

SECTION 15840

AIR TERMINAL UNITS

**PART 1 –GENERAL**

1.1 SUMMARY

- A. Section includes constant volume terminal units, variable volume terminal units, dual duct terminal units, fan powered terminal units, variable volume regulators, integral sound attenuation, integral heating coils, integral damper motor operators, integral controls.

1.2 REFERENCES

- A. NFPA 90A (National Fire Protection Association) - Installation of Air Conditioning and Ventilation Systems.
- B. UL 181 (Underwriters Laboratories, Inc.) - Factory-Made Air Ducts and Connectors.

1.3 SUBMITTALS

- A. Section 01330 - Submittal Procedures: Submittal procedures.
- B. Product Data: Submit data indicating configuration, general assembly, and materials used in fabrication. Include catalog performance ratings that indicate airflow, static pressure, and NC designation. Include electrical characteristics and connection requirements. Include schedules listing discharge and radiated sound power level for each of second through sixth octave bands at inlet static pressures of 1 inch to 4 inches wg.
- C. Manufacturer's Installation Instructions: Submit support and hanging details, and service clearances required.
- D. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

1.4 CLOSEOUT SUBMITTALS

- A. Section 01770 - Execution Requirements: Closeout procedures.
- B. Project Record Documents: Record actual locations of units, controls components and send a copy to Stanford Maps and Records

- C. Operation and Maintenance Data: Submit manufacturer's descriptive literature, operating instructions, maintenance and repair data, and parts lists. Include directions for resetting constant volume regulators.

#### 1.5 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.
- B. Installer: Company specializing in performing work of this section with minimum three years documented experience.

#### 1.6 PRE-INSTALLATION MEETING

- A. Section 01330 - Administrative Requirements: Pre-installation meeting.
- B. Convene minimum one week prior to commencing work of this section.

#### 1.7 FIELD MEASUREMENTS

- A. Verify field measurements prior to fabrication.

#### 1.8 COORDINATION

- A. Section 01330 - Administrative Requirements: Coordination and project conditions.
- B. Coordinate work with Controls Contractor.

#### 1.9 WARRANTY

- A. Section 01770 - Execution Requirements: Product warranties and product bonds.
- B. Provide 5 year manufacturer warranty for air terminal units.

#### 1.10 EXTRA MATERIALS

- A. Section 01770 - Execution Requirements, 01782 - Operation and Maintenance Data: Requirements for extra materials.

## PART 2 –PRODUCTS

### 2.1 AIR TERMINAL UNITS

- A. Ceiling mounted variable air volume, constant volume, or fan powered supply air control terminals for connection to single or dual duct, central air systems, with pneumatic, electric, system powered, or electronic variable volume control, pneumatic or mechanical system powered constant volume control, hot water heating coils.
- B. Identify each terminal unit with clearly marked identification label and airflow indicator. Include unit nominal airflow, maximum factory-set airflow and minimum factory-set airflow and coil type.

### 2.2 SINGLE DUCT VARIABLE VOLUME UNITS

- A. Use Titus air terminals, VAV boxes, or equal, unless specified otherwise.
- B. Basic Assembly
  - 1. Casings: Minimum 22 gage galvanized steel.
  - 2. Lining: Minimum 1 inch thick neoprene or vinyl coated fibrous glass insulation, 1/5 lb./cu ft density, meeting NFPA 90A requirements and UL 181 erosion requirements. Face lining with 4 mil Mylar or Tedlar film.
  - 3. Plenum Air Inlets: Round stub connections or S slip and drive connections for duct attachment.
  - 4. Plenum Air Outlets: S slip-and-drive connections.
- C. Basic Unit:
  - 1. Configuration: Air volume damper assembly inside unit casing. Locate control components inside protective metal shroud.
  - 2. Volume Damper: Construct of galvanized steel with peripheral gasket and self-lubricating bearings; maximum damper leakage: 2 percent of design air flow at 3 inches rated inlet static pressure.
  - 3. Mount damper operator to position damper as indicated per design.
- D. Attenuation Section: Line attenuation sections with 2 inch thick insulation.
- E. Multi Outlet Attenuation Section: With 8 inch or less if design indicates diameter collars, each with butterfly balancing damper with lock.
- F. Round Outlet: Discharge collar matching inlet size.

G. Hot Water Heating Coil:

1. Construction: ½ inch copper tube mechanically expanded into aluminum plate fins, leak tested under water to 200 psig pressure, factory installed. No spiral wound coils.
2. Capacity: Based on 180 degree F entering water, 150 degree F leaving water and 50 percent total air volume.
3. Hydrostatic test with pressure gage positively pressurized for delivery.

H. Electric Heating Coil: \* Note: Allowed only where no other heat source is available and approved by Stanford University in writing.

1. Construction: UL listed, slip-in type, open coil design, integral control box factory wired and installed, with:
  - a. Primary and secondary over-temperature protection.
  - b. Minimum airflow switch.
  - c. Pneumatic/electric switches and relays or Magnetic contactor for each step of control.

I. Automatic Damper Operator: Damper operators are Belimo for electric and Johnson Control or Honeywell for Pneumatic unless approved otherwise in writing by Stanford Engineer.

1. Electric Actuator: 24 volt with high limit with remote temperature read and reset capability.
2. Pneumatic Damper Operator: 8-13 or 3-13 spring range depending on design with pilot positioner.
3. Maximum Volume Controller and Probe: Pneumatic, with calibration pressure taps for high flow limited proportional variable-air-volume control.
4. Velocity Reset Controller and Probe:
  - a. Pneumatic.
  - b. Calibration pressure taps for pressure independent control to compensate for varying inlet static pressure.
  - c. Minimum and maximum limits set at reset device.
  - d. Maintain airflow to within 5 percent of set point with inlet static pressure variations up to 2 inches.
  - e. Reset span, fixed at 5 psi or adjustable 3 to 8 psi shall remain constant regardless of minimum or maximum setting. Reset start point shall be adjustable from 3-10 psi.

J. Thermostat: Wall-mounted pneumatic Honeywell two-pipe, Wall-mounted electric or Electronic type with appropriate mounting hardware.

### 2.3 DUAL DUCT VARIABLE VOLUME UNITS

- A. Use suitable Titus model, or equal, unless otherwise approved in writing by Stanford engineer.
- B. Basic Assembly:
  - 1. Casings: Minimum 22 gage galvanized steel.
  - 2. Lining: Minimum 1 inch thick neoprene or vinyl coated fibrous glass insulation, 1.5lb/cu ft density, meeting NFPA 90A requirements and UL 181 erosion requirements. Face lining with 4 mil Mylar or Tedlar film.
  - 3. Plenum Air Inlets: Round stub connections or S slip and drive connections for duct attachment.
  - 4. Plenum Air Outlets: S-slip and drive connections.
- C. Basic Unit:
  - 1. Configuration: Two air volume dampers inside unit casing with mixing attenuation section as required by design. Locate control components inside protective metal shrouds.
  - 2. Volume Dampers: Construct of galvanized steel with peripheral gasket and self lubricating bearings; maximum damper leakage: 2 percent of design air flow at 3 inches rated inlet static pressure.
  - 3. Mount damper operators to position dampers normally open or normally closed as indicated by design.
- D. Automatic Damper Operator: Belimo, Honeywell, or Johnson Controls unless otherwise approved
  - 1. Electric Actuator: 24 volt with high limit and with remote temperature read and reset capability.
  - 2. Pneumatic Damper Operator: 8-13 or 3-13 psig spring range as design dictates.
  - 3. Velocity Reset Controller and Probe:
    - a. Pneumatic.
    - b. Calibration pressure taps for pressure independent control to compensate for varying inlet static pressure.
    - c. Minimum and maximum limits set at reset device.
    - d. Maintain airflow to within 5 percent of set point with inlet static pressure variations up to 2 inches.
    - e. Reset span, fixed at 5 psi or adjustable 3 to 8 psi shall remain constant regardless of minimum or maximum setting per design. Reset start point shall be adjustable from 3-10 psi.
- E. Thermostat: Wall-mounted pneumatic, Wall-mounted electric or Electronic type with appropriate mounting hardware.

F. Control Sequence:

1. Cooling damper to be normally open or closed based on application.
2. Modulate cold damper closed as warm damper opens. Provide for dual-duct constant volume operation.
3. Sequence so warm damper actuator may be field adjusted to start opening simultaneous with closing of cold damper or delayed until up to 10 degrees F change in room temperature after cold damper has closed.
4. Sequence pneumatic operators with spring ranges selected so warm damper begins to open after cooling damper has fully closed.
5. Provide pneumatic pressure independent controls or high limit controls for control of both warm and cold damper, factory calibrated for maximum airflow.

2.4 FAN POWERED VARIABLE VOLUME UNITS

A. Basic Assembly:

1. Casings: Minimum 22 gage galvanized steel.
2. Lining: Minimum 1 inch thick neoprene or vinyl coated fibrous glass insulation, 1/5 lb./cu ft density, meeting NFPA 90A requirements and UL 181 erosion requirements. Face lining with 4 mil Mylar or Tedlar film.
3. Plenum Air Inlets: Round stub connections and S slip and drive connections for duct attachment.
4. Plenum Air Outlets: S-slip and drive connections.

B. Basic Unit:

1. Configuration: Air volume damper assembly and fan in series or parallel arrangement inside unit casing per design. Locate control components inside protective metal shroud.
2. Volume Damper: Construct of galvanized steel with peripheral gasket and self-lubricating bearings; maximum damper leakage: 2 percent of design air flow at 3 inches rated inlet static pressure.
3. Mount damper operator to position damper normally open or normally closed as indicated by design.

C. Automatic Damper Operator:

1. Electric Actuator: 24 volt with high limit with remote temperature read and reset capability.
2. Pneumatic Damper Operator: 8-13 or 3-13 psig spring range per design.

3. Maximum Volume Controller and Probe: Pneumatic, with calibration pressure taps for high flow limited proportional variable-air volume control.
4. Velocity Reset Controller and Probe:
  - a. Pneumatic.
  - b. Calibration pressure taps for pressure independent control to compensate for varying inlet static pressure.
  - c. Minimum and maximum limits set at reset device.
  - d. Maintain airflow to within 5 percent of set point with inlet static pressure variations up to 2 inches.
  - e. Reset span, fixed at 5 psi or adjustable 3 to 8 psi shall remain constant regardless of minimum or maximum setting. Reset start point shall be adjustable from 3-10 psi.

D. Fan Assembly

1. Fan: Forward curved centrifugal type with direct drive permanent split-capacitor type, thermally protected motor.
2. Speed Control: Infinitely adjustable with electric/pneumatic and electronic controls.
3. Isolation: Fan/motor assembly on rubber isolators.

E. Attenuation Section: Line attenuation sections with 2 inch thick insulation.

F. Hot Water Heating Coil:

1. Construction: ½ inch copper tube mechanically expanded into aluminum plate fins, leak tested under water to 200 psig pressure, factory installed. No spiral wound coils allowed.
2. Capacity: Based on 180 degree F entering water, 165 degree F leaving water and 50 percent total air volume.

G. Electric Heating Coil:

1. Construction: UL listed, slip-in type, open coil design, integral control box factory wired and installed, with:
  - a. Primary and secondary over-temperature protection.
  - b. Minimum airflow switch.
  - c. Pneumatic/electric switches and relays or Magnetic contactor for each step of control.
  - d. Electric heating coils only allowed in no other source of heating is available.

H. Wiring

1. Factory mounted and wire controls. Mount electrical components in control box with removable cover. Incorporate single point electrical connection to power source.

2. Factory mounted transformer for control voltage on electric and electronic control units. Provide terminal strip in control box for field wiring of thermostat and power source.
3. Wiring Terminations: Wire fan and controls to terminal strip. Provide terminal lugs to match branch-circuit conductor quantities, sizes, and materials indicated. Enclose terminal lugs in terminal box.
4. Disconnect Switch: Factory mount fused disconnect switch in control panel or on equipment.

I. Controls:

1. Pneumatic, Electric or Electronic Controls: Contain in NEMA-1 enclosure with access panel sealed from airflow and mounted on side of unit. Factory mounted controls and thermostat to accomplish the following specified sequence of operation.
2. Electronic Control, Central System Fan "On" - Occupied Mode:
  - a. When duct pressure is sensed indicating primary air system operating, thermostat and primary variable volume damper proportions air flow from central system.
  - b. As thermostat senses reduced cooling demand, volume damper closes. At field adjustable point, unit fan is energized.
  - c. If central duct system pressure varies, volume damper maintains constant primary airflow.
  - d. As thermostat senses no cooling requirement, control system closes volume damper. Before heating is initiated, control enters field adjustable no load band. On sensing need for heat, heating coil is energized proportionally.
3. Electronic Control, Central System Fan "Off" - Unoccupied Mode:
  - a. Provide field adjustable temperature setback. On need for heat, terminal unit fan and heating coil are energized.
  - b. Hold volume damper closed.
4. Pneumatic/Electric Control, Central System Fan "On" -Occupied Mode:
  - a. As thermostat senses cooling, volume damper proportions airflow from central system.
  - b. As thermostat senses less cooling and damper closes, pneumatic/electric or damper position switch energizes fan per design.
  - c. Electronic fan speed control manually adjusts maximum fan speed to match downstream resistance.
  - d. Velocity reset primary air control (pressure independent) with maximum and minimum limits.
  - e. Hi-limit device, factory set, limits maximum primary airflow.



- f. As thermostat senses no cooling, control system closes volume damper to stop flow from central-system primary air duct before heating is initiated. On sensing further need for heat, heating coil is energized.
- 5. Pneumatic/Electric Control, Central System Fan "Off" - Unoccupied Mode:
  - a. Thermostat cycles fan.
  - b. Day/night thermostat cycles fan and controls at reduced temperature.
- J. Thermostat: Wall-mounted pneumatic, Wall-mounted electric or Electronic type with appropriate mounting hardware.

## 2.5 MECHANICAL TYPE VARIABLE VOLUME UNITS

### A. Basic Assembly:

- 1. Casings: Minimum 22 gage galvanized steel; maximum casing leakage: 3 percent of design air flow at 6 inches minimum inlet static pressure.
- 2. Lining: Minimum 1 inch thick neoprene or vinyl coated fibrous glass insulation, 1.5lb./cu ft density, meeting NFPA 90A requirements and UL 181 erosion requirements. Face lining with 4 mil Mylar or Tedlar film.
- 3. Plenum Air Inlets: Round/oval stub connections or S slip and drive connections for duct attachment.
- 4. Plenum Air Outlets: S-slip and drive connections.

### B. Basic Unit:

- 1. Configuration: Air volume damper assembly and control components inside unit casing.
- 2. Volume Damper: Construct of galvanized steel with peripheral gasket and self lubricating bearings; maximum damper leakage: 2 percent of design air flow at 3 inches rated inlet static pressure.
- 3. Mount damper operator to position damper normally open or normally closed as indicated.

### C. Regulator:

- 1. Location: Air volume damper and automatic flow control assembly inside unit casing.
- 2. Construction: Extruded aluminum or 20 gage galvanized steel components; key damper blades into shaft with nylon fitted pivot points.
- 3. Automatic flow control assembly: Combine spring rates matched for each volume regulator size with machined dashpot for stable operation.
- 4. Air volume control damper shall be factory- calibrated assembly consisting of damper and damper shaft extension for connection to externally mounted control actuator.
- 5. Internally mounted pneumatic or electric actuator with pilot positioner: Position damper normally open or normally closed as indicated.

D. Multi Outlet Adapter Section: With 8 inch diameter collars, each with butterfly balancing damper with lock.

E. Hot Water Heating Coil:

1. Construction: ½ inch copper tube mechanically expanded into aluminum plate fins, leak tested under water to 200 psig pressure, factory installed. No spiral wound coils allowed.
2. Capacity: Based on 180 degree F entering water, 155 degree F leaving water and 50 percent total air volume.

F. Electric Heating Coil:

1. Construction: UL listed, slip-in type, open coil design, integral control box factory wired and installed, with:
  - a. Primary and secondary over-temperature protection.
  - b. Minimum airflow switch.
  - c. Pneumatic/electric switches and relays or Magnetic contactor for each step of control.

G. Automatic Damper Operator:

1. Electric Actuator: 24 volt with high limit with remote temperature read and reset capability.
2. Pneumatic Damper Operator: 8-13 or 3-13 psig spring range per design.

H. Thermostat: Wall-mounted pneumatic, Wall-mounted electric or Electronic type with appropriate mounting hardware.

## 2.6 SYSTEM POWERED VARIABLE VOLUME UNITS

A. Basic Assembly:

1. Casings: Galvanized steel.
2. Lining: Minimum ½ inch thick neoprene or vinyl coated fibrous glass insulation, 1.5 lb/cu ft density, meeting NFPA 90A requirements and UL 181 erosion requirements. Face lining with 4 mil Mylar or Tedlar film.
3. Plenum Air Inlets: Round/oval stub connections.
4. Plenum Air Outlets: S-slip and drive connections.

B. Basic Unit:

1. Configuration: Air volume damper and automatic flow control assemblies inside unit casing.
2. Volume Damper: Construct of galvanized steel with peripheral gasket and self lubricating bearings.

- C. Regulator Assembly: System-air powered bellows section incorporating polypropylene bellows for volume regulation and thermostatic control. Polypropylene material shall perform at temperatures of 0 to 140 degrees F and be impervious to moisture and fungus. Design bellows for 10 inches static pressure and factory check for leaks.
- D. Multi Outlet Attenuation Section: With 8 inch diameter collars, each with butterfly balancing damper with lock.
- E. Hot Water Heating Coil:
  - 1. Construction: ½ inch copper tube mechanically expanded into aluminum plate fins, leak tested under water to 200 psig pressure, factory installed. No spiral wound coil allowed.
  - 2. Capacity: Based on 180 degrees F entering water, 155 degrees F leaving water and 50 percent total air volume.
- F. Electric Heating Coil:
  - 1. Construction: UL listed, slip-in type, open coil design, integral control box factory wired and installed, with:
    - a. Primary and secondary over-temperature protection.
    - b. Minimum airflow switch.
    - c. Pneumatic/electric switches and relays or Magnetic contactor for each step of control.
- G. Controls:
  - 1. Suitable for operation with duct pressures between 0.25 and 3.0 inches (60 and 750 Pa) static pressure.
  - 2. Mount controls in sheet metal enclosure on unit.
  - 3. Factory mounted and piped 5-micron filter, velocity resetting adjustable high limit control and amplifying relay.
  - 4. System powered aspirating diffuser or wall mounted thermostat.
  - 5. Limit switch shall activate heating system.
  - 6. Provide morning warm up control to sense duct temperature and control unit at maximum airflow during heating mode.

### **PART 3 –EXECUTION**

#### **3.1 EXAMINATION**

- A. Section 01330 - Administrative Requirements: Coordination and project conditions.
- B. Verify ductwork is ready to receive work.

#### **3.2 INSTALLATION**

- A. Provide ceiling access doors or locate units above easily removable ceiling components.

B. Support units individually from structure. Do not support from adjacent ductwork.

C. Provide minimum of 5 ft of 2 inch thick lined ductwork downstream of units.

### 3.3 ADJUSTING

A. Section 01770 - Execution Requirements: Testing, adjusting, and balancing.

B. Reset volume with damper operator attached to assembly allowing flow range modulation from 100 percent of design flow to 0 percent full flow. Set units with heating coils for minimum 0 percent full flow.

END OF SECTION