SECTION 233600 - AIR TERMINAL UNITS

Revise this Section by deleting and inserting text to meet Project-specific requirements.

This Section uses the term "Architect." Change this term to match that used to identify the design professional as defined in the General and Supplementary Conditions.

Verify that Section titles referenced in this Section are correct for this Project's Specifications; Section titles may have changed.

1. GENERAL
   * + 1. RELATED DOCUMENTS

Retain or delete this article in all Sections of Project Manual.

* + - * 1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
      1. SUMMARY
         1. Section Includes:

Bypass, single-duct air terminal units.

Modulating, single-duct air terminal units.

Parallel, fan-powered air terminal units.

Series, fan-powered air terminal units.

Dual-duct air terminal units.

Induction air terminal units.

Diffuser-type air terminal units.

Balancing terminal units.

Pressure control terminal units.

Critical environment control valve.

Underfloor air distribution terminal units.

Underfloor air distribution floor induction units.

Exhaust single-duct terminal units.

Casing liner.

* + - 1. SUBMITTALS
         1. Submittals for this section are subject to the er-evaluation fee identified in Article 4 of the General Conditions.
         2. Manufacturer’s installation instructions shall be provided along with product data.
         3. Submittals shall be provided in the order in which they are specified and tabbed (for combined submittals).
         4. Product Data: For each type of air terminal unit.

Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for air terminal units.

Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

* + - * 1. Sustainable Design Submittals:
        2. Shop Drawings: For air terminal units.

Include plans, elevations, sections, and mounting details.

Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

Retain first subparagraph below if equipment includes wiring.

Include diagrams for power, signal, and control wiring.

Hangers and supports, including methods for duct and building attachment[**, seismic restraints,**] and vibration isolation.

Retain "Coordination Drawings" paragraph below for situations where limited space necessitates maximum utilization for efficient installation of different components or if coordination is required for installation of products and materials by separate installers. Coordinate paragraph with other Sections specifying products listed below. Preparation of coordination drawings requires the participation of each trade involved in installations within the limited space.

* + - * 1. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

Ceiling suspension assembly members.

Size and location of initial access modules for acoustic tile.

Ceiling-mounted items including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.

* + - * 1. Field quality-control reports.
      1. CLOSEOUT SUBMITTALS
         1. Operation and Maintenance Data: For air terminal units to include in emergency, operation, and maintenance manuals.

Include the following:

Instructions for resetting minimum and maximum air volumes.

Instructions for adjusting software set points.

* + - 1. MAINTENANCE MATERIAL SUBMITTALS
         1. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

Fan-Powered-Unit Filters: Furnish [**one**] <**Insert number**> spare filter(s) for each filter installed.

1. PRODUCTS

Manufacturers and products listed in SpecAgent and MasterWorks Paragraph Builder are neither recommended nor endorsed by the AIA or Deltek. Before inserting names, verify that manufacturers and products listed there comply with requirements retained or revised in descriptions and are both available and suitable for the intended applications. For definitions of terms and requirements for Contractor's product selection, see Section 016000 "Product Requirements."

* + - 1. SYSTEM DESCRIPTION
         1. 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.

Sustainable design systems require compliance with requirements in ASHRAE 62.1, including requirements for controls, surfaces in contact with airstream, particulate filtration, finned-tube coil selection and cleaning, and equipment access. Verify, with manufacturers, availability of units with components and features that comply with these requirements.

* + - * 1. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and System Start-up."
        2. ASHRAE Compliance: Applicable requirements in ASHRAE/IES 90.1, "Section 6 - Heating, Ventilating, and Air Conditioning."
      1. BYPASS, SINGLE-DUCT AIR TERMINAL UNITS

* + - * 1. [Manufacturers:](http://www.specagent.com/Lookup?ulid=11369) Subject to compliance with requirements, provide products by one of the following:

[Carrier Global Corporation](http://www.specagent.com/Lookup?uid=123457155432).

[Krueger-HVAC; brand of Johnson Controls International plc, Global Products](http://www.specagent.com/Lookup?uid=123457155434).

[Titus; brand of Johnson Controls International plc, Global Products](http://www.specagent.com/Lookup?uid=123457155433).

Approved equivalent.

* + - * 1. Configuration: Diverting-damper assembly inside unit casing with control components inside a protective metal shroud.
        2. Casing: [**0.040-inch-**] [**0.034-inch-**] <**Insert dimension**> thick galvanized steel, single wall.

Verify, with air terminal unit manufacturer, availability of casing liner.

Casing Liner: Comply with requirements in "Casing Liner" Article for [**fibrous-glass**] [**flexible elastomeric**] duct liner.

Retain "Diverter Assembly" Paragraph below for units with mechanical volume regulators.

* + - * 1. Diverter Assembly: [**Galvanized-steel gate, with polyethylene linear bearings**] [**Aluminum blade, with nylon-fitted pivot points**].

Retain first paragraph below for multioutlet attenuator section or indicate number of outlets and outlet sizes on Drawings or in a schedule.

* + - * 1. Multioutlet Attenuator Section: With [**two**] [**three**] [**four**] <**Insert number**> [**6-inch-**] [**8-inch-**] [**10-inch-**] diameter collars, each with locking butterfly balancing damper.

Verify, with air terminal unit manufacturer, availability of liner.

Attenuator Section Liner: Comply with requirements in "Casing Liner" Article for [**fibrous-glass**] [**flexible elastomeric**] duct liner.

Retain "Airstream Surfaces" Subparagraph below to comply with sustainable design systems.

Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

Retain one of first two paragraphs below if heating coil is required.

* + - * 1. Hydronic Heating Coils: Copper tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch, and rated for a minimum working pressure of 200 psig and a maximum entering-water temperature of 220 deg F. Include manual air vent and drain valve. Provide hydronic heating coils for air terminal units scheduled on Drawings.
        2. Electric-Resistance Heating Coils: Nickel-chromium heating wire, free of expansion noise and hum, mounted in ceramic inserts in a galvanized-steel housing; with primary automatic, and secondary manual, reset thermal cutouts. Terminate elements in stainless-steel, machine-staked terminals secured with stainless-steel hardware. Provide electric-resistance heating coils for air terminal units scheduled on Drawings.

Retain one of first two subparagraphs below.

Stage(s): [**1**] [**2**] [**3**].

SCR controlled.

Access door interlocked disconnect switch.

Downstream air temperature sensor with local connection to override discharge-air temperature to not exceed a maximum temperature set point (adjustable).

Subparagraphs below are optional features.

Nickel chrome 80/20 heating elements.

Airflow switch for proof of airflow.

Fuses in terminal box for overcurrent protection (for coils more than 48 A).

Mercury contactors.

Pneumatic-electric switches and relays.

Magnetic contactor for each step of control (for three-phase coils).

Retain one of two paragraphs below, or delete both if controls are specified in Section 230923 "Direct Digital Control (DDC) System for HVAC."

* + - * 1. Electric Controls: Damper actuator and thermostat.

Damper Actuator: 24 V, powered closed, powered open[**with microswitch to energize heating control circuit**].

Thermostat: Wall-mounted electric type with temperature display in Fahrenheit and Celsius, and space temperature set point.

Retain "Changeover Thermostat" Subparagraph below for heating-cooling changeover for morning warm-up.

Changeover Thermostat: Duct-mounted, field-adjustable, electric type reverses action of zone thermostat when air temperature reaches 70 deg F.

* + - * 1. Electronic Controls: Bidirectional damper operator and microprocessor-based thermostat. Control devices shall be compatible with temperature controls specified in Section 230923 "Direct Digital Control (DDC) System for HVAC" and shall have the following features:

Damper Actuator: 24 V, powered open, [**spring**] [**capacitous**] return.

Thermostat: Wall-mounted electronic type with the following features:

Subparagraphs below are optional features.

Temperature set-point display in Fahrenheit and Celsius.

Auxiliary switch to energize heating control circuit.

Changeover thermistor to reverse action.

Retain "Direct Digital Controls" Paragraph below if control components are specified with control system; delete if control components are packaged with equipment.

* + - * 1. Direct Digital Controls: Single-package unitary controller and actuator specified in Section 230923 "Direct Digital Control (DDC) System for HVAC."
      1. MODULATING, SINGLE-DUCT AIR TERMINAL UNITS

* + - * 1. [Manufacturers:](http://www.specagent.com/Lookup?ulid=13694) Subject to compliance with requirements, provide products by one of the following:

[Carrier Global Corporation](http://www.specagent.com/Lookup?uid=123457155530).

[Johnson Controls, Inc](http://www.specagent.com/Lookup?uid=123457155533).

[Price Industries](http://www.specagent.com/Lookup?uid=123457155525).

[Titus; brand of Johnson Controls International plc, Global Products](http://www.specagent.com/Lookup?uid=123457155526).

[Trane](http://www.specagent.com/Lookup?uid=123457155527).

Approved equivalent.

* + - * 1. Configuration: Volume-damper assembly inside unit casing with control components inside a protective metal shroud.
        2. Casing: [**0.040-inch-**] [**0.034-inch-**] <**Insert dimension**> thick galvanized steel, single wall.

Verify, with air terminal unit manufacturer, availability of casing liner.

Casing Liner: Comply with requirements in "Casing Liner" Article for [**fibrous-glass**] [**flexible elastomeric**] duct liner.

Air Inlet: Round stub connection or S-slip and drive connections for duct attachment.

Air Outlet: S-slip and drive connections[**, size matching inlet size**].

Access: Removable panels for access to parts requiring service, adjustment, or maintenance; with airtight gasket.

Retain "Airstream Surfaces" Subparagraph below to comply with sustainable design systems.

Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

Retain "Regulator Assembly" Paragraph below for units with system-air-powered volume regulators.

* + - * 1. Regulator Assembly: System-air-powered bellows section incorporating polypropylene bellows for volume regulation and thermostatic control. Bellows shall operate at temperatures from zero to 140 deg F, shall be impervious to moisture and fungus, shall be suitable for 10-inch wg static pressure, and shall be factory tested for leaks.
        2. Volume Damper: Galvanized steel with peripheral gasket and self-lubricating bearings.

Leakage rates in "Maximum Damper Leakage" Subparagraph below vary among manufacturers and with pressure rating.

Maximum Damper Leakage: AHRI 880 rated, [**2**] [**3**] percent of nominal airflow at [**3-inch wg**] [**6-inch wg**] inlet static pressure.

Damper Position: Normally [**open**] [**closed**].

* + - * 1. Attenuator Section: [**0.034-inch steel**] [**0.032-inch aluminum**] sheet.

Verify, with air terminal unit manufacturer, availability of casing liner.

Attenuator Section Liner: Comply with requirements in "Casing Liner" Article for [**fibrous-glass**] [**flexible elastomeric**] duct liner.

Retain "Airstream Surfaces" Subparagraph below to comply with sustainable design systems.

Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

Retain first paragraph below for multioutlet attenuator section or indicate number of outlets and outlet sizes on Drawings or in a schedule.

* + - * 1. Multioutlet Attenuator Section: With [**two**] [**three**] [**four**] <**Insert number**> [**6-inch-**] [**8-inch-**] [**10-inch-**] diameter collars, each with locking butterfly balancing damper.

Retain one of first two paragraphs below if heating coil is required.

* + - * 1. Hydronic Heating Coils: Copper tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch, and rated for a minimum working pressure of 200 psig and a maximum entering-water temperature of 220 deg F. Include manual air vent and drain valve. Provide hydronic heating coils for air terminal units scheduled on Drawings.
        2. Electric-Resistance Heating Coils: Nickel-chromium heating wire, free of expansion noise and hum, mounted in ceramic inserts in a galvanized-steel housing; with primary automatic, and secondary manual, reset thermal cutouts. Terminate elements in stainless-steel, machine-staked terminals secured with stainless-steel hardware. Provide electric-resistance heating coils for air terminal units scheduled on Drawings.

Retain one of first two subparagraphs below.

Stage(s): [**1**] [**2**] [**3**].

SCR controlled.

Access door interlocked disconnect switch.

Downstream air temperature sensor with local connection to override discharge-air temperature to not exceed a maximum temperature set point (adjustable).

Retain applicable subparagraphs below.

Nickel chrome 80/20 heating elements.

Airflow switch for proof of airflow.

Fan interlock contacts.

Fuses in terminal box for overcurrent protection (for coils more than 48 A).

Mercury contactors.

Pneumatic-electric switches and relays.

Magnetic contactor for each step of control (for three-phase coils).

Retain first paragraph below if controls are not specified as a part of the HVAC control system.

* + - * 1. Control devices shall be compatible with temperature controls system specified in Section 230923 "Direct Digital Control (DDC) System for HVAC."

Electric Damper Actuator: 24 V, powered open, [**spring**] [**capacitous**] return.

Pneumatic Damper Operator: [**0- to 13-psig**] <**Insert range**> spring range.

Electronic Damper Actuator: 24 V, powered open, [**spring**] [**capacitous**] return.

Electric Thermostat: Wall-mounted electronic type with clock display, temperature display in Fahrenheit and Celsius, and space temperature set point.

If retaining both direct- and reverse-acting thermostats, indicate location of each type on Drawings.

Pneumatic Thermostat: Wall-mounted, pneumatic type, [**direct acting**] [**and**] [**reverse acting**] with appropriate mounting hardware.

Electronic Thermostat: Wall-mounted electronic type with temperature set-point display in Fahrenheit and Celsius.

Pneumatic Velocity Controller: Factory calibrated and field adjustable to minimum and maximum air volumes; shall maintain constant airflow dictated by thermostat within 5 percent of set point while compensating for inlet static-pressure variations up to 4-inch wg; and shall have a multipoint velocity sensor at air inlet.

Electronic Velocity Controller: Factory calibrated and field adjustable to minimum and maximum air volumes; shall maintain constant airflow dictated by thermostat within 5 percent of set point while compensating for inlet static-pressure variations up to 4-inch wg; and shall have a multipoint velocity sensor at air inlet.

Terminal Unit Controller: Pressure-independent, variable-air-volume (VAV) controller with electronic airflow transducer with multipoint velocity sensor at air inlet, factory calibrated to minimum and maximum air volumes, and having the following features:

Subparagraphs below are optional features.

Occupied and unoccupied operating mode.

Remote reset of airflow or temperature set points.

Adjusting and monitoring with portable terminal.

Communication with temperature-control system specified in Section 230923 "Direct Digital Control (DDC) System for HVAC."

Room Sensor: Wall mounted with temperature set-point adjustment and access for connection of portable operator terminal.

Retain "Controls" Paragraph below for units with system-powered controls and if control sequences are not specified in Section 230993.11 "Sequence of Operations for HVAC DDC."

* + - * 1. Controls:

Suitable for operation with duct pressures between 0.25- and 3.0-inch wg inlet static pressure.

System-powered, wall-mounted thermostat.

* + - * 1. Control Sequences:

Occupied:

On a call for cooling, airflow will increase as the damper opens towards maximum setting to satisfy set point.

On a call for less cooling, airflow will decrease as the damper closes towards minimum setting to satisfy set point.

Retain first subparagraph below if air terminal units have heating coils as indicated in "Hydronic Heating Coils" or "Electric-Resistance Heating Coils" Paragraph, and if control sequences are not specified in Section 230993.11 "Sequence of Operation for HVAC DDC."

On a call for heating, after terminal unit has reached minimum airflow set point, [**hydronic heating coil valve will modulate toward open**] [**electric-resistance heating coil will sequence control**] to satisfy set point.

Unoccupied:

Damper closes to minimum setting.

* + - 1. PARALLEL FAN-POWERED AIR TERMINAL UNITS

* + - * 1. [Manufacturers:](http://www.specagent.com/Lookup?ulid=11418) Subject to compliance with requirements, provide products by one of the following:

[Carnes Company](http://www.specagent.com/Lookup?uid=123457155439).

[Carrier Global Corporation](http://www.specagent.com/Lookup?uid=123457155447).

[Johnson Controls, Inc](http://www.specagent.com/Lookup?uid=123457155450).

[Price Industries](http://www.specagent.com/Lookup?uid=123457155443).

[Trane](http://www.specagent.com/Lookup?uid=123457155445).

Approved equivalent.

* + - * 1. Configuration: Volume-damper assembly and fan in parallel arrangement inside unit casing with control components inside a protective metal shroud. [**Designed for quiet operation.**] [**Low-profile design.**]
        2. Casing: [**0.040-inch-**] [**0.034-inch-**] <**Insert dimension**> thick galvanized steel, single wall.

Verify, with air terminal unit manufacturer, availability of casing liner.

Casing Liner: Comply with requirements in "Casing Liner" Article for [**fibrous-glass**] [**flexible elastomeric**] duct liner.

Air Inlets: Round stub connections or S-slip and drive connections for duct attachment.

Air Outlet: S-slip and drive connections.

Access: Removable panels for access to parts requiring service, adjustment, or maintenance; with airtight gasket and quarter-turn latches.

Fan: Forward-curved centrifugal, located at plenum air inlet.

Retain "Airstream Surfaces" Subparagraph below to comply with sustainable design systems.

Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

* + - * 1. Volume Damper: Galvanized steel with flow-sensing ring and peripheral gasket and self-lubricating bearings.

Leakage rates in "Maximum Damper Leakage" Subparagraph below vary among manufacturers and with pressure rating.

Maximum Damper Leakage: AHRI 880 rated, [**2**] [**3**] percent of nominal airflow at [**3-inch wg**] [**6-inch wg**] inlet static pressure.

"Damper Position" Subparagraph below applies to pneumatic controls only.

Damper Position: Normally [**open**] [**closed**].

* + - * 1. Velocity Sensors: Multipoint array with velocity sensors.

Default motor characteristics are specified in Section 230513 "Common Motor Requirements for HVAC Equipment."

* + - * 1. Motor:

Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."

Type: [**Permanent-split capacitor with SCR for speed adjustment**] [**Electronically commutated motor**].

Fan-Motor Assembly Isolation: Rubber isolators.

Verify enclosure types with manufacturer of specified equipment. Delete "Enclosure" Subparagraph below if included in schedule on Drawings.

Enclosure: [**Open dripproof**] [**Totally enclosed, fan cooled**] [**Totally enclosed, air over**] [**Open, externally ventilated**] [**Totally enclosed, nonventilated**] [**Severe duty**] [**Explosion proof**] [**Dust-ignition-proof machine**].

Retain first six subparagraphs below if options are available from equipment manufacturers and are different from default requirements specified in Section 230513 "Common Motor Requirements for HVAC Equipment." Consider each subparagraph and retain only those that vary from default requirements.

Enclosure Materials: [**Cast iron**] [**Cast aluminum**] [**Rolled steel**].

Motor Bearings: <**Insert requirements**>.

Unusual Service Conditions:

Ambient Temperature: <**Insert deg F**>.

Altitude: <**Insert feet**> above sea level.

Retain first subparagraph below if application requires this rating.

High humidity.

<**Insert conditions**>.

Efficiency: Premium efficient.

NEMA Design: <**Insert designation**>.

Service Factor: <**Insert value**>.

Motor Speed: [**Single speed**] [**Multispeed**].

Speed Control: Infinitely adjustable with pneumatic-electric and electronic controls.

Retain "Electrical Characteristics" Subparagraph below if characteristics are not indicated on Drawings.

Electrical Characteristics:

Horsepower: <**Insert horsepower**>.

Volts: [**120**] [**208**] [**230**] [**460**] <**Insert value**>.

Phase: [**Single**] [**Poly**].

Hertz: 60.

Full-Load Amperes: <**Insert value**>.

Minimum Circuit Ampacity: <**Insert value**>.

Maximum Overcurrent Protection: <**Insert amperage**>.

Verify available filter types with manufacturer. Indicate filter thickness in an Air Terminal Unit Schedule on Drawings.

* + - * 1. Filters:

Retain "Minimum Efficiency Reporting Value and Average Arrestance" Subparagraph below if requiring MERV 1, 2, 3, or 4 in the "Material" subparagraphs below. Retain "Minimum Efficiency Reporting Value" Subparagraph if requiring MERV 5 and higher in "Material" subparagraphs below.

Minimum Efficiency Reporting Value and Average Arrestance: According to ASHRAE 52.2.

Minimum Efficiency Reporting Value: According to ASHRAE 52.2.

Retain one or more of three "Material" subparagraphs below. Indicate filter type in an Air Terminal Unit Schedule on Drawings if all units are not filtered identically. Two-inch- (50-mm-) thick foam is unavailable. LEED 2009 IEQ Prerequisite 1 and LEED v4 EQ Prerequisite, "Minimum Indoor Air Quality Performance," require compliance with ASHRAE 62.1 (2007 and 2010 versions respectively), which requires a MERV rating of 6 or higher for service to occupied spaces. LEED 2009 IEQ Credit 5 and LEED v4 IEQ Credit, "Enhanced Indoor Air Quality Strategies," require MERV 13 or higher. Insert values appropriate to Project sustainability goals.

Material: Polyurethane foam, [**MERV 3**] <**Insert value**>.

Material: Glass fiber treated with adhesive, [**MERV 5**] <**Insert value**>.

Material: Pleated cotton-polyester media, [**MERV 7**] <**Insert value**>.

Thickness: [**2 inches**] [**1 inch**] <**Insert thickness**>.

* + - * 1. Attenuator Section: [**0.034-inch galvanized steel**] [**0.032-inch aluminum**] sheet.

Verify, with air terminal unit manufacturer, availability of liner.

Attenuator Section Liner: Comply with requirements in "Casing Liner" Article for [**fibrous-glass**] [**flexible elastomeric**] duct liner.

Retain "Airstream Surfaces" Subparagraph below to comply with sustainable design systems.

Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

Retain one of first two paragraphs below if heating coil is required.

* + - * 1. Hydronic Heating Coils: Copper tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch, and rated for a minimum working pressure of 200 psig and a maximum entering-water temperature of 220 deg F. Include manual air vent and drain valve. Provide hydronic heating coils for air terminal units scheduled on Drawings.

Location: Plenum air inlet.

* + - * 1. Electric-Resistance Heating Coils: Nickel-chromium heating wire, free of expansion noise and hum, mounted in ceramic inserts in a galvanized-steel housing; with primary automatic, and secondary manual, reset thermal cutouts. Terminate elements in stainless-steel, machine-staked terminals secured with stainless-steel hardware. Provide electric-resistance heating coils for air terminal units scheduled on Drawings.

Location: Plenum air inlet.

Retain one of first two subparagraphs below.

Stage(s): [**1**] [**2**] [**3**].

SCR controlled.

Access door interlocked disconnect switch.

Downstream air temperature sensor with local connection to override discharge-air temperature to not exceed a maximum temperature set point (adjustable).

Retain applicable subparagraphs below.

Nickel chrome 80/20 heating elements.

Airflow switch for proof of airflow.

Fan interlock contacts.

Fuses in terminal box for overcurrent protection (for coils more than 48 A).

Mercury contactors.

Pneumatic-electric switches and relays.

Magnetic contactor for each step of control (for three-phase coils).

* + - * 1. Factory-Mounted and -Wired Controls: Electrical components mounted in control box with removable cover. Incorporate single-point electrical connection to power source.

Control Transformer: Factory mounted for control voltage on electric and electronic control units with terminal strip in control box for field wiring of thermostat and power source.

Wiring Terminations: Fan and controls to terminal strip. Terminal lugs to match quantities, sizes, and materials of branch-circuit conductors. Enclose terminal lugs in terminal box that is sized according to NFPA 70.

Disconnect Switch: Factory-mounted, fuse type.

* + - * 1. Control Panel Enclosure: NEMA 250, Type 1, with access panel sealed from airflow and mounted on side of unit.

Retain first paragraph below if controls are not specified as a part of the HVAC control system.

* + - * 1. Control devices shall be compatible with temperature controls system specified in Section 230923 "Direct Digital Control (DDC) System for HVAC."

Electric Damper Actuator: 24 V, powered open, [**spring**] [**capacitous**] return.

Pneumatic Damper Operator: [**0- to 13-psig**] <**Insert range**> spring range.

Electronic Damper Actuator: 24 V, powered open, [**spring**] [**capacitous**] return.

Electric Thermostat: Wall-mounted electronic type with clock display, temperature display in Fahrenheit and Celsius, and space temperature set point.

Pneumatic Thermostat: Wall-mounted pneumatic type [**direct acting**] [**reverse acting**] [**direct or reverse acting as indicated on Drawings**] with appropriate mounting hardware.

Electronic Thermostat: Wall-mounted electronic type with temperature set-point display in Fahrenheit and Celsius.

Pneumatic Velocity Controller: Factory calibrated and field adjustable to minimum and maximum air volumes; shall maintain constant airflow dictated by thermostat within 5 percent of set point while compensating for inlet static-pressure variations up to 4-inch wg; and shall have a multipoint velocity sensor at air inlet.

Electronic Velocity Controller: Factory calibrated and field adjustable to minimum and maximum air volumes; shall maintain constant airflow dictated by thermostat within 5 percent of set point while compensating for inlet static-pressure variations up to 4-inch wg; and shall have a multipoint velocity sensor at air inlet.

Terminal Unit Controller: Pressure-independent, VAV controller with electronic airflow transducer with multipoint velocity sensor at air inlet, factory calibrated to minimum and maximum air volumes, and having the following features:

Retain "Control Sequence" Paragraph below if control sequences are not specified in Section 230993.11 "Sequence of Operations for HVAC DDC."

* + - * 1. Control Sequence:

Occupied (Primary Airflow On):

Operate as throttling control for cooling.

As cooling requirement decreases, control valve throttles toward minimum airflow.

Retain first option in subparagraph below for electric heat; second option, for hot water.

As heating requirement increases, fan energizes to draw in warm plenum air[**and electric heat is energized in steps**][**and electric heat modulates under SCR control**][**and the hot-water coil valve is energized**].

Unoccupied (Primary Airflow Off):

When pressure at primary inlet is zero or less, fan is de-energized.

Retain first option in subparagraph below for electric heat; second option, for hot water.

As heating requirement increases, fan energizes to draw in warm plenum air[**and electric heat is energized in steps**][**and electric heat modulates under SCR control**][**and the hot-water coil valve will be energized**].

* + - 1. SERIES FAN-POWERED AIR TERMINAL UNITS

* + - * 1. [Manufacturers:](http://www.specagent.com/Lookup?ulid=11428) Subject to compliance with requirements, provide products by one of the following:

[Carrier Global Corporation](http://www.specagent.com/Lookup?uid=123457155460).

[Johnson Controls, Inc](http://www.specagent.com/Lookup?uid=123457155463).

[Price Industries](http://www.specagent.com/Lookup?uid=123457155456).

[Trane](http://www.specagent.com/Lookup?uid=123457155458).

Approved equivalent.

If retaining both options in "Configuration" Paragraph below, indicate location of each configuration on Drawings or in schedule on Drawings.

* + - * 1. Configuration: Volume-damper assembly and fan in series arrangement inside unit casing with control components inside a protective metal shroud [**for installation above a ceiling**] [**and**] [**within a raised access floor**].

Two subparagraphs below are optional features.

Designed for quiet operation.

Low-profile design.

* + - * 1. Casing: [**0.040-inch-**] [**0.034-inch-**] <**Insert dimension**> thick galvanized steel, single wall.

Verify, with air terminal unit manufacturer, availability of casing liner.

Casing Liner: Comply with requirements in "Casing Liner" Article for [**fibrous-glass**] [**flexible elastomeric**] duct liner.

Air Inlets: Round stub connections or S-slip and drive connections for duct attachment.

Air Outlet: S-slip and drive connections.

Access: Removable panels for access to parts requiring service, adjustment, or maintenance; with airtight gasket and quarter-turn latches.

Fan: Forward-curved centrifugal.

Retain "Airstream Surfaces" Subparagraph below to comply with sustainable design systems.

Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

* + - * 1. Volume Damper: Galvanized steel with flow-sensing ring and peripheral gasket and self-lubricating bearings.

Leakage rates in "Maximum Damper Leakage" Subparagraph below vary among manufacturers and with pressure rating.

Maximum Damper Leakage: AHRI 880 rated, [**2**] [**3**] percent of nominal airflow at [**3-inch wg**] [**6-inch wg**] inlet static pressure.

"Damper Position" Subparagraph below applies to pneumatic controls only.

Damper Position: Normally [**open**] [**closed**].

* + - * 1. Velocity Sensors: Multipoint array with velocity sensors in air inlets and air outlets.

Default motor characteristics are specified in Section 230513 "Common Motor Requirements for HVAC Equipment."

* + - * 1. Motor:

Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."

Type: [**Permanent-split capacitor with SCR for speed adjustment**] [**Electronically commutated motor**].

Fan-Motor Assembly Isolation: Rubber isolators.

Verify enclosure types with manufacturer of specified equipment. Delete "Enclosure" Subparagraph below if included in schedule on Drawings.

Enclosure: [**Open dripproof**] [**Totally enclosed, fan cooled**] [**Totally enclosed, air over**] [**Open, externally ventilated**] [**Totally enclosed, nonventilated**] [**Severe duty**] [**Explosion proof**] [**Dust-ignition-proof machine**].

Retain first six subparagraphs below if options are available from equipment manufacturers and are different from default requirements specified in Section 230513 "Common Motor Requirements for HVAC Equipment." Consider each subparagraph and retain only those that vary from default requirements.

Enclosure Materials: [**Cast iron**] [**Cast aluminum**] [**Rolled steel**].

Motor Bearings: <**Insert requirements**>.

Unusual Service Conditions:

Ambient Temperature: <**Insert deg F**>.

Altitude: <**Insert feet**> above sea level.

Retain first subparagraph below if application requires this rating.

High humidity.

<**Insert conditions**>.

Efficiency: Premium efficient.

NEMA Design: <**Insert designation**>.

Service Factor: <**Insert value**>.

Motor Speed: [**Single speed**] [**Multispeed**].

Speed Control: Infinitely adjustable with pneumatic-electric and electronic controls.

Retain "Electrical Characteristics" Subparagraph below if characteristics are not indicated on Drawings.

Electrical Characteristics:

Horsepower: <**Insert horsepower**>.

Volts: [**120**] [**208**] [**230**] [**460**] <**Insert value**>.

Phase: [**Single**] [**Poly**].

Hertz: 60.

Full-Load Amperes: <**Insert value**>.

Minimum Circuit Ampacity: <**Insert value**>.

Maximum Overcurrent Protection: <**Insert amperage**>.

Verify available filter types with manufacturer. Indicate filter thickness in an Air Terminal Unit Schedule on Drawings.

* + - * 1. Filters:

Retain "Minimum Efficiency Reporting Value and Average Arrestance" Subparagraph below if requiring MERV 1, 2, 3, or 4 in "Material" subparagraphs below. Retain "Minimum Efficiency Reporting Value" Subparagraph if requiring MERV 5 and higher in "Material" subparagraphs below.

Minimum Efficiency Reporting Value and Average Arrestance: According to ASHRAE 52.2.

Minimum Efficiency Reporting Value: According to ASHRAE 52.2.

Retain one or more of three "Material" subparagraphs below. Indicate filter type in an Air Terminal Unit Schedule on Drawings if all units are not filtered identically. Two-inch- (50-mm-) thick foam is unavailable. LEED 2009 IEQ Prerequisite 1 and LEED v4 EQ Prerequisite, "Minimum Indoor Air Quality Performance," require compliance with ASHRAE 62.1 (2007 and 2010 versions respectively), which requires a MERV rating of 6 or higher for service to occupied spaces. LEED 2009 IEQ Credit 5 and LEED v4 IEQ Credit, "Enhanced Indoor Air Quality Strategies," require MERV 13 or higher. Insert values appropriate to Project sustainability goals.

Material: Polyurethane foam; [**MERV 3**] <**Insert value**>.

Material: Glass fiber treated with adhesive; [**MERV 5**] <**Insert value**>.

Material: Pleated cotton-polyester media [**MERV 7**] <**Insert value**>.

Thickness: [**2 inches**] [**1 inch**].

* + - * 1. Attenuator Section: [**0.034-inch galvanized steel**] [**0.032-inch aluminum**] sheet.

Verify, with air terminal unit manufacturer, availability of liner.

Attenuator Section Liner: Comply with requirements in "Casing Liner" Article for [**fibrous-glass**] [**flexible elastomeric**] duct liner.

Retain "Airstream Surfaces" Subparagraph below to comply with sustainable design systems.

Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

Retain one of first two paragraphs below if heating coil is required.

* + - * 1. Hydronic Heating Coils: Copper tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch, and rated for a minimum working pressure of 200 psig and a maximum entering-water temperature of 220 deg F. Include manual air vent and drain valve. Provide hydronic heating coils for air-terminal units scheduled on Drawings.
        2. Electric-Resistance Heating Coils: Nickel-chromium heating wire, free of expansion noise and hum, mounted in ceramic inserts in a galvanized-steel housing; with primary automatic, and secondary manual, reset thermal cutouts. Terminate elements in stainless-steel, machine-staked terminals secured with stainless-steel hardware. Provide electric-resistance heating coils for air terminal units scheduled on Drawings.

Retain one of first two subparagraphs below.

Stage(s): [**1**] [**2**] [**3**].

SCR controlled.

Access door interlocked disconnect switch.

Downstream air temperature sensor with local connection to override discharge-air temperature to not exceed a maximum temperature set point (adjustable).

Retain applicable subparagraphs below.

Nickel chrome 80/20 heating elements.

Airflow switch for proof of airflow.

Fan interlock contacts.

Fuses in terminal box for overcurrent protection (for coils more than 48 A).

Mercury contactors.

Pneumatic-electric switches and relays.

Magnetic contactor for each step of control (for three-phase coils).

* + - * 1. Factory-Mounted and -Wired Controls: Electrical components mounted in control box with removable cover. Incorporate single-point electrical connection to power source.

Control Transformer: Factory mounted for control voltage on electric and electronic control units with terminal strip in control box for field wiring of thermostat and power source.

Wiring Terminations: Fan and controls to terminal strip. Terminal lugs to match quantities, sizes, and materials of branch-circuit conductors. Enclose terminal lugs in terminal box that is sized according to NFPA 70.

Disconnect Switch: Factory-mounted, fuse type.

* + - * 1. Control Panel Enclosure: NEMA 250, Type 1, with access panel sealed from airflow and mounted on side of unit.

Retain first paragraph below if controls are not specified as a part of the HVAC control system.

* + - * 1. Control devices shall be compatible with temperature controls system specified in Section 230923 "Direct Digital Control (DDC) System for HVAC."

Electric Damper Actuator: 24 V, powered open, [**spring**] [**capacitous**] return.

Pneumatic Damper Operator: [**0- to 13-psig**] <**Insert range**> spring range.

Electronic Damper Actuator: 24 V, powered open, [**spring**] [**capacitous**] return.

Electric Thermostat: Wall-mounted electronic type with clock display, temperature display in Fahrenheit and Celsius, and space temperature set point.

Pneumatic Thermostat: Wall-mounted pneumatic type [**direct acting**] [**reverse acting**] [**direct or reverse acting as indicated on Drawings**] with appropriate mounting hardware.

Electronic Thermostat: Wall-mounted electronic type with temperature set-point display in Fahrenheit and Celsius.

Pneumatic Velocity Controller: Factory calibrated and field adjustable to minimum and maximum air volumes; shall maintain constant airflow dictated by thermostat within 5 percent of set point while compensating for inlet static-pressure variations up to 4-inch wg; and shall have a multipoint velocity sensor at air inlet.

Electronic Velocity Controller: Factory calibrated and field adjustable to minimum and maximum air volumes; shall maintain constant airflow dictated by thermostat within 5 percent of set point while compensating for inlet static-pressure variations up to 4-inch wg; and shall have a multipoint velocity sensor at air inlet.

Terminal Unit Controller: Pressure-independent, VAV controller with electronic airflow transducer with multipoint velocity sensor at air inlet, factory calibrated to minimum and maximum air volumes, and having the following features:

Retain applicable subparagraphs below.

Occupied and unoccupied operating mode.

Remote reset of airflow or temperature set points.

Adjusting and monitoring with portable terminal.

Communication with temperature-control system specified in Division 23 Section "Instrumentation and Control for HVAC."

Retain "Control Sequence" Paragraph below if control sequences are not specified in Section 230993.11 "Sequence of Operations for HVAC DDC."

* + - * 1. Control Sequence:

Occupied (Primary Airflow On):

Operate as throttling control for cooling.

As cooling requirement decreases, control valve throttles toward minimum airflow.

Retain first option in subparagraph below for electric heat; second option, for hot water.

As heating requirement increases, fan energizes to draw in warm plenum air[**and electric heat is energized in steps**][**and electric heat modulates under SCR control**][**and the hot-water coil valve is opened**].

Unoccupied (Primary Airflow Off):

When externally initiated, begin the morning warm-up/cool-down function. Damper drives to the fully open position without regard for the preset maximum.

When pressure at primary inlet is zero or less, fan is de-energized.

Retain first option in subparagraph below for electric heat; second option, for hot water.

As heating requirement increases, fan energizes to draw in warm plenum air[**and electric heat is energized in steps**][**and electric heat modulates under SCR control**][**and the hot-water coil valve is opened**].

* + - 1. DUAL-DUCT AIR TERMINAL UNITS

* + - * 1. [Manufacturers:](http://www.specagent.com/Lookup?ulid=11429) Subject to compliance with requirements, provide products by one of the following:

[Carrier Global Corporation](http://www.specagent.com/Lookup?uid=123457155473).

[Johnson Controls, Inc](http://www.specagent.com/Lookup?uid=123457155476).

[Price Industries](http://www.specagent.com/Lookup?uid=123457155469).

[Trane](http://www.specagent.com/Lookup?uid=123457155471).

Approved equivalent.

* + - * 1. Configuration: [**Mixing**] [**and**] [**non-mixing**] with two volume dampers inside unit casing with mixing attenuator section and control components inside a protective metal shroud[**with a third primary air inlet with volume damper**].
        2. Casing: [**0.040-inch-**] [**0.034-inch-**] <**Insert dimension**> thick galvanized steel, single wall.

Verify, with air terminal unit manufacturer, availability of casing liner.

Casing Liner: Comply with requirements in "Casing Liner" Article for [**fibrous-glass**] [**flexible elastomeric**] duct liner.

Air Inlets: Round stub connections or S-slip and drive connections for duct attachment.

Air Outlet: S-slip and drive connections.

Access: Removable panels for access to parts requiring service, adjustment, or maintenance; with airtight gasket.

Retain "Airstream Surfaces" Subparagraph below to comply with sustainable design systems.

Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

* + - * 1. Volume Damper: Galvanized steel with peripheral gasket and self-lubricating bearings.

Leakage rates in "Maximum Damper Leakage" Subparagraph below vary among manufacturers and with pressure rating.

Maximum Damper Leakage: AHRI 880 rated, 3 percent of nominal airflow at [**3-inch wg**] [**6-inch wg**] inlet static pressure.

"Damper Position" Subparagraph applies to pneumatic controls only.

Damper Position: Normally [**open**] [**closed**].

* + - * 1. Velocity Sensors: Multipoint array with velocity sensors in air inlets and air outlets.
        2. Attenuator Section: [**0.034-inch galvanized steel**] [**0.032-inch aluminum**] sheet.

Verify, with air terminal unit manufacturer, availability of liner.

Attenuator Section Liner: Comply with requirements in "Casing Liner" Article for [**fibrous-glass**] [**flexible elastomeric**] duct liner.

Retain "Airstream Surfaces" Subparagraph below to comply with sustainable design systems.

Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

Retain first paragraph below for multioutlet attenuator section or indicate number of outlets and outlet sizes on Drawings or in a schedule.

* + - * 1. Multioutlet Attenuator Section: With [**two**] [**three**] [**four**] <**Insert number**> [**6-inch-**] [**8-inch-**] [**10-inch-**] [**12-inch-**] diameter collars, each with locking butterfly balancing damper.

Verify, with air terminal unit manufacturer, availability of liner.

Attenuator Section Liner: Comply with requirements in "Casing Liner" Article for [**fibrous-glass**] [**flexible elastomeric**] duct liner.

Retain first paragraph below if controls are not specified as a part of the HVAC control system.

* + - * 1. Control devices shall be compatible with temperature controls system specified in Section 230923 "Direct Digital Control (DDC) System for HVAC."

Electric Damper Actuator: 24 V, powered open, [**spring**] [**capacitous**] return.

Pneumatic Damper Operator: [**0- to 13-psig**] <**Insert range**> spring range.

Electronic Damper Actuator: 24 V, powered open, [**spring**] [**capacitous**] return.

Electric Thermostat: Wall-mounted electronic type with clock display, temperature display in Fahrenheit and Celsius, and space temperature set point.

Pneumatic Thermostat: Wall-mounted pneumatic type with appropriate mounting hardware.

Electronic Thermostat: Wall-mounted electronic type with temperature set-point display in Fahrenheit and Celsius.

Pneumatic Velocity Controller: Factory calibrated and field adjustable to minimum and maximum air volumes; shall maintain constant airflow dictated by thermostat within 5 percent of set point while compensating for inlet static-pressure variations up to 4-inch wg; and shall have a multipoint velocity sensor at air inlet.

Electronic Velocity Controller: Factory calibrated and field adjustable to minimum and maximum air volumes; shall maintain constant airflow dictated by thermostat within 5 percent of set point while compensating for inlet static-pressure variations up to 4-inch wg; and shall have a multipoint velocity sensor at air inlet.

Terminal Unit Controller: Pressure-independent, VAV controller with electronic airflow transducer with multipoint velocity sensor at air inlet, factory calibrated to minimum and maximum air volumes, and having the following features:

* + - * 1. Control Sequence:

[**System**] [**Room thermostat**] modulates VAV damper and dual-duct damper.[**Room sensor reports temperature.**]

When Space Temperature Is below Set Point: Close VAV damper, open hot-deck dampers and close cold-deck dampers, then open VAV damper.

When Space Temperature Is above Set Point: Close VAV damper, close hot-deck dampers and open cold-deck dampers, then open VAV damper.

Retain one of two subparagraphs below.

Occupancy sensor reports occupancy and enables occupied temperature set point.

Occupancy sensor switches set point from occupied setting to unoccupied setting.

* + - 1. INDUCTION AIR TERMINAL UNITS

* + - * 1. [Manufacturers:](http://www.specagent.com/Lookup?ulid=11431) Subject to compliance with requirements, provide products by the following:

[Anemostat Products; a Mestek company](http://www.specagent.com/Lookup?uid=123457155479).

Approved equivalent.

* + - * 1. Configuration: Volume-damper assembly inside unit casing with mechanical induction damper mounted on casing and control components inside a protective metal shroud.
        2. Casing: [**0.040-inch-**] [**0.034-inch-**] <**Insert dimension**> thick galvanized steel, single wall.

Verify, with air terminal unit manufacturer, availability of casing liner.

Casing Liner: Comply with requirements in "Casing Liner" Article for [**fibrous-glass**] [**flexible elastomeric**] duct liner.

Air Inlet: Round stub connection for duct attachment.

Air Outlet: S-slip and drive connections[**, size matching inlet size**].

Access: Removable panels for access to parts requiring service, adjustment, or maintenance; with airtight gasket.

Fan: Forward-curved centrifugal.

Retain "Airstream Surfaces" Subparagraph below to comply with sustainable design systems.

Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

* + - * 1. Volume Damper: Galvanized steel with peripheral gasket and self-lubricating bearings.

Leakage rates in "Maximum Damper Leakage" Subparagraph below vary among manufacturers and with pressure rating.

Maximum Damper Leakage: AHRI 880 rated, [**2**] [**3**] percent of nominal airflow at [**3-inch wg**] [**6-inch wg**] inlet static pressure.

Damper Position: Normally [**open**] [**closed**].

* + - * 1. Induction Damper: Galvanized-steel, multiblade assembly with self-lubricating bearings.

Retain one of first two paragraphs below if heating coil is required.

* + - * 1. Hydronic Heating Coils: Copper tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch, and rated for a minimum working pressure of 200 psig and a maximum entering-water temperature of 220 deg F. Include manual air vent and drain valve. Provide hydronic heating coils for air terminal units scheduled on Drawings.
        2. Electric-Resistance Heating Coils: Nickel-chromium heating wire, free of expansion noise and hum, mounted in ceramic inserts in a galvanized-steel housing; with primary automatic, and secondary manual, reset thermal cutouts. Terminate elements in stainless-steel, machine-staked terminals secured with stainless-steel hardware. Provide electric-resistance heating coils for air terminal units scheduled on Drawings.

Retain one of first two subparagraphs below.

Stage(s): [**1**] [**2**] [**3**].

SCR controlled.

Access door interlocked disconnect switch.

Downstream air temperature sensor with local connection to override discharge-air temperature to not exceed a maximum temperature set point (adjustable).

Retain applicable subparagraphs below.

Nickel chrome 80/20 heating elements.

Airflow switch for proof of airflow.

Fan interlock contacts.

Fuses in terminal box for overcurrent protection (for coils more than 48 A).

Mercury contactors.

Pneumatic-electric switches and relays.

Magnetic contactor for each step of control (for three-phase coils).

Retain first paragraph below if controls are not specified as a part of the HVAC control system.

* + - * 1. Control devices shall be compatible with temperature controls system specified in Section 230923 "Direct Digital Control (DDC) System for HVAC."

Electric Damper Actuator: 24 V, powered open, [**spring**] [**capacitous**] return.

Pneumatic Damper Operator: [**0- to 13-psig**] <**Insert range**> spring range.

Electronic Damper Actuator: 24 V, powered open, [**spring**] [**capacitous**] return.

Electric Thermostat: Wall-mounted electronic type with clock display, temperature display in Fahrenheit and Celsius, and space temperature set point.

Pneumatic Thermostat: Wall-mounted pneumatic type [**direct acting**] [**reverse acting**] [**direct or reverse acting as indicated on Drawings**] with appropriate mounting hardware.

Electronic Thermostat: Wall-mounted electronic type with temperature set-point display in Fahrenheit and Celsius.

Pneumatic Velocity Controller: Factory calibrated and field adjustable to minimum and maximum air volumes; shall maintain constant airflow dictated by thermostat within 5 percent of set point while compensating for inlet static-pressure variations up to 4-inch wg; and shall have a multipoint velocity sensor at air inlet.

Electronic Velocity Controller: Factory calibrated and field adjustable to minimum and maximum air volumes; shall maintain constant airflow dictated by thermostat within 5 percent of set point while compensating for inlet static-pressure variations up to 4-inch wg; and shall have a multipoint velocity sensor at air inlet.

Terminal Unit Controller: Pressure-independent, VAV controller with electronic airflow transducer with multipoint velocity sensor at air inlet, factory calibrated to minimum and maximum air volumes, and having the following features:

* + - * 1. Control Sequence:

Damper controlling induced air from ceiling plenum opens or closes in response to decrease or increase in primary to ensure constant discharge airflow.

As heating requirement increases, fan energizes to draw in warm plenum air.

Retain one of three subparagraphs below.

Electric heat is energized in steps.

Electric heat modulates under SCR control.

Hot-water coil valve is opened.

* + - 1. DIFFUSER-TYPE AIR TERMINAL UNITS

* + - * 1. [Manufacturers:](http://www.specagent.com/Lookup?ulid=11432) Subject to compliance with requirements, provide products by one of the following:

[Acutherm; by Price](http://www.specagent.com/Lookup?uid=123457155481).

[Carnes Company](http://www.specagent.com/Lookup?uid=123457155484).

[Titus; brand of Johnson Controls International plc, Global Products](http://www.specagent.com/Lookup?uid=123457184873).

Approved equivalent.

* + - * 1. Configuration: Volume-damper, diffuser, controller assembly [**and electric heater**] and wall-mounted thermostat [**with master-slave capability**].
        2. Volume Damper: Galvanized steel with peripheral gasket and self-lubricating bearings.
        3. Diffuser: Galvanized steel with white baked-enamel finish.

Retain "Control Sequence" Paragraph below if controls are not specified as a part of the HVAC control system.

* + - * 1. Control Sequence: Diffusion dampers open and close to regulate airflow into the room in response to room temperature. The dampers are mechanically actuated by internal, factory-set thermal element thermostats[**with limited field adjustment**].
      1. BALANCING TERMINAL UNITS

* + - * 1. [Manufacturers:](http://www.specagent.com/Lookup?ulid=11434) Subject to compliance with requirements, provide products by the following:

[Titus; brand of Johnson Controls International plc, Global Products](http://www.specagent.com/Lookup?uid=123457155487).

Approved equivalent.

* + - * 1. Configuration: Manually operated volume-damper assembly with locking mechanism inside unit casing with multipoint, center-averaging velocity sensors[**for installation above a ceiling**].
        2. Casing: [**0.040-inch-**] [**0.034-inch-**] <**Insert dimension**> thick galvanized steel, single wall.

Leakage: Maximum 2 percent of nominal airflow at 3-inch wg static pressure.

Air Inlet: Round stub connection for duct attachment.

Air Outlet: S-slip and drive connections.

Verify, with air terminal unit manufacturer, availability of casing liner.

Casing Liner: Comply with requirements in "Casing Liner" Article for [**fibrous-glass**] [**flexible elastomeric**] duct liner.

Retain "Airstream Surfaces" Subparagraph below to comply with sustainable design systems.

Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

* + - * 1. Volume Damper: Galvanized steel with peripheral gasket and self-lubricating bearings.

Leakage rates in "Maximum Damper Leakage" Subparagraph below vary among manufacturers and with pressure rating.

Maximum Damper Leakage: AHRI 880 rated, [**2**] [**3**] percent of nominal airflow at [**3-inch wg**] [**6-inch wg**] inlet static pressure.

Retain "Direct Digital Controls" Paragraph below if control components are specified with the control system; delete if control components are packaged with the equipment.

* + - * 1. Direct Digital Controls: Single-package unitary controller and actuator specified in Section 230923 "Direct Digital Control (DDC) System for HVAC."
      1. PRESSURE CONTROL TERMINAL UNITS

* + - * 1. [Manufacturers:](http://www.specagent.com/Lookup?ulid=11436) Subject to compliance with requirements, provide products by one of the following:

[Carnes Company](http://www.specagent.com/Lookup?uid=123457155489).

[Price Industries](http://www.specagent.com/Lookup?uid=123457155492).

Approved equivalent.

* + - * 1. Configuration: Volume damper assembly inside unit casing with control components inside a protective metal shroud.
        2. Casing: [**0.040-inch-**] [**0.034-inch-**] <**Insert dimension**> thick galvanized steel, single wall.

Verify, with air terminal unit manufacturer, availability of casing liner.

Casing Liner: Comply with requirements in "Casing Liner" Article for [**fibrous-glass**] [**flexible elastomeric**] duct liner.

Air Inlet: Round stub connection for duct attachment.

Air Outlet: S-slip and drive connections.

Access: Removable panels for access to diverting damper and other parts requiring service, adjustment, or maintenance; with airtight gasket.

Retain "Airstream Surfaces" Subparagraph below to comply with sustainable design systems.

Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

Retain "Diverter Assembly" Paragraph below for units with mechanical volume regulators.

* + - * 1. Diverter Assembly: [**Galvanized-steel gate, with polyethylene linear bearings**] [**Aluminum blade, with nylon-fitted pivot points**].

Retain first paragraph below for multioutlet attenuator section or indicate number of outlets and outlet sizes on Drawings or in a schedule.

* + - * 1. Multioutlet Attenuator Section: With [**two**] [**three**] [**four**] <**Insert number**> [**6-inch-**] [**8-inch-**] [**10-inch-**] diameter collars, each with locking butterfly balancing damper.

Verify, with air terminal unit manufacturer, availability of liner.

Attenuator Section Liner: Comply with requirements in "Casing Liner" Article for [**fibrous-glass**] [**flexible elastomeric**] duct liner.

Retain one of two paragraphs below, or delete both if controls are specified in Section 230923 "Direct Digital Control (DDC) System for HVAC."

* + - * 1. Electronic Controls: Bidirectional damper operator and microprocessor-based thermostat. Control devices shall be compatible with temperature controls specified in Section 230923 "Direct Digital Control (DDC) System for HVAC" and shall have the following features:

Static pressure tap for field installation.

Adjustable control module.

Retain "Direct Digital Controls" Paragraph below if control components are specified with the control system; delete if control components are packaged with the equipment.

* + - * 1. Direct Digital Controls: Single-package unitary controller and actuator specified in Section 230923 "Direct Digital Control (DDC) System for HVAC."
        2. Control Sequence:

Under the control of a static pressure sensor, damper opens or closes to maintain static pressure downstream branch duct.

* + - 1. CRITICAL ENVIRONMENT CONTROL VALVE

* + - * 1. [Manufacturers:](http://www.specagent.com/Lookup?ulid=11438) Subject to compliance with requirements, provide products by one of the following:

[Anemostat Products; a Mestek company](http://www.specagent.com/Lookup?uid=123457184874).

[Price Industries](http://www.specagent.com/Lookup?uid=123457155493).

Approved equivalent.

* + - * 1. Configuration: [**Volume damper**] [**Venturi valve**] assembly inside an externally insulated unit casing with control components inside a protective metal shroud.
        2. Casing:

Type 316 stainless steel, 0.0375 inch, with continuously welded seams.

[**Aluminum**] [**Heresite-coated aluminum**].

Galvanized steel.

Verify, with air terminal unit manufacturer, availability of casing liner.

Casing Liner: Comply with requirements in "Casing Liner" Article for [**fibrous-glass**] [**flexible elastomeric**] duct liner.

* + - * 1. Sensors: Multipoint, Type 316 stainless steel[**, removable**].

Retain one of first two paragraphs below if heating coil is required.

* + - * 1. Hydronic Heating Coils: Copper tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch, and rated for a minimum working pressure of 200 psig and a maximum entering-water temperature of 220 deg F. Include manual air vent and drain valve. Provide hydronic heating coils for air terminal units scheduled on Drawings.
        2. Electric-Resistance Heating Coils: Nickel-chromium heating wire, free of expansion noise and hum, mounted in ceramic inserts in a galvanized-steel housing; with primary automatic, and secondary manual, reset thermal cutouts. Terminate elements in stainless-steel, machine-staked terminals secured with stainless-steel hardware. Provide electric-resistance heating coils for air terminal units scheduled on Drawings.

Retain one of first two subparagraphs below.

Stage(s): [**1**] [**2**] [**3**].

SCR controlled.

Access door interlocked disconnect switch.

Downstream air temperature sensor with local connection to override discharge-air temperature to not exceed a maximum temperature set point (adjustable).

* + - * 1. Control Sequence:

Occupied (Primary Airflow On):

Operate as throttling control for cooling.

As cooling requirement decreases, control valve throttles toward minimum airflow.

Retain first option in subparagraph below for electric heat; second option, for hot water.

As heating requirement increases, fan energizes to draw in warm plenum air[**and electric heat is energized in steps**][**and electric heat modulates under SCR control**][**and the hot-water coil valve is opened**].

Unoccupied (Primary Airflow Off):

When externally initiated, begin the morning warm-up/cool-down function. Damper drives to the fully open position without regard for the preset maximum.

When pressure at primary inlet is zero or less, fan is de-energized.

Retain first option in subparagraph below for electric heat; second option, for hot water.

As heating requirement increases, fan energizes to draw in warm plenum air[**and electric heat is energized in steps**][**and electric heat modulates under SCR control**][**and the hot-water coil valve is opened**].

* + - 1. UNDERFLOOR AIR DISTRIBUTION TERMINAL UNITS

* + - * 1. [Manufacturers:](http://www.specagent.com/Lookup?ulid=11439) Subject to compliance with requirements, provide products by one of the following:

[Carrier Global Corporation](http://www.specagent.com/Lookup?uid=123457155495).

[Johnson Controls, Inc](http://www.specagent.com/Lookup?uid=123457155496).

[Price Industries](http://www.specagent.com/Lookup?uid=123457155498).

[Titus; brand of Johnson Controls International plc, Global Products](http://www.specagent.com/Lookup?uid=123457155494).

Approved equivalent.

* + - * 1. Configuration: Volume-damper assembly and fan in series arrangement inside unit casing with control components inside a protective metal shroud within a raised access floor. Designed for [**pressurized floor cavity supply**] [**and**] [**ducted air supply**].
        2. Casing: [**0.040-inch-**] [**0.034-inch-**] <**Insert dimension**> thick galvanized steel, single wall.

Integral floor discharge diffusers.

Mixing damper.

VAV throttling damper.

Leveling feet.

Verify, with air terminal unit manufacturer, availability of casing liner.

Casing Liner: Comply with requirements in "Casing Liner" Article for [**fibrous-glass**] [**flexible elastomeric**] duct liner.

Air Outlet: S-slip and drive connections.

Access: Removable panels for access to parts requiring service, adjustment, or maintenance; with airtight gasket and quarter-turn latches.

Fan: Forward-curved centrifugal [**in double blower configuration**] [**with double blowers as indicated**].

Retain "Airstream Surfaces" Subparagraph below to comply with sustainable design systems.

Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

* + - * 1. Volume Damper: Galvanized steel with flow-sensing ring and peripheral gasket and self-lubricating bearings.

Leakage rates in "Maximum Damper Leakage" Subparagraph below vary among manufacturers and with pressure rating.

Maximum Damper Leakage: AHRI 880 rated, [**2**] [**3**] percent of nominal airflow at [**3-inch wg**] [**6-inch wg**] inlet static pressure.

Damper Position: Normally [**open**] [**closed**].

* + - * 1. Velocity Sensors: Multipoint array with velocity sensors in air inlets and air outlets.

Default motor characteristics are specified in Section 230513 "Common Motor Requirements for HVAC Equipment."

* + - * 1. Motor:

Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."

Type: [**Permanent-split capacitor with SCR for speed adjustment**] [**Electronically commutated motor**].

Fan-Motor Assembly Isolation: Rubber isolators.

Verify enclosure types with manufacturer of specified equipment. Delete "Enclosure" Subparagraph below if included in schedule on Drawings.

Enclosure: [**Open dripproof**] [**Totally enclosed, fan cooled**] [**Totally enclosed, air over**] [**Open, externally ventilated**] [**Totally enclosed, nonventilated**] [**Severe duty**] [**Explosion proof**] [**Dust-ignition-proof machine**].

Retain first six subparagraphs below if options are available from equipment manufacturers and are different from default requirements specified in Section 230513 "Common Motor Requirements for HVAC Equipment." Consider each subparagraph and retain only those that vary from default requirements.

Enclosure Materials: [**Cast iron**] [**Cast aluminum**] [**Rolled steel**].

Motor Bearings: <**Insert requirements**>.

Unusual Service Conditions:

Ambient Temperature: <**Insert deg F**>.

Altitude: <**Insert feet**> above sea level.

Retain first subparagraph below if application requires this rating.

High humidity.

<**Insert conditions**>.

Efficiency: Premium efficient.

NEMA Design: <**Insert designation**>.

Service Factor: <**Insert value**>.

Motor Speed: [**Single speed**] [**Multispeed**].

Retain "Electrical Characteristics" Subparagraph below if characteristics are not indicated on Drawings.

Electrical Characteristics:

Horsepower: <**Insert horsepower**>.

Volts: [**120**] [**208**] [**230**] [**460**] <**Insert value**>.

Phase: [**Single**] [**Poly**].

Hertz: 60.

Full-Load Amperes: <**Insert value**>.

Minimum Circuit Ampacity: <**Insert value**>.

Maximum Overcurrent Protection: <**Insert amperage**>.

Retain one or more options in "Controller Type" Paragraph below.

* + - * 1. Controller Type: [**Plenum Pressure Controllers**] [**Individual Diffuser Controller**] [**Terminal Unit Controller**].
        2. Accessories:

Inlet filter.

Disconnect switch.

Transformers.

Airflow switch.

* + - * 1. Control Sequence:

Occupied (Primary Airflow On):

Operate as throttling control for cooling.

As cooling requirement decreases, control valve throttles toward minimum airflow.

Retain first option in subparagraph below for electric heat; second option, for hot water.

As heating requirement increases, fan energizes to draw in warm plenum air[**and electric heat is energized in steps**][**and electric heat modulates under SCR control**][**and the hot-water coil valve is opened**].

Unoccupied (Primary Airflow Off):

When externally initiated, begin the morning-warm-up/cool-down function. Damper drives to the fully open position without regard for the preset maximum.

When pressure at primary inlet is zero or less, fan is de-energized.

Retain first option in subparagraph below for electric heat; second option, for hot water.

As heating requirement increases, fan energizes to draw in warm plenum air[**and electric heat is energized in steps**][**and electric heat modulates under SCR control**][**and the hot-water coil valve is opened**].

* + - 1. UNDERFLOOR AIR DISTRIBUTION FLOOR INDUCTION UNITS

* + - * 1. [Manufacturers:](http://www.specagent.com/Lookup?ulid=11535) Subject to compliance with requirements, provide products by one of the following:

[Carrier Global Corporation](http://www.specagent.com/Lookup?uid=123457155516).

[Price Industries](http://www.specagent.com/Lookup?uid=123457155518).

Approved equivalent.

* + - * 1. Configuration: Raised-access floor-mounting units with ducted primary air[**and hydronic coil(s)**]. Air is discharged to space through nozzles. Design includes secondary air induced from served space.
        2. Casing: [**0.040-inch-**] [**0.034-inch-**] <**Insert dimension**> thick galvanized steel, single wall. Casing includes removable aluminum linear grille and plenum[**with interior painted black**].

Provide air mixing chamber.

Provide casing space for control valves and actuators.

Casing to have adjustable feet.

* + - * 1. Hydronic Heating Coils: [**One row**] [**Two rows**] [**As indicated on Drawings**]. Copper tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch, and rated for a minimum working pressure of 200 psig and a maximum entering-water temperature of 220 deg F. Include manual air vent and drain valve. Provide hydronic heating coils for air terminal units scheduled on Drawings.

Coils to be painted black.

* + - 1. EXHAUST SINGLE-DUCT TERMINAL

* + - * 1. [Manufacturers:](http://www.specagent.com/Lookup?ulid=11440) Subject to compliance with requirements, provide products by one of the following:

[Anemostat Products; a Mestek company](http://www.specagent.com/Lookup?uid=123457155502).

[Price Industries](http://www.specagent.com/Lookup?uid=123457155513).

Approved equivalent.

* + - * 1. Configuration: Volume-damper assembly inside unit casing with control components inside a protective metal shroud.
        2. Casing: [**0.040-inch-**] [**0.034-inch-**] <**Insert dimension**> thick galvanized steel, single wall. Casing includes removable aluminum linear grille and plenum.

Air Inlet: Round stub connection or S-slip and drive connections for duct attachment.

Air Outlet: S-slip and drive connections[**, size matching inlet size**].

Access: Removable panels for access to parts requiring service, adjustment, or maintenance; with airtight gasket.

Retain "Airstream Surfaces" Subparagraph below to comply with sustainable design systems.

Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

Retain "Regulator Assembly" Paragraph below for units with system-air-powered volume regulators.

* + - * 1. Regulator Assembly: System-air-powered bellows section incorporating polypropylene bellows for volume regulation and thermostatic control. Bellows shall operate at temperatures from zero to 140 deg F, shall be impervious to moisture and fungus, shall be suitable for 10-inch wg static pressure, and shall be factory tested for leaks.
        2. Volume Damper: Galvanized steel with peripheral gasket and self-lubricating bearings.

Leakage rates in "Maximum Damper Leakage" Subparagraph below vary among manufacturers and with pressure rating.

Maximum Damper Leakage: AHRI 880 rated, [**2**] [**3**] percent of nominal airflow at [**3-inch wg**] [**6-inch wg**] inlet static pressure.

Damper Position: Normally [**open**] [**closed**].

* + - * 1. Attenuator Section: [**0.034-inch galvanized steel**] [**0.032-inch aluminum**] sheet.

Verify, with air terminal unit manufacturer, availability of casing liner.

Casing Liner: Comply with requirements in "Casing Liner" Article for [**fibrous-glass**] [**flexible elastomeric**] duct liner.

Retain first paragraph below for multioutlet attenuator section or indicate number of outlets and outlet sizes on Drawings or in a schedule.

* + - * 1. Multioutlet Attenuator Section: With [**two**] [**three**] [**four**] <**Insert number**> [**6-inch-**] [**8-inch-**] [**10-inch-**] diameter collars, each with locking butterfly balancing damper.

Verify, with air terminal unit manufacturer, availability of liner.

Attenuator Section Liner: Comply with requirements in "Casing Liner" Article for [**fibrous-glass**] [**flexible elastomeric**] duct liner.

Retain one of first five paragraphs below, or delete all five if controls are specified in Section 230923 "Direct Digital Control (DDC) System for HVAC."

* + - * 1. Electric Controls: Damper actuator and thermostat.

Damper Actuator: 24 V, powered open, [**spring**] [**capacitous**] return.

Thermostat: Wall-mounted electronic type with clock display, temperature display in Fahrenheit and Celsius, and space temperature set point.

* + - * 1. Electronic Controls: Bidirectional damper operator and microprocessor-based thermostat with integral airflow transducer and room sensor. Control devices shall be compatible with temperature controls specified in Section 230923 "Direct Digital Control (DDC) System for HVAC" and shall have the following features:

Damper Actuator: 24 V, powered open, [**spring**] [**capacitous**] return.

Velocity Controller: Factory calibrated and field adjustable to minimum and maximum air volumes; shall maintain constant airflow dictated by thermostat within 5 percent of set point while compensating for inlet static-pressure variations up to 4-inch wg; and shall have a multipoint velocity sensor at air inlet.

Thermostat: Wall-mounted electronic type with temperature set-point display in Fahrenheit and Celsius.

Retain first "Direct Digital Controls" Paragraph below if control components are specified with the control system; retain second if control components are packaged with the equipment.

* + - * 1. Direct Digital Controls: Single-package unitary controller and actuator specified in Section 230923 "Direct Digital Control (DDC) System for HVAC."
        2. Direct Digital Controls: Bidirectional damper operators and microprocessor-based controller and room sensor. Control devices shall be compatible with temperature controls specified in Section 230923 "Direct Digital Control (DDC) System for HVAC" and shall have the following features:

Damper Actuator: 24 V, powered open, [**spring**] [**capacitous**] return.

Terminal Unit Controller: Pressure-independent, VAV controller with electronic airflow transducer with multipoint velocity sensor at air inlet, factory calibrated to minimum and maximum air volumes, and having the following features:

Retain applicable subparagraphs below.

Occupied and unoccupied operating mode.

Remote reset of airflow or temperature set points.

Adjusting and monitoring with portable terminal.

Communication with temperature-control system specified in Section 230923 "Direct Digital Control (DDC) System for HVAC."

Pressure Sensor: Duct mounted with pressure set-point adjustment[**and access for connection of portable operator terminal**].

Retain "Controls" Paragraph below for units with system-powered controls and if control sequences are not specified in Section 230993.11 "Sequence of Operations for HVAC DDC." Revise sequence descriptions to suit Project.

* + - * 1. Controls:

Suitable for operation with duct pressures between 0.25- and 3.0-inch wg inlet static pressure.

System-powered, wall-mounted thermostat.

* + - * 1. Control Sequence:

Damper blade opens or closes to maintain differential pressure set point in response to upstream and downstream differential pressure sensors.

* + - 1. CASING LINER

See Section 230713 "Duct Insulation" for applicable duct insulation and installation requirements for air terminal device application.

Sustainable design systems require that duct insulation R-value comply with ASHRAE/IES 90.1 tables titled "Minimum Duct Insulation R-Value, Cooling and Heating Only Supply Ducts and Return Ducts" and "Minimum Duct Insulation R-Value, Combined Heating and Cooling Supply Ducts and Return Ducts." If using liner alone to suit thermal requirements, verify that material selected is available in thickness needed to provide thermal performance without jeopardizing other requirements.

Retain one of two "Casing Liner" paragraphs below.

* + - * 1. Casing Liner: Fibrous-glass duct liner, complying with ASTM C1071, NFPA 90A, or NFPA 90B; and with NAIMA AH124, "Fibrous Glass Duct Liner Standard."

Minimum Thickness: [**1/2 inch**] [**3/4 inch**] [**1 inch**].

Retain "Maximum Thermal Conductivity" Subparagraph below to require thermal conductivity exceeding the minimum requirements in ASTM C1071. Retaining subparagraph may create a restrictive proprietary specification.

Maximum Thermal Conductivity:

Option for thermal conductivity in first two subparagraphs below exceeds the values in ASTM C1071. If retaining, verify availability of performance with duct liner manufacturers.

Type I, Flexible: [**0.27 Btu x in./h x sq. ft. x deg F**] <**Insert value**> at 75 deg F mean temperature.

Type II, Rigid: [**0.23 Btu x in./h x sq. ft. x deg F**] <**Insert value**> at 75 deg F mean temperature.

Coating in "Antimicrobial Erosion-Resistant Coating" Subparagraph below is an optional feature for duct liner.

Antimicrobial Erosion-Resistant Coating: Apply to the surface of the liner that will form the interior surface of the duct to act as a moisture repellent and erosion-resistant coating. Antimicrobial compound shall be tested for efficacy by an NRTL and registered by the EPA for use in HVAC systems.

[**Solvent**] [**Water**]-Based Liner Adhesive: Comply with NFPA 90A or NFPA 90B and with ASTM C916.

Flexible elastomeric duct liner in "Casing Liner" Paragraph below is not suitable for temperatures higher than 220 deg F (104 deg C).

* + - * 1. Casing Liner: Flexible elastomeric duct liner fabricated of preformed, cellular, closed-cell, sheet materials complying with ASTM C534, Type II, Grade 1; and with NFPA 90A or NFPA 90B.

Available thicknesses for flexible elastomeric duct liner are 3/8, 1/2, 3/4, and 1 inch (10, 13, 19, and 25 mm). Indicate thickness on Drawings.

Surface-burning characteristics in "Minimum Thickness" Subparagraph below are available in limited thicknesses. Verify maximum thickness with manufacturers.

Minimum Thickness: [**1/2 inch**] [**3/4 inch**].

Surface-Burning Characteristics: Maximum flame-spread index of 25 and maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.

Liner Adhesive: As recommended by insulation manufacturer and complying with NFPA 90A or NFPA 90B.

* + - 1. SOURCE QUALITY CONTROL

Retain this article for factory-assembled units. Factory tests are an added cost option and may not be available from some manufacturers. Verify requirement with Owner.

* + - * 1. Factory Tests: Test assembled air terminal units according to AHRI 880.

Label each air terminal unit with plan number, nominal airflow, maximum and minimum factory-set airflows, [**coil type,**]and AHRI certification seal.

1. EXECUTION
   * + 1. HANGER AND SUPPORT INSTALLATION
          1. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Ch. 5, "Hangers and Supports" and with Section 230529 "Hangers and Supports for HVAC Piping and Equipment."

Verify, with structural engineer, attachment selection and spacing in first two paragraphs below.

* + - * 1. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.

Where practical, install concrete inserts before placing concrete.

Install powder-actuated concrete fasteners after concrete is placed and completely cured.

Use powder-actuated concrete fasteners for standard-weight aggregate concretes and for slabs more than 4 inches thick.

Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes and for slabs less than 4 inches thick.

Retain subparagraph below for projects that require seismic restraints.

Do not use powder-actuated concrete fasteners for seismic restraints.

* + - * 1. Hangers Exposed to View: Threaded rod and angle or channel supports.
        2. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
      1. SEISMIC-RESTRAINT-DEVICE INSTALLATION
         1. Install hangers and braces designed to support the air terminal units and to restrain against seismic forces required by applicable building codes. Comply with [**SMACNA's "Seismic Restraint Manual: Guidelines for Mechanical Systems."**] [**ASCE/SEI 7.**] Comply with requirements for seismic-restraint devices in Section 230548 "Vibration and Seismic Controls for HVAC."
         2. Select seismic-restraint devices with capacities adequate to carry present and future static and seismic loads.
         3. Install cables so they do not bend across edges of adjacent equipment or building structure.
         4. Install cable restraints on air terminal units that are suspended with vibration isolators.
         5. Attachment to Structure: If specific attachment is not indicated, anchor bracing and restraints to structure, to flanges of beams, to upper truss chords of bar joists, or to concrete members.
         6. Drilling for and Setting Anchors:

Identify position of reinforcing steel and other embedded items before drilling holes for anchors. Do not damage existing reinforcement or embedded items during drilling. Notify Architect if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.

Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.

Wedge Anchors: Protect threads from damage during anchor installation. Install heavy-duty sleeve anchors with sleeve fully engaged in the structural element to which anchor is to be fastened.

Set anchors to manufacturer's recommended torque, using a torque wrench.

Install zinc-coated steel anchors for interior applications and stainless-steel anchors for applications exposed to weather.

* + - 1. TERMINAL UNIT INSTALLATION
         1. Install air terminal units according to NFPA 90A, "Standard for the Installation of Air Conditioning and Ventilating Systems."
         2. Install air terminal units level and plumb. Maintain sufficient clearance for normal service and maintenance.

Delete paragraph below if thermostats are specified in Section 230923 "Direct Digital Control (DDC) System for HVAC."

* + - * 1. Install wall-mounted thermostats.
      1. PIPING CONNECTIONS
         1. Where installing piping adjacent to air terminal unit, allow space for service and maintenance.
         2. Hot-Water Piping: Comply with requirements in Section 232113 "Hydronic Piping" and Section 232116 Hydronic Piping Specialties," and connect heating coils to supply with shutoff valve, strainer, control valve, and union or flange; and to return with balancing valve and union or flange.
      2. DUCTWORK CONNECTIONS
         1. Comply with requirements in [**Section 233113 "Metal Ducts"**] [**Section 233116 "Nonmetal Ducts"**] for connecting ducts to air terminal units.

Coordinate duct installations and specialty arrangements with Drawings.

* + - * 1. Make connections to air terminal units with flexible connectors complying with requirements in Section 233300 "Air Duct Accessories."
      1. ELECTRICAL CONNECTIONS
         1. Install field power to each air terminal unit electrical power connection. Coordinate with air terminal unit manufacturer and installers.
         2. Connect wiring in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
         3. Ground equipment in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."
         4. Install electrical devices furnished by manufacturer, but not factory mounted, in accordance with NFPA 70 and NECA 1.
         5. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.

Retain one of two subparagraphs below. First subparagraph cross-references Section 260553 "Identification for Electrical Systems" and should be retained for consistent electrical identification. Second is an abbreviated version of the product specified in Section 260553 "Identification for Electrical Systems."

Nameplate shall be laminated acrylic or melamine plastic signs, as specified in Section 260553 "Identification for Electrical Systems."

Nameplate shall be laminated acrylic or melamine plastic signs with a black background and engraved white letters at least [**1/2 inch**] <**Insert dimension**> high.

* + - 1. CONTROL CONNECTIONS
         1. Install control and electrical power wiring to field-mounted control devices.
         2. Connect control wiring in accordance with Section 260523 "Control-Voltage Electrical Power Cables."
      2. IDENTIFICATION
         1. Label each air terminal unit with plan number, nominal airflow, and maximum and minimum factory-set airflows. Comply with requirements in Section 230553 "Identification for HVAC Piping and Equipment" for equipment labels and warning signs and labels.
      3. FIELD QUALITY CONTROL

Retain "Manufacturer's Field Service" Paragraph below to require a factory-authorized service representative to perform tests and inspections.

* + - * 1. Manufacturer's Field Service: Engage a company field advisor to test and inspect components, assemblies, and equipment installations, including connections.

Retain "Perform the following tests and inspections" Paragraph below to require Contractor to perform tests and inspections.

* + - * 1. Perform the following tests and inspections[**with the assistance of a company field advisor**]:

After installing air terminal units and after electrical circuitry has been energized, test for compliance with requirements.

Retain "Leak Test" Subparagraph below for air terminal units with hot-water coils.

Leak Test: After installation, fill water coils and test for leaks. Repair leaks and retest until no leaks exist.

Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.

Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

See Section 014000 "Quality Requirements" for retesting and reinspecting requirements and Section 017300 "Execution" for requirements for correcting the Work.

* + - * 1. Air terminal unit will be considered defective if it does not pass tests and inspections.
        2. Prepare test and inspection reports.
      1. STARTUP SERVICE
         1. [**Engage a factory-authorized service representative to perform] [Perform]** startup service.

Complete installation and startup checks according to manufacturer's written instructions.

Verify that inlet duct connections are as recommended by air terminal unit manufacturer to achieve proper performance.

Verify that controls and control enclosure are accessible.

Verify that control connections are complete.

Verify that nameplate and identification tag are visible.

Verify that controls respond to inputs as specified.

<**Insert startup steps if any**>.

* + - 1. DEMONSTRATION
         1. [**Engage a factory-authorized service Company Service Advisor to train**] [**Train**] Director’s Representative's maintenance personnel to adjust, operate, and maintain air terminal units.

END OF SECTION 233600