

**DIVISION 23 – HEATING VENTILATING AND AIR CONDITIONING****SECTION 23 36 16 – VARIABLE-AIR-VOLUME UNITS****PART 1: GENERAL****1.1 Section Includes**

- A. Dual Duct terminal units.
- B. Variable Air Volume terminal units.
- C. Variable volume regulators.
- D. Integral damper motor operators.
- E. Integral controls.

**1.2 Related Sections**

- A. Section 23 00 00 – Heating, Ventilation and Air Conditioning (HVAC).
- B. Section 23 31 00 – HVAC Ducts and Casings.
- C. Section 23 09 53 – Pneumatic and Electric Control HVAC.
- D. Section 23 05 93 – System Preparation for Testing, Adjusting, and Balancing.
- E. Section 23 05 93.01 – System Testing, Adjusting, and Balancing.
- F. Section 25 51 00 – Integrated Automation Facility Controls

**1.3 References**

- A. NFPA 90A – Installation of Air Conditioning and Ventilation Systems.
- B. UL 181 – Factory-Made Air Ducts and Connectors.
- C. ADC 1062 – Air Distribution and Control Device Test Code.
- D. ARI 880-89 – Standard for Air Terminals.

**1.4 Submittals**

- A. Submit shop drawings under provisions of Section 25 51 00 Section 1.5
- B. Submit product data under provisions of Section 25 51 00 Section 1.5
- C. Submit product data indicating configuration, general assembly, and materials used in fabrication. Include catalog performance ratings which indicate air flow, static pressure, and NC designation.
- D. Include schedules listing discharge and radiated sound power level for each of second through seventh octave bands at inlet static pressures of one-inch wg.

- E. Submit manufacturer's installation instructions under provisions of Section 25 51 00 Section 1.5

### **1.5 Operation and Maintenance Data**

- A. Submit operation and maintenance data under provisions of Section 23 00 00.
- B. Include manufacturer's descriptive literature, operating instructions, maintenance and repair data, and parts list.

### **1.6 Qualifications**

- A. Manufacturer: Company specializing in manufacturing the products specified in this Section with minimum three years documented experience.

### **1.7 WARRANTY**

- A. Provide manufacturer's warranty under the provisions outlined in Section 23 00 00 Section 1.06-A.

## **PART 2: PRODUCTS**

### **2.1 Variable Volume Terminal Unit**

- A. The Contractor shall furnish and install pressure independent single duct with hot water reheat or dual duct variable air volume control assemblies with attenuator-mixers (dual duct units), of the sizes, capacities, and configurations shown on the Drawings.
- B. Casing Construction.
  - 1. The units shall be constructed of a minimum of 22 gage galvanized steel and internally lined with a minimum of 1-inch thick, 1.6 pound per cubic foot density insulation. The insulation shall be foil faced with the edges fastened with foil tape insulation to be held in place via water based adhesive and mechanical weld tabs. The casing shall be insulated throughout its interior.
  - 2. All interior features of the boxes (such as mixing baffles, damper housing, etc.) shall be secured within the casing to avoid excessive movements or rattling with air movement. Terminal units shall be designed not to extend beyond the ends of the unit. (For example, the actuator mounting brackets, etc., shall not extend beyond the plane of the inlet "bulkhead.") The only exception shall be flow sensors installed in the inlet duct connections. Note that if a separate flow station is installed within the frame of the casing, then it shall be so installed not to allow air flow to bypass the flow measurement station.
  - 3. The terminal units shall be constructed with inlet and discharge ductwork connections. The inlet ductwork connections shall extend a minimum of 4 inches from the unit casing including an allowance for the installation of air flow station (s) or probe (s). The discharge connection shall include 1" extension with slip and drive connections for use by the contractor to secure the discharge ductwork or appurtenances to the unit and shall be reinforced to provide a rigid assembly.

- C. Casing Leakage. Assembled units shall be so constructed and sealed to limit air leakage to the following listed quantities at 6” static pressure. Leakage curves or tables will be required as part of the submittal data. The following is the maximum allowable casing leakage including all components:

Diameter	Maximum Allowed CFM (Area x 2000 fpm)	Maximum Allowable CFM Damper Leakage
4” – 6”	393	8.0
7” – 8”	698	14.0
9” – 10”	1091	22.0
11” – 12”	1571	30.0
13” – 14”	2138	40.0

- D. Damper Construction. The damper blades shall be an equivalent of 18 gage galvanized steel aluminum and shall be securely riveted or bolted through the damper shafts to assure no slippage of the blades. The damper shafts shall operate in rust-proof self-lubricating bearings. Damper shafts penetrating the unit casings shall be sealed against leakage, and bearings shall be installed for protection against wear in the casing penetration. Damper shafts shall be formed of, or cut from solid stock; no hollow shafts will be allowed. The dampers shall seat against gasketed stops or the dampers shall have gasketed edges. The damper actuator linkage, if used, shall be constructed of material of sufficient strength to avoid bucking under extreme loads. Also, linkages shall not allow play greater than 5 degrees of damper movement. The controls for the dampers shall cause the dampers to fail in the position of last control (freeze in place) or fail to the open position.
- E. Damper Leakage. The following is the maximum damper leakage allowable for the various size diameter inlets at 6” w.g. differential pressure. The damper leakage shall not exceed the values listed in the table below at 6” S.P., following ARI 880 Testing Procedures.

Diameter	Maximum Allowed CFM (Area x 2000 fpm)	Maximum Allowable CFM Damper Leakage
4” – 6”	393	5.0
7” – 8”	698	8.0
9” – 10”	1091	10.0
11” – 12”	1571	13.0
13” – 14”	2138	14.0

- F. Unit Pressure drop. If dual duct units have been approved, they shall come with an integral attenuator-mixer, but with no other accessories, the static pressure across the assembly with an equivalent 2000 fpm inlet velocity through one inlet shall not exceed 0.50 inches water gage, with the total flow through either inlet.

- G. Mixing. If dual duct units have been approved, units as specified herein shall provide mixing within the units, and not rely upon the discharge ductwork to provide for the completion of the mixing process.
- H. Flow Measurement. Air flow through the unit shall be accomplished using a multi-port sensing device with a minimum of four radially distributed pick-up points connected to a center averaging chamber with adequate internal passages to prevent restrictions that can result in control “hunting”. On VAV systems, sensors shall be mounted in each supply duct connection. On constant volume dual duct systems, one sensor shall be mounted in the cold duct and one sensor shall be mounted in the box discharge.
- I. Sound. (Note that the maximum sound levels listed in this paragraph refer to raw sound levels, with no credits taken for the construction.)
  - 1. Discharge Sound. Maximum discharge Sound Power Levels at 2000 fpm primary inlet velocity with 1.5- inch w.g. inlet static pressure shall not exceed that listed in the following table. No credit for lined discharge duct, branching, flow division, and reflection, room absorption or any other effects shall be allowed. Sound values are based on series fan powered boxes.

Center Frequency Octave Band	(Hz)	Sound Power Level (dB re 10-12 Watts)
2	125	83
3	250	79
4	500	78
5	1000	77
6	2000	74
7	4000	74

- 2. All sound power levels shall be obtained from testing in accordance with ARI-ADC Standard 880 and shall be certified at ARI-880 certification points.
- J. Manufacturer. All Terminal Units shall be manufactured by ETI, Titus, Metal\*Aire, or Naylor-Hart. No other manufacturers or models are acceptable. Even though specific manufacturers may be named herein, the material supplied by any approved manufacturer shall meet all the provisions of this specification without exception.
- K. General Performance. Devices using mechanical CFM limiters will not be accepted, nor shall it be necessary to change control components to make airflow rate changes. If used, DDC flow stations shall be furnished, mounted and adjusted by the terminal unit assembly manufacturer to assure their proper placement within the units. If DDC controls of another manufacturer (NOT the terminal unit manufacturer) are provided for this project, the terminal unit manufacturer shall be responsible only for the construction of the terminal unit and the installation of internal control components installed at the manufacturer’s factory, and shall not be responsible for the installation of controls not installed at the terminal unit manufacturers factory, nor shall the

manufacturer be responsible for the performance of the DDC controls. The performance of DDC controls, especially in connection with the terminal units, shall be the responsibility of the DDC controls manufacturer.

- L. Control Performance. Assemblies shall be able to be reset to any airflow between minimum and the maximum cfm shown on Drawings. To allow for maximum flexibility and future changes, it shall be necessary to make only simple screwdriver or keyboard adjustments to arrange each unit for any maximum air flow within the ranges for each inlet size as scheduled on the Drawings. The control devices shall be designed to maintain the desired flow regardless of inlet flow deflection. (All terminal units shall be installed with a minimum of three diameters of straight duct directly prior to the entry into each terminal unit connection.)
- M. Control Sequences. The control sequence arrangement shall be as described on the Drawings; and the terminal units shall be shipped from the manufacturer with all necessary control devices to accomplish each sequence, except as may be prohibited by the controls manufacturer. The desired sequence shall be adjustable according to space usage or a change in space conditions. For approved dual duct installations, separate maximum CFM values for hot and cold ducts with zero minimum flow values for both hot and cold ducts, with adjustable mixing of hot and cold air flow to allow for adjustable minimum total air flow from the terminal unit.
- N. DDC Systems.
  - 1. Electronic motors and controllers shall be furnished by temperature control contractor and installed by the terminal unit manufacturer. The controls manufacturer shall be responsible for the installation of the controls. The controls manufacturer shall be responsible for the operational performance of the entire system. The terminal unit manufacturer shall remain responsible only for the performance of the mechanical components of the unit.
  - 2. A temperature sensor will be installed in the discharge duct of all Terminal Equipment Boxes. Sensor provided by DDC contractor for field installation.

## **PART 3: EXECUTION**

### **3.1 Installation**

- A. Refer also to requirements included in Part 2 of this Specification.
- B. Install in accordance with manufacturer's instructions.
- C. Provide ceiling access doors or located units above easily removable ceiling components.
- D. Support units individually from structure. Do not support from ductwork.
- E. Connect to ductwork in accordance with Section 23 31 00

### **3.2 Test and Balance**

- A. Testing and Balancing will be complete prior to beginning commissioning.
- B. All systems will be Tested and Balanced.

- C. Testing and Balance documents will be turned over to the Owner on both physical and digital media prior to begin of Commissioning.

### **3.3 Commissioning**

- A. Systems will be Commissioned per the contract documents.

Commissioning reports will be turned over to the Owner on both physical and digital media prior to final acceptance and building occupancy.

END OF SECTION 23 36 16