Specification Text File

Suggested Specifications

Series Flow (Constant Volume) Fan Powered Terminals – 35S Series

(Section 15840)

1.01 Furnish and install constant volume series fan powered terminal units of the sizes and capacities as indicated on the drawings. Units shall be pressure independent with (pneumatic, analog electronic, digital electronic) controls. Units shall be manufactured by **Nailor Industries Inc.** Model **35S**.

1.02 The entire terminal unit shall be designed and built as a single unit. The units shall be provided with a primary variable air volume damper that controls the air quantity in response to a (pneumatic, electronic) thermostat. The space limitations shall be reviewed carefully to ensure that all units will fit into the space allowed.

1.03 Unit casings shall be space frame construction utilizing 16 gauge galvanized steel corner structural members and 20 gauge galvanized steel panels. Unit shall be fully lined with fiberglass insulation which shall be at least 3/4" (19 mm) thick dual density insulation complying with NFPA 90 for fire and smoke resistivity and UL 181 for erosion. Any cut edges of insulation shall be coated with NFPA 90 approved sealant.

1.04 Unit casing shall have four access panels, one on each side of the unit and one on the bottom and top for easy access to motor and blower assembly and for maintenance and replacement of parts without disturbing duct connections. The unit shall be rated to operate in left hand or right hand mode by turning the unit over. Access panels shall be attached to casing with (screws, quick acting latches, hinges). Casing leakage shall not exceed 2% of terminal rated airflow at 0.5" w.g. (125 Pa) interior casing pressure. All high side casing joints shall be sealed with approved sealant and high side casing leakage shall not exceed 2% of terminal rated airflow at 3" w.g. (750 Pa).

1.05 Units shall have round inlets for the primary air connections and shall have a 6" (152 mm) deep inlet duct collar for field connection. The outlets shall be rectangular and suitable for flanged duct connections. Casing shall have mounting area for hanging by sheet metal straps from a concrete slab.

1.06 The damper shall be of rectangular, multiple inclined opposed blade construction and designed to operate on a 45° arc. Blades shall be minimum 16 ga. galvanized steel, single thickness construction with heavy duty gasket glued to the blades. The blades shall be screwed through the damper shaft to ensure that no slippage occurs. Blade shafts shall pivot on corrosion free bearings. Damper leakage shall not exceed 2% of the terminal rated cfm at 3" w.g. (750 Pa) inlet static pressure.

1.07 Entire terminal unit shall be factory assembled with (pneumatic, electronic) controls. All components including all controls except the room thermostat and (pneumatic piping, field wiring) shall be factory installed and mounted with the unit.

1.08 Provide a (pneumatic, analog electronic, digital electronic) flow control device that will limit the maximum and minimum airflow to that scheduled on the drawings. Airflow limits shall be factory set. Thermostat signal shall reset the flow control device to adjust primary airflow to match load requirements. Control of the terminal unit shall be pressure independent.

1.09 The terminal unit shall be capable of operation as described herein with inlet static pressure of 0.05" w.g. (12 Pa) at full cooling with no mixing of induced and primary air. (The sequence of operation should be described here, if not part of the temperature controls specifications). Mixing of the primary and secondary airstreams shall be such that no more than 2.5° F (1.4°C) variation shall exist in the discharge airstream for each 20° F (11.1°C) of difference between the primary and secondary airstreams.

1.10 Blower casings shall be constructed of heavy gauge coated steel. Blower wheel shall be forward curved centrifugal type, dynamically balanced and driven by direct drive, single speed split capacitor motors. Motors shall be suitable for (120, 208, 240, 277 volts) single phase power. Motors shall have built-in overload protection, bearings capable of low rpm oiling, permanently oiled bearings and a built-in anti-backward rotation device. Fan assembly shall be mounted so as to isolate the casing from the motor and blower vibration at no less than four points. Isolation shall be supplied at the motor and at the blower mounting points.

1.11 An electronic motor speed controller sized and designed for the specific blower motor combination shall be provided to allow infinitely adjustable fan speed from the minimum voltage stop to the line voltage signal to the motor. A minimum voltage stop shall be employed to ensure that fan cannot run in stall mode.

1.12 Units shall incorporate a single point electrical (and pneumatic) connection for the entire unit. All electrical components shall be UL or ETL listed or recognized and installed in accordance with the National Electrical Code. All electrical components shall be mounted in a control box. The entire assembly shall be ETL listed (cETL in Canada) and so labeled.

1.13 All sound data shall be compiled in an independent laboratory and in accordance with the latest version of ARI 880. All units shall be ARI certified and bear the ARI certification label.

1.14 Unit maximum radiated sound power levels at 1.0" w.g. (250 Pa) inlet pressure and 0.25" w.g. (63 Pa) discharge static pressure shall not exceed the values in Tables 1 and 2 at the specified airflow. No credit or reduction shall in any way be considered for room, plenum, ceiling, and/or similar item effects.

Unit Size	Airflow		Sound Power Octave Band Center Frequency (Hz.)					
	cfm	l/s	2	3	4	5	6	7
			125	250	500	1000	2000	4000
2	450	212	63	60	55	52	53	53
3	900	425	68	60	59	56	60	60
4	1300	614	72	67	63	58	61	62
5	1700	802	75	70	64	59	63	66
6	2000	944	76	72	65	62	64	67

Table 1. Maximum Radiated Sound Power Levels.
Full Cooling (Fan on and 100% primary air).

Unit Size	Airflow		Sound Power Octave Band Center Frequency (Hz.)					
	cfm	l/s	2	3	4	5	6	7
			125	250	500	1000	2000	4000
2	450	212	58	51	47	40	34	31
3	900	425	66	55	54	49	46	42
4	1300	614	72	63	58	53	51	47
5	1700	802	73	67	59	54	52	50
6	2000	944	74	68	61	58	55	52

Table 2. Maximum Radiated Sound Power Levels.
Full heating (Fan only).

1.15 Unit maximum discharge sound power levels at 1.0" w.g. (250 Pa) inlet pressure and 0.25" w.g. (63 Pa) discharge static pressure shall not exceed the values in Table 3 at the specified airflow. No credit or reduction shall in any way be considered for room, downstream duct, elbows and/or similar item effects.

Unit Size	Airflow		Sound Power Octave Band Center Frequency (Hz.)					
	cfm	l/s	2	3	4	5	6	7
			125	250	500	1000	2000	4000
2	450	212	57	59	58	54	52	49
3	900	425	63	64	65	63	60	57
4	1300	614	68	70	69	68	65	64
5	1700	802	72	71	71	70	67	66
6	2000	944	73	74	74	73	70	70

Table 3. Maximum Discharge Sound Power Levels.
Full cooling (Fan on and 100% primary air).

Suggested Specifications

Series Flow (Constant Volume) Fan Powered Terminals – 35S Series (continued)

Options

"STEALTH™"

Specification Text File

Substitute the following paragraphs:

1.01 Furnish and install series flow (constant volume) fan powered terminal units of the sizes and capacities as indicated on the drawings. Units shall be pressure independent with (pneumatic, analog electronic, digital electronic) controls. Units shall be manufactured by **Nailor Industries Inc.** Model **35SST "Stealth™"**.

1.14 Unit maximum radiated sound power levels at 1.0" w.g. (250 Pa) inlet pressure and 0.25" w.g. (63 Pa) discharge static pressure shall not exceed the values in Tables 4 and 5 at the specified airflow. No credit or reduction shall in any way be considered for room, plenum, ceiling, and/or similar item effects.

Unit Size	Airflow		Sound Power Octave Band Center Frequency (Hz.)					
	cfm	l/s	2	3	4	5	6	7
			125	250	500	1000	2000	4000
2	450	212	59	60	48	40	36	37
3	900	425	63	61	52	46	42	42
4	1300	614	68	63	57	49	45	46
5	1700	802	70	66	57	51	48	48
6	2000	944	73	66	60	53	50	50

Table 4. Maximum Radiated Sound Power Levels. Full Cooling (Fan on and 100% primary air).

Unit Size	Airflow		Sound Power Octave Band Center Frequency (Hz.)					
	cfm	l/s	2	3	4	5	6	7
			125	250	500	1000	2000	4000
2	450	212	55	51	39	34	32	29
3	900	425	58	55	48	41	35	30
4	1300	614	66	59	52	46	39	36
5	1700	802	69	62	53	48	46	42
6	2000	944	71	63	56	50	45	40

Table 5. Maximum Radiated Sound Power Levels. Full Heating (Fan only).

1.15 Unit maximum discharge sound power levels at 1.0" w.g. (250 Pa) inlet pressure and 0.25" w.g. (63 Pa) discharge static pressure shall not exceed the values in Table 6 at the specified airflow. No credit or reduction shall in any way be considered for room, downstream duct, elbows and/or similar item effects.

Unit Size	Airflow		Sound Power Octave Band Center Frequency (Hz.)					
	cfm	l/s	2	3	4	5	6	7
			125	250	500	1000	2000	4000
2	450	212	57	59	58	54	52	49
3	900	425	63	64	65	63	60	57
4	1300	614	68	70	69	68	65	64
5	1700	802	72	71	71	70	67	66
6	2000	944	73	74	74	73	70	70

Table 6. Maximum Discharge Sound Power Levels. Full cooling (Fan on and 100% primary air).

Electric Heat

Specification Text File

Substitute the following paragraphs:

1.01 Furnish and install series flow (constant volume) fan powered terminal units with integral electric heat of the sizes and capacities as indicated on the drawings. Units shall be pressure independent with (pneumatic, analog electronic, digital electronic) controls. Units shall be manufactured by **Nailor Industries Inc.** Model **35SE** or **35SEST "Stealth™"** (select one).

1.12 An electric heater shall be factory mounted and pre-wired as an integral package with the fan powered terminal unit. Heaters shall be sized as shown on the drawings. The entire assembly including the electric heater shall be ETL listed (cETL in Canada) for zero clearance and so labeled and shall meet all requirements of the latest National Electrical Code (Canadian Electrical Code, CSA Standard C22.1). The unit with the heater mounted shall be listed and rated to be turned over for either left or right hand configuration. The unit shall have a single point electrical (and pneumatic) connection. Heater casing and panel shall be a minimum of 20 gauge galvanized steel. Each heater shall be complete with primary disc type automatic high limit, contactors as required, ground terminal, fan relay for interlocking the heater and fan and high grade nickel chrome alloy resistance wire. Element wires shall be suspended in insulators designed to expose the entire face area of the wire thereby eliminating hot spots. Each heater shall be supplied with factory supplied and pre-wired branch circuit fusing as required by NEC and UL. Circuiting and fusing shall also be in accordance with the circuiting requirements as shown on the plans. Additional accessories shall include (control transformer, circuit fusing, disconnect switch, electric step controller, pneumatic electric switches) for staging the heater.
(Additional performance requirements that you might want to include can be found in the electric heater section). The electric heater shall be located on the discharge side of the fan so as not to add heat to the motor and shorten its expected lifetime.

Heater voltage and stages to be as follows:
0 to 5.0 kW ..... 277V/1 phase, 1 Step
5.1 kW and up ..... 480V/3 phase, 1 Step

Hot Water Heating Coils

Specification Text File

Substitute the following paragraphs:

1.01 Furnish and install series flow (constant volume) fan powered terminal units with integral hot water coils of the sizes and capacities as indicated on the drawings. Units shall be pressure independent with (pneumatic, analog electronic, digital electronic) controls. Units shall be manufactured by **Nailor Industries Inc.** Model **35SW** or **35SWST "Stealth™"** (select one).

1.12 A hot water coil shall be factory mounted as an integral package with the fan powered terminal unit. Hot water coils shall be sized as shown on the drawings. The entire assembly including the hot water coil shall be ETL listed (cETL in Canada) for zero clearance and so labeled and shall meet all requirements of the latest National Electrical Code. The unit shall have a single point electrical (and pneumatic) connection. Water coil casing and panels shall be a minimum of 20 gauge galvanized steel. Access panels shall be supplied on the top and bottom of the unit for easy access to the coil for inspection and cleaning. All copper, including the headers and return bends, shall be encased to eliminate heat loss during heating sequence and heat gain during cooling sequence. Coils shall be 1, 2 or 3 row as required and heating capacities shall be as shown on the plans. Coils shall have aluminum plate fins spaced 10 per inch and bonded to 1/2" (13 mm) O.D. copper tubes. Copper connections shall be sweat. All coils shall be tested at a minimum of 300 psi under water to produce a guaranteed working pressure of 250 psi. Controls and valves for the hot water coils shall be field mounted. Heating coils shall be located on the discharge side of the fan so as not to add heat to the motor and shorten its expected lifetime.

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Suggested Specifications

Series Fan Powered VAV Terminal Units MODEL SERIES 35SST "STEALTH™"

(Section 15840)

The following specification is recommended where an independent laboratory test and performance verification is required.
The specification includes Digital Controls by Division 17, EPIC™/ECM motor and 'IAQ' Solid Metal Liner (Double Wall Construction).

PART 1 – GENERAL

1.01 RELATED DOCUMENTS

A. The requirements of the General Conditions, Supplementary Conditions, and the following specification sections apply to all Work herein:

1. Section 15 - - - General
2. Section 15 - - - Scope of Work
3. Section 15 - - - Design Conditions
4. Section 15 - - - Electric Motors and Controllers
5. Section 15 - - - Access Doors and Color Coded Identification in General Construction
6. Section 15 - - - Ductwork and Sheet Metal
7. Section 15 - - - Testing, Balancing and Adjusting

1.02 SUMMARY

A. Furnish and install all air terminal units herein specified and as indicated on the Drawings.

1.03 REFERENCE STANDARDS

A. All air terminal units shall be designed, manufactured and tested in accordance with the latest applicable industry standards including the following:

1. ANSI/ASHRAE Standard 130-96.
2. ARI Standard 880-98.
3. Underwriters Laboratories UL Standard 1995.
4. Underwriters Laboratories UL Standard 1996.

1.04 QUALITY ASSURANCE

A. All equipment and material to be furnished and installed on this project shall be UL or ETL listed, in accordance with the requirements of the Authority having jurisdiction, and suitable for its intended use on this Project. Space limitations shall be reviewed to ensure that the equipment will fit into the space allowed.

B. All equipment and material to be furnished and installed on this project shall be run tested at the factory and results of that testing shall be tabulated and provided to the engineer when the equipment ships to the job site. See paragraph 2.03 G for specific requirements.

C. All equipment and material to be furnished and installed on this project shall have been pre-tested in a mock up facility suitable to the engineer. The test shall be as described in 2.03 D. The test results shall be supplied with the equipment submittal.

1.05 SUBMITTALS

A. The following submittal data shall be furnished according to the Conditions of the Construction Contract, Division 1 Specifications, and Section 15 - - - General and shall include but not be limited to:

1. Series Fan Powered Variable Air Volume Terminal Units, complete with capacity data, test data, construction details, physical dimensions, electrical characteristics, etc.

1.06 ACOUSTICS

Section A of this acoustical specification describes sound power levels as tested to ARI 880 and ASHRAE 130. These are not the selection criteria for this specification. The selection criteria will be in section B where sound pressure readings are taken in an actual mock up that will exhibit worst case performance for the purpose of guaranteeing equipment performance when the building is commissioned and turned over to the occupant. Section A is important in that it provides a guideline for the minimum performance that the terminal units will have to meet in order to anticipate performance that will be acceptable under section B.

A. Sound Power Acoustical Performance:

1. Discharge Noise: Maximum permissible sound power levels in octave bands of discharge sound through discharge ducts from terminal units operated at an inlet pressure of **0.75" w.g.** and the maximum amount of air volume shown on the Project Mechanical Drawings leaving the terminal unit and entering the reverberant chamber shall be as follows:

Octave Band	NC-35	NC-40
2	67	71
3	64	69
4	67	72
5	66	71
6	67	72
7	67	72

Table 1. Maximum Discharge Sound Power Levels (dB re 10^{-12} Watts)

2. Radiated Noise: Maximum permissible radiated sound power levels in octave bands of radiated transmission from terminal units operated at an inlet pressure of **0.75" w.g.** and the maximum scheduled air quantity in an installed condition over occupied spaces shall be as follows:

Octave Band	NC-35	NC-40
2	64	68
3	57	62
4	53	58
5	50	55
6	50	55
7	53	58

Table 2. Maximum Radiated Sound Power Levels (dB re 10^{-12} Watts)

B. Sound Pressure Acoustical Performance:
Each size of each terminal unit to be used on this project shall be completely laboratory tested for air performance and acoustics. Performance to NC 30, 35, 40 and 45 shall be charted for each size unit showing its maximum and minimum range limits under each NC condition listed above. If heater options change the overall performance, then the equipment shall be shown with electric and hot water coils in addition to no heat configurations. This data shall be submitted with the equipment submittal. Units that comply with the sound power data listed above, may comply with the sound pressure performance. Testing is required to determine compliance and the performance range. Units that do not comply with the sound power performance in paragraph 1.06 A. probably will not comply with the sound pressure requirements or will have restricted ranges of acceptance.

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Suggested Specifications

Series Fan Powered VAV Terminal Units MODEL SERIES 35SST "STEALTH™" (continued)

1.07 WARRANTY

A. Manufacturer shall warrant equipment for one year from start up or 18 months from shipment.

PART 2 - PRODUCTS

2.01 UNAUTHORIZED MATERIALS

A. Materials and products required for the work of this section shall not contain asbestos, polychlorinated biphenyl's (PCB) or other hazardous materials identified by the Engineer or Owner.

2.02 ACCEPTABLE MANUFACTURERS

A. These Specifications set forth the minimum requirements for series fan powered VAV terminal units. If they comply with these Specifications, series fan powered VAV terminal units manufactured by one of the following manufacturers will be acceptable:

1. Nailor Industries.

2.03 VARIABLE PRIMARY AIR VOLUME SERIES FAN POWERED TERMINAL UNITS

A. Furnish and install series fan powered VAV terminal units as indicated on the Drawings. The units shall be designed and built as a single unit and provided with a primary variable air volume damper that controls the primary air quantity in response to a temperature control signal. The damper construction shall be rectangular with multiple opposed blades designed to operate on a 45° arc. Blades shall be 16 gauge galvanized steel, single thickness construction with heavy-duty gasket glued to the blades. Units shall be suitable for pressure independent control with **Digital [DDC]** controls. The units shall contain a fan and motor assembly and [electric or hot water] heating coils where scheduled and/or indicated on the Drawings. The fan shall provide a constant volume of discharge air at all air blending ratios from minimum to maximum scheduled primary air quantities and zero to 100% return airflow rates and shall be controlled in sequence as outlined hereinafter. The space limitations shall be reviewed carefully to ensure all terminal units will fit into the space provided including National Electric Code clearances required in front of all panels containing electrical devices. Units shall be of space frame construction with 16 gauge corner posts for structural support and attachment points. Removable access doors or panels of minimum 20 gauge galvanized steel on the top, bottom and both sides of the terminal unit shall provide access to service the fan, electric motor and all internal components. Panels shall be attached with [screws or quick connect latches or hinges]. Units shall be fully rated, even with electric or hot water heater coils, to operate in left hand or right hand mode by turning the unit over. Unit shall be fully lined with at least 3/4" thick, dual density fiberglass insulation completely encapsulated between solid outer and inner solid liners, which comply with NFPA 90 for fire and smoke resistivity and UL 181 for erosion. Casing leakage shall not exceed 2% of terminal rated airflow at 0.5" w.g. interior casing pressure. All high side casing joints shall be sealed with approved sealant and high side casing leakage shall not exceed 2% of terminal rated airflow at 3" w.g.. Provide a filter rack with a 1" thick throwaway filter to be used during construction. Terminal unit manufacturer shall provide flow curves for the primary air sensor clearly labeled and permanently attached on the bottom or side of each fan terminal.

The unit shall include all equipment and controls as required to provide a complete and operating system with at least the following equipment and controls:

1. Single point electrical connection for the voltage/phase as scheduled in the Contract Documents. See Electrical Drawings for power feeder arrangements. Motors shall be rated at **[120 or 277]** volt single phase as scheduled in the contract documents.
2. A toggle disconnect switch for cooling only units, or a door interlocking disconnect switch for terminal units with electric heating coils. All disconnecting devices shall be sized and located as required to disconnect all ungrounded power conductors to all internal electrical components.
3. Individual overcurrent protection devices as required to protect individual units and transformers.
4. The primary inlet shall be equipped with an inlet collar sized to fit the primary duct size shown on the Drawings. Any transitions shall be provided and installed by the Division 15 Mechanical Subcontractor. The inlet collar shall provide at least a 6" length with a 1/8" high raised single or double bead located approximately 1½" from the inlet connection. The primary and fan design cfm settings shall be clearly and permanently marked on the bottom of the unit along with the terminal unit identification numbers. Each terminal unit shall incorporate a Nailor Diamond Flow sensor with four pick up points on each side to insure that with typical duct turbulence, the controller fidelity shall be ± 5% of set volume even with a hard 90° elbow at the inlet. Static variation of 0.5" w.g. to 6.0" w.g. shall not affect the flow reading. Provide a transformer with 24 volt AC secondary to provide power for the unit's controls and the Division 17 controls. The VAV terminal unit manufacturer and the Division 17 Building Controls Subcontractor shall verify compatibility of the multipoint flow sensors with transducer and DDC microprocessor furnished under Division 17 prior to bidding this Project.
5. The outlets shall be rectangular and suitable for flanged duct connections. Space frame casing shall have mounting area for hanging by sheet metal straps from a concrete slab or shall be supplied with angle brackets for mounting on all thread rods.
6. Fan motor assembly shall be a forward curved centrifugal fan with a direct drive motor. Motors shall be General Electric ECM and/or Nailor EPIC™ variable speed brushless DC motors specifically designed for use with a single phase, **[120 or 277]** volt, 60 Hertz electrical input. Motor shall be complete with and operated by a single phase integrated controller/inverter that operates the wound stator and senses rotor position to electrically commutate the stator. All motors shall be designed for synchronous rotation. Motor rotor shall be permanent magnet type with near zero rotor losses. Motor shall have built-in soft start and slewed speed change ramps. Motor shall be able to be mounted with shaft in horizontal or vertical orientation. Motor shall be permanently lubricated with ball bearings. Motor shall be direct coupled to the blower. Motor shall maintain a minimum of 65% efficiency over its entire operating range. Provide isolation between fan motor assembly and unit casing in at least 4 locations to eliminate any vibration from the fan to the terminal unit casing. Provide anti-back rotation system or provide a motor that is designed to overcome reverse rotation and not affect life expectancy.
    a. The manufacturer of the fan powered terminal units shall set the fan discharge airflow (cfm) at the factory. If the fan powered terminal unit manufacturer cannot factory set the fan airflow (cfm), he shall send factory technicians to the field to adjust the GE ECM™ and/or Nailor EPIC™ motor and the associated controller/inverter to the discharge airflow (cfm) indicated in the Schedules in the Contract Documents. Fan airflow (cfm) shall be constant within ± 5% regardless of

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Suggested Specifications

Series Fan Powered VAV Terminal Units MODEL SERIES 35SST "STEALTH™" (continued)

changes in static upstream or downstream of the terminal unit after it is installed in the field. Fan airflow (cfm) is to be set with a potentiometer and digital meter. Neither SCR's nor rheostats shall be an acceptable means of setting the fan airflow (cfm). The terminal unit manufacturer shall provide one speed adjustment device to the Owner for field adjustment of the fan speed should construction or design changes become necessary.

b. A witnessed test shall be conducted by the fan powered terminal unit manufacturer in an independent testing laboratory to confirm that the terminal unit and the fan motor as an assembly performs in accordance with this specification. If the fan powered terminal unit and DC motor as an assembly fails to perform as specified and as scheduled on the drawings, the terminal unit manufacturer shall make adjustments and take all corrective action as necessary at the terminal unit manufacturer's sole expense.

7. The terminal unit shall be listed in accordance with UL 1995 as a composite assembly consisting of the terminal unit with or without the electric or hot water heating device.

8. **Heating Option. (Insert Electric or Hot Water Coil Spec.)**

9. The terminal unit shall be capable of operation as described herein with inlet static pressure of not more than 0.05" w.g. at full cooling with no mixing of induced and primary air. **[The sequence of operation should be described here if not part of the temperature controls specifications.]** The primary air damper shall be of a design that shall vary primary air supply in response to an electronic signal. Primary air damper close-off leakage shall not exceed 2% of the maximum ARI rated primary air cfm as shown in the manufacturer's catalog for each size terminal unit at 3" w.g. inlet static pressure. Submit damper leakage test data to the Engineer for review. Damper linkage and actuator shall be located inside the terminal unit. Damper connection to the operating shaft shall be a positive mechanical through bolt connection to prevent any slippage. Provide non-lubricated Celcon® or bronze oilite bearings for the damper shaft. The primary air damper in conjunction with the DDC controller furnished under Division 17 shall be selected to provide accurate control at low primary air velocities. The total deviation in primary airflow shall not exceed ± 5% of the primary airflow (cfm) corresponding to a 300 fpm air velocity through the primary air damper.

10. Provide a mixing chamber to provide mixing of primary air and plenum air from 100% primary air to 0% primary air. Mixing of the primary and secondary air streams shall be as described in paragraph 2.03 D. The deviation of fan supply air at design conditions and primary air flow rates from 100% primary air to 0% primary air shall not exceed 5%.

11. Provide duct inlet and outlet connections as indicated on the Drawings.

12. A double wall galvanized sheet metal housing shall be provided for the terminal unit casing. The casing construction shall be a minimum 20 gauge outer sheet with a minimum 22 gauge perforated or 26 gauge solid inner sheet encapsulating minimum 3/4" thick, dual density, minimum 1½ lb. density fiberglass insulation. The terminal units utilizing 22 gauge perforated inner sheets shall have reinforced foil faced fiberglass insulation. Each terminal unit shall incorporate the Nailor "Stealth™" attenuator for low radiated noise generation. The terminal units shall not exceed the depth indicated on the Drawings. Mounting connections for hanging the unit by sheet metal straps shall be clearly identified on the housing. All components, including all controls and wiring, shall be factory installed,except the room sensor or thermostat. No field assembly will be allowed. The unit shall be complete and suitable to accept the following field connections:

a. Primary duct.
b. Secondary duct.
c. Single point electrical connection. See Drawings for control box locations required for each terminal unit.
d. DDC controller control signals and wiring.
e. Room sensor connection.

B. The terminal unit shall be capable of operating throughout the full cataloged primary airflow range with an inlet static pressure of 0.10" w.g. or less. All downstream static pressure requirements are to be supplied by the terminal unit internal fan. See the schedules on the Contract Documents for static pressure requirements.

C. The control sequence shall be as specified in Division 17 (DDC by others).

D. Each size of each terminal unit to be used on this Project shall be completely laboratory tested for air performance and acoustics. The acceptability of the independent testing laboratory is subject to review by the Owner, Project Acoustical Consultant, and the Engineer. The terminal unit manufacturer shall submit complete details, brochures, instrumentation information, etc., for review. The laboratory shall be capable of properly testing the largest terminal unit on this Project. See paragraph 1.06 B for acoustic guidelines. The air volume listed on the Drawings for the terminal units shall be supplied for the test with the primary cold duct supplying 48°F air and the plenum bypass air at 80°F. At primary air damper or valve positions as indicated hereinafter and with an inlet static pressure of 0.20" w.g., 0.50" w.g., and 1.0" w.g. the unit shall be capable of producing a mixed airstream of which the temperature shall not vary more than 2.5°F over the duct 48" downstream of box for each 30°F temperature difference between the temperatures of the entering warm and cold air. The variation of temperature shall be proportionally less at smaller temperature differences. There shall be at least fifteen temperature readings made at the discharge outlet duct over the entire discharge area as described in ARI 880 with the air entering the unit in each of the following proportions:

1. 25% cold air and 75% plenum air.
2. 50% cold air and 50% plenum air.
3. 75% cold air and 25% plenum air.

Operation of the flow control device shall be demonstrated to repeat under all conditions of operation of the primary air damper or valve and duct pressures as specified hereinbefore. If the VAV fan powered terminal unit manufacturer has conducted the hereinbefore specified air performance and air mixing tests and has demonstrated to the Engineer and Owner compliance with the specified criteria the previous testing will be accepted and will not need to be repeated. Test results shall clearly state fan performance at test altitude and at Project altitude. See Section 15 - - - Design Conditions.

E. After the manufacturer has submitted certified copies of the laboratory air performance and acoustical performance test results to the Engineer, the Engineer may witness the laboratory tests to verify compliance with the Specifications. See Section 15 - - - General for additional submittal and certification requirements.

F. All fan powered terminal units shall be identified on the bottom of the unit (minimum 1/2" high letters) and on the shipping carton, with

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Series Fan Powered VAV Terminal Units MODEL SERIES 35SST "STEALTH™" (continued)

the floor and box number that identifies it along with the airflow (cfm) settings. Every unit shall have a unique number combination that matches numbers on the contractor's coordination drawings as to its location and capacity and is coordinated with the DDC controller and the Division 17 Building Control System submittal drawings.

G. The terminal unit manufacturer will verify the operation of each fan powered terminal before shipment. Testing shall include at least the following:

1. Apply electric power to the unit.
2. Start the fan and verify fan rotates properly.
3. The terminal unit manufacturer shall factory or field adjust the GE ECM™ and/or Nailor EPIC™ motor and associated controller/inverter to the discharge airflow (cfm) indicated in the Schedules. (Refer to paragraph 2.03 A.6.a. hereinbefore.)
4. Energize the electric heat through the electric heating coil relay. Verify the signal with a volt meter and ammeter to ensure proper heater operation.
5. De-energize the electric heating coil and verify the signal with a volt-meter to ensure the heater is de-energized.
6. If DDC controls are mounted, disconnect the primary air damper actuator from the DDC terminal unit controller. Provide separate power source to the actuator to verify operation and rotation of damper. Drive the damper closed and verify by feel or observation that damper is driven fully closed. Return primary air damper to the fully open position prior to shipment.
7. Provide a written inspection report for each terminal unit signed and dated by the factory test technician verifying all terminal unit wiring and testing has been performed per the manufacturer's testing and quality assurance requirements.

Heat Options
Electric Heat

Specification Text File

(Insert the following paragraphs).

2.03.A.8 Fan Powered Terminal Unit Electric Heating Coils.

a. Electric heating coils shall consist of open coils of high grade nickel and chromium resistance wire or nichrome elements and insulated with ceramic insulators in galvanized steel brackets, supported in heavy gauge galvanized steel frames. Each unit employing an electric heating coil shall be constructed and installed in accordance with the requirements of the local authorities and shall be UL or ETL listed specifically with the heater as a component of the terminal unit device.

b. Coils shall have the capacities indicated in Contract Documents. Coils rated up through 5 kW shall be single phase, 277 volt, 60 hertz and coils larger than 5 kW shall be three phase, four wire, 480Y/277 volt, 60 hertz. Electric heating coils up to and including 4 kW shall be single stage. Electric coils above 4 kW shall be two stage.

c. Terminal bolts, nuts and washers shall be of corrosion resistant materials. Coils shall be constructed so the installation may be accomplished in accordance with the provisions of the National Electrical Code, for zero clearance. Coils shall be given a 2000 volt dielectric test at the factory.

d. Automatic reset thermal cutouts and an airflow switch shall be furnished for heater protection. An airflow switch shall prove fan airflow before the electric heater can be energized. Both devices shall be serviceable through terminal box without removing heating element from the terminal device. The entire heating element rack shall be removable through an access panel with a hinged door without disturbing the duct connection.

e. Heating coils shall have a terminal box and cover, with quiet type built-in mercury step controlled contactors for each circuit, branch circuit fusing for each branch circuit if heater is in excess of 48 amps per the NEC, and a static pressure or air flow safety interlock switch for installation in the heater control enclosure. Contactors mounted in terminal units shall be quiet mercury step type for terminal units, which are located above the ceiling in tenant occupied spaces with an acoustical requirement of NC40 or less. Contactors mounted in fan powered terminal units located in other areas may be quiet type magnetic or mercury step contactors. Provide a separate 120 or 24 volt control power transformer with an integral or separately mounted primary and/or secondary overcurrent protection device in accordance with NEC requirements. Provide a door interlocking disconnect switch for each unit.

f. All wiring of built-in devices shall be brought to clearly marked terminal strips. A complete wiring diagram shall be permanently attached to the heating coil panel cover or to the bottom of the terminal unit.

g. Electric heating coils shall be designed for operation with the DDC controller and control system as specified in the Division 17 specification.

h. Heating coils and the associated control panels shall be constructed to mount on the discharge end of the terminal unit. The heating coil control panel NEC required working clearances shall be parallel to the terminal unit discharge duct.

i. Shop Drawings shall be submitted for review as specified in Section 15 - - - General. These Shop Drawings shall indicate specifically the exact construction, materials, internal wiring, NEC working clearances, etc., of the terminal units and electric heating coils to be furnished under these Specifications.

Hot Water Heat

Specification Text File

(Insert the following paragraphs).

2.03.A.8 Fan Powered Terminal Unit Hot Water Heating Coils.

a. Terminal unit hot water heating coils shall be installed completely within the terminal unit casing and enclosing the coil headers, return bends, "U" bends, and the factory piping assemblies. Provide an access door or panel on the bottom of the terminal unit for servicing and cleaning the unit and to completely expose coil headers and any valves supplied by the terminal unit manufacturer.

b. The factory hydrostatic or air pressure test of the coil and entire piping assembly shall be maintained for a minimum of one minute after which each piping joint connection, etc. shall be examined to verify there is no evidence of weeping or leakage. If liquid was used for the pressure testing, it shall be completely drained and blown out of all coils and the internal piping system prior to shipment. If air pressure is used, the entire coil and piping assembly shall be completely submerged under water. Hot water heating coils shall be constructed with copper tubes and either aluminum plate fins or spiral fins. Coils shall have a maximum of 10 fins per inch. Fin thickness shall be 0.0045". Supply and return connections shall be on the same hard drawn

Specification Text File

Suggested Specifications

Series Fan Powered VAV Terminal Units MODEL SERIES 35SST "STEALTH™" (continued)

end of the coil and shall be ASTM B88-72, H23, I-59 Type K hard drawn seamless copper water pipe. Fins shall be bonded to the tubes by means of mechanical expansion of the tubes or by spiral winding under tension.

c. Coils shall have galvanized steel casings on all sides no lighter than 20 gauge.

d. Tubes shall be 1/2" O.D., spaced on 1 1/4" centers and shall have a minimum wall thickness of 0.016". Hot water shall be equally distributed through all tubes by the use of orifices or header design. Water velocity in the tubes shall not exceed five feet per second. The water pressure drop through the coil shall not exceed 10 feet. Heating coil face velocities shall not exceed the maximum face velocity indicated in the schedules on the Contract Documents.

e. Coils shall have manual air vent connections except on those return connections where the coil header piping is designed to be self-venting.

f. Coils and piping assemblies shall be tested at 300 psig static pressure for a working pressure of 250 psig or as indicated on the Contract Document.

g. Coil ratings, calculations, and selection data shall be in accordance with the applicable ARI Standards and shall be submitted with the Shop Drawings.

h. The complete heating coil piping assembly, including all of the listed appurtenances, shall be provided and factory installed by the terminal unit manufacturer. The coil and piping assembly shall be factory pressure tested.

i. All piping, valves, and fittings shall be suitable for the working pressure shown on the Contract Documents. The internal piping shall be sized to limit the velocity to no more than 8 fps at maximum design flow.

Model Substitution Options

Model Series 35S Fan Powered Terminal Units

(Substitute the following paragraph. Deletes "Stealth" option and solid metal liner).
2.03.A.12.
The terminal units shall not exceed the depth indicated on the drawings. Mounting connections for hanging the unit by sheet metal straps shall be clearly identified on the housing. All components, including all controls and allowed. The unit shall be complete and suitable to accept the following field connections.

Model Series 37S Low Profile Series Fan Powered Terminal Unit

Specification Text File

(Substitute the following in body of text).
2.03.A.
Units shall be of 20 gauge construction. Removable access panels or doors of minimum 20 gauge galvanized steel on the top and bottom of the terminal shall provide access to service the fan, electric motor and all internal components.
Insulation: (Replace 3/4" thick, with 1/2" thick)
(Delete "... completely encapsulated between solid outer and inner solid liners,").

(Substitute the following paragraph).
2.03.A.12
The terminal units shall not exceed the depth indicated on the Drawings or 11" whichever is smaller. Mounting connections for hanging the unit by sheet metal straps shall be clearly identified on the housing. All components, including all controls and wiring, shall be factory installed, except the room sensor or thermostat. No field assembly will be allowed. The unit shall be complete and suitable to accept the following field connections:

Model Series 37SST "Stealth™" Low Profile Series Fan Powered Terminal Units

Specification Text File

(Substitute the following paragraph).
2.03.A.
Units shall be of 20 gauge construction. Removable access doors or panels of minimum 20 gauge galvanized steel on the top and bottom of the terminal shall provide access to service the fan, electric motor and all internal components.
Insulation: (Replace 3/4" thick, with 1/2" thick)

PSC Motor
(In lieu of EPIC™/ECM)

(Substitute the following paragraph).
2.03.A.6
Fan motor assembly shall be forward curved centrifugal fan with a direct drive motor. Motors shall be fasco "Engineered for efficiency" or General Electric "Energy Saver" motors specifically designed for use with a single phase, (120, 208 or 277) volt 60 Hertz electric input, Motor shall have built-in overload protection, bearings capable of low rpm oiling and permanently oiled bearings. Motor shall be direct couple to the blower. Provide isolation between fan motor assembly and unit casing in at least 4 locations to eliminate any vibration from the fan to the terminal unit casing. Provide anti-back rotation system or provide a motor that is designed to overcome reverse rotation and not affect life expectancy. An electronic motor speed controller sized and designed for the specific blower motor combination shall be provided to allow infinitely fan speed from the minimum voltage stop to the line voltage signal to the motor. A minimum voltage stop shall be employed to ensure that the fan cannot run in a stall mode.

Specification Text File

Suggested Specifications

Parallel Flow (Variable Volume) Fan Powered Terminals – 35N Series

(Section 15840)

1.01 Furnish and install variable volume parallel fan powered terminal units of the sizes and capacities as indicated on the drawings. Units shall be pressure independent with (pneumatic, analog electronic, digital) controls. Units shall be manufactured by **Nailor Industries Inc.** Model **35N**.

1.02 The entire terminal unit shall be designed and built as a single unit. The units shall be provided with a primary variable air volume damper that controls the air quantity in response to a (thermostat or digital controller/zone sensor). The units shall also include a fan that sequences on and off in response to the (thermostat or digital controller/zone sensor). The space limitations shall be reviewed carefully to ensure that all units will fit into the space allowed.

1.03 Unit casings shall be 20 ga. galvanized steel. Unit shall be fully lined with fiberglass insulation which shall be at least 3/4" (19 mm) thick dual density insulation complying with NFPA 90 for fire and smoke resistivity and UL 181 for erosion. Any cut edges of insulation shall be coated with NFPA 90 approved sealant.

1.04 The terminal casing shall have full size bottom access panels for easy access to motor and blower assembly and for maintenance and replacement of parts without disturbing duct connections. Access panels shall be attached to casing with (screws, 1/4 turn fasteners).

1.05 Units shall have round inlets for the primary air connections and shall have a minimum 6" (152 mm) deep inlet duct collar for field connection. Models with no heat or electric heat shall have rectangular outlets suitable for flanged duct connections. Models with hot water coils shall have a discharge opening with slip and drive connection. Casing shall have mounting area for hanging by sheet metal straps from a concrete slab.

1.06 The damper shall be round and of laminated 2 x 20 ga. galvanized steel construction with a peripheral gasket and a solid steel 1/2" (13 mm) diameter shaft, pivoted in self-lubricating bronze oilite bearings. Damper leakage shall not exceed 2% of the terminal rated airflow at 3" w.g. (750 Pa) inlet static pressure.

1.07 Entire terminal unit shall be factory assembled with (pneumatic, analog electronic, digital) controls. All components including all controls except the room (thermostat or zone sensor) and (pneumatic piping, field wiring) shall be factory installed and mounted with the unit.

1.08 Provide a (pneumatic, analog electronic, digital) flow control device that will limit the maximum and minimum airflow to that scheduled on the drawings. Control of the terminal unit shall be pressure independent.

1.09 (The sequence of operation should be described here, if not part of the temperature controls specifications).

1.10 Blower casings shall be constructed of heavy gauge coated steel. Blower wheel shall be forward curved centrifugal type, dynamically balanced and driven by direct drive, single speed split capacitor motors. Motors shall be suitable for (120, 208, 240, 277 volts) single phase power. Motors shall have built-in overload protection, bearings capable of low rpm oiling, permanently oiled bearings and a built-in, anti-backward rotation device. Fan assembly shall be mounted so as to isolate the casing from the motor and blower vibration at no less than four points. Isolation shall be supplied at the motor and at the blower mounting points. A gasketed backdraft damper shall be included on the fan discharge to preclude primary air leakage back into the plenum space.

1.11 A solid state SCR fan speed controller sized and designed for the specific blower motor combination shall be provided to allow infinitely adjustable fan speed from the minimum voltage stop to the line voltage signal to the motor. A minimum voltage stop shall be employed to ensure that fan cannot run in stall mode.

1.12 Units shall incorporate a single point electrical (and pneumatic) connection for the entire unit. All electrical components shall be ETL listed or recognized and installed in accordance with the National Electrical Code. All electrical components shall be mounted in a control box. The entire assembly shall be ETL listed and labeled to meet UL 1995 and CSA C22.2 No. 236.

1.13 All sound data shall be compiled in an independent laboratory and in accordance with the latest version of ARI 880. All units shall be ARI certified and bear the ARI certification label.

1.14 Unit maximum radiated and discharge sound power levels with fan only and 0.25" w.g. (63 Pa) discharge static pressure shall not exceed the values in Tables 1 and 2 at the specified airflow. No credit or reduction shall in any way be considered for room, plenum, ceiling, downstream duct, elbows and/or similar item effects.

Unit Size	Airflow		Sound Power Octave Band Center Frequency (Hz)					
	cfm	l/s	2	3	4	5	6	7
			125	250	500	1000	2000	4000
2	400	189	50	49	49	42	34	30
3	700	330	61	58	58	54	50	46
5	1000	472	64	57	57	52	47	44
6	1500	708	67	62	62	58	55	53

Table 1. Maximum Radiated Sound Power Levels. Heating Cycle (Fan only).

Unit Size	Airflow		Sound Power Octave Band Center Frequency (Hz)					
	cfm	l/s	2	3	4	5	6	7
			125	250	500	1000	2000	4000
2	400	189	54	44	47	42	38	33
3	700	330	56	53	56	51	46	42
5	1000	472	54	52	54	52	48	45
6	1500	708	61	62	62	61	57	55

Table 2. Maximum Discharge Sound Power Levels. Heating Cycle (Fan only).

1.15 Unit maximum radiated and discharge sound power levels with 100% primary air and fan off at 1.0" w.g. (250 Pa) inlet pressure and 0.25" w.g. (63 Pa) discharge static pressure shall not exceed the values in Table 3 and 4 at the specified airflow. No credit or reduction shall in any way be considered for room, plenum, ceiling, downstream duct, elbows and/or similar item effects.

Unit/ Inlet Size	Airflow		Sound Power Octave Band Center Frequency (Hz)					
	cfm	l/s	2	3	4	5	6	7
			125	250	500	1000	2000	4000
2 – 08	700	330	62	57	51	39	38	36
3 – 10	1100	519	61	56	51	42	40	40
5 – 12	1600	755	60	58	51	43	43	42
6 – 14	2100	991	60	56	52	44	43	44

Table 3. Maximum Radiated Sound Power Levels. Cooling Cycle (100% primary air and fan off).

Unit/ Inlet Size	Airflow		Sound Power Octave Band Center Frequency (Hz)					
	cfm	l/s	2	3	4	5	6	7
			125	250	500	1000	2000	4000
2 – 08	700	330	65	64	58	54	52	54
3 – 10	1100	519	62	65	59	52	54	55
5 – 12	1600	755	64	67	62	54	56	58
6 – 14	2100	991	63	63	60	54	55	56

Table 4. Maximum Discharge Sound Power Levels. Cooling Cycle (100% primary air and fan off).

Suggested Specifications

Parallel Flow (Variable Volume) Fan Powered Terminals – 35N Series (continued)

Options

Electric Heat

Substitute the following paragraphs:

1.01 Furnish and install variable volume parallel fan powered terminal units with integral electric heat of the sizes and capacities as indicated on the drawings. Units shall be pressure independent with (pneumatic, analog electronic, digital) controls. Units shall be manufactured by **Nailor Industries Inc.** Model **35NE**.

1.12 An electric heater shall be factory mounted and pre-wired as an integral package with the fan powered terminal unit. Heaters shall be sized as shown on the drawings. The entire assembly including the electric heater shall be ETL listed for zero clearance and so labeled and shall meet all requirements of the latest National Electrical Code, CSA C22.2 No.236). The unit shall have a single point electrical (and pneumatic) connection. Heater casing and panel shall be a minimum of 20 ga. galvanized steel. Each heater shall be complete with automatic reset high limit thermal cut-outs, control voltage transformer as required, ground terminal, fan relay for interlocking the heater and fan and high grade nickel chrome alloy resistance wire.

Element wires shall be suspended in insulators designed to expose the entire face area of the wire thereby eliminating hot spots. Each heater shall be supplied with factory supplied and pre-wired branch circuit fusing as required by NEC and UL. Circuiting and fusing shall also be in accordance with the circuiting requirements as shown on the plans.

Additional accessories shall include (control transformer, circuit fusing, disconnect switch, SCR controller, pneumatic electric switches) for staging the heater. (Additional performance requirements that you might want to include can be found in the electric heater section). The electric heater shall be located on the discharge side of the fan so as not to add heat to the motor and shorten its expected lifetime.

Coils rated up through 5 kW shall be single phase, 277 volt, 60 Hz and coils larger than 5 kW shall be three phase, four wire wye, 480 volt, 60 Hz. Electric heating coils up to and including 4 kW shall be single stage. Electric coils above 4 kW shall be two stage.

Hot Water Heating Coils

Substitute the following paragraphs:

1.01 Furnish and install Variable Volume Parallel Fan Powered Terminal Units with integral hot water coils of the sizes and capacities as indicated on the drawings. Units shall be pressure independent with (pneumatic, analog electronic, digital) controls. Units shall be manufactured by **Nailor Industries Inc.** Model **35NW**.

1.12 A hot water coil shall be factory mounted as an integral package with the fan powered terminal unit. Hot water coils shall be sized as shown on the drawings. The entire assembly including the hot water coil shall be ETL listed for zero clearance and so labeled and shall meet all requirements of the latest National Electrical Code (CSA C22.2 No.236). The unit shall have a single point electrical (and pneumatic) connection. Access panels on the bottom of the unit shall permit easy access to the coil for inspection and cleaning. Coils shall be 1, 2 or 3 row as required and heating capacities shall be as shown on the plans. Coils shall have aluminum plate fins spaced 10 per inch and bonded to 1/2" (13 mm) O.D. copper tubes. Copper connections shall be sweat. All coils shall be tested at a minimum of 300 psi under water to produce a guaranteed working pressure of 250 psi. Controls and valves for the hot water coils shall be field mounted. Heating coils shall be located on the discharge side of the fan so as not to add heat to the motor and shorten its expected lifetime.

Liner Options:

(Substitute in the appropriate specification section)

Steri-Liner

Unit shall be fully lined with non-porous, sealed liner which complies with NFPA 90A and UL 181. Installation shall be 13/16" (21 mm) minimum thickness, 4 lb. density with reinforced aluminum foil-scrim-kraft (FSK) facing. All cut edges shall be secured with steel angles or end caps to encapsulate edges and prevent erosion. Insulation shall be Nailor Steri-Liner or equal.

Fiber-Free Liner

Unit shall be fully lined with a non-porous closed cell elastomeric foam liner which complies with NFPA 90A, ASTM E84 and UL 181. Installation shall be 3/4" (19 mm) minimum thickness and secured to the interior of the terminal with mechanical fasteners. No fiberglass is permitted. Insulation shall be Nailor Fiber-Free Liner or equal.

Suggested Specifications

Control Specifications (select one)

Pneumatic Controls (Pressure Independent)

1. The terminal unit manufacturer shall provide factory mounted pressure independent controls which can be reset to modulate airflow between zero and the maximum cataloged capacity. Maximum airflow limits or mechanical volume regulators are not acceptable.
2. Each unit shall be supplied with a **Nailor** 'Diamond Flow' sensor with four pick-up points on each side to ensure that controller fidelity shall be within ± 5% of set volume under various same size duct inlet conditions and inlet static variation of 0.05" – 6.0" w.g. (13 – 1493 Pa). The sensor shall amplify the sensed velocity pressure and provide a minimum differential pressure of 0.03" w.g. (7 Pa) at 500 fpm (2.54 m/s) inlet velocity. Flow measuring taps shall be furnished with each terminal.
3. The reset volume flow controller shall have a constant reset span regardless of the minimum and maximum airflow settings selected. Reset span shall be adjustable from a minimum of 5 psi up to a maximum of 10 psi. Reset start point shall be adjustable from 3 – 10 psi. Controller air bleed off through the flow sensor is not acceptable. Controller shall be field convertible for direct or reverse acting. The compressed air consumption of the controller shall not exceed 1.0 SCFH at 20 psi. Acceptable controller is Kreuter CSC-3011 or equal.
4. Reset volume controller shall be factory calibrated and set for the scheduled maximum and minimum airflow settings. Flow measuring taps and flow charts shall be supplied with each terminal unit for field balancing and adjustment of airflow. All pneumatic tubing shall be UL listed fire retardant (FR) type. Each terminal shall be supplied with a label showing unit type, size, tag location, minimum and maximum airflow settings and control sequence number. Pneumatic spring return actuators shall be provided and factory mounted by the terminal unit manufacturer.
5. Reset volume controller shall be factory set and calibrated for operation with a direct/reverse (select one) acting room thermostat. The actuator/damper connection shall be factory mounted to fail to a normally open/closed (select one) position upon loss of control main air pressure.

Analog Electronic Controls (Pressure Independent)

1. The terminal unit manufacturer shall provide factory mounted pressure independent analog electronic controls which can be reset to modulate airflow between zero and the maximum cataloged capacity. Each terminal shall be equipped a label showing unit type, tag location, minimum and maximum airflow settings and control sequence number. Controls shall be factory calibrated and set for the scheduled minimum and maximum flow rates.
2. Each unit shall be supplied with a **Nailor** 'Diamond Flow' sensor with four pick-up points on each side to ensure that controller fidelity shall be within ± 5% of set volume under various same size duct inlet conditions and inlet static variation of 0.05" – 6.0" w.g. (13 – 1493 Pa). The sensor shall amplify the sensed velocity pressure and provide a minimum differential pressure of 0.03" w.g. (7 Pa) at 500 fpm (2.54 m/s) inlet velocity. Flow measuring taps shall be furnished with each terminal. All pneumatic tubing shall be UL listed for fire retardant (FR) type.
3. The velocity controller shall have a constant 2°F (1.11°C) reset span regardless of minimum and maximum airflow limits. It shall include an onboard flow-through transducer utilizing twin platinum resistance temperature detectors and shall be capable of controlling a velocity setpoint from 0 – 3300 fpm with an accuracy of 3%. The controller shall allow all airflow adjustments to be made from the matching room thermostat. The thermostat shall be furnished by the terminal unit manufacturer and provide a live velocity readout and feature semi-concealed setpoint slider(s) and setpoint indicator(s) and thermometer with a fahrenheit (centigrade optional) scale plate.
4. The terminal shall have a 24 VAC combination controller/actuator single assembly. The actuator shall be of a direct drive design and provide a minimum torque of 50 in. lbs. (5.6 Nm). The actuator shall be of the floating reversible type and include a magnetic clutch, adjustable stops and a gear disengagement button. A tri-color LED shall indicate green for opening, red for closing and white for satisfied damper positions. Power consumption of the controller/actuator shall not exceed 4 VA.
5. The terminal manufacturer shall provide a Class 2, 24 VAC control transformer with internal current limiting protection. All controls shall be installed in an approved NEMA 1 enclosure.

Digital (DDC) Controls (Pressure Independent) Factory Mounting Procedure

1. The terminals shall be equipped with pressure independent direct digital controls supplied by the controls contractor under the automatic temperature controls division 17 and mounted by the terminal unit manufacturer. The controls contractor shall, in addition to sending the controls to the terminal unit manufacturer, provide technical data sheets for all components to be mounted, including dimensional data, mounting hardware and method, as well as application specific wiring and piping diagrams for each terminal type as depicted on the schedules and mechanical drawings.
2. Controls shall be compatible with the pneumatic 'Diamond Flow' multi-point averaging flow sensor supplied by the terminal manufacturer. The sensor shall have four pick-up points on each side to ensure that controller fidelity shall be ± 5% of set volume with any typical air turbulence in the duct and any typical flex inlet condition and with an inlet static variation of 0.05" w.g. to 6.0" w.g. (12 – 1500 Pa). The sensor shall amplify the sensed velocity pressure and provide a minimum differential pressure of 0.03" w.g. (7 Pa) at 500 fpm (2.54 m/s) inlet velocity. Flow measuring taps and flow curves shall be furnished with each terminal.
3. Controls shall be configured and field calibrated in the field by the controls contractor after terminal installation has been completed. Pneumatic tubing shall be UL Listed fire retardant (FR) type. Each terminal shall be supplied with a label showing unit type, size and tag location.
4. The terminal manufacturer shall provide a Class 2, 24 VAC control transformer with internal current limiting protection and disconnect switch. All controls shall be installed in an approved NEMA 1 enclosure supplied and installed by the terminal manufacturer.