

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and Divisions 00 and 01, apply to this Section.
- B. Related Sections:
 - 1. Division 23.

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Single-Duct Air Terminals.
 - 2. Dual-Duct Air Terminals.
 - 3. Fan-Powered Air Terminals.
 - 4. Diffuser Air Terminals.

1.3 SUBMITTALS

- A. General: See Section 23 05 00 for general requirements of Product Data, Shop Drawings, Reports and Certificates, and Operation and Maintenance data submittals.
- B. Product Data: In addition to requirements of Section 23 05 00, include a schedule showing drawing designation, room location, number furnished, model number, size, and accessories furnished. Provide submittals of the following:
 - 1. Single-Duct Air Terminals
 - 2. Dual-Duct Air Terminals
 - 3. Fan-Powered Air Terminals
 - 4. Diffuser Air Terminals
- C. Shop Drawings: None required.
- D. Reports and Certificates: None required.

1.4 CODES AND STANDARDS

- A. Codes and Standards shall be the current version adopted by the Authority Having Jurisdiction.

1.5 QUALITY ASSURANCE

- A. Product Options: Drawings and schedules indicate requirements of air terminals and are based on specific systems indicated. Other manufacturers' systems with equal performance characteristics may be considered. Refer to Division 01 Section "Substitutions."
- B. Listing and Labeling: Provide electrically operated air terminals specified in this Section that are listed and labeled.
 - 1. The Terms "Listed" and "Labeled": As defined in NFPA 70, Article 100.

2. Listing and Labeling Agency Qualifications: A "Nationally Recognized Testing Laboratory" as defined in OSHA Regulation 1910.7.
- C. NFPA Compliance: Install air terminals that meet NFPA 90A, "Standard for the Installation of Air Conditioning and Ventilating Systems."
- D. Comply with NFPA 70 for electrical components and installation.
- E. All terminals including those equipped with electric heating coils must be UL and/or ETL rated and approved as an assembly.
- F. Sound Power Levels: All sound data submitted must be ARI certified. Submit both radiated and discharge sound power levels for review. Conform to maximum allowable sound power levels shown in documents.
- G. Controls shall be factory installed. Refer to controls section of this specification. Cost associated with installation of control component associated with air terminals shall be by this section.
- H. Source Quality Control:
 1. Testing Requirements: Test and rate air terminals according to ARI 880, "Industry Standard for Air Terminals."
 2. Identification: Label each air terminal with plan number, nominal airflow, maximum and minimum factory-set airflows, coil type, and ARI certification seal.

PART 2 – PRODUCTS

2.1 SINGLE-DUCT AIR TERMINALS

- A. Manufacturers: Subject to compliance with requirements, provide air terminals by one of the following:
 1. Single-Duct Air Terminals:
 - a. Nailor Industries, Inc.
 - b. Titus
 - c. Trane
 - d. Metalaire
 - e. Envirotec
 - f. Or Approved Equal
- B. Configuration: Volume-damper assembly inside unit casing. Locate control components inside protective metal shroud.
- C. Casings: Galvanized steel sheet metal, 22-gauge minimum thickness.
- D. Casing Lining: [Fibrous-glass insulation with coated face; 1.5-lb/cu. ft. density with 4.0-lb/cu. ft. face; complying with NFPA 90A, UL 181 and ASTM E84; minimum of 3/4-inch- thick. Coat liner surfaces with erosion-resistant coating contains EPA registered anti-microbial agent that will not support growth of fungus or bacteria] [Rigid fibrous-glass insulation with foil face; 4.0-lb/cu. ft. density; comply with NFPA 90A, UL 181 and ASTM C665; minimum of 3/4-inch thick.] [Fibrous-glass insulation with solid metal liner; 1.5-lb/cu. ft. density; comply with NFPA 90A, UL 181 and ASTM E84; minimum of 3/4-inch thick.] [Non-fibrous closed-cell

- elastomeric or polyethylene foam insulation; minimum 3/4-inch thick; 1.5-lbcu. ft. density; comply with NFPA 90A, UL 181 and ASTM E84.] Secure lining to prevent delamination, sagging, or settling.
- E. Air Inlets: Round stub connection.
 - F. Air Outlets: Rectangular, S-slip and drive, duct mounting collar or flanged connection.
 - G. Volume Damper: Construct of galvanized steel with sandwich gasket and self-lubricating bearings.
 - 1. Maximum Damper/Air Valve Leakage: 1 percent of nominal airflow at 3-inch wg inlet static pressure.
 - H. Hot-Water Heating Coil: 1/2-inch copper tube, mechanically expanded into aluminum-plate fins; leak tested underwater to 200 psig; and factory installed.
 - I. Electric Heating Coil: Open-coil design with integral control box factory wired and installed. Include the following features:
 - 1. Primary overtemperature protection.
 - 2. Minimum airflow switch.
 - 3. Pneumatic-electric switches and relays.
 - 4. Mercury contactor for each step of control.
 - 5. Transformer required for coil controls and safeties.
 - J. Factory-mounted and –wired controls. Mount electrical components in control panel enclosure with removable cover. Control panel enclosure shall be NEMA 250, Type 1, with access panel sealed from airflow and mounted on side of unit. Incorporate single-point electrical connection to power source.
 - 1. Factory-mount transformer for DDC system control voltage and DDC terminal unit controller. Provide all wiring and connections between DDC components mounted in terminal unit control enclosure and all other terminal mounted sensing, control and power devices.
 - 2. Wiring Terminations: All connection points for field wire shall be terminated on a terminal strip; terminal lugs to match quantities, sizes, and materials of branch-circuit conductors. Enclose terminal lugs in terminal box sized according to NFPA 70.
 - 3. Disconnect Switch: Factory-mounted, fused, disconnect switch.
 - K. Inlet Air Flow Sensor: Multiport, averaging flow sensor. Accuracy +5% of full flow with 1-1/2 diameter of straight duct upstream.
 - L. Single-Duct Air Terminal Boxes Noise Specification: All air terminal boxes shall have been tested in complete accordance with the latest revision of ARI Industry Standard 880-98 for Air Terminals in a laboratory that is ARI-certified to conduct the test. When operating at the design capacities scheduled below, the tested radiated and discharge sound power values shall not exceed the values scheduled in the following table. Air terminals used in a pressure-independent system shall be tested with their inlet velocity sensors installed. Data is listed by octave bands and is without corrections for room absorption or duct attenuation.

Maximum Sound Power Levels, Lw

dB re 1 picowatt

CFM	Inlet Pressure	Frequency	125	250	500	1K	2K	4K
		Band No.	2	3	4	5	6	7
2000	1.0"	Radiated	69	64	64	64	61	61
2000	1.0"	Discharge	71	66	64	64	61	61
1400	2.0"	Radiated	69	64	64	64	61	61
1400	2.0"	Discharge	71	68	65	64	61	61

Octave Band Center Frequency in Hz

2.2 DUAL-DUCT AIR TERMINALS

- A. Manufacturers: Subject to compliance with requirements, provide air terminals by one of the following:
 1. Dual-Duct Air Terminals:
 - a. Nailor Industries, Inc.
 - b. Titus
 - c. Trane
 - d. Metalaire
 - e. Envirotec
 - f. Or Approved Equal
- B. Casings: Galvanized steel sheet metal 22-gauge minimum thickness.
- C. Casing Lining: [Fibrous-glass insulation with coated face; 1.5-lb/cu. ft. density with 4.0-lb/cu. ft. face; complying with NFPA 90A, UL 181 and ASTM E84; minimum of 3/4-inch- thick. Coat liner surfaces with erosion-resistant coating contains EPA registered anti-microbial agent that will not support growth of fungus or bacteria] [Rigid fibrous-glass insulation with foil face; 4.0-lb/cu. ft. density; comply with NFPA 90A, UL 181 and ASTM C665; minimum of 3/4-inch thick.] [Fibrous-glass insulation with solid metal liner; 1.5-lb/cu. ft. density; comply with NFPA 90A, UL 181 and ASTM E84; minimum of 3/4-inch thick.] [Non-fibrous closed-cell elastomeric or polyethylene foam insulation; minimum 3/4-inch thick; 1.5-lbcu. ft. density; comply with NFPA 90A, UL 181 and ASTM E84.] Secure lining to prevent delamination, sagging, or settling.
- D. Air Inlets: Round stub connections.
- E. Air Outlets: Rectangular, S-slip and drive, duct mounting collar or flanged connection.
- F. Volume Damper: Construct of galvanized steel with sandwich gasket and self-lubricating bearings.
 1. Maximum Damper/Air Valve Leakage: 1 percent of nominal airflow at 3-inch wg inlet static pressure.
- G. Factory-mounted and –wired controls. Mount electrical components in control panel enclosure with removable cover. Control panel enclosure shall be NEMA 250, Type 1, with access panel sealed from airflow and mounted on side of unit. Incorporate single-point electrical connection to power source.

1. Factory-mount transformer for DDC system control voltage and DDC terminal unit controller. Provide all wiring and connections between DDC components mounted in terminal unit control enclosure and all other terminal mounted sensing, control and power devices.
 2. Wiring Terminations: All connection points for field wire shall be terminated on a terminal strip; terminal lugs to match quantities, sizes, and materials of branch-circuit conductors. Enclose terminal lugs in terminal box sized according to NFPA 70.
 3. Disconnect Switch: Factory-mounted, fused, disconnect switch.
- H. Inlet Air Flow Sensor(s): Multiport, averaging flow sensor. Accuracy +5% of full flow with 1-1/2 diameter of straight duct upstream.
- I. Dual-Duct Air Terminal Boxes Noise Specification: All air terminal boxes shall have been tested in complete accordance with the latest revision of ARI Industry Standard 880-98 for Air Terminals in a laboratory that is ARI-certified in conduct the test. When operating at the design capacities scheduled below, the tested radiated and discharge sound power values shall not exceed the values scheduled in the following table. Air terminals used in a pressure-independent system shall be tested with their inlet velocity sensors installed. Data is listed by octave bands and is without corrections for room absorption or duct attenuation.

Maximum Sound Power Levels, Lw

dB re 1 picowatt

CFM	Inlet Pressure	Frequency	125	250	500	1K	2K	4K
		Band No.	2	3	4	5	6	7
3600	1.0"	Radiated	69	64	64	64	61	61
3600	1.0"	Discharge	74	68	65	64	61	61
1300	2.0"	Radiated	69	64	64	64	66	65
1300	2.0"	Discharge	71	68	65	64	61	61

Octave Band Center Frequency in Hz

2.3 FAN-POWERED AIR TERMINALS

- A. Manufacturers: Subject to compliance with requirements, provide air terminals by one of the following:
1. Fan Powered Air Terminals:
 - a. Nailor Industries, Inc.
 - b. Titus
 - c. Trane
 - d. Metalaire
 - e. Envirotec
 - f. Or Approved Equal
- B. Configuration: Volume-damper assembly and fan in series arrangement inside unit casing. Locate control components inside protective metal shroud.
- C. Casings: Galvanized steel sheet metal 20-gauge minimum thickness.

- D. Casing Lining: [Fibrous-glass insulation with coated face; 1.5-lb/cu. ft. density with 4.0-lb/cu. ft. face; complying with NFPA 90A, UL 181 and ASTM E84; minimum of 3/4-inch- thick. Coat liner surfaces with erosion-resistant coating contains EPA registered anti-microbial agent that will not support growth of fungus or bacteria] [Rigid fibrous-glass insulation with foil face; 4.0-lb/cu. ft. density; comply with NFPA 90A, UL 181 and ASTM C665; minimum of 3/4-inch thick.] [Fibrous-glass insulation with solid metal liner; 1.5-lb/cu. ft. density; comply with NFPA 90A, UL 181 and ASTM E84; minimum of 3/4-inch thick.] [Non-fibrous closed-cell elastomeric or polyethylene foam insulation; minimum 3/4-inch thick; 1.5-lb/cu. ft. density; comply with NFPA 90A, UL 181 and ASTM E84.] Secure lining to prevent delamination, sagging, or settling.
- E. Primary Air Inlets: Round stub connection.
- F. Air Outlets: Rectangular, S-slip and drive, duct mounting collar or flanged connection.
- G. Access: Removable panels to permit access to dampers and other parts requiring service, adjustment, or maintenance; with airtight gasket and quarter-turn latches.
- H. Volume Damper: Construct of galvanized steel with sandwich gasket and self-lubricating bearings.
 - 1. Maximum Damper/Air Valve Leakage: 1 percent of nominal airflow at 3-inch wg inlet static pressure.
- I. Fan Section: Galvanized-steel housing, direct-drive, forward-curved fan with [permanent split-capacitor motor][ECM motor]. Motor shall have thermal overload protection. Mount fan motor assembly on rubber isolators.
 - 1. Speed Control: [Solid-state controller, adjustable down to 55 percent of full speed][High/medium/low][Solid-state variable speed controller; pressure-independent constant fan air flow].
- J. Filter: Provide 1-inch low efficiency filter on terminals without water heating coil. Provide 1-inch pleated medium efficiency filter on terminals with water coil. Maximum allowed face velocity shall be 450 fpm unless indicated otherwise. Provide sheet metal transition as required to mount filter on terminal unit.
- K. Plenum Air Inlet Attenuator: Neoprene- or vinyl-coated, fibrous-glass insulation. Liner material thickness to match casing liner thickness. Attenuator shall have one internal directional change minimum.
- L. Hot-Water Heating Coil: 1/2-inch copper tube, mechanically expanded into aluminum-plate fins; leak tested underwater to 200 psig; and factory installed.
- M. Electric Heating Coil: Open-coil design with integral control box factory wired and installed. Include the following features:
 - 1. Primary overtemperature protection.
 - 2. Minimum airflow switch.
 - 3. Pneumatic-electric switches and relays.
 - 4. Mercury contactor for each step of control.
 - 5. Transformer required for coil controls and safeties.

- N. Factory-mounted and -wired controls. Mount electrical components in control panel enclosure with removable cover. Control panel enclosure shall be NEMA 250, Type 1, with access panel sealed from airflow and mounted on side of unit. Incorporate single-point electrical connection to power source.
1. Factory-mount transformer for DDC system control voltage and DDC terminal unit controller. Provide all wiring and connections between DDC components mounted in terminal unit control enclosure and all other terminal mounted sensing, control and power devices.
 2. Wiring Terminations: All connection points for field wire shall be terminated on a terminal strip; terminal lugs to match quantities, sizes, and materials of branch-circuit conductors. Enclose terminal lugs in terminal box sized according to NFPA 70.
 3. Disconnect Switch: Factory-mounted, fused, disconnect switch.
- O. Fan Powered Air Terminal Boxes Noise Specification: All fan powered air terminal boxes shall have been tested in complete accordance with the latest revision of ARI Industry Standard 880-98 for Air Terminals in a laboratory that is ARI-certified to conduct the test. When operating at the design capacities scheduled below, the tested radiated and discharge sound power values shall not exceed the values scheduled in the following table. Air terminals used in a pressure-independent system shall be tested with their inlet velocity sensors installed. Data is listed by octave bands and is without corrections for room absorption or duct attenuation.

Maximum Sound Power Levels, Lw

dB re 1 picowatt

Fan CFM	Primary CFM	Inlet Pressure	External Fan S.P.	Frequency	125	250	500	1K	2K	4K
				Band No.	2	3	4	5	6	7
1800	1800	1.0"	0.25	Radiated	70	65	64	64	66	65
1800	1800	1.0"	0.25	Discharge	70	66	65	64	61	61
1500	1500	1.5	0.25	Radiated	70	65	64	64	66	65
1500	1500	1.5	0.25	Discharge	70	66	65	64	61	61

Octave Band Center Frequency in Hz

2.4 DIFFUSER AIR TERMINALS

- A. Manufacturers: Subject to compliance with requirements, provide air terminals by one of the following:
1. Diffuser Air Terminals:
 - a. Acutherm
 - b. Or Approved Equal
- B. Configuration: Volume-damper assembly inside unit casing. Locate control components inside protective metal shroud.
- C. Casings: Steel or aluminum sheet metal.
- D. Air Inlets: Round stub connections for duct attachment.

- E. Volume Damper: Construct of galvanized steel with peripheral gasket and self-lubricating bearings.
- F. Diffuser: Galvanized-steel, insulated plenum with extruded-aluminum or sheet-steel diffuser, having fixed or variable geometry designed to operate from 100 percent to minimum airflow, manual adjustment of airflow direction, and white baked-enamel finish.
- G. Controls: Self-contained.

PART 3 – EXECUTION

3.1 INSTALLATION

- A. Install air terminals level and plumb, according to manufacturer's written instructions, rough-in drawings, original design, and referenced standards; and maintain sufficient clearance for normal service and maintenance.
- B. Support terminal units using [double deflection rubber hangers and][threaded rod supports] with seismic restraints as specified in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment."
- C. [Provide flexible connectors at inlet and outlet of terminal units. Provide a minimum of 3 duct diameters of straight duct after flexible connector at terminal unit inlet][Provide a minimum of 3 duct diameters of straight duct upstream of terminal unit].
- D. Do not operate units until construction is complete and site is clean. Verify clean filters are in place prior to balancing.
- E. Install adjacent piping to allow service and maintenance of air terminals.
- F. Hot-Water Piping: In addition to requirements in Division 23 Section "Hydronic Piping," connect heating coils to supply with shutoff valve, strainer, control valve, and union or flange; and to return with circuit balancing valve and union or flange.
- G. Electrical: Comply with applicable requirements in Division 26 Sections, ground equipment.

3.2 FIELD QUALITY CONTROL

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

3.3 CLEANING

- A. After completing system installation, including outlet fittings and devices, inspect exposed finish. Remove burrs, dirt, and construction debris, and repair damaged finishes.

3.4 START-UP PROCEDURES

- A. Verify that installation of each air terminal is according to the Contract Documents.
- B. Check that inlet duct connections are as recommended by air terminal manufacturer to achieve proper performance.

- C. Check that controls and control enclosure are accessible.
- D. Verify that control connections are complete.
- E. Check that nameplate and identification tag are visible.
- F. Verify that controls respond to inputs as specified.

3.5 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel as specified below:
 - 1. Train Owner's maintenance personnel on procedures and schedules related to startup and shutdown, troubleshooting, servicing, and preventive maintenance. Provide 2 hours of training per air terminal type.
 - 2. Review data in the maintenance manuals. Refer to Division 01 Section Operation and Maintenance Data.
 - 3. Schedule training with Owner, through Architect, with at least 7 days' advance notice.

END OF SECTION