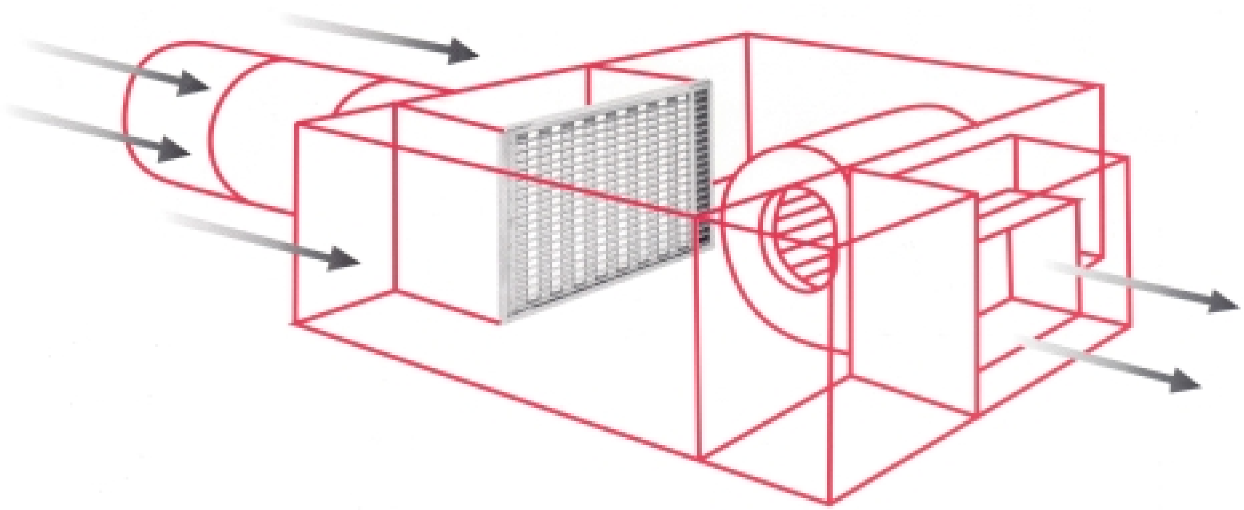
WARREN TECHNOLOGY

QUIET PLUS®

VARIABLE AIR VOLUME

TERMINAL UNITS



Featuring

Zebra®

Precision Air Valves

Model FBC

Constant Volume, Fan Powered

Series Flow

Catalog No. FBC-04

STATEMENT OF PURPOSE

As an established industry leader in the HVAC market, our philosophy is to add value to the industry by providing quality products and services, and to the community by encouraging participation in its development and progress.

We believe in the application of the Golden Rule to all our business relationships ... with our customers, management and employees, stockholders, sales representatives, suppliers, government, and the community; we believe we have definite obligations to each.

We also believe that our customers are entitled to products and services of the highest quality at a fair price. Our objective is to provide complete customer satisfaction. To assure that we meet this goal in our daily operations, management and employees subscribe to the following guidelines:

> ***"Engineer, develop, manufacture and market quality products that meet or exceed industry standards.***
>
> ***Be a dependable source of supply and effect timely deliveries to meet customer needs."***

TABLE OF CONTENTS

Due to a continuous process of product improvement, specifications &/or designs are subject to change at any time without notice and without incurring obligations.

Warren Quiet Plus® VAV Terminal Units

Variable Air Volume Terminal Units regulate the flow of conditioned supply-air into occupied spaces, to assure that comfortable temperature levels are maintained at much lower energy costs than other types of central systems.

Building owners and designers are aware and concerned about HVAC-system noise levels. Traditionally-designed VAV terminal units are often the most significant factor contributing to a noisy indoor environment. This has a significant impact on occupant comfort and productivity.

Advanced technology and experience have been combined by Warren to create a product line of VAV terminal units which offer a quantum improvement in VAV design and performance. Quiet Plus® VAV terminal units offer ultra-quiet operation plus laminar flow and precision control.

Warren Technology has invested extensively in engineering, product design, and testing in order to provide system designers with accurate flow and acoustic performance data.

Innovative, flexible manufacturing processes governed by modern computer-aided design and manufacturing (CAD/CAM) systems allow Warren to adapt quickly to new design requirements.

Model FBC Series-Fan Terminals

The Quiet Plus® FBC unit feeds VAV supply air into a Constant-Volume discharge-fan. The VAV inlet uses the patented Zebra® precision air valve, with superb acoustic performance, laminar flow, and highly accurate control.

Model FBC has six unit sizes, with capacities ranging from 500 to 2300 CFM. Electronic (analog or DDC), electric and pneumatic control packages are available with velocity-sensing pressure-independent or thermostatically-driven pressure-dependent options. Control sequences can be chosen to meet virtually any cooling, heating, or ventilation requirement.

Warren's Electric and Hot Water coils are custom-designed for each application to provide the most reliable, stable operation available.

CONTROLLABILITY

Warren Quiet Plus VAV Terminal Units have lower sound levels than conventional units. Oversizing to attain acceptable sound levels is unnecessary, so selection may be based on controllability, which ensures maximum performance.

Figure 2 shows the effect of airflow rate and ΔP_S on controllability for VAV valves. The maximum operating range of a VAV valve is the physical distance (linear or rotational) in which it modulates. The Effective Operating Range is equal to the maximum operating range minus the amount the valve must close to compensate for the system static pressure at the design airflow rate. Optimum controllability is attained by selecting the smallest sized unit which meets the design airflow and sound requirements.

Effective Operating Ranges of less than 50% are not recommended for VAV terminal units.

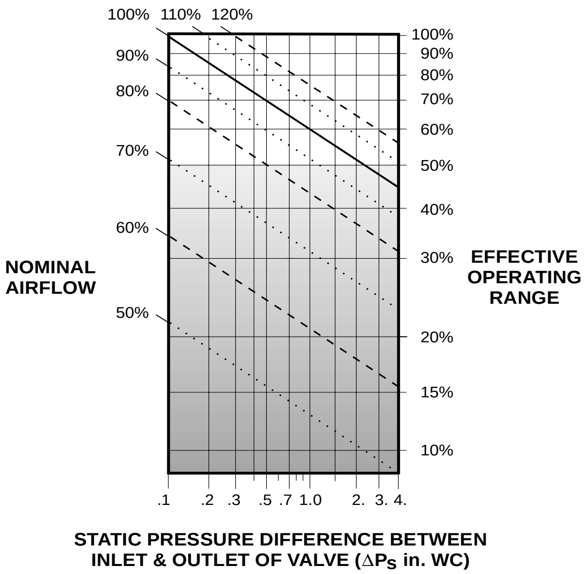


Figure 2. Controllability Graph

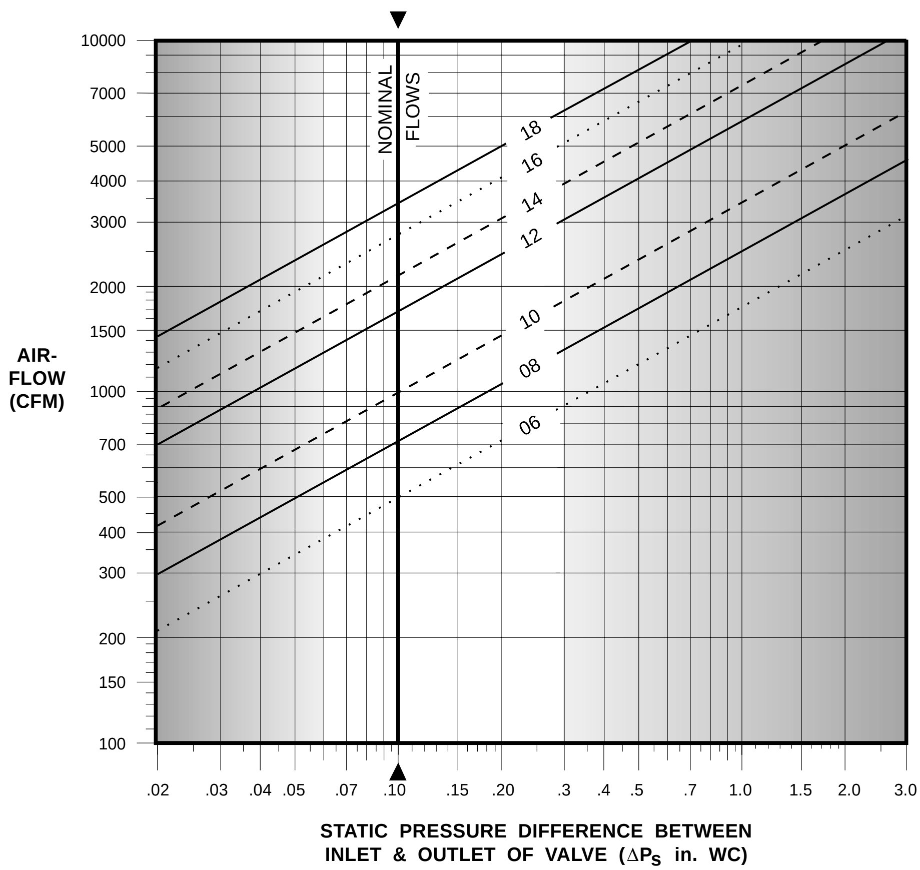


Figure 3. Warren Zebra Valve Airflow Performance Data

AIR FLOW CAPACITIES

Warren's Quiet Plus VAV Units are offered in a full range of terminal sizes to accommodate most specified airflow requirements.

Figure 3 shows airflow performance data (full open valve) for sizes 06-14 inches, given various static pressure differences between the inlet and outlet of the unit (ΔP_S).

Nominal capacities are based on a ΔP_S of 0.10 in. WC, 2000 FPM inlet velocity, 1000 FPM outlet velocity, and 100% effective operating range.

SELECTION PROCESS

A. Design data required:
   1. Discharge CFM (contact factory if inlet CFM is not the same)
   2. External duct static pressure loss (ESP) downstream, not including coil
   3. Inlet static pressure (ISP) = ΔP_S*
   4. Heating requirements in MBH or kW
   5. Maximum allowable NC or Sound Power
   6. Details about box installation and room, for acoustically-critical cases

B. Establish the designation (see page 17 for other order-code details):

   FBCN = No Heat
   FBCE = Electric Heating Coil
   FBCW = Hot Water Heating Coil

C. Select a unit size from Table 1 (page 4) that most closely matches the design cooling CFM. *For optimum controllability, select nominal size or smaller. Oversizing will degrade the effective operating range of the unit.*

D. Confirm that the selected unit's fan will deliver the design CFM at the external duct static pressure loss (ESP) using the fan curves on page 8. Approximate typical electric and hot water coil pressure drops are built into the selection curves.

E. If an electric heating coil is required, confirm that the design kW does not exceed the maximum allowable kW using Formula 6 (page 9). Use Tables 8–10 and the Procedure on pages 10–11 to select a hot water heating coil if required, then double-check the fan-curves.

F. Confirm that the unit size selected does not exceed the maximum allowable NC by using Quick-Select Table 2 (page 5) for acoustically non-critical installations, or for critical installations use tables and formulae in Warren's *Acoustic Applications Guide*. If the unit selected exceeds the maximum allowable NC or Sound Power, then select the next larger unit size and repeat steps D and E.

ΔP_S is always equal to ISP for constant volume terminal units because the downstream static pressure for the unit valve is zero. The external static pressure (ESP) is overcome by the fan.

G. Check the effective operating range of the unit against the design requirements using Figure 2 (page 2); remember ΔP_S = ISP for this unit. Calculate the percent of nominal airflow using the following formula:

$$\text{\% of Nominal Airflow} = \frac{\text{Design CFM}}{\text{Nominal CFM}} \times 100$$

If the effective operating range of the selected unit falls below 50% on the graph, the next smaller unit should be considered. Reselect, and repeat steps D through F.

EXAMPLE (Typical Installation)

A. Given design requirements:
   1. Discharge CFM = Inlet CFM = 1100
   2. External duct (downstream) static pressure loss (ESP) = 0.30 in. WC
   3. Inlet static pressure (ISP) = ΔP_S = 1.0 in. WC
   4. Electric heating coil = 6 kW
   5. Maximum allowable NC = 35
   6. Installation = not acoustically critical

B. Since the design requires electric heat, the model designation is FBCE.

C. Select FBCEB10M from Table 1 (page 4).

D. Using the fan curve on page 8 for an FBCE**C**10H, confirm that the fan will deliver 1100 CFM at 0.30 in. WC external duct static pressure (ESP).

E. Using Formula 6 (page 9), confirm that the required kW does not exceed the maximum allowable (1100 CFM ÷ 70 = 15.7 maximum allowable kW; therefore, 6 kW at 1100 CFM is acceptable).

F. Quick-Select Table 2 (page 5) indicates that the NC of the selected unit does not exceed the maximum allowable NC 35. For size 10H at 1100 CFM with 1.0" ΔP_S, the discharge NC is 23 and the radiated NC is 35.

G. The % of nominal airflow = 1100 ÷ 1000 = 110%. Checking the effective operating range at 110% for 1.0" ΔP_S from Figure 2 (page 2), it is determined that the effective operating range of the unit is 68% (effective operating ranges below 50% are not recommended).

   The design requirements can be met with the selection of model FBCEC10H.

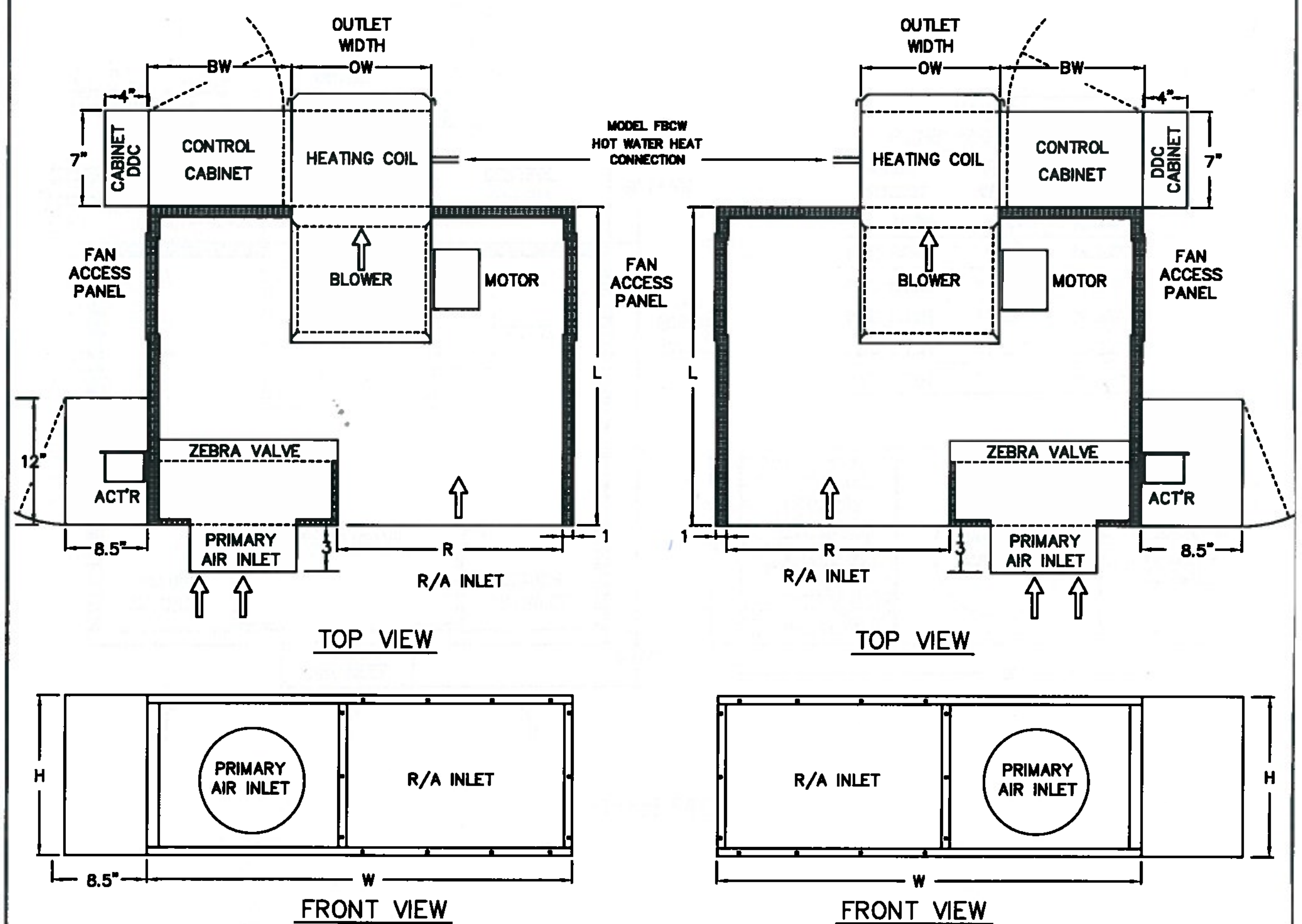
Table 1. Model FBC Capacity and Dimensional Data

Model Number	Inlet Size (in.)	Valve Nominal CFM	Fan Range CFM	Fan HP	Dimensions⑥ W (in.)	H (in.)	L (in.)	Outlet Width (in.)	Outlet Height (in.)	Weight (Est.)⑦ (lbs.)
FBC_A06M	6	500	500–700	1/5	24	15	30	12	10	100
FBC_B08M	8	700	700–1000	1/4	32	15	30	14	10	135
FBC_B10M	10	900	800–1100	1/4	40	15	30	16	10	135
FBC_C10H	10	1000	1000–1400	1/3	40	17	30	14	14⑧	175
FBC_D12H	12	1600	1250–1800	1/2	42	17	30	18	14⑧	185
FBC_E14H	14	2100	1700–2300	3/4	46	17	30	22	14⑧	200

NOTES:

1) Valve nominal CFM based on maximum 2000 FPM inlet velocity, 1000 FPM outlet velocity, and ΔP_s of 0.10 in. WC.
2) Fan range CFM based on 0.40 in. WC external static pressure (see Fan Performance Curves on page 8).
3) FBCN = No heat FBCE = Electric heat FBCW = Hot water coil.
4) FBC units include fan section with motor, fan speed controller, fan relay, single point wiring, door interlock disconnect switch, lined plenum with slip and drive outlet connection and air valve assembly.
5) See page 16 for metric conversion factors.

⑥ Special controls may increase the size of the control cabinet &/or the unit.
⑦ Add 20% to weight for electric heat or 1-row hot water coil; add 30% to weight for 2-row hot water coil.
⑧ Outlet Height increases 1" for these hot water coils (14" → 15").



MODEL FBC – LEFT SIDE POSITION –SP

MODEL FBC – RIGHT SIDE POSITION –STD

Table 2. Model FBC QUICK-SELECT Sound Data, Discharge and Radiated NC Levels

Unit Size	CFM	Min ΔP_s	Min ΔPs		0.5" ΔP_s		1.0" ΔP_s		3.0" ΔP_s	
			Dis	Rad	Dis	Rad	Dis	Rad	Dis	Rad
A06M	500	.10	–	–	–	–	–	20	–	25
	600	.15	–	–	–	22	–	23	–	27
	700	.20	–	–	–	25	–	25	–	30
B08M	700	.10	–	20	–	21	–	24	–	28
	800	.12	–	21	–	23	–	27	–	30
	1000	.18	21	26	23	27	23	30	24	34
B10M	800	.07	–	22	–	22	–	26	–	31
	900	.09	–	25	–	25	–	29	20	32
	1100	.12	20	31	20	32	22	34	23	36
C10H	1000	.10	21	26	21	26	22	31	22	34
	1100	.12	22	32	22	33	23	35	23	37
	1400	.19	25	39	25	40	30	41	30	42
D12H	1250	.06	–	21	–	24	–	30	–	36
	1600	.10	–	25	21	28	22	32	23	38
	1800	.12	22	32	24	33	25	35	26	41
E14H	1700	.06	20	26	22	26	23	31	24	33
	2100	.10	28	35	34	35	35	35	35	38
	2300	.12	31	41	38	41	39	41	39	46

PERFORMANCE NOTES:

1) "–" indicates an NC level less than 20.
2) "ΔP_S" is equal to the inlet static pressure (ISP).
3) Test data obtained in accordance with ARI/ADC Test Standard 880.
4) Quick-Select NC levels are generated using tables and formulae in Warren's *Acoustic Applications Guide*.
5) Discharge NC levels are based on the following:
   a) 10 dB room absorption
   b) 5 feet of rectangular lined duct
   c) 5 feet of standard flex duct
   d) end reflection
   e) flow division
6) Radiated NC levels are based on the following:
   a) 10 dB room absorption
   b) mineral fiber acoustical ceiling tile

Table 3. Fan Electrical Data

Fan Size	Motor H.P.	Motor Amperage		
		120 V	208/240 V	277 V
		FLA	FLA	FLA
A	1/5	2.7	1.5	1.8
B	1/4	3.7	2.5	2.2
C	1/3	5.6	3.1	3.0
D	1/2	9.9	4.2	4.1
E	3/4	11.9	5.3	4.5

Table 4. Model FBC DISCHARGE Sound Power in Decibels, Fan Delivering 100% Primary Air

Sound Power Levels, Lw, re 10^{-12} Watts

Unit Size	CFM	Min ΔP_s	Min ΔP_s							0.5" ΔP_s							1.0" ΔP_s							3.0" ΔP_s						
			2	3	4	5	6	7	NC	2	3	4	5	6	7	NC	2	3	4	5	6	7	NC	2	3	4	5	6	7	NC
A06M	500	.10	50	50	51	50	49	48	–	51	51	52	51	50	49	–	52	52	53	52	51	50	–	53	53	54	52	52	51	–
	600	.15	52	53	54	52	52	51	–	53	53	54	53	53	52	–	54	54	55	54	54	53	–	55	55	56	55	55	54	–
	700	.20	56	55	55	55	54	53	–	56	56	56	56	55	55	–	57	57	57	57	56	56	–	58	57	58	58	57	57	–
B08M	700	.10	57	58	57	55	55	54	–	57	58	58	56	56	54	–	58	59	58	57	56	55	–	59	60	60	59	56	56	–
	800	.12	58	58	59	58	58	56	–	59	59	60	59	58	57	–	60	60	60	60	58	58	–	61	61	62	62	59	59	–
	1000	.18	65	63	64	63	63	62	21	65	65	65	64	63	62	23	66	65	66	65	63	63	23	67	66	68	67	64	64	24
B10M	800	.07	59	59	58	58	57	56	–	59	59	59	59	58	57	–	61	60	60	60	59	58	–	61	61	61	60	60	59	–
	900	.09	61	61	60	60	60	59	–	62	61	61	61	61	60	–	64	62	62	62	62	61	–	64	63	63	63	64	62	20
	1100	.12	65	63	62	62	62	61	20	65	63	63	63	63	63	20	69	65	65	65	65	65	22	69	66	66	66	66	66	23
C10H	1000	.10	63	63	62	62	62	61	21	63	63	63	63	63	62	21	64	64	63	64	64	63	22	64	64	64	65	65	64	22
	1100	.12	65	64	63	63	63	63	22	66	64	64	64	64	64	22	67	65	65	65	65	65	23	67	65	65	66	66	66	23
	1400	.19	71	70	69	69	70	70	25	71	70	70	70	71	71	25	72	71	71	71	72	72	30	73	71	71	72	73	72	30
D12H	1250	.06	61	57	54	53	51	51	–	63	59	57	54	52	51	–	65	60	58	54	53	52	–	65	60	59	55	54	53	–
	1600	.10	65	63	60	58	57	57	–	67	65	61	59	58	57	21	69	66	62	60	60	58	22	69	67	63	60	60	58	23
	1800	.12	69	66	64	62	60	60	22	71	68	65	63	61	60	24	73	69	66	64	63	61	25	73	70	67	64	63	61	26
E14H	1700	.06	66	64	63	61	59	59	20	69	66	64	61	59	59	22	69	67	64	61	60	60	23	70	68	64	62	60	61	24
	2100	.10	72	71	69	67	65	65	28	75	73	70	67	65	65	34	75	73	70	68	66	66	35	76	73	72	69	67	67	35
	2300	.12	75	73	72	71	69	69	31	78	75	73	71	69	69	38	78	75	74	72	70	70	39	79	75	75	72	71	71	39

Table 5. FAN-ONLY Discharge Sound

Fan Size	CFM	Octave Band					
		2	3	4	5	6	7
A	500	57	54	56	57	54	54
	600	60	57	58	59	58	58
	700	62	59	60	61	60	61
B	700	63	61	62	61	59	58
	800	66	63	64	63	61	60
	1100	72	68	69	69	67	67
C	1000	65	60	64	65	63	61
	1200	68	64	68	68	67	64
	1400	71	67	71	71	70	67
D	1250	70	66	63	60	59	58
	1600	74	69	67	63	62	62
	1800	78	73	70	67	66	65
E	1700	75	71	67	64	63	63
	2100	82	77	74	72	70	70
	2300	87	81	78	76	74	73

PERFORMANCE NOTES:

1) Test data obtained in accordance with ARI/ADC Test Standard 880.
2) Data is raw, without any corrections for room absorption, duct attenuation, multiple diffuser splits, etc.
3) Sound data listed is within ARI tolerances shown in the following table:

Band Hz	2 125	3 250	4 500	5 1000	6 2000	7 4000
dB	6	4	3	3	3	3

4) "ΔP_s" is equal to the inlet static pressure (ISP), in. WC.
5) "–" indicates an NC level less than 20.
6) Discharge NC levels are based on the following:
   a) 10 dB room absorption
   b) 5 feet of rectangular lined duct
   c) 5 feet of standard flex duct
   d) end reflection
   e) flow division
7) Fan operating with external static pressure of 0.40 in. WC.

Table 6. Model FBC RADIATED Sound Power in Decibels, Fan Delivering 100% Primary Air

Sound Power Levels, Lw, re 10^{-12} Watts

Unit Size	CFM	Min ΔP_s	Min ΔP_s							0.5" ΔP_s							1.0" ΔP_s							3.0" ΔP_s						
			2	3	4	5	6	7	NC	2	3	4	5	6	7	NC	2	3	4	5	6	7	NC	2	3	4	5	6	7	NC
A06M	500	.10	51	48	44	37	35	35	–	54	51	46	43	41	40	–	54	52	49	45	43	42	20	57	54	51	49	47	47	25
	600	.15	53	49	45	39	38	38	–	56	53	48	46	44	44	22	56	54	51	48	46	44	23	59	56	54	51	49	49	27
	700	.20	55	51	47	42	40	40	–	58	55	50	48	47	47	25	58	56	53	50	48	47	25	62	59	56	54	52	52	30
B08M	700	.10	56	53	47	42	39	39	20	56	53	49	45	44	42	21	57	55	52	49	46	45	24	61	58	55	53	51	51	28
	800	.12	69	55	49	45	42	41	21	60	56	50	47	46	45	23	60	57	55	51	48	47	27	62	60	57	54	53	53	30
	1000	.18	64	59	55	49	48	47	26	64	59	56	52	50	49	27	65	62	58	55	53	52	30	66	64	60	58	57	57	34
B10M	800	.07	57	55	49	45	44	43	22	57	55	50	46	45	44	22	59	56	54	51	49	48	26	62	59	57	55	54	54	31
	900	.09	60	58	53	47	46	45	25	60	58	53	49	47	46	25	61	59	56	54	52	51	29	64	62	59	56	55	55	32
	1100	.12	64	63	57	52	51	50	31	64	63	57	53	51	50	32	64	63	61	58	56	55	34	68	65	63	60	59	59	36
C10H	1000	.10	62	59	54	50	48	47	26	62	59	54	51	49	48	26	63	60	58	56	54	53	31	66	64	60	58	57	57	34
	1100	.12	65	63	58	53	51	51	32	65	64	58	54	52	52	33	66	64	62	59	57	57	35	69	66	64	61	60	60	37
	1400	.19	71	70	65	59	57	57	39	71	71	65	60	58	58	40	72	71	67	65	63	64	41	74	72	68	66	65	65	42
D12H	1250	.06	55	54	47	40	34	32	21	56	56	48	41	37	35	24	56	58	52	46	41	40	30	59	59	56	52	50	49	36
	1600	.10	59	58	51	44	38	37	25	61	58	52	45	41	39	28	62	60	55	48	45	43	32	63	63	58	54	52	51	38
	1800	.12	63	63	55	47	42	41	32	64	63	56	48	45	44	33	65	64	57	50	47	45	35	66	65	60	56	54	53	41
E14H	1700	.06	61	59	51	45	39	38	26	62	59	53	46	41	39	26	63	62	55	48	45	43	31	66	65	60	56	54	53	33
	2100	.10	69	67	60	52	47	45	35	69	67	60	53	48	46	35	69	67	60	53	50	48	35	70	69	65	60	59	57	38
	2300	.12	72	72	65	57	51	50	41	72	72	65	58	53	52	41	73	72	65	58	54	53	41	74	75	69	64	61	60	46

Table 7. FAN-ONLY Radiated Sound

Fan Size	CFM	Octave Band					
		2	3	4	5	6	7
A	500	60	53	47	43	41	41
	600	62	56	49	45	44	44
	700	65	59	51	48	46	46
B	700	62	58	51	48	44	43
	800	64	59	52	49	46	45
	1100	72	64	58	54	52	52
C	1000	67	63	58	54	52	51
	1200	70	65	59	55	54	53
	1400	73	68	62	58	57	56
D	1250	62	57	50	46	43	42
	1600	66	61	53	49	46	45
	1800	70	64	57	52	50	48
E	1700	68	63	55	51	48	47
	2100	75	70	62	58	54	53
	2300	78	73	66	61	58	57

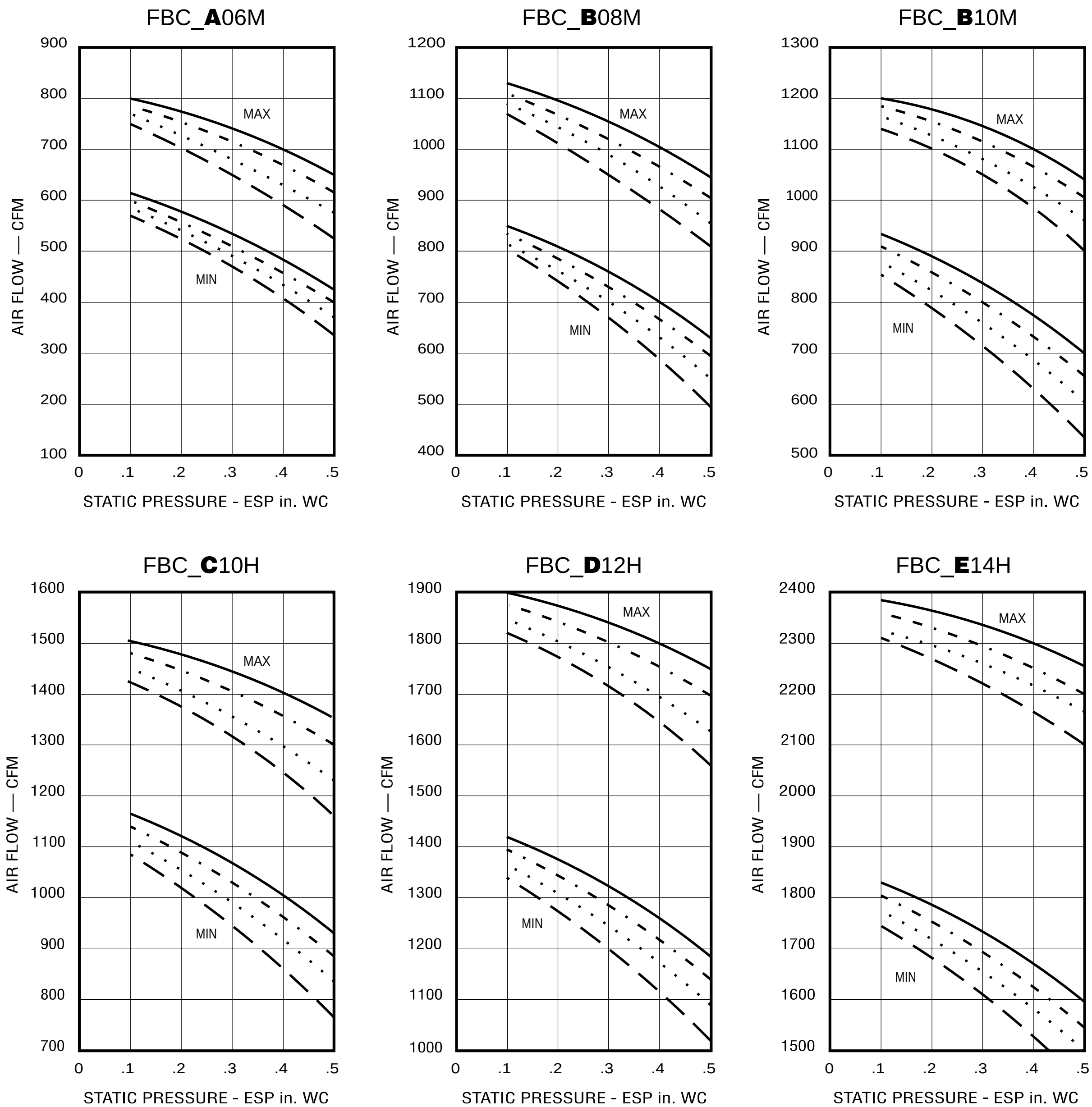
PERFORMANCE NOTES:

1) Test data obtained in accordance with ARI/ADC Test Standard 880.
2) Data is raw, without any corrections for room absorption, or ceiling effect.
3) Sound data listed is within ARI tolerances shown in the following table:

Band Hz	2 125	3 250	4 500	5 1000	6 2000	7 4000
dB	6	4	3	3	3	3

4) "ΔP_S" is equal to the inlet static pressure (ISP), in. WC.
5) "–" indicates a sound level less than 20.
6) Radiated NC levels are based on the following:
   a) 10 dB room absorption
   b) mineral fiber acoustical ceiling tile
7) Fan operating with external static pressure of 0.40 in. WC.

Model FBC Fan Performance Curves



LEGEND		
MODEL	HEAT OPTIONS	LINE TYPE
FBCN	NO HEATING COILS	= ———————
FBCE	ELECTRIC HEAT COILS	= – – · – – · ·
FBCW	1 ROW WATER COILS	= · · · · · · · · ·
FBCW	2 ROW WATER COILS	= — — — –

Standard Heater Features for Terminal Units with Electric Controls:
- Automatic Reset Thermal Cutout
- Backup Thermal Cutout
- De-energizing Magnetic Contactors
- Transformer for 24 Volt Controls
- Power Terminal Block

Standard Heater Features for Terminal Units with Pneumatic Controls:
- Automatic Reset Thermal Cutout
- Backup Thermal Cutout
- Pneumatic Electric Switches
- Power Terminal Block

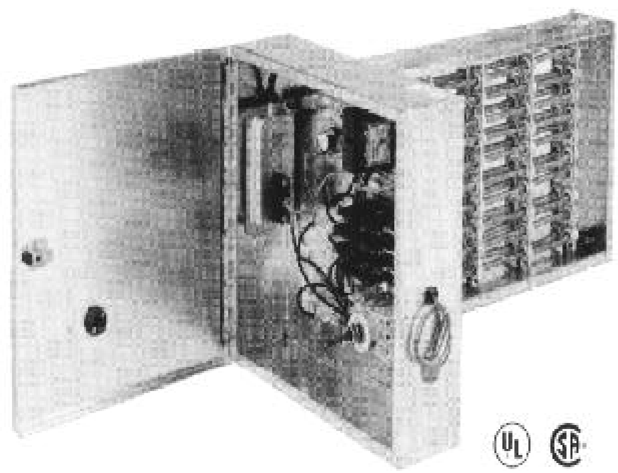
Optional Features:
- Air Flow Switches
- Disconnect Switch
- Magnetic Disconnecting Contactors
- Mercury De-energizing Contactors
- Mercury Disconnecting Contactors
- Fusing
- SCR Controls

DESCRIPTION

Warren brings its industry-leading electric heating technology to the Quiet Plus® VAV product line. Computerized design provides maximum versatility and dependability, since exact electrical and heat requirements are achieved. The Zebra® damper's laminar flow assures optimium performance even at low flow settings. Unlike any other coil manufacturer, Warren keeps permanent records for each unit to assure the correct sizing of future replacements.

ELEMENT DESIGN

Warren's exclusive computerized "Calculated Wire Temperature Method" ensures that the elements never exceed the melting-point of the alloy, even in still, free air. By knowing the exact operating temperature of the elements, the common problems of hot-spots in heaters can be virtually eliminated. This method has resulted in a near-zero failure rate for properly-installed units in the field for over two decades. An infinite number of size and voltage requirements can be handled, to predict exact performance and element life expectancy.



CONSTRUCTION

Warren's element-support system permits their high-grade refractory ceramic insulators to expand and contract freely without cracking or breaking. Modular design of the frames and boxes using heavy gauge galvanized steel keeps quality high and costs low. One-piece construction of the frame and control box makes installation easy.

ENGINEERING DATA

General:

1. Conversion: 1 kW = 3413 BTU/hr
2. Load Req: kW = CFM x Δ°F / 3160
3. Watts = Volts x Amps = Volts^2 / Ohms
4. 1-phase Amps = Watts / Volts
5. 3-phase Amps = Watts / (Volts x 1.73)

Coil-Specific:

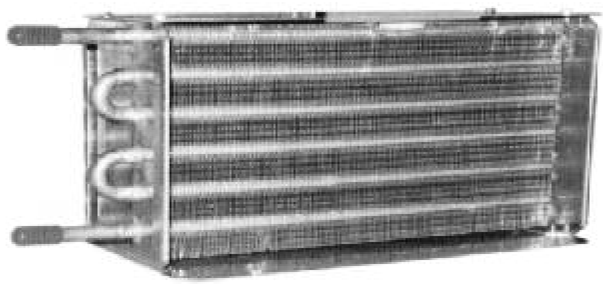
6. Max Allowed kW = Htg CFM / 70
7. Air ΔP in. WC = 0.08 x Htg CFM / Clg CFM

EXAMPLE

Heating CFM = 850, Cooling CFM = 850,
Temp Rise = 25°F, Volts/phase = 240V/3ph

Load Req: 850 CFM x 25°F / 3160 = 6.7 kW
Current: 6700 W / (240 V x 1.73) = 16.1 A

Max kW Allowed: 850 CFM / 70 = 12.1 kW
Pressure Loss: 0.08 x 850 / 850 = 0.08 in. WC



Standard Features:
- Galvanized Casing
- Slip & Drive Connections
- Aluminum Finned Tubular Construction
- All Copper Tubes
- 1/2" O.D. Male Connections

SELECTION PROCEDURE FOR HOT WATER COILS:

1. Use the heating CFM and downstream SP (not including HW coil losses) to select a unit size from the fan-curves on page 8, based on two-row coil max-min limits. If a unit cannot be found with a range that includes the CFM/SP point desired, select a unit that can produce somewhat higher SP at the same CFM. Check Figure 2 (pg. 2) for acceptable operating range, and Tables 2–7 (pgs. 5–7) for acceptable acoustic performance.
2. Check the heating-coil data in Table 10 for that unit's size. If the design CFM is within the table's range, check if adequate heating capacity (MBH) &/or airside ΔT is available for the application (use corrections from Tables 8–9 below if necessary). Select one-row coils if possible, to reduce SP penalties and cost. If the required CFM or heating capacity is outside the table's range, consider using a different water temperature, or a different unit size.
3. When a unit has been found with adequate heating capacity, a final check of the fan-curves must be done. Add the coil SP-loss from Table 10 to the downstream SP-loss for the application, plus any filtration pressure-losses, and check if that sum (the total fan External Static Pressure) is within the "No Heating Coils" fan curves on page 8. If so, record the waterside GPM and head-loss from Table 10 for the desired MBH heating capacity.

Table 8. MBH and ΔT Correction Factors for Entering Water – Air Temp other than 115°F

Correction Factor = (Entering Water Temp – Entering Air Temp) / 115°F

Ent'g H_2O-Air °F	65	75	85	95	105	115	125	135	145	155
Correction Factor	0.57	0.65	0.74	0.83	0.91	1.00	1.09	1.17	1.26	1.35

Table 9. CFM Correction Factors for Air Density other than Sea Level at 70°F

Correction Factor = 0.0564 x (460 + Deg. F) / [29.9 – (0.000956 x Feet)]

Elevation (feet)		–1000	0	1000	2000	3000	4000	5000	6000	7000	8000
CFM	70°F	0.97	1.00	1.03	1.07	1.11	1.15	1.19	1.24	1.29	1.34
Factor	55°F	0.94	0.97	1.00	1.04	1.07	1.11	1.16	1.20	1.25	1.31

Notes for Hot-Water Coil Selection Table 10:

1. Tables are based on a 115°F temperature difference between entering water (185°F) and entering air (70°F). CFM values are based on air density entering the coil at Sea Level and 70°F. For other entering water-air temperature differences, multiply the rated MBH and air ΔT by a factor from Table 8. For other entering-air conditions, multiply rated CFM by a factor from table 9. *Fan-terminal coils are activated only after the VAV damper has been shut to minimum flow. The coil entering air temp is equal to the room temp plus heat-gain (from recessed lights) &/or loss (from cold roof or un-insulated supply ducts) in the ceiling plenum, plus fan heat, minus the cooling effect of minimum-ventilation cold air added by the VAV damper. The combined effect typically results in coil entering air temp's between 65–75°F. Typical HW supply temp's are 170–200°F.*
2. The fins per inch, water circuits and water velocity in each coil have been carefully selected to optimize the unit's performance and general applicability in its CFM range. The highest one-row coil capacity typically overlaps the lowest capacity for the same unit's two-row coil at the same airflow rate. If performance outside the specified CFM or MBH ranges is required, contact the factory for customized selections. *Tables are based on one-row coils with 14 fins/inch and two-row coils with 8 fins/inch. Fins are typically .0055" thick corrugated aluminum on 0.016" thick half-inch copper tubes. Number of circuits ranges from 1 to 6, depending on the application. Header connection pipe sizes vary with number of circuits. These details may vary by application.*
3. Water flow rates (GPM) and head loss (feet of water) columns are based on 1.0, 3.0, 5.0, and 7.0 FPS water-velocity through the coils. GPM varies from one coil to another for a given FPS based on the number of circuits. Head-loss varies based on the total tube-length of the coil and header. If performance outside the specified GPM or ft. H_2O ranges is required, contact the factory for customized selections. *Selections at water velocities higher than 7 FPS result in significant head-loss increases , with minor increases in capacity. Water velocity selections lower than 1 FPS are in the laminar-flow region, which results in major changes in capacity with minor changes in velocity, making the coil harder to control in a stable fashion.*

Table 10. Hot Water Heating Coil Data

SIZE		AIRSIDE		WATERSIDE				
A06M 10"h 12"w	1 row 5/8" O.D.	Heating CFM	SP loss in. H_2O	Ft. H_2O:	0.08	0.51	1.22	2.2
				GPM:	1.20	3.50	5.80	8.10
		450	0.11	MBH:	12.8	16.1	17.1	17.6
				Air ΔT:	27	33	35	36
		550	0.15	MBH:	13.7	17.5	18.6	19.2
				Air ΔT:	23	30	32	33
		650	0.21	MBH:	14.4	18.6	20.0	20.7
				Air ΔT:	21	27	29	30
	2 row 5/8" O.D.	Heating CFM	SP loss in. H_2O	Ft. H_2O:	0.16	1.07	2.59	4.64
				GPM:	1.20	3.50	5.80	8.10
		450	0.14	MBH:	17.7	21.4	22.4	22.9
				Air ΔT:	36	44	46	47
		550	0.20	MBH:	19.0	23.4	24.6	25.2
				Air ΔT:	32	40	42	43
		650	0.28	MBH:	20.1	25.1	26.5	27.3
				Air ΔT:	29	36	38	39

SIZE		AIRSIDE		WATERSIDE				
B08M 10"h 14"w	1 row 5/8" O.D.	Heating CFM	SP loss in. H_2O	Ft. H_2O:	0.09	0.56	1.36	2.44
				GPM:	1.20	3.50	5.80	8.10
		600	0.14	MBH:	15.3	19.7	21.0	21.7
				Air ΔT:	24	30	33	34
		750	0.20	MBH:	16.3	21.4	23.1	23.9
				Air ΔT:	20	27	29	30
		900	0.28	MBH:	17.2	22.9	24.8	25.8
				Air ΔT:	18	24	26	27
	2 row 5/8" O.D.	Heating CFM	SP loss in. H_2O	Ft. H_2O:	0.18	1.18	2.86	5.13
				GPM:	1.20	3.50	5.80	8.10
		600	0.18	MBH:	21.0	26.2	27.7	28.4
				Air ΔT:	33	41	43	44
		750	0.27	MBH:	22.7	28.8	30.6	31.5
				Air ΔT:	28	36	38	39
		900	0.37	MBH:	24.0	31.0	33.1	34.1
				Air ΔT:	25	32	34	35

SIZE		AIRSIDE		WATERSIDE				
B10M 10"h 16"w	1 row 5/8" O.D.	Heating CFM	SP loss in. H_2O	Ft. H_2O:	0.09	0.62	1.49	2.68
				GPM:	1.20	3.50	5.80	8.10
		700	0.14	MBH:	17.2	22.5	24.1	24.9
				Air ΔT:	23	30	32	33
		850	0.20	MBH:	18.2	24.2	26.1	27.1
				Air ΔT:	20	26	29	30
		1000	0.27	MBH:	19.0	25.7	27.9	29.0
				Air ΔT:	18	24	26	27
	2 row 5/8" O.D.	Heating CFM	SP loss in. H_2O	Ft. H_2O:	0.20	1.29	3.13	5.61
				GPM:	1.20	3.50	5.80	8.10
		700	0.19	MBH:	23.6	29.9	31.7	32.6
				Air ΔT:	31	40	42	43
		850	0.27	MBH:	25.1	32.4	34.6	35.6
				Air ΔT:	27	35	38	39
		1000	0.36	MBH:	26.4	34.6	37.1	38.3
				Air ΔT:	25	32	34	36

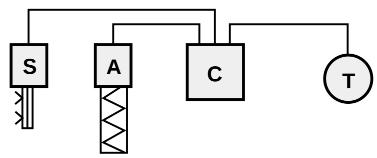
SIZE		AIRSIDE		WATERSIDE				
C10H 15"h 14"w	1 row 5/8" O.D.	Heating CFM	SP loss in. H_2O	Ft. H_2O:	0.13	0.87	2.11	3.78
				GPM:	1.20	3.50	5.80	8.10
		900	0.14	MBH:	21.3	28.6	30.9	32.1
				Air ΔT:	22	30	32	33
		1100	0.20	MBH:	22.5	30.8	33.6	35.0
				Air ΔT:	19	26	28	30
		1300	0.26	MBH:	23.5	32.7	35.8	37.4
				Air ΔT:	17	23	26	27
	2 row 7/8" O.D.	Heating CFM	SP loss in. H_2O	Ft. H_2O:	0.16	1.16	2.86	5.16
				GPM:	1.70	5.20	8.70	12.20
		900	0.18	MBH:	31.0	39.2	41.5	42.6
				Air ΔT:	32	41	43	44
		1100	0.26	MBH:	33.1	42.7	45.4	46.7
				Air ΔT:	28	36	38	39
		1300	0.35	MBH:	34.9	45.7	48.9	50.4
				Air ΔT:	25	33	35	36

SIZE		AIRSIDE		WATERSIDE				
D12H 15"h 18"w	1 row 5/8" O.D.	Heating CFM	SP loss in. H_2O	Ft. H_2O:	0.16	1.04	2.51	4.51
				GPM:	1.20	3.50	5.80	8.10
		1200	0.15	MBH:	26.0	36.3	39.7	41.4
				Air ΔT:	20	28	31	32
		1450	0.20	MBH:	27.3	38.9	42.8	44.8
				Air ΔT:	18	25	27	29
		1700	0.27	MBH:	28.3	41.1	45.5	47.8
				Air ΔT:	16	22	25	26
	2 row 7/8" O.D.	Heating CFM	SP loss in. H_2O	Ft. H_2O:	0.20	1.38	3.40	6.14
				GPM:	1.70	5.20	8.0	12.20
		1200	0.19	MBH:	38.2	50.2	53.5	55.1
				Air ΔT:	30	39	41	43
		1450	0.27	MBH:	40.4	54.2	58.2	60.1
				Air ΔT:	26	35	37	39
		1700	0.36	MBH:	42.3	57.7	62.3	64.5
				Air ΔT:	23	32	34	35

SIZE		AIRSIDE		WATERSIDE				
E14H 15"h 22"w	1 row 5/8" O.D.	Heating CFM	SP loss in. H_2O	Ft. H_2O:	0.19	1.21	2.92	5.24
				GPM:	1.20	3.50	5.80	8.10
		1600	0.17	MBH:	30.6	44.6	49.4	51.8
				Air ΔT:	18	26	29	30
		1900	0.23	MBH:	31.8	47.3	52.7	55.6
				Air ΔT:	16	23	26	27
		2200	0.30	MBH:	32.7	49.7	55.7	58.8
				Air ΔT:	14	21	24	25
	2 row 7/8" O.D.	Heating CFM	SP loss in. H_2O	Ft. H_2O:	0.23	1.60	3.94	7.12
				GPM:	1.70	5.20	8.70	12.20
		1600	0.23	MBH:	45.3	62.2	67.1	69.4
				Air ΔT:	26	36	39	40
		1900	0.31	MBH:	47.5	66.5	72.2	75.0
				Air ΔT:	23	33	35	37
		2200	0.40	MBH:	49.3	70.3	76.7	79.8
				Air ΔT:	21	30	32	34

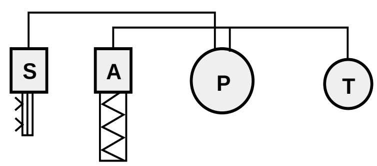
BASIC CONTROL MODES

1. Full-Range Pressure Independent with Max and Min Flow Settings



The air flow is sensed by the controller (C) through a flow sensor (S). The controller operates the air valve actuator (A) to regulate air flow. The airflow setting of the controller is reset by the thermostat (T) in response to the room temperature demand. Minimum and maximum controller airflow rates are adjustable. The controller maintains the flow rate required by the thermostat, independent of upstream pressure fluctuations.

2. Maximum Airflow-Limiting Pressure Independent (single-point PI)



The air flow is sensed by an air pressure switch (P) through a flow sensor (S). The thermostat (T) controls the air valve actuator (A), which regulates air flow in response to the room temperature demand. The air pressure switch overrides the thermostat to limit the maximum airflow. The maximum airflow setting is adjustable through the air pressure switch. The minimum airflow is manually adjusted.

3. Pressure Dependent

The air valve actuator (A) is controlled directly by the thermostat (T) in response to the room temperature demand. Maximum and minimum airflow (pressure dependent) adjustments are made by manually setting the open and close limit switches. Flow rates may vary due to upstream pressure changes, even if the thermostat does not require a change.

BASIC CONTROL TYPES

1. Pneumatic

Compressed air (20 psig) is used to power a system of modulating controls such as thermostats, actuators, controllers, and various relays. This system is used to provide any number of desired control sequences.

2. Electric

Floating, multi-position air valve control is accomplished by a 24-volt thermostat (single-pole double-throw, center null, bimetal or mercury bulb). This thermostat controls a 24-volt reversible actuator that positions the air valve. Electric relays, air pressure switches, time delays, and cycle timers are used to provide a wide variety of control sequences and functions.

3. Electronic Analog

Modulating control is accomplished by solid state, analog electronic circuitry that senses temperature and air flow. This control package uses a 24-volt reversible actuator to position the air valve, providing a variety of sequences and functions.

4. Electronic, Direct Digital

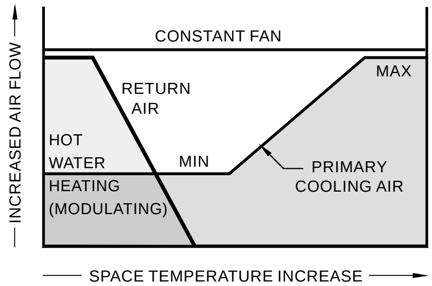
This type of control is similar to electronic analog, except that inputs and setpoints are interpreted by a digital microprocessor chip, which can be programmed to make complex calculations and decisions. Many DDC controllers also offer optional input &/or output communications with a central Building Automation System.

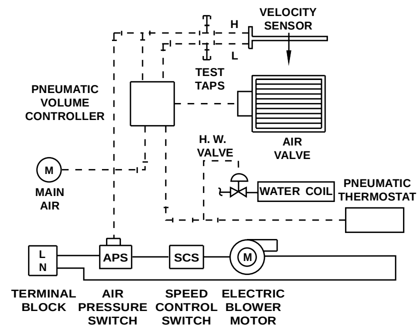
CONTROL SYSTEM OPTIONS

- Cooling with electric heat
- Cooling with hot water heat
- Warm-up cycle
- Summer/winter dual temperature setpoints

PRESSURE INDEPENDENT — PNEUMATIC*

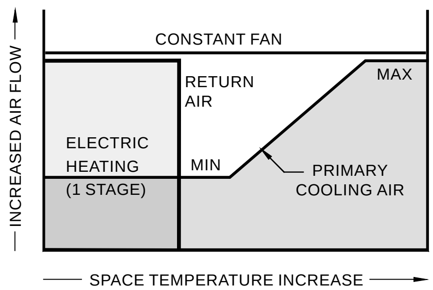
These controls provide a submaster volume controller whose velocity setpoint is reset between adjustable minimum and maximum limits by the room thermostat master controller. Control sequences can be provided for NO or NC dampers, RA or DA thermostats, and unlimited stages of heat.

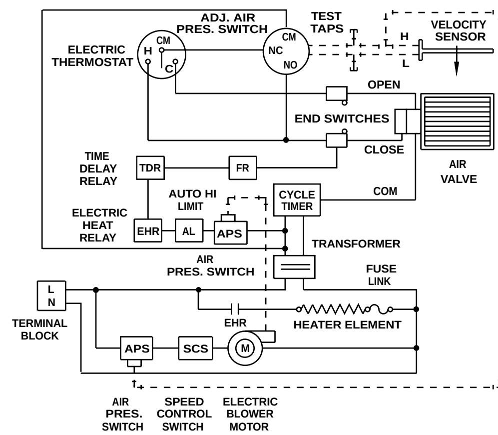




AIRFLOW LIMITING — ELECTRIC*

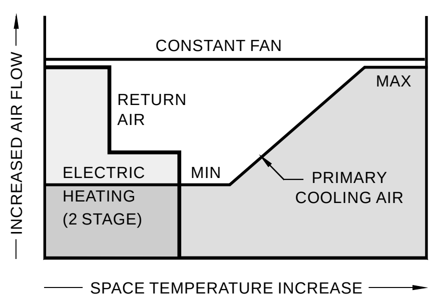
These controls provide a thermostat as the master controller and an adjustable air pressure switch to limit maximum airflow. The air pressure switch overrides the thermostat when the maximum airflow is reached. Minimum airflow is set with an end-switch. A cycle timer is included to prevent overshooting.

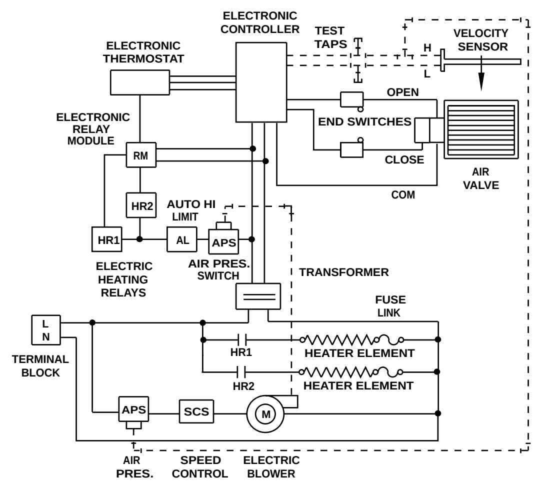




PRESSURE INDEPENDENT — ELECTRONIC*

These controls provide a submaster velocity controller that is reset by the room thermostat master controller. Maximum and minimum CFM limits can be field adjusted at the thermostat. Control sequences can be provided for cooling-only, or cooling with multiple stages of heat.





DIRECT DIGITAL CONTROL*

Warren constant volume fan powered VAV units are also available with Direct Digital Control (DDC).

**For specific control sequences, consult submittal data or the factory.*

SUGGESTED SPECIFICATIONS

Furnish and install Warren Technology constant volume fan powered terminal units (Model FBC) of the sizes and capacities shown on the plans.

The primary air inlets shall be pressure independent and shall reset to any airflow between the minimum and maximum desired air volumes.

The assembly casing shall be constructed of heavy-gauge galvanized steel, with gauges conforming to the requirements of UL 1995. The casing shall be formed and assembled with sufficient strength and rigidity to withstand normal handling and maintain operational integrity. Unit casing shall have removable bottom panel and side access panel to allow removal of fan and servicing of unit.

The casing shall be fully lined internally with 1-inch thick, dual density fiberglass insulation or engineered polymer foam insulation (EPFI) per specifications outlined in UL 181 and NFPA 90A. There shall be no cut edges of insulation exposed in the airstream.

The primary air valve shall be a sliding pleated plate with multiple alternately spaced orifices and with full linear stroke, open to close. Air flow through the valve shall be laminar throughout the open to close cycle. The valve mechanism shall be direct drive, utilizing a pneumatic or 24-VAC bidirectional electric actuator.

Electric heat shall be provided as scheduled on the plans utilizing the computer selected Calculated Wire Temperature method of element selection to assure optimum VAV performance, or provide hot water coils as scheduled on the plans.

Sound ratings through the primary air valve and the blower shall not exceed the discharge and radiated sound-power ratings shown on the schedules.

Fan blower shall be constructed of steel with forward curved blades, dynamically balanced wheel and direct drive motor. Motor shall be permanent split capacitor type, with permanently lubricated bearings and thermal overload protection. Motor shall be designed for use with electronic fan speed controller. The blower wheel and motor assembly shall be internally suspended and isolated from the blower housing on rubber-in-shear isolators to minimize vibration.

A speed controller shall be provided to allow continuously adjustable fan speed from maximum to minimum. Speed control shall be electronic and shall be matched to operate with the motor. Speed control shall be equipped with a minimum voltage stop to ensure that motor will not operate in the stall mode. Voltage stop shall be factory adjusted.

Units shall incorporate a single point electrical and control connection which shall be provided for the entire assembly. All controls shall be mounted within the unit assembly, sealed from primary air flow. All other electrical components shall be enclosed in a single control box with a hinged access panel mounted on the side of the assembly. The panel shall incorporate a door-mounted disconnect switch. The entire unit shall be ETL listed.

ACCESSORIES

- Custom Access Panel
- Tedlar Lining
- Foil Lining
- Perforated Metal Lining
- Sound Attenuator
- Variable-Speed Fan (0–10V input)

APPLICATIONS

Constant Volume Fan Powered, Series Flow Terminal Units are designed for use in low, medium, or high pressure single duct VAV systems that require cooling and periodic heating, while maintaining a constant supply of air. Primary air is delivered to the space through the recirculating fan. At maximum cooling demand, 100% primary air is delivered through the fan. As the cooling demand decreases, the primary air valve begins to close, and the fan begins to induce ceiling plenum air to make up the difference. If the cooling demand continues to decrease, the primary air valve closes, at which point the fan will induce maximum air flow from the ceiling plenum. If further heating is required, optional electric or hot water heating coils may be utilized.

By delivering a constant volume of air to the space during the day, room air motion is maintained throughout the heating and cooling cycles. The fan does not cycle on and off as with intermittent models (except at night), therefore sound levels remain constant.

Constant volume fan powered terminal units may be utilized in low temperature design applications where the amount of primary air and induced air may be varied and mixed to achieve desired set points. Contact factory for details.

PACKAGING

All Warren VAV Terminal Units are individually wrapped in a protective polymer cover, and individually boxed or palletized for shipment.

RECEIVING AND INITIAL INSPECTION

Upon receipt, immediately check the contents of cartons or the condition of palletized units. If there is any damage, file a damage claim per the instruction card in each package, and notify Warren **immediately**.

HANDLING AND STORAGE

To avoid damage to controls, wiring, or tubing, always lift terminal units from the bottom. Units should be stored in an upright position with the protective cover in place. Do not stack. Units should never be stored outdoors or in areas affected by inclement weather or construction debris.

CODES

All Warren products must be installed by licensed, qualified contractors. All equipment must be installed and wired in compliance with all applicable local code requirements. All units must be installed with adequate service access.

INSTALLATION PRECAUTIONS

All equipment must be installed and wired in accordance with Warren installation instructions.

Thoroughly check that construction debris has not entered the terminal unit or its intended ductwork. Construction debris may seriously damage or adversely affect the operation of this equipment. Never operate terminal units without the proper filters in place. Units should not be used for temporary heat or allowed to operate before completing factory recommended checkout procedure. Checklist and operating data must be recorded and forwarded to the factory to validate warranty.

START-UP

Before start-up of this equipment, carefully check factory and required field wiring against approved schematic furnished by Warren.

REPAIRS

Any field repairs, modifications, or troubleshooting expenses are solely the responsibility of the purchaser unless written authorization is obtained from the factory. No back charges or costs to Warren will be honored unless a predetermined work authorization agreement is issued by Warren.

LIMITED WARRANTY

All Warren products are covered by standard limited warranties, provided that the equipment has been properly installed and that all warranty registration documents have been completed and returned to the factory.

RECOMMENDED DESIGN NC LEVELS

Offices	
Executive	NC 25-30
Conference Rooms	NC 25-30
Private	NC 30-35
Open-plan Areas	NC 35-40
Business machines/computers	NC 40-45
Lobbies	NC 40-45
Hospitals and Clinics	
Private rooms	NC 25-30
Wards	NC 30-35
Operating rooms	NC 25-30
Laboratories	NC 35-40
Corridors	NC 30-35
Public Areas	NC 35-40
Churches	NC 30-35
Schools	
Lecture and classrooms	NC 25-30
Open-plan classrooms	NC 35-40
Libraries	NC 35-40
Courtrooms	NC 35-40
Playhouse	NC 20-35
Movie theaters	NC 30-35
Restaurants	NC 40-45
Concert and recital halls	NC 15-20
Recording studios	NC 15-20
TV studios	NC 20-25
Private residences	NC 25-30
Apartments	NC 30-35
Hotels/Motels	
Individual rooms or suites	NC 30-35
Meeting/banquet rooms	NC 30-35
Halls, corridors, lobbies	NC 35-40
Service/support areas	NC 40-45

Reference: ASHRAE Handbook — HVAC Applications

METRIC / S.I. CONVERSION FACTORS

(multiply metric value by factor to get Imperial units)

Length:	1 mm	=	0.0394 in.	Air pressure:	1 kPa	=	4.02 in. H_2O
Area:	1 m^2	=	10.76 ft^2	Water press:	1 kPa	=	0.335 ft. H_2O
Weight:	1 kg	=	2.20 lb.	Velocity:	1 m/sec	=	197 fpm
Density:	1 kg/m^3	=	0.0624 lb/ft^3	Air-flow:	1 m^3/hr	=	0.588 cfm
Heat:	1 kW	=	3.413 mBh	Air-flow:	1 L/sec	=	2.12 cfm
Temp:	deg. F	=	(9/5 x deg. C) + 32	Water-flow:	1 L/sec	=	15.9 gpm

WARREN TECHNOLOGY
PRODUCTS & SYSTEMS

Warren Technology designs, develops, and manufactures quality products for the heating, ventilation and air-conditioning industry.

Our mission is to provide indoor environmental solutions that enhance personal comfort, improve indoor air quality, and increase energy savings.

Advanced computer-aided design and integrated flexible manufacturing systems developed during the past 46 years enable Warren to respond rapidly to changing customer requirements.

Warren's Uni•VAV® Individual Room Comfort System provides individual temperature control for buildings with almost any type of forced air HVAC system.

Air handling systems for any building, large or small, may be upgraded to achieve greater energy efficiency while providing for the individual temperature needs of each occupant.

The Uni•VAV®, and UNI•GUARD™ systems are designed to improve individual comfort control, productivity and indoor air quality.

UNI•VAV®
- Individual Zone Control
- Energy-Saving Diversification
- System Design Flexibility

Leopard Intellivent®
Personal VAV Diffusers
- Individual Temperature Control
- Easy to Install and Relocate

Valid Air®
High Performance Diffusers
- Increased Air Circulation
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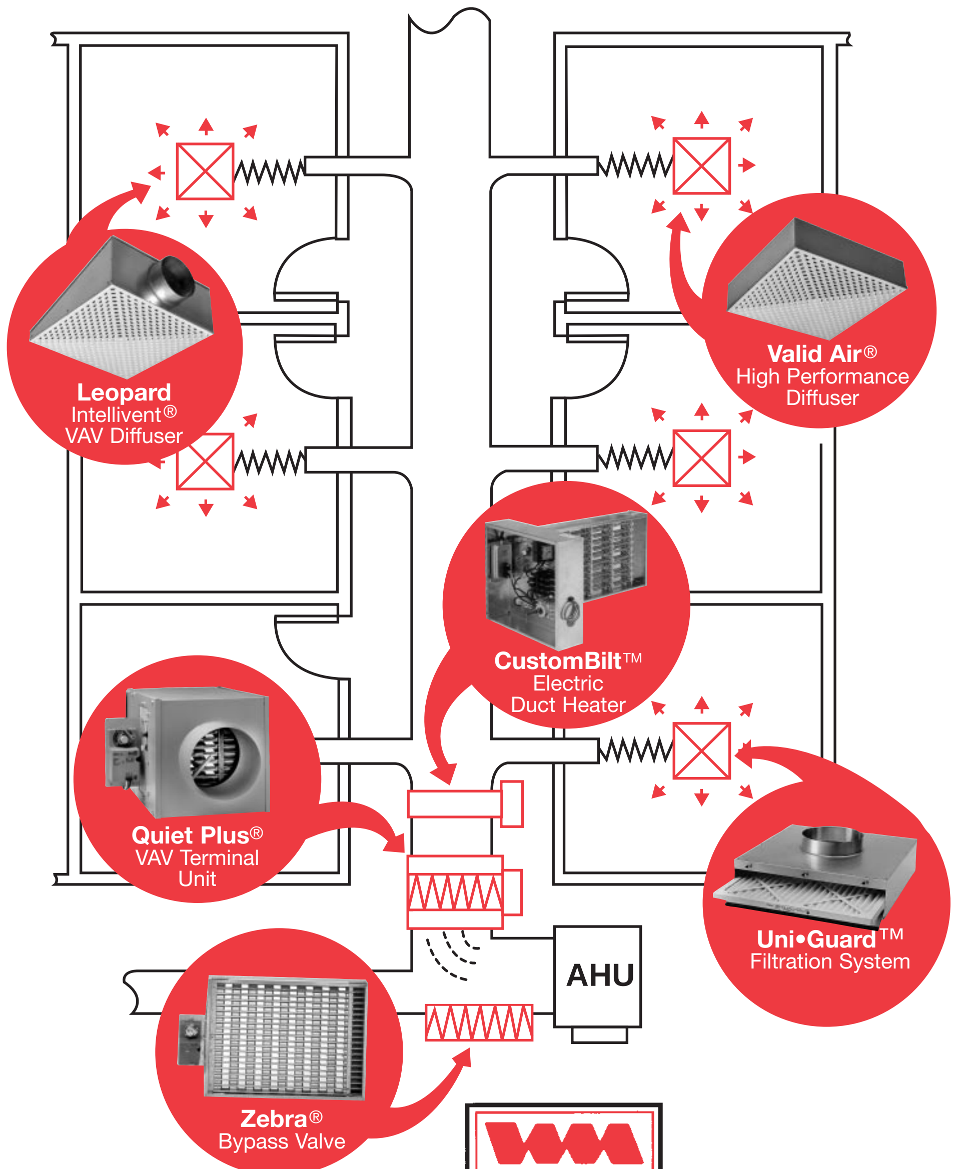

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