SECTION 23 36 00
AIR TERMINAL UNITS

PART 1 – GENERAL

1.01 WORK INCLUDED

A. The work of this Section shall include, but is not limited to, the following:

1. Fan-powered terminal units
2. Factory-mounted and calibrating control modules, actuators

1.02 RELATED DOCUMENTS

A. Section 23 05 01 – HVAC General Provisions

B. Section 23 05 13 – Electric Motors for HVAC Equipment

C. Section 23 05 53 – Identification for HVAC

D. Section 23 05 93 – Testing, Adjusting and Balancing for HVAC

E. Section 23 07 00 – Insulation for HVAC

F. Section 23 09 23 – Building Management System (BMS)

G. Section 23 09 93 – Sequence of Operations for HVAC Controls

H. Section 23 33 19 – Acoustics

I. Section 23 82 16 – Air Coils

J. Division 26 – Electrical Specifications

1.03 REFERENCE STANDARDS

Published specifications standards, tests or recommended methods of trade, industry or governmental organizations apply to work in this Section where cited below:

A. ASHRAE – American Society of Heating, Refrigeration, and Air Conditioning Engineers: ASHRAE Std. 130 Laboratory Methods of Testing Air Terminal Units

B. AHRI – Air Conditioning and Refrigeration Institute: AHRI 880 Performance Rating of Air Terminals

C. UL – Underwriters Laboratories Inc.

1. UL 1995 Heating and Cooling Equipment
2. UL 181 Standard for Factory-Made Air Ducts and Air Connectors

D. NFPA – National Fire Protection Association

1. NFPA 90A Standard for the Installation of Air-Conditioning and Ventilating

Systems
2. NFPA 70 National Electrical Code (NEC)

1.04 QUALITY ASSURANCE

A. Sound ratings for all units shall not exceed values specified in Section 23 33 19 – Acoustics at 1-inch water gauge static pressure.

B. Terminal units shall be listed as a composite assembly per UL 1995.

1.05 SUBMITTALS

A. Submit manufacturer's leakage rating, certified airflow performance test data, sound performance test data and certified dimensioned drawings.

B. Submit materials of construction, assembly details and mounting details.

C. Submit actuators and linkages with control requirements specified.

D. Submit electric motor details including motor mounting details, speed, voltage, efficiency and type.

E. Submit control diagrams including line voltage, low voltage and control air.

F. Certify compatibility between multi-point sensor, actuator and controls.

PART 2 – PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Fan Powered Terminal Units: Titus, Trane, Nailor Industries

2.02 FAN POWERED TERMINAL UNITS

A. Furnish fan-powered terminal devices as indicated on the Drawings. Refer to equipment schedules for duct connection sizes and capacities. Provide the terminal units with a primary variable air volume damper that controls the primary air quantity in response to a control signal. The terminal units shall contain a fan and motor assembly, and **a hot water** heating coil where scheduled or indicated on the Drawings. The fan shall provide a constant volume of discharge air at all air-blending ratios from minimum to maximum scheduled primary air quantities and zero to 100 percent return airflow rates. Review the space limitations carefully to ensure all terminal units will fit in the space allowed including National Electric Code clearances required in front of all panels containing electrical devices.

B. Provide an access door or doors to service all internal components and a removable panel to service the fan and electric motor. Provide cam latches for the access doors.

C. Provide a filter rack with a 1-inch thick disposable MERV 13 filter. Filter shall be replaced after final air balancing.

D. The terminal units shall include equipment and controls with the following as a minimum:

1. Single point electrical connection for the voltage/phase as scheduled. Refer to Electrical Drawings and specifications for power wiring requirements.
2. Circuit breakers or fused disconnect switches sized to protect all terminal unit electrical components.
3. Individual electrical overcurrent protection devices as required to protect individual terminal unit devices and transformers.

4. Provide a multi-point flow sensor device that controls the maximum primary airflow for the terminal unit to that indicated on the Drawings, through a transducer and a Direct Digital Control (DDC) microprocessor provided by the Control Contractor. Locate the multi-point flow sensor in the primary duct connection in a position to accurately monitor the supply airflow. Equip the primary inlet with a gradual transition (SMACNA Construction Standards) as required to connect to the primary duct size shown on the Drawings. The transition shall be provided by the terminal unit manufacturer and field-installed by the Contractor. Provide a 4-inch long minimum transition with a ⅛-inch high raised bead approximately 1½ inches from the inlet connection. Permanently mark the primary and fan design airflow settings on the bottom of the terminal unit. Provide a transformer with 24-volt AC secondary to provide power for the controls. The terminal unit manufacturer and the Contractor shall verify compatibility of multi-point sensor with transducer and DDC microprocessor prior to fabricating any equipment. The multi-point flow sensors and flow transducers in conjunction with the DDC control system shall be capable of controlling the terminal unit discharge air volume (CFM) to within 5 percent of scheduled design fan air volume (CFM).

5. Fan motor assembly shall be a forward-curved centrifugal fan with a direct-drive motor. Motors shall be General Electric ECM or equal, variable-speed direct current brushless motors specifically designed for use with a single phase, **277**-volt, 60-hertz electrical input. Motor shall be complete with and operated by a single-phase integrated controller/inverter that operates the wound stator and senses rotor position to electrically commutate the stator. An integral controller furnished by the terminal unit manufacturer shall provide a signal to the ECM motor to maintain constant supply airflow. All motors shall be designed for synchronous rotation.

    a. Motor rotor shall be permanent magnet type with near zero rotor losses.
    b. Motor shall have built-in soft start and soft speed change ramps.
    c. Motor shall be able to be mounted with shaft in horizontal or vertical orientation.
    d. Motor shall be permanently lubricated with ball bearings.
    e. Motor shall be direct-coupled to the blower.
    f. Motor shall maintain a minimum of 70 percent efficiency over its entire operating range.
    g. Provide isolation between fan motor assembly and unit casing to eliminate any vibration from the fan to the terminal unit casing.
    h. Provide anti-back rotation system or provide a motor that is designed to overcome reverse rotation and not affect life expectancy.
    i. Motors and inverter assemblies manufactured by Emerson, General Electric, Fasco, or A.O. Smith shall be acceptable.

6. The manufacturer of the fan-powered terminal units shall set the fan discharge airflow (cfm) at the factory or in the field. The factory setting for the fan cfm shall

be clearly marked on each terminal unit nameplate; or the field setting shall be permanently marked on the nameplate. If the fan cfm cannot be set, factory technicians shall be sent to the field to adjust the motor and the associated controller/inverter to the discharge airflow on the drawings. Fan cfm shall be constant within plus or minus 5 percent regardless of changes in static upstream or downstream of the terminal unit after it is installed in the field.

a. Fan cfm shall be set with a potentiometer and digital meter. Neither SCR's nor rheostats shall be an acceptable means of setting the fan cfm.
b. One speed adjustment device shall be provided by the terminal unit manufacturer to the Owner for field adjustment of the fan speed should construction or design changes become necessary.

7. The terminal unit shall be listed in accordance with UL 1995 as a composite assembly consisting of the terminal unit with or without the electric or hot water heating device.

E. The primary air damper shall vary primary air supply in response to an electronic signal. Damper leakage at shut-off shall not exceed 4 percent of the scheduled maximum fan airflow at 2 inches water gauge. Provide damper connection to the operating shaft of a positive mechanical type to prevent any slippage. Provide non-lubricated Delrin or Mylar bearings for the damper shaft. Damper shaft shall be permanently marked on the end to indicate damper position. The damper shall incorporate a mechanical stop to prevent overstroking, and a synthetic seal to limit close-off leakage. Damper shall be life cycle tested to 10,000 cycles minimum.

F. Select the primary air damper in conjunction with the DDC microprocessor furnished under Section 23 09 23 – Building Management System (BMS) for HVAC to provide control at low primary air velocities. The total deviation in primary airflow shall not exceed plus or minus 5 percent of the primary airflow corresponding to a 300 feet per minute air velocity through the primary air at 0.2 inches water gauge inlet static pressure. The primary airflow accuracy and repeatability shall be laboratory demonstrated and proven with any inlet configuration and inlet static pressure from 0.2 to 2.0 inches water gauge.

G. Sound attenuation of air stream noise and acoustical treatment of terminal unit shall comply with Section 23 33 19 – Acoustics with 1-inch water gauge inlet pressure, 0.3-inch water gauge discharge pressure, and the specified design air volume scheduled on the Drawings. Record radiated noise and self-generated noise readings at ½-, 1- and 1½-inch water gauge inlet static pressures.

H. Provide thermal insulation for all portions of the terminal unit in contact with primary cold or fan-powered heated air. Insulation shall be a fiber-free product such as closed cell foam that complies with UL 181 and NFPA 90A for smoke and flame spread, mechanically fastened to the casing. All cut edges of insulation shall be sealed from the air streams by use of sheetmetal nosings. Exposed fiberglass shall not be accepted.

I. Provide a double wall galvanized sheetmetal cabinet with minimum 20 gauge steel outer sheet and perforated 22 gauge steel inner sheet. Clearly identify mounting connections for hanging the terminal unit by sheetmetal straps. Factory install all components, including all controls and wiring, except the following field connections:

1. Primary duct

2. Secondary duct
3. Single point electrical connection
4. Control signals
5. Space temperature sensor connection

J. The terminal unit shall be designed to provide the published airflow range at an inlet static pressure of ¼ inches water gauge or less. Downstream static pressure shall be accommodated by the unit internal fan.

K. The following equipment shall be supplied by Control (BMS) Contractor and installed by the fan-powered terminal unit manufacturer:

1. DDC microprocessor-based controller
2. Pressure transducer if it is not contained in the DDC microprocessor

L. The Control Contractor shall furnish the DDC unit controller and flow transducers (if not integral with the unit controller) to the terminal unit manufacturer's factory. The Contractor shall supply written instructions and drawings containing sufficient information to enable the manufacturer to undertake the installation. The manufacturer shall prepare a drawing of the wiring for the terminal unit controller and all associated instrumentation and final control elements based on the information provided by the Contractor. The Contractor shall visit the manufacturer's facility at the completion of the first production run for this Project and prior to the shipping of any units to the project site, to inspect the installation of the DDC controller. The manufacturer shall not make any factory adjustments to the DDC unit controller or enter any data into the DDC unit controller. All testing, entry of data and adjustments of any kind to the unit controller shall be undertaken by the Contractor at the project site.

M. The ECM motor and fan assembly shall have a multi-point flow sensor factory-installed in each air induction port. An averaging flow sensor of equal accuracy may be provided at the fan inlet in lieu of flow sensors at each induction port. UL Listed (FR) type tubing shall be factory installed as required for the flow sensors and sheetmetal cabinet pressure fittings.

1. 24-volt AC transformer
2. 24-volt AC fan start/stop relay

3. **Hot water** heating coil control through the BMS.
4. Manual and/or automatic fan speed adjustment device
5. Sheetmetal enclosure for the DDC controller
6. Primary air damper and linkage

N. The terminal-unit manufacturer shall verify the operation of each fan-powered terminal before shipment. Testing shall include the following as a minimum:

1. Apply electric power to the unit.
2. Start the fan and verify fan rotates properly.

3. The terminal-unit manufacturer shall factory- or field-adjust the ECM motor and associated controller/inverter to the discharge cfm indicated on the Drawings.

4. Energize and de-energize the electric heat through the electric heating coil relay. Verify the signal with a volt meter to ensure proper heater operation.

5. Disconnect the primary air damper actuator from the DDC terminal unit controller. Provide separate power source to the actuator to verify operation and rotation of damper. Command/actuate the damper closed and verify that the damper is driven fully closed. Return primary air damper to the fully open position prior to shipment.
6. Provide a written inspection report for each terminal unit signed and dated by the factory test technician verifying all terminal unit wiring and testing has been performed as specified and per the manufacturer's testing and quality assurance requirements.

O. The Control Contractor shall provide the terminal-unit manufacturer with multi-color point-to-point wiring diagrams detailing the wiring of the controller and other control equipment or device installed on the terminal unit. The manufacturer shall review and approve the wiring diagrams and coordinate any changes necessary with the Contractor. The manufacturer shall incorporate the final version of the wiring diagram in the terminal unit shop drawing submittals.

2.03 VAV AND FAN-POWERED TERMINAL UNITS – HOT WATER HEATING COILS

A. Hot water heating coils shall be integrally factory-mounted as part of the terminal unit. Coils shall comply with Section 23 82 16 – Air Coils.

PART 3 – EXECUTION

3.01 INSTALLATION

A. Maintain service clearance for terminal unit controls and line voltage electrical components.

B. Stencil all terminal units with nametags on the bottom casing panel to match tags shown on the Drawings. Lettering/numbering shall be 3 inches high using red primer paint.

C. Terminal-unit manufacturer shall provide flow curves for the primary air sensors clearly labeled and permanently attached on the bottom or side of each terminal unit.

END OF SECTION 23 36 00