SECTION 15850

AIR TERMINAL UNITS - VARIABLE VOLUME

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Fan powered terminal units.

1. Parallel flow (variable volume).

B. Sound attenuator.

C. Integral terminal unit controls.

1. Direct digital.

1.2 PRODUCTS FURNISHED BUT NOT INSTALLED UNDER THIS SECTION

A. Section 15900: Controls and Instrumentation: Thermostats and control components.

1.3 PRODUCTS INSTALLED BUT NOT FURNISHED UNDER THIS SECTION

A. None.

1.4 REFERENCES

A. NFPA 90A: Installation of Air Conditioning and Ventilation Systems.

B. UL 181: Factory-Made Air Ducts and Connectors.

C. UL 1995: Heating and Cooling Equipment.

D. CUL C22.2 No. 236: Heating and Cooling Equipment.

E. ASTM A 527: (Steel Sheet, Zinc Coated Galvanized).

1.5 SUBMITTALS

A. Submit shop drawings and product data sheets indicating configuration, general assembly, and materials used in fabrication.

B. Submit product performance data indicating design airflow, minimum static pressure drop, fan operating condition.

C. Submit installation, operation and maintenance documentation.

1.6 QUALIFICATIONS

A. Manufacturer: The company manufacturing the products specified in this section shall have a minimum of ten years experience producing products of this type.

1.7 WARRANTY

A. Provide manufacturer's parts warranty for one year from unit start-up or eighteen months from unit shipment, whichever is shorter.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. General

1. Single terminal units shall be UL listed as an assembly.

2. Fan powered terminal units shall be UL listed as an assembly.

B. Specified Manufacturers

1. Trane Models.

2. Environmental Technologies Inc. Models.

3. Titus Models.

4. Tempmaster Models.

2.2 MANUFACTURED UNITS

A. Fan powered terminal units.

1. Ceiling mounted primary and recirculated air control terminal unit for connection to a single medium pressure duct of a central air distribution system. Terminals units may be provided with controls and integral heating coils.

B. Identify each terminal unit with clearly marked identification label and airflow indicator. Label shall include unit nominal airflow, maximum factory-set airflow, minimum factory-set airflow, and coil type.

2.3 FABRICATION

A. Casings: Units shall be completely factory-assembled, manufactured of corrosion protected steel, and fabricated with a minimum of 18-gauge metal on the high pressure (inlet) side of the terminal unit damper and 22-gauge metal on the low pressure (outlet) side and unit casing.

B. Plenum air filters shall be provided on all fan-powered units.

C. Insulation - Matte Faced - The interior surface of unit casing acoustically and thermally lined with a minimum of 1/2 inch, 1.75 lb./cu. ft. density glass fiber with a high density facing. The insulation R-Value shall be a minimum of 1.9. Insulation shall meet NFPA-90A and UL 181 requirements. The cut edges on the discharge of the unit shall be covered by a metal flange.

D. Assembly: Primary air control damper, airflow sensor, fans, controls and optional heating coil in single cabinet.

E. Rectangular Supply Air Outlet Connections: Rectangular outlet connections for units without optional heating coils on the outlet of the terminal unit shall be flange type. Rectangular outlet connections for units with optional heating coils on the outlet of the terminal unit shall be flange type.

2.4 PRIMARY AIR CONTROL DAMPER ASSEMBLY

A. Locate primary air control damper assembly inside unit casing. Construct the damper assembly from extruded aluminum and/or a minimum 22 gauge galvanized steel components. Maximum damper leak rate shall not exceed 1% of damper nominal CFM at 4-inch wg. differential.

B. Provide damper assembly with integral flow sensor. Flow sensor shall be provided regardless of control type. Flow sensor shall be a multi-point, averaging, ring or cross type. Bar or single point sensing type is not acceptable.

C. Terminal unit manufacturer shall provide and factory install an electric 24 VAC 3-wire floating control damper actuator.

2.5 HEATING COILS

A. Electric Heating Coil: Supplied and installed by box manufacture.

B. Capacity: Provide coils in capacities as scheduled on the drawings.

2.6 FAN ASSEMBLY

A. Fan assembly shall be forward curved centrifugal fan with direct drive permanently lubricated, permanent split-capacitor type, thermally protected, three speed motor. Motor must be capable of continuous operation under maximum fan load with no external static pressure.

B. Fan motor horsepower shall not exceed the horsepower scheduled for each unit. Fan motors shall be high efficiency and shall not exceed those shown in the table below for each motor size.

	115 Volt	277 Volt
FAN HP	AMPS	
1/15	1.3	0.4
1/8	1.3	1.1
1/3	2.9	3.6
½	4.4	3

C. Internally suspend and isolate fan motor assembly from unit casing by using rubber isolators or torsion flex mounting legs.

D. Unit shall be equipped with a fan motor disconnect switch which breaks both legs of power entering the control box.

E. Provide unit with the fan motor factory-wired to the appropriate motor speed for the scheduled operating conditions.

2.7 WIRING

A. Factory install and wire power line fusing, a disconnect switch and a 24 VAC transformer for control voltage on fan powered direct digital or electronic control units. Provide terminal strip in control box for field wiring of thermostat and power source.

B. Factory wire fan to terminal strip.

C. Factory install and wire terminal unit controls. Install electrical components in control box with removable cover. Incorporate single point electrical connection to power source.

2.8 DIRECT DIGITAL VAV CONTROLS

A. Direct Digital Controls

1. General. DDC Controls, actuator and factory costs to mount, calibrate and test the system shall be the responsibility of Section 15900 BAS/Building Management System Contractor.

2. Terminal unit manufacturer shall provide price for factory mounting, continuity check, calibrating, and testing of direct digital controls to the BAS. Field mounted DDC controls are not acceptable.

3. Multi-point, multi-axis flow ring or cross sensor to be furnished and mounted by terminal unit manufacturer. Single point or flow bar sensors are not acceptable. Shall be capable of maintaining airflow to within +/- 5 percent of rated unit airflow set point with 1.5 duct diameters straight duct upstream from the unit.

B. Variable Air Volume (VAV) Terminal Unit Control

1. The VAV terminal units shall be individually controlled by a DDC VAV controller per VAV terminal unit. The DDC VAV controller, damper motor, transducer and transformer shall be supplied by the BAS contractor and furnished to the terminal unit supplier. The cost to factory mount, calibrate and test the controller, transducer, transformer and actuator shall be coordinated prior to bid day and included in the BAS price.

    a. To assure proper operation and control, the BAS contractor as part of this bid shall recalibrate the transducers six (6) months after acceptance of the BAS system to correct any deviations as a result of transducer drift.

2. Submit a copy of the calibration report to the Engineer, Mechanical Contractor, Test, Adjust and Balance Contractor and Owner.

a. Refer to Section 15900 Terminal Units for requirements.

3. The BAS shall perform the following VAV Terminal unit control strategies and provide the points as listed on the DDC/VAV point list and the specified monitoring and diagnostics.

   a. Grouping - The BAS shall be able to group VAV boxes via keyboard commands. These groups shall make it possible for the operator to send a common command to all boxes in a group to operate in the same mode. A sample of this group report must be provided in the submittal package for approval by engineer and owner. BAS shall also compile on a group basis, the following:

      1. Minimum group temperature
      2. Maximum group temperature
      3. Average group temperature
      4. Group boxes total airflow

   b. Set point Control - The BAS shall edit the zone space temperature set point of each VAV box. The zone temperature set point shall be operator adjustable. Individual zone set point and control logic shall reside at the zone level, and not be dependent upon the BAS for control. In the event of communication loss, the box will continue to control to current set points.

   c. Cooling Valve Control - The BAS shall control the cooling air valve to a fully open, fully closed, maximum CFM, or minimum CFM position based on operator commands. The operator shall also have the capability to adjust the maximum & minimum airflow limits of the air valve through the BAS.

   d. Operating Mode - The BAS shall place the box in either the occupied or unoccupied mode based on an operator adjustable time schedule. Separate heating & cooling set points shall be editable for each mode through the BAS. Other modes available for special applications shall include full open, full closed, maximum flow, and minimum flow.

   e. Control Offset - The BAS shall be capable of offsetting the cooling or heating set points of one or more groups of boxes by an operator adjustable amount. This capability will allow for automatic zone set point changes based on system requirements, such as demand limiting.

   f. Automatic Calibration - The system shall automatically calibrate its airflow sensing & air valve position measurement system at system startup and on a scheduled basis.

   g. Override Button - The VAV box shall be capable of being placed in the "occupied" mode by pressing an override button mounted on the zone temperature sensor.

   h. Portable interface terminal - The VAV box shall have a communications port on the space sensor for use with a hand held portable operator's terminal. This portable terminal shall give the operator the capability to interrogate & edit DDC/VAV box parameters. Portable interface terminal shall also have the capability to interrogate and edit DDC/VAV box parameters from a central controller.

   i. Terminal unit status reports - For each terminal unit, the BAS shall provide an operating status summary of all unit sensed values (zone temperature, CFM, etc.), set points, and modes.

j. Terminal unit group report - For each group of VAV terminal units, the BAS shall report the group mode, heating and cooling airflow, average zone temperature, minimum zone temperature, and maximum zone temperature. The report shall also display for each terminal unit in the group the present temperature control set points and the current zone temperature.

4. Terminal box diagnostics.

a. If zone temperature sensor input fails above its high range, unit shall control at its maximum CFM set point. If sensor input fails below its low range, unit shall control to its minimum CFM set point.

b. In both cases, all heat outputs shall be disabled. And a diagnostic message shall be displayed upon operator inquiry.

c. If flow-measuring system fails, unit shall automatically convert to a pressure dependent, damper position based algorithm. Diagnostic message shall be displayed upon operator inquiry.

d. If zone temperature set point potentiometer on zone sensor fails, unit shall automatically control to program occupied set points. Diagnostic message shall be displayed upon operator inquiry.

e. If communications are lost, controller shall continue to operate in the current mode of operation. All set points shall be retained in nonvolatile memory. If communications are not restored within 15 minutes, unit shall automatically initiate a reset and then calibrate the flow sensor and damper position.

2.9 TESTING / VERIFICATION

A. Factory run test all fan-powered units.

B. Factory set and check all analog electronic and pneumatic controllers to within 5% of scheduled maximum and minimum settings. Base performance on tests conducted in accordance with ARI 880.

C. Maximum Casing Leakage: 1 percent of nominal air flows at 0.5 in wg inlet static pressure.

D. Maximum Damper Leakage: 1 percent of design air flows at 4 in wg inlet static pressure.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install in accordance with manufacturer's instructions.

3.2 ADJUSTING

A. Reset volume with damper operator attached to assembly allowing flow range modulation from 100 percent of design airflow to 25 percent nominal airflow for cooling only units and 30 percent for units with heating coils.

PART 4 - SEQUENCE OF OPERATIONS

4.1 DDC VARIABLE AIR VOLUME SYSTEM SEQUENCE OF OPERATION

A. General. DDC Controls, actuator and factory costs to mount, calibrate and test the system shall be the responsibility of Section 15900 BAS/Building Management System Contractor.

B. Terminal unit manufacturer shall provide price for factory mounting and continuity check of direct digital controls to the BAS contractor. Field mounted DDC controls are not acceptable.

C. Multi-point, multi-axis flow ring or cross sensor to be furnished and mounted by terminal unit manufacturer. Single point or flow bar sensors are not acceptable. Shall be capable of maintaining airflow to within +/- 5 percent of rated unit airflow set point with 1.5 duct diameters straight duct upstream from the unit.

4.2 VAV TERMINAL UNIT CONTROL

A. The VAV terminal units shall be individually controlled by a DDC VAV controller per VAV terminal unit. The DDC VAV controller, damper motor, transducer and transformer shall be supplied by the BAS contractor and furnished to the terminal unit supplier. The cost to factory mount, calibrate and test the controller, transducer, transformer and actuator shall be coordinated prior to bid day and included in the BAS price.

1. To assure proper operation and control, the BAS contractor as part of this bid shall calibrate the transducers six (6) months after acceptance of the BAS system to correct any deviations as a result of transducer drift.

B. Submit a copy of the calibration report to the Engineer, Mechanical Contractor, Test, Adjust and Balance Contractor and Owner.

1. Refer to Section 15900 Terminal Units for requirements.

C. The BAS shall perform the following VAV Terminal unit control strategies and provide the points as listed on the DDC/VAV point list and the specified monitoring and diagnostics.

1. Grouping - The BAS shall be able to group VAV boxes via keyboard commands. These groups shall make it possible for the operator to send a common command to all boxes in a group to operate in the same mode. A sample of this group report must be provided in the submittal package for approval by engineer and owner. BAS shall also compile on a group basis, the following:

a. Minimum group temperature

b. Maximum group temperature

c. Average group temperature

d. Current airflow through boxes in group (total)

D. Set point Control - The BAS shall edit the zone space temperature set point of each VAV box. The zone temperature set point shall be operator adjustable. Individual zone set point and control logic shall reside at the zone level, and not be dependent upon the BAS for control. In the event of communication loss, the box will continue to control to current set points.

E. Cooling Valve Control - The BAS shall control the cooling air valve to a fully open, fully closed, maximum CFM, or minimum CFM position based on operator commands. The operator shall also have the capability to adjust the maximum & minimum airflow limits of the air valve through the BAS.

F. Operating Mode - The BAS shall place the box in either the occupied or unoccupied mode based on an operator adjustable time schedule. Separate heating & cooling set points shall be editable for each mode through the BAS. Other modes available for special applications shall include full open, full closed, maximum flow, and minimum flow.

G. Control Offset - The BAS shall be capable of offsetting the cooling or heating set points of one or more groups of boxes by an operator adjustable amount. This capability will allow for automatic zone set point changes based on system requirements, such as demand limiting.

H. Automatic Calibration - The system shall automatically calibrate its airflow sensing & air valve position measurement system at system startup and on a scheduled basis.

I. Override Button - The VAV box shall be capable of being placed in the "occupied" mode by pressing an override button mounted on the zone temperature sensor.

J. Terminal unit status reports - For each terminal unit, the BAS shall provide an operating status summary of all unit sensed values (zone temperature, CFM, etc.), set points, and modes.

K. Terminal unit group report - For each group of VAV terminal units, the BAS shall report the group mode, heating and cooling airflow, average zone temperature, minimum zone temperature, and maximum zone temperature. The report shall also display for each terminal unit in the group the present temperature control set points and the current zone temperature.

L. Zone Sensors

1. The zone sensor shall be accurate to within 0.5° F. The sensor shall be a product of the VAV box controls manufacturer and designed specifically for the installed controller.

M. Terminal box diagnostics.

1. If zone temperature sensor input fails above its high range, unit shall control at its maximum CFM set point. If sensor input fails below its low range, unit shall control to its minimum CFM set point.

2. In both cases, all heat outputs shall be disabled. a diagnostic message shall be displayed upon operator inquiry.

3. If flow-measuring system fails, unit shall automatically convert to a pressure dependent, damper position based algorithm. Diagnostic message shall be displayed upon operator inquiry.

4. If zone temperature set point potentiometer on zone sensor fails, unit shall automatically control to the current programmed occupied set points. Diagnostic message shall be displayed upon operator inquiry.

5. If a wireless zone temperature sensor fails, the UCM shall remove it from the averaging calculation and use the remaining sensors if applicable. If averaging is not implemented the UCM shall switch to the backup zone sensor. VAV controller shall send an alarm message to the building automation system. A report shall be printable that shows sensor assignments by serial number, time since the last transmission was received and the signal strength of the transmission.

6. If communications are lost, controller shall continue to operate in the current mode of operation. All set points shall be retained in nonvolatile memory. If communications are not restored within 15 minutes, unit shall automatically initiate a reset and then calibrate the flow sensor and damper position.

4.03 SEQUENCE OF OPERATION, PARALLEL FAN POWERED TERMINAL UNITS WITH DDC CONTROLS

A. Occupied Cycle

1. Intermittent Fan Control - As the space temperature falls below cooling set point, the terminal unit shall modulate to its minimum cooling CFM. Upon a continued drop in temperature and/or unit CFM, the parallel fan will be energized. Upon a further decrease in space temperature, the terminal unit will modulate to heating minimum CFM. The heating will then be staged on as follows:

B. Unoccupied Cycle

1. The air valve shall drive closed. The fan and heat shall cycle to maintain a reduced space temperature.

END OF SECTION