provide minimum arrestance according to ASHRAE 52.1, and a minimum efficiency reporting value (MERV) according to ASHRAE 52.2.
  3. Provide filter holding frames arranged for flat or angular orientation, with access doors on one side of unit. Filters shall be removable from one side or lifted out from access plenum.
- C. Extended-Surface, Disposable Panel Filters:
  1. Factory-fabricated, dry, extended-surface type.
  2. Thickness: 2 inches.
  3. Arrestance (ASHRAE 52.1): 90.
  4. Merv (ASHRAE 52.2): 11.

5. Media: Fibrous material formed into deep-V-shaped pleats and held by self-supporting wire grid.
6. Media-Grid Frame: Nonflammable cardboard.
7. Mounting Frames: Welded, galvanized steel, with gaskets and fasteners, suitable for bolting together into built-up filter banks.

D. Filter Gage:

1. 3-1/2-inch- diameter, diaphragm-actuated dial in metal case.
2. Vent valves.
3. Black figures on white background.
4. Front recalibration adjustment.
5. 2 percent of full-scale accuracy.
6. Range: 0- to 2.0-inch wg.
7. Accessories: Static-pressure tips with integral compression fittings, 1/4-inch aluminum tubing, and 2- or 3-way vent valves.

## 2.5 DAMPERS

- A. General Requirements for Dampers: Leakage rate, according to AMCA 500, "Laboratory Methods for Testing Dampers for Rating," shall not exceed 2 percent of air quantity at 2000-fpm face velocity through damper and 4-inch wg pressure differential.
- B. Temtrol TD-6, Ruskin CD-50 or approved equal. Provide Class 1 rated, ultra low leak dampers (less than 3 cfm/sq ft. @ 1" w.g.) as indicated on the unit drawings. Low leakage dampers shall have extruded aluminum airfoil blades. Flat or formed metal blades are not acceptable. The damper blade shall incorporate santoprene rubber edge seals and zinc plated or stainless steel tubular steel shaft for a non-slip operation. Shaft bearings shall be spherical – non corrosive nylon to eliminate friction and any metal to metal contact. Damper jamb seals shall be UV rated, nylon glass reinforced or stainless steel spring arcs designed for a minimum air leakage and smooth operation. Damper linkage shall be concealed within a 16 gauge galvanized steel frame. Operators furnished and installed by others
- C. Damper Operators: Comply with requirements in Division 23 Section "Instrumentation and Control for HVAC."
- D. Electronic Damper Operators:
  1. Direct-coupled type designed for minimum 60,000 full-stroke cycles at rated torque.
  2. Electronic damper position indicator shall have visual scale indicating percent of travel and 2- to 10-V dc, feedback signal.
  3. Operator Motors:

- a. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Division 23 Section "Common Motor Requirements for HVAC."
  - b. Size to operate with sufficient reserve power to provide smooth modulating action or two-position action.
  - c. Permanent Split-Capacitor or Shaded-Pole Type: Gear trains completely oil immersed and sealed. Equip spring-return motors with integral spiral-spring mechanism in housings designed for easy removal for service or adjustment of limit switches, auxiliary switches, or feedback potentiometer.
4. Nonspring-Return Motors for Dampers Larger Than 25 Sq. Ft.: Size for running torque of 150 in. x lbf and breakaway torque of 300 in. x lbf.
  5. Spring-Return Motors for Dampers Larger Than 25 Sq. Ft.: Size for running and breakaway torque of 150 in. x lbf.
  6. Size dampers for running torque calculated as follows:
    - a. Parallel-Blade Damper with Edge Seals: 7 inch-lb/sq. ft. of damper.
    - b. Opposed-Blade Damper with Edge Seals: 5 inch-lb/sq. ft. of damper.
    - c. Parallel-Blade Damper without Edge Seals: 4 inch-lb/sq. ft. of damper.
    - d. Opposed-Blade Damper without Edge Seals: 3 inch-lb/sq. ft. of damper.
    - e. Dampers with 2- to 3-Inch wg of Pressure Drop or Face Velocities of 1000 to 2500 fpm: Increase running torque by 1.5.
    - f. Dampers with 3- to 4-Inch wg of Pressure Drop or Face Velocities of 2500 to 3000 fpm: Increase running torque by 2.0.
  7. Coupling: V-bolt and V-shaped, toothed cradle.
  8. Overload Protection: Electronic overload or digital rotation-sensing circuitry.
  9. Fail-Safe Operation: Mechanical, spring-return mechanism with external, manual gear release on nonspring-return actuators.
  10. Power Requirements (Two-Position Spring Return): 24-V ac.
  11. Power Requirements (Modulating): Maximum 10 VA at 24-V ac or 8 W at 24-V dc.
  12. Proportional Signal: 2- to 10-V dc or 4 to 20 mA, and 2- to 10-V dc position feedback signal.
  13. Temperature Rating: Minus 22 to plus 122 deg F.
  14. Run Time: 12 seconds open, 5 seconds closed.

## 2.6 DISCHARGE PLENUM SECTION

- A. AHU Discharge Plenums shall be of identical construction as the AHU and shall be manufactured by the AHU manufacturer. Third party plenums of field fabricated plenums are not acceptable. Discharge plenums shall be capable of withstanding a minimum of 6" of pressure, acoustically lined and shall be double wall construction. Discharge Plenums are to be stacked on top of Fan sections.
- B. 2.8 SOURCE QUALITY CONTROL

- 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."
  - 1. Water Coils: All coil assemblies shall be leak tested under water at 315 PSIG and PERFORMANCE is to be CERTIFIED under ARI Standard 410. Coils exceeding the range of ARI standard rating conditions shall be noted.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Equipment Mounting: Install air-handling units on steel bases without vibration isolation devices. Secure units to base with screws. Retain first paragraph below for equipment supported on vibration isolation devices without a concrete base. Retain "without vibration isolation devices" option for units that have fans with internal vibration isolation and seismic restraints.
- B. Arrange installation of units to provide access space around air-handling units for service and maintenance.
- C. Do not operate fan system until filters (temporary or permanent) are in place. Replace temporary filters used during construction and testing, with new, clean filters.
- D. Install filter-gage, static-pressure taps upstream and downstream of filters. Mount filter gages on outside of filter housing or filter plenum in accessible position. Provide filter gages on filter banks, installed with separate static-pressure taps upstream and downstream of filters.
- E. Comply with requirements for piping specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- F. Install piping adjacent to air-handling unit to allow service and maintenance.
- G. Connect piping to air-handling units mounted on vibration isolators with flexible connectors.
- H. Connect condensate drain pans using NPS 1-1/4, ASTM B 88, Type M copper tubing. Extend to nearest equipment or floor drain. Construct deep trap at connection to drain pan and install cleanouts at changes in direction.
- I. Hot- and Chilled-Water Piping: Comply with applicable requirements in Division 23 Section "Hydronic Piping." Install shutoff valve and union or flange at each coil supply connection. Install balancing valve and union or flange at each coil return connection.

- J. Connect duct to air-handling units with flexible connections. Comply with requirements in Division 23 Section "Air Duct Accessories."
- K. All electrical and automatic control devices not previously called out or listed below are to be furnished and installed in the field by OTHERS.
  - 1. All wiring shall be (75°C) Insulated copper wires.
  - 2. The unit shall feature a mounted permanent nameplate displaying at a minimum the manufacturer, serial number, model number and current and amps voltage. The unit must have an ETL or UL Listing and bear the appropriate mark.
  - 3. Conduit shall consist of a combination of EMT or flexible metal conduit as required. Liquidtite flexible metal conduit may be used outside the air tunnel for wet locations

END OF SECTION 237313