OPERATION

Parallel type fan terminals are arranged such that the primary air is controlled at the inlet of the terminal, typical of single duct terminals, with varying primary air quantities delivered to the space. The fan is located out of the primary air stream, and upon start-up, delivers air to the space in addition to the primary air. 100% of fan air flow is ceiling plenum air, also commonly called induction air. Since the fan typically operates during heating modes only, these types of fan terminals are often called intermittent fan terminals. A diagrammatic plan view of Anemostat's Model QPT parallel fan terminal is shown in Figure 4:

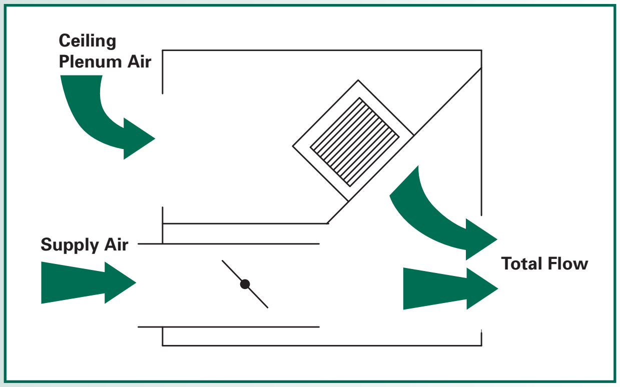

Figure 4: Model QPT Parallel Fan Terminal

Conditioned, primary air is delivered to the terminal, from a central system, through a duct, into the fan terminal cabinet. The quantity of primary air is often regulated by a pressure independent control system, responsive to the space thermostat (temperature). During cooling modes, the primary air flow rate to the space varies (VAV) to match the load, while the unit fan remains off. As the space temperature enters the heating mode, typically the primary air at minimum, the unit fan is energized. The fan induces ceiling plenum air into the cabinet, and discharges the air into the discharge duct, mixing with the minimum primary air. Supplemental heat is then added as required to meet heating loads. A flow diagram is shown in Diagram 5.

SYSTEM PRESSURE

The central system needs to provide the minimum terminal operating pressure at maximum design flow in addition to the pressure requirements after the fan terminal, for the discharge duct and outlets. Minimum operating pressures shown for Model QPT are differential pressures across the fan terminal only.

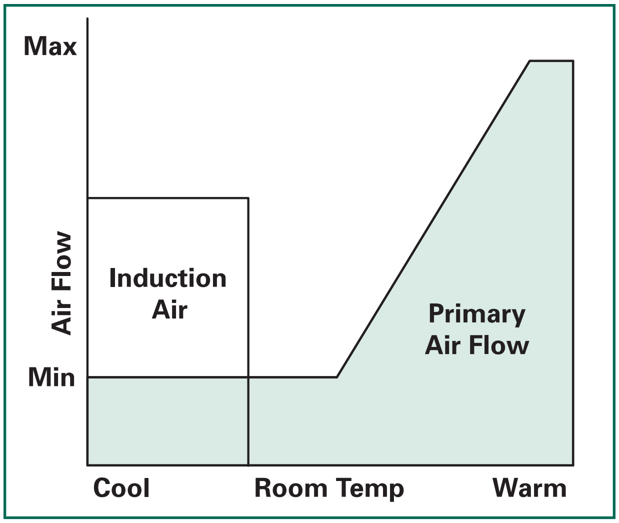

Diagram 5: Air Flow Diagram Parallel Fan Terminal

ACOUSTICS

Since the unit fan operates intermittently but energizes instantaneously, there are abrupt changes in terminal unit sound levels from cooling to heating modes. Further, the outlet sound levels will increase with additional fan air flow. The radiated sound is often the dominant path to the space, and requires sufficient analysis to insure acceptable space sound pressure levels. Radiated sound levels may be adequately controlled by selecting terminal unit fans operating at less than maximum RPM.

Selection Procedures for Parallel Fan Terminals

General

The specific selection examples given will provide the procedure required to properly select Parallel type fan terminals. Often, the selection process is iterative, requiring re-selection in order to meet all performance requirements.

Performance Criteria

The performance requirements of the fan terminals are predetermined by load calculations for both heating and cooling loads, supply air and ceiling plenum air temperatures, air change rates, acoustical requirements, etc. With these design criteria, fan terminals are selected for:
Fan Capacity
Heating Coil Capacity
Primary Inlet Capacity
Acoustical Requirements

Fan Capacity

The fan capacity is typically sized for 50-60% of the maximum cooling load handled by the conditioned primary air, and is determined by the maximum heating load of the space. In selecting the proper fan, the external or downstream static pressure (DSP) in the discharge duct must be determined. With the required fan capacity (CFM) and external static pressure known, refer to the fan curves to select a cabinet (fan) size that operates at this design point. The curve axes are Fan CFM vs. Downstream Static Pressure (DSP), and define the maximum to minimum operating range available for that unit size. The design operating point should fall between the maximum and minimum fan capacity curves. When a heating coil is used, the maximum capacity curve is shown with the coil.

Heating Coil Capacity

The space-heating load is calculated for MBH (thousands of BTU/hr), at winter indoor design temperature. From this, the coil leaving air temperature (LAT), at the design airflow rate (fan capacity) is determined. This is the heating supply air temperature to the space. The heat output from the coil can then be determined giving the air temperature rise required to bring the coil entering air temperature (EAT) up to the required coil LAT. During heating, the coil entering air is typically a mixture of both ceiling plenum air and minimum primary air and the mixed temperature can be calculated for the coil EAT. Coil heat transfer equations are given in the examples to follow.

Primary Inlet Capacity

The inlet size selected is based on both the maximum and minimum primary airflow rates.

The maximum primary airflow rate determines the minimum operating pressure requirement for the terminal. This is the pressure required in the inlet supply duct for the maximum primary airflow rate with the damper in the full-open position. Minimum operating pressure requirements are provided for each inlet size in table 52 page D-47. For flow control, both the maximum and minimum primary airflow rates must fall within the Primary CFM Ranges as shown in table 33 on page D-46. The primary ranges shown represent limitations of the controlling devices. For direct digital controls provided by the control contractor, the controllable range is dependent upon the controller.

Acoustical Requirements

For parallel type fan terminals, the maximum sound levels may occur during full cooling with maximum primary airflow, or during heating when the fan is energized. Both operating conditions should be evaluated to determine which condition dictates the space sound level. Radiated sound levels typically dictate the space sound pressure levels. A space NC level is easiest to specify, but attenuation assumptions for the path should be carefully verified. A detailed analysis using AHRI Standard 885 in predicting space sound pressure levels, to determine the maximum permissible octave band sound power levels of the fan terminal is preferred.

Example 1

Model QPT Parallel Fan Terminal with Hot Water Heat

Select Cabinet for Fan Capacity

Required information:

Design Cooling Airflow	1550 CFM
Design Min Ventilation Air	200 CFM
Required Fan Airflow	800 CFM
Fan Downstream Static Pressure (DSP) at design airflow	0.25" wg
Fan Motor Voltage	277 volts

From the fan curves on page D-50, select terminal size QPTW-2-25, assuming a 1 row coil. This terminal selection is capable of delivering the design flow by adjusting the fan speed with the manual SCR speed controller, and/or by changing the motor HP taps. The fan curves represent the upper and lower operating limits of the fan terminal. The desired operating point must fall below the appropriate high-speed curve (basic assembly, 1 row, 2 row hot water coil) and above the minimum speed curve.

Select Hot Water Coil

Required information:

Winter indoor design temp.	70° F
Entering Water Temp. (EWT)	180° F
Space heating load	28,000 Btu/Hr
H.W. Coil Airflow	1000 CFM
Primary air temperature	55° F
Ceiling plenum temperature	73° F

The space-heating load is the heat loss rate of the space, and therefore, the heat added to the space by the supply air must be 28,000 Btu/Hr (or 28 MBH). The discharge air temperature required from the fan terminal to the space may be calculated from equation (1):

Equation 1

Q = CFM x ∅T x 1.08

Where,
Q is energy rate in Btu/hr
CFM is volumetric airflow rate
∅T is (Supply Air Temp – Space Temp)

28,000 Btu/Hr =
1000 CFM x (Supply air temp - 70°F) x 1.08

or, Supply air temp = 96°F

The hot water coil must provide a discharge temperature or leaving air temperature (LAT) of 96°F at an airflow rate of 1000 CFM (a blend of 200 CFM minimum primary air + 800 CFM of ceiling plenum air) to maintain the space temperature of 70°F. The hot water coil entering air temperature (EAT) is calculated from the mixture of primary and

ceiling plenum air, equation (2):

Equation 2

Design Flow x Coil EAT =
(Primary Flow x Primary Temp) +
(Plenum Air x Plenum Temp)

1000 CFM x Coil EAT =
(200 CFM x 55°F) + (800 CFM x 73°F)

or, Hot Water Coil EAT = 69°F

Since the air temperature entering the coil is less than the space temperature, the coil heat output is greater than the space-heating load. The hot water coil heat output, Q, is calculated in Btu/hr using equation (1):

Q = CFM x ∅T x 1.08

Q = 1000 x (96°F - 69°F) x 1.08

Q = 29,160 Btu/Hr or 29.2 MBH

Where ∅T is the temperature rise of the air across the coil (LAT-EAT).

Refer to the QPTW cabinet size 2, 1 row hot water coil performance data on page D-42. The data tables are based on a coil EWT-EAT of 125°F, as noted at the bottom of the page. For this example, the EWT-EAT is 180°F - 67°F = 113°F. By interpolation, the adjustment factor is .90. At 2 GPM, for 1000 CFM, find 33.4 MBH (Table 48) x .90 (factor) = 30.0 MBH, which meets the minimum requirement of 29.2 MBH, as calculated above.

Select Primary Inlet Size:

Required information:
Maximum primary airflow 1550 CFM
Minimum primary airflow 200 CFM

Refer to the primary airflow capacity tables on page D-46, select the inlet size and flow range for the 1550-200 CFM operating range of this fan terminal.

If the design flow rates do not fall within range, the minimum primary flow rate must be increased as required. The heating coil selection must be repeated if the minimum primary airflow is changed.

Inlet size selected (analog controls): 12" ø

Minimum operating total

Pressure required (table 52, pg D-47) Cabinet size 2, 12" inlet with 1 row hot water coil = .08" (terminal) + .14" (1 row coil) = .22" w.g.

Verify Acoustical Acceptance:

The terminal radiated sound levels typically dictate the room sound pressure level, and therefore, are evaluated at maximum cooling capacity and also maximum heating capacity at the expected system inlet static pressure. An acoustical analysis using AHRI Std 885 Appendix E attenuation assumptions for predicting space sound pressure levels determines the allowable sound power levels of the fan terminal to meet NC levels. From the typical NC design values in table 3, page D-71, for an open office space:

Required information:
Design inlet static pressure 1.0" w.g.
Noise Criteria NC-37
Max radiated sound power levels, Lw. by octave band, for both 100% Primary Flow condition and 100% Fan Flow condition as determined by AHRI 885 Calculations:

Octave Band	2	3	4	5	6	7
Sound Power	72	66	62	64	67	71

For Model QPT-2-25:
Primary Radiated Sound Power, 12", 1550 CFM, 1" Inlet Ps (table 56, pg D-57)

Octave Band	2	3	4	5	6	7
Sound Power	60	56	49	45	45	41

Fan Radiated Sound Power, 800 CFM (table 55, pg D-56)

Octave Band	2	3	4	5	6	7
Sound Power	60	62	56	54	52	49

The sound power levels for this terminal are below the maximum allowable as determined by AHRI 885 prediction methods. If fan terminal sound power or NC levels are too high, re-select a larger cabinet (fan) at reduced operating speeds, and recheck performance criteria.

Example 2

Model QPTE Series Fan Terminal with Electric Heat

Select Cabinet for Fan Capacity

Required information:
Design fan airflow 400 CFM
Downstream Static Pressure (DSP) at design airflow .25" wg
Fan Motor Voltage 277 volts
Electric Heat Voltage 277 volts

From the fan curves on page D-48, select QPTE cabinet size 1-25 (QPTE-1-25).

Select Electric Heating Coil

Required information:
Winter indoor design temp. 72°F
Space heating load 14,000 Btu/Hr
Minimum primary CFM 150 CFM
Primary air temperature 58°F
Ceiling plenum temperature 75°F

The discharge air temperature required from the fan terminal to the space may be calculated from equation (1):

Equation 1

Q = CFM x ØT x 1.08

Where,
Q is energy rate in Btu/hr
CFM is volumetric airflow rate
ØT is (Supply Air Temp – Space Temp)

14,000 Btu/Hr =
550 CFM x (Supply air temp - 72°F) x 1.08

or, Supply air temp = 96°F

The electric coil must provide a discharge temperature or leaving air temperature (LAT) of 96°F at an airflow rate of 550 CFM (a blend of 150 CFM minimum primary air + 400 CFM of ceiling plenum air) to maintain the space temperature of 72°F. The coil entering air temperature (EAT) is calculated from the mixture of primary and ceiling plenum air:

Design Flow x Coil EAT =
(Primary Flow x Primary Temp) +
(Plenum Air x Plenum Temp)

550 CFM x Coil EAT =
(150 CFM x 58°F) + (400 CFM x 75°F)

or, Electric Coil EAT = 70°F

Since the air temperature entering the coil is less than the space temperature, the coil heat output is greater than the space-heating load. The electric coil heat output, Q, is calculated, in Btu/hr by:

Q = CFM x ØT x 1.08

Q = 550 x (96°F - 70°F) x 1.08 = 15,440 Btu/Hr
where ØT is the temperature rise of the air across the coil (LAT-EAT).

Converting to Kilowatts

15,440 Btu/Hr x 1 Kw / 3,412 Btu/Hr) = 4.6 Kw

The heating coil selection must be repeated if the minimum primary airflow is changed.

Select Primary Inlet Size:

Required information:
Maximum primary airflow 400 CFM
Minimum primary airflow 150 CFM

Refer to the primary airflow capacity tables on page D-46, select the inlet size for the 400-150 CFM operating range of this fan terminal.

If the design flow rates do not fall within range, the minimum primary flow rate must be increased as required. The heating coil selection must be repeated if the minimum primary airflow is changed.

Inlet size availability: 6" or 7"or 8" ø
Minimum operating
Pressure required (table 52, pg D-47) for 400 cfm:

Cabinet size 1,
6" ø - .18" wg
7" ø - .07" wg
8" ø - .04" wg

Verify Acoustical Acceptance

Required information:
Design inlet static pressure 1.0" w.g.
Max radiated sound power levels, Lw by octave band,
Noise Criteria NC = 32

Max radiated sound power levels, Lw. by octave band, 100% Primary Flow and 100% Fan Flow as determined by AHRI 885 Calculations:

Octave Band	2	3	4	5	6	7
Sound Power	68	62	57	59	62	66

For Model QPT-1-25:

Primary Radiated Sound Power, 6", 400 CFM, 1" Inlet Ps (table 56, pg D-57)

Octave Band	2	3	4	5	6	7
Sound Power	58	56	49	39	41	42

Fan Radiated Sound Power, 400 CFM (table 55, pg D-56)

Octave Band	2	3	4	5	6	7
Sound Power	62	59	51	45	42	37

The sound power levels for this terminal are below the maximum allowable as determined by AHRI 885 prediction methods. Sound power or NC level may be reduced by selecting a large cabinet (fan) at reduced operating speeds.