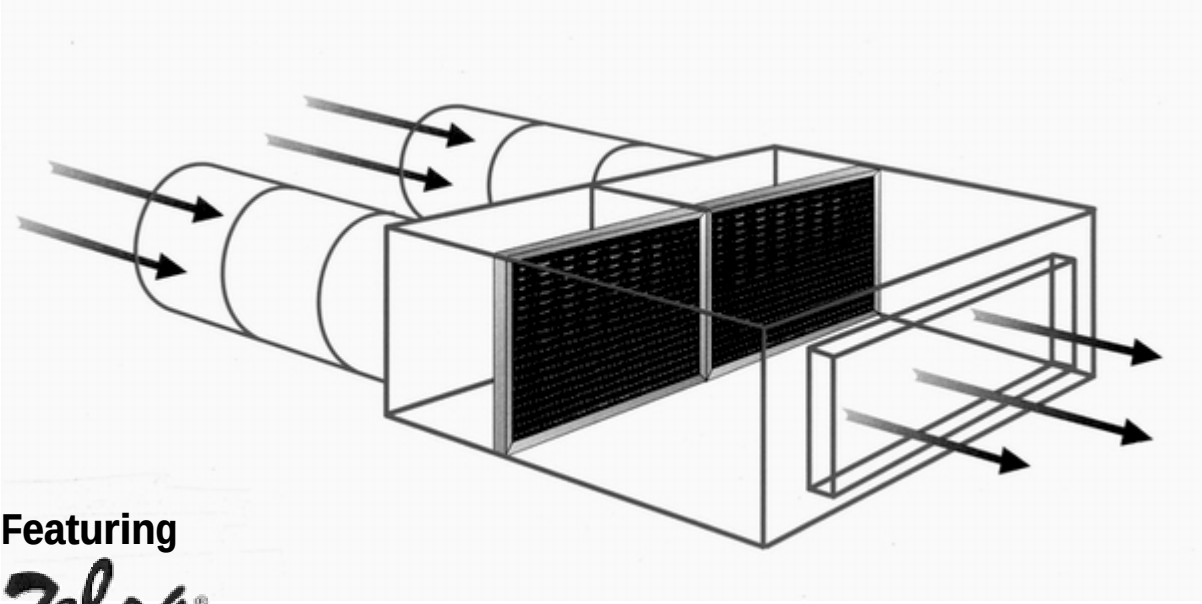
WARREN
TECHNOLOGY

QUIET PLUS®

VARIABLE AIR VOLUME TERMINAL UNITS



Featuring

Zebra®

Precision Air Valves

Model DT
Double Duct Throttling

Catalog No. DT-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."

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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 DT Double-Duct Throttling Units

The heart of the Quiet Plus® DT unit is the patented Zebra® precision air valve, which has the best performance for acoustics, laminar flow, and accurate control in the HVAC industry.

Model DT has 9 unit sizes, with capacities ranging from 200 to 5400 CFM, each with two independent dampers (and actuators). Electronic (analog or DDC), electric and pneumatic controls are available with velocity-sensing pressure-independent or thermostat-driven pressure-dependent options, and many control sequences.

Cross-V™ blades assure well-mixed air when both inlets are active, with minimal noise and pressure effects. Options include: reduced hot-inlet diameters, custom Cross-V heights, octopus outlets, and several insulation/lining choices.

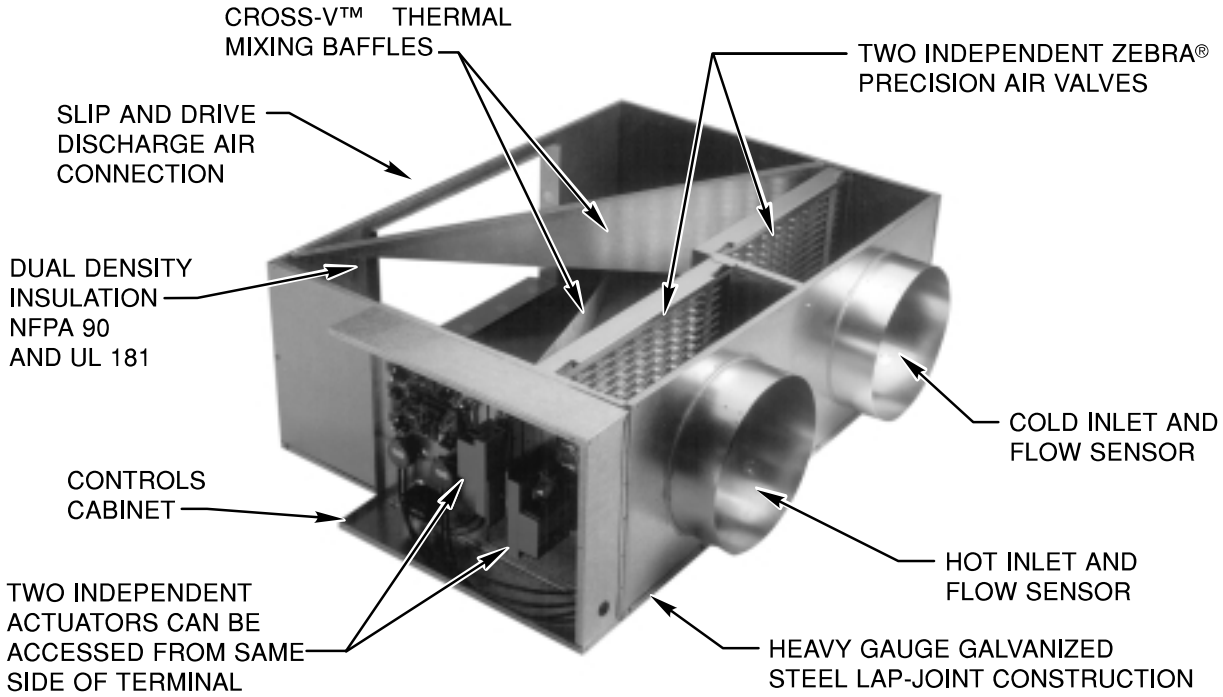


Figure 1. Model DT Double-Duct Throttling Unit (Top Removed)

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_Z 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.

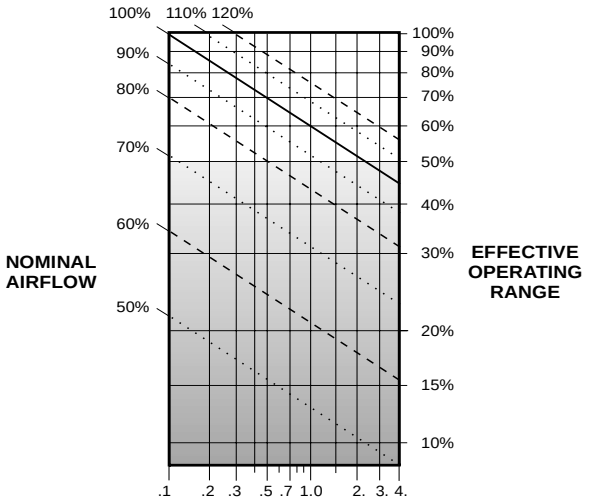


Figure 2. Controllability Graph

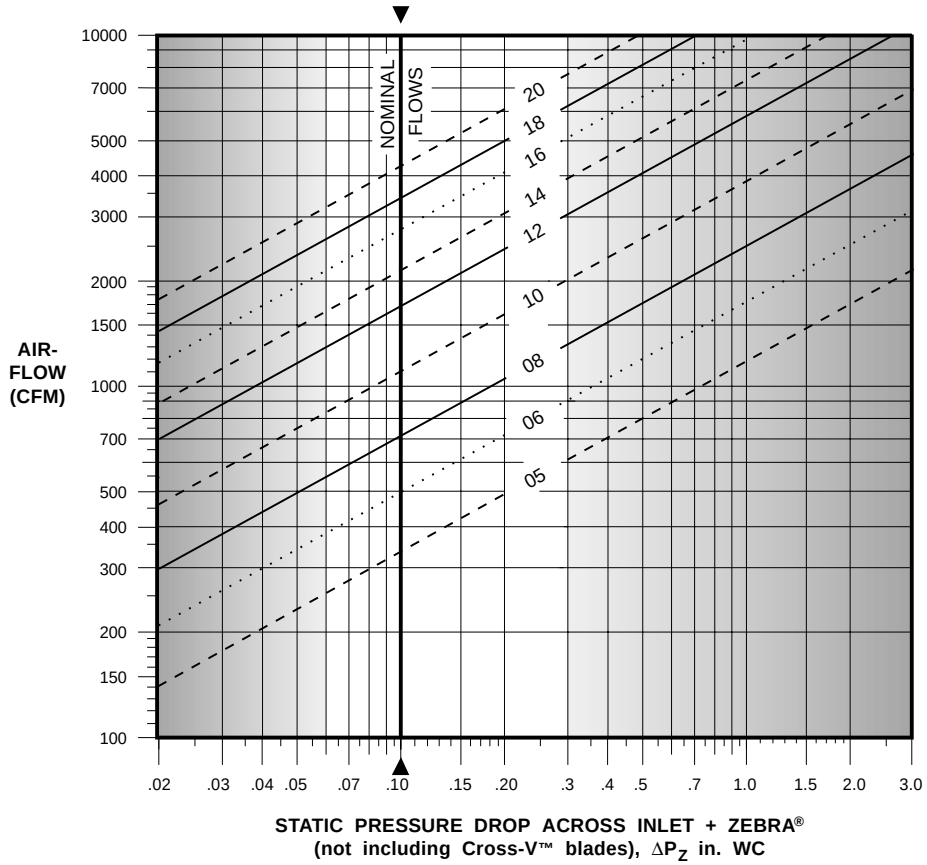


Figure 3. Warren Zebra Valve Airflow Performance Data

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 05-20 inches, for a given static pressure drop across the Zebra® damper (not incl. Cross-V™ blades).

Nominal capacities are based on a ΔP_Z 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. Cooling Inlet
      a. Maximum CFM
      b. Minimum CFM
      c. Inlet static pressure (ISP)
   2. Heating Inlet
      a. Maximum CFM
      b. Minimum CFM
      c. Inlet static pressure (ISP)
   3. Downstream external static pressure (ESP)
   4. Maximum allowable NC or Sound Power (discharge & radiated)
   5. Details about box installation and room, for acoustically-critical cases

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

C. Calculate the static pressure loss (ΔP_S) of the unit separately for each inlet, based on the nominal unit-size for that inlet diameter:

$$\Delta P_S = ISP - ESP$$

D. Confirm that the unit size for each inlet and its respective flow and pressure 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 C and D.

E. Check the effective operating range of each inlet against the design requirements using Figure 2 (page 2). Find Y-axis value:

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

Find X-axis value, which is the total SP drop across the box (ΔP_S above), minus the drop across the Cross-V™ mixing blades. The blades' SP-drop is the difference between Min ΔP_S and Min ΔP_Z from the first two columns of Table 2, (ref. note 2) on page 5:

$$\text{Actual } \Delta P_Z = \Delta P_S - (\text{Min } \Delta P_S - \text{Min } \Delta P_Z)$$

F. Use the % Nominal Airflow and Actual ΔP_Z with Figure 2 to find the effective operating range. If the selected unit's range falls below 50% on the graph, the next smaller unit should be considered. Reselect, and repeat steps C through E.

EXAMPLE (Typical Installation)

A. Given design requirements:
   1. Cooling:
      a. Max CFM = 1600
      b. Min CFM = 300
      c. ISP = 1.30 in. WC
   2. Heating:
      a. Max CFM = 1000
      b. Min CFM = 0
      c. ISP = 1.00 in. WC
   3. Downstream ESP = 0.26 in. WC
   4. Maximum allowable NC = 30
   5. Installation = not acoustically critical

B. Determine Maximum CFM:
   1. Cooling = 1600
   2. Heating = 1000 + 300 = 1300
   3. Maximum CFM = 1600

   From Table 1 (page 4) for 1600 CFM nominal, select unit size DT12M, with a 10" heating inlet for 1000 CFM.

C. Calculate the static pressure loss ΔP_S for the cooling ($\Delta P_{S,C}$) and heating ($\Delta P_{S,H}$) inlets:

$\Delta P_{S,C}$ = ISP-ESP = 1.30-0.26 = 1.04 in. WC_C
$\Delta P_{S,H}$ = ISP-ESP = 1.00-0.26 = 0.74 in. WC_H

D. Quick-Select Table 2 (page 5) indicates that for size DT12M at 1600 CFM with 1.04" $\Delta P_{S,C}$ both the discharge and the radiated NC's are less than 20 (satisfies NC-30). For DT10M at 1000 CFM with 0.74" $\Delta P_{S,H}$ both the NC's are also less than 20.

E. Find % of Nominal Airflow:
   12" Cooling = 1600 / 1600 = 100%
   10" Heating = 1000 / 1100 = 91%

   Find ΔP_Z across each inlet, using Min ΔP_S & ΔP_Z from Table 2 (page 5):
   Act. $\Delta P_{Z,C}$ = 1.04 – (.21-.09) = 0.92 in. WC
   Act. $\Delta P_{Z,H}$ = 0.74 – (.25-.09) = 0.59 in. WC

F. Figure 2 (page 2) indicates that the cold-inlet effective operating range at 100% of Nominal airflow for 0.92 in. WC is 60% (ranges below 50% are not recommended). The hot-inlet range at 91% of Nominal for 0.59 in. WC is 58% (acceptable).

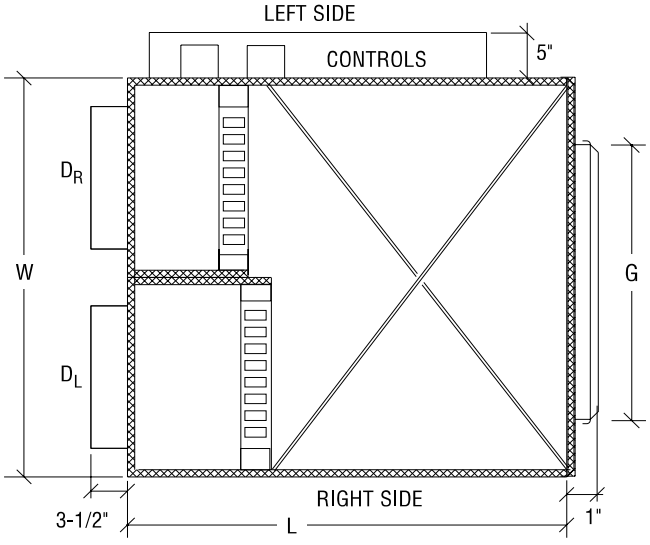
Therefore, we conclude that the specified design requirements can be met with the a DT12M unit, using a 10" hot inlet.

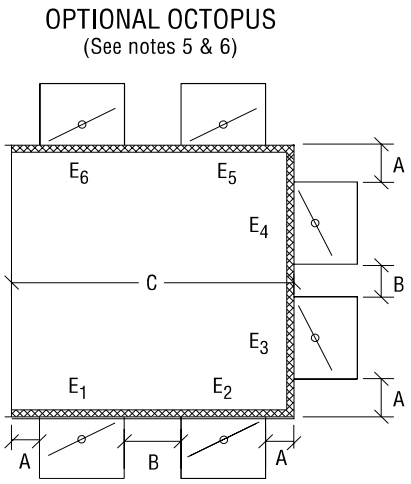
Table 1. Model DT Capacity and Dimensional Data

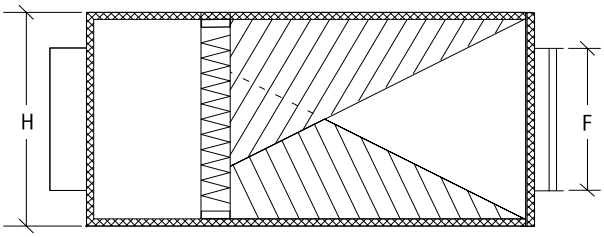
Model Number	Inlet Size (in.)	Inlet Shape	Nominal CFM	Maximum CFM (Range)	Dimensions W (in.)	Dimensions H (in.)	Dimensions L (in.)	Outlet G (in.)	Outlet F (in.)	Weight (Est.) (lbs.)
DT_05L	5	Rnd	300	200–400	16	10	18	8	8	50
DT_06L	6	Rnd	450	300–600	20	10	18	10	8	55
DT_08L	8	Rnd	700	500–900	28	10	24	15	8	65
DT_10M	10	Rnd	1100	800–1400	26	15	24	15	13	80
DT_12M	12	Rnd	1600	1200–2000	40	15	30	21	13	90
DT_14M	14	Rnd	2200	1600–2800	48	15	36	28	13	100
DT_16T	16	Rnd	2800	2100–3500	46	20	36	26	18	115
DT_18T	18	Rnd	3500	2600–4400	54	20	36	32	18	130
DT_20T	20	Rnd	4300	3200–5400	72	20	36	40	18	145

NOTES:

1) DT units include lined plenum, inlet collar, end-cap with S & D outlet connection, and air valve assemblies.
2) Nominal CFM based on maximum 2000 FPM inlet velocity, 1000 FPM outlet velocity, and ΔP_z of 0.10 in. WC.
3) See page 12 for metric conversion factors.
4) Cross-V blade height and angles may be customized to meet specific mixing requirements. Pressure drop and acoustic performance will vary. Contact factory with specifications.
5) Octopus discharge width and height limits the number and sizes of outlets on the back. Minimum dimensions are: A = 0.5 inches, B = 1.0 inches. Octopus length (C) is function of number and size of side outlets, in one-foot increments.
6) Octopus outlets normally are all the same size. Balancing dampers are standard. If a variety of sizes are used on one terminal, they must be specified in the sequence shown (E_1, E_2,...E_n).







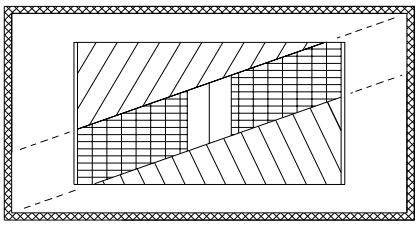


Table 2. Model DT QUICK-SELECT Sound Data, Discharge and Radiated NC Levels

Unit Size	CFM	Min ΔP_Z (note 2)	Min ΔP_S (note 3)	Min ΔP_S		0.5" ΔP_S		1.0" ΔP_S		3.0" ΔP_S	
				Dis	Rad	Dis	Rad	Dis	Rad	Dis	Rad
	200	.04	.09	–	–	–	–	–	–	–	–
05L	300	.08	.16	–	–	–	–	–	–	–	–
	400	.14	.26	–	–	–	–	–	–	–	–
	300	.04	.10	–	–	–	–	–	–	–	–
06L	450	.08	.18	–	–	–	–	–	–	–	–
	600	.15	.32	–	–	–	–	–	–	–	–
	500	.05	.13	–	–	–	–	–	–	–	–
08L	700	.10	.22	–	–	–	–	–	–	–	–
	900	.15	.33	–	–	–	–	–	–	–	–
	800	.07	.17	–	–	–	–	–	–	–	–
10M	1100	.10	.27	–	–	–	–	–	–	–	–
	1400	.17	.42	–	–	–	–	–	–	21	23
	1200	.05	.12	–	–	–	–	–	–	–	–
12M	1600	.09	.21	–	–	–	–	–	–	–	–
	2000	.14	.32	–	–	–	–	–	–	21	24
	1600	.07	.16	–	–	–	–	–	–	–	–
14M	2200	.11	.26	–	–	–	–	–	–	20	23
	2800	.17	.40	–	–	–	–	–	–	24	26
	2100	.06	.15	–	–	–	–	–	–	–	–
16T	2800	.10	.24	–	–	–	–	–	–	21	24
	3500	.16	.35	–	–	–	–	–	–	25	27
	2600	.06	.16	–	–	–	–	–	–	24	22
18T	3500	.11	.27	–	–	–	–	–	–	27	25
	4400	.17	.39	–	–	–	–	–	–	28	29
	3200	.06	.14	–	–	–	–	–	–	27	24
20T	4300	.11	.25	–	–	–	–	22	22	30	27
	5400	.17	.37	–	–	21	27	25	28	33	31

PERFORMANCE NOTES:

1) "–" indicates an NC level less than 20.
2) "ΔP_Z" is the combined static-pressure loss of the inlet and the Zebra® damper, not including the Cross-V™ mixing blades.
3) "ΔP_S" is the difference in static pressure from inlet to discharge, in. WC.
4) Test data obtained in accordance with ARI/ADC Test Standard 880.
5) Quick-Select NC levels are generated using tables and formulae in Warren's *Acoustic Applications Guide*.
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) Radiated NC levels are based on the following:
   a) 10 dB room absorption
   b) mineral fiber acoustical ceiling tile

Table 3. Model DT DISCHARGE Sound Power in Decibels

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
	200	.09	32	34	33	30	27	24	–	39	43	48	45	43	41	–	39	44	48	48	47	46	–	46	48	53	55	57	57	–
05L	300	.16	39	41	41	39	35	31	–	43	48	52	52	49	46	–	43	48	52	52	51	49	–	47	53	56	59	60	60	–
	400	.26	43	45	46	44	40	36	–	45	52	56	55	55	52	–	46	52	57	56	56	53	–	51	55	59	63	64	64	–
	300	.10	35	38	38	33	32	28	–	44	48	52	51	48	45	–	44	50	54	53	53	51	–	49	53	58	60	62	62	–
06L	450	.18	44	48	48	45	42	38	–	49	54	58	56	54	52	–	49	54	58	58	57	56	–	52	57	62	65	66	66	–
	600	.32	52	56	56	55	51	47	–	52	58	62	59	58	57	–	54	58	63	61	59	59	–	55	59	65	68	68	68	–
	500	.13	36	39	39	37	34	29	–	42	45	50	49	46	45	–	45	49	54	55	54	53	–	49	53	56	60	61	61	–
08L	700	.22	44	47	46	45	41	36	–	46	50	55	54	51	50	–	50	53	58	59	57	56	–	52	56	60	64	65	65	–
	900	.33	50	53	53	52	47	43	–	52	56	60	59	56	55	–	53	57	61	62	61	60	–	55	59	63	67	68	68	–
	800	.17	38	41	42	39	34	32	–	44	48	54	53	51	49	–	49	52	56	58	57	56	–	54	58	64	66	67	67	–
10M	1100	.27	45	48	49	47	42	40	–	48	53	57	56	54	53	–	52	55	60	61	60	58	–	56	60	65	68	69	69	–
	1400	.42	50	53	55	53	49	47	–	53	57	62	61	59	57	–	55	59	65	66	65	63	–	59	63	68	71	72	72	21
	1200	.12	40	42	45	40	37	37	–	46	49	56	54	51	51	–	50	53	60	59	58	58	–	57	59	66	68	67	68	–
12M	1600	.21	47	49	54	49	46	45	–	50	54	60	58	55	55	–	53	56	62	62	61	61	–	60	62	68	69	69	69	–
	2000	.32	53	55	61	57	54	51	–	53	58	64	62	59	57	–	56	59	64	65	64	63	–	61	64	69	72	72	71	21
	1600	.16	38	41	45	43	39	37	–	49	53	57	56	55	54	–	51	54	59	61	60	60	–	57	60	66	68	69	69	–
14M	2200	.26	45	48	51	50	46	44	–	52	56	61	60	58	57	–	54	57	64	65	64	63	–	59	63	68	70	70	70	20
	2800	.40	52	55	58	56	53	51	–	55	59	64	63	61	59	–	57	61	68	68	66	65	–	62	65	70	74	74	74	24
	2100	.15	40	43	46	43	40	38	–	51	54	59	58	57	55	–	52	55	60	61	60	61	–	59	63	68	70	70	70	–
16T	2800	.24	47	50	54	51	48	46	–	54	58	63	62	60	59	–	55	58	64	65	64	63	–	61	65	70	73	73	73	21
	3500	.35	53	56	60	57	54	52	–	56	61	66	65	64	61	–	58	62	67	68	67	65	–	64	67	72	75	76	76	25
	2600	.16	42	46	49	47	43	41	–	52	56	61	60	59	57	–	55	58	63	65	64	64	–	60	64	69	72	72	72	24
18T	3500	.27	49	53	56	54	50	48	–	56	60	65	64	63	62	–	58	61	67	68	67	66	–	63	66	72	75	75	75	27
	4400	.39	58	61	65	62	59	57	–	59	63	68	67	65	63	–	62	65	69	71	69	68	–	66	69	75	77	78	78	28
	3200	.14	43	46	49	47	44	43	–	54	59	63	62	61	60	–	56	59	66	67	66	65	–	62	66	72	75	75	75	27
20T	4300	.25	53	56	60	57	54	54	–	58	63	66	65	64	63	–	60	64	69	70	69	68	22	65	69	74	77	77	77	30
	5400	.37	60	64	69	65	61	61	–	63	67	71	70	69	67	21	65	67	73	75	72	71	25	68	72	78	80	80	80	33

PERFORMANCE NOTES:

1) Test data obtained in accordance with ARI/ADC Test Standard 880, adjusted for mixing-blade effects according to SMACNA & ASHRAE formulae.
2) Data is raw, without any corrections for room absorption, or ceiling effect.
3) Sound data (prior to mix-blade adjustments) is within ARI tolerances shown in the following table:

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

4) "ΔP_S" is the difference in static pressure from inlet to discharge, including Cross-V™ mixing blades, 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

Table 4. Model DT RADIATED Sound Power in Decibels

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
	200	.09	23	21	33	30	27	24	–	26	23	27	24	43	41	–	27	26	31	27	22	46	–	33	30	35	36	35	32	–
05L	300	.16	30	26	26	39	35	31	–	31	28	32	29	24	46	–	31	31	35	29	25	49	–	36	34	38	39	37	35	–
	400	.26	33	30	33	28	22	36	–	34	32	36	32	26	20	–	34	33	38	33	27	21	–	40	37	42	41	39	36	–
	300	.10	26	23	22	–	32	28	–	32	30	33	30	24	45	–	33	31	36	31	28	22	–	36	34	39	41	38	35	–
06L	450	.18	35	32	35	30	23	38	–	37	35	39	35	27	22	–	37	35	40	36	30	27	–	42	38	44	44	42	38	–
	600	.32	43	40	43	39	31	26	–	41	39	43	39	30	26	–	42	39	44	40	31	28	–	46	41	48	46	45	39	–
	500	.13	30	27	39	37	34	29	–	34	30	34	30	25	45	–	35	32	37	35	31	26	–	37	35	39	41	39	37	–
08L	700	.22	35	32	32	26	41	36	–	36	34	38	35	29	22	–	39	35	41	38	33	27	–	42	40	44	44	42	39	–
	900	.33	38	35	39	35	28	21	–	42	38	42	39	33	26	–	43	39	45	43	34	29	–	45	42	46	47	45	41	–
	800	.17	28	26	21	39	34	32	–	35	33	36	31	24	49	–	38	36	39	36	31	26	–	41	39	44	43	42	39	–
10M	1100	.27	37	36	34	27	42	40	–	39	37	39	35	27	21	–	42	39	42	39	34	29	–	44	43	46	45	43	41	–
	1400	.42	43	42	42	38	30	47	–	45	43	45	40	33	26	–	46	45	47	45	38	32	–	48	46	50	49	47	44	23
	1200	.12	37	34	33	40	37	37	–	37	36	38	29	23	51	–	39	36	41	38	33	29	–	45	42	46	45	43	40	–
12M	1600	.21	43	41	43	34	24	45	–	43	40	43	36	27	22	–	46	41	44	41	36	32	–	48	45	50	48	46	43	–
	2000	.32	47	44	48	42	35	27	–	47	44	47	39	33	25	–	49	44	48	44	39	35	–	58	48	52	50	47	44	24
	1600	.16	37	34	30	43	39	37	–	36	35	37	31	24	54	–	40	38	41	39	34	28	–	44	43	46	45	43	41	–
14M	2200	.26	42	39	39	35	24	44	–	42	41	43	37	29	22	–	44	43	45	44	37	32	–	48	46	50	47	46	43	23
	2800	.40	47	46	48	44	37	27	–	47	46	49	45	37	27	–	47	46	49	47	41	34	–	51	49	53	50	48	45	26
	2100	.15	38	34	30	22	40	38	–	38	36	38	32	25	55	–	41	39	42	39	35	30	–	45	44	47	46	44	42	–
16T	2800	.24	43	41	41	37	27	46	–	44	42	44	39	30	23	–	45	43	47	44	39	33	–	49	47	52	49	46	44	24
	3500	.35	49	46	49	44	37	28	–	49	46	49	45	38	29	–	49	47	51	48	42	36	–	52	51	55	52	49	46	27
	2600	.16	39	36	33	26	43	41	–	41	38	40	34	27	57	–	44	41	45	43	37	32	–	46	46	49	48	46	44	22
18T	3500	.27	45	44	42	37	28	48	–	45	44	46	40	32	25	–	46	45	48	46	42	35	–	51	50	53	51	49	46	25
	4400	.39	53	50	53	48	40	32	–	51	48	51	47	39	30	–	52	49	52	49	45	37	–	55	53	56	54	51	49	29
	3200	.14	41	37	34	26	44	43	–	42	41	42	36	29	22	–	45	43	46	45	38	34	–	49	48	51	50	48	46	24
20T	4300	.25	48	46	47	40	31	54	–	47	46	48	43	35	26	–	49	47	50	48	43	37	22	53	52	55	53	51	48	27
	5400	.37	56	54	57	50	43	37	–	54	52	55	50	41	34	27	54	52	56	53	47	40	28	57	56	59	57	54	51	31

PERFORMANCE NOTES:

1) Test data obtained in accordance with ARI/ADC Test Standard 880, adjusted for mixing-blade effects according to SMACNA & ASHRAE formulae.
2) Data is raw, without any corrections for room absorption, or ceiling effect.
3) Sound data (prior to mix-blade adjustments) is within ARI tolerances shown in the following table:

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

4) "ΔP_S" is the difference in static pressure from inlet to discharge, including Cross-V™ mixing blades, in. WC.
5) "–" indicates an NC level less than 20.
6) Radiated NC levels are based on the following:
   a) 10 dB room absorption
   b) mineral fiber acoustical ceiling tile

DOUBLE-DUCT APPLICATIONS

Ultimate Control Flexibility

Warren's DT Double-Duct terminal units provide the ultimate in control flexibility for a modern Variable-Air-Volume system. Two separate primary air-streams (hot and cold) attach to independently-controlled Zebra® precision air valves which are mounted on a common box. Depending on the comfort needs of the moment, the controls allow varying amounts of cold or hot air into the box. The discharge flow may be Variable-Volume, Constant-Volume, Variable-to-Minimum, or many other patterns, to fit the your specific requirements. Controls can be set to limit the pressure or temperature of the discharge if desired.

Low Noise, Energy and Clearance

Highly sophisticated systems can be devised which minimize energy consumption, noise levels, and ceiling-space requirements. This is done by using both primary airstreams for cooling purposes in the summer, and then resetting one of the airstreams to return-air temperature in mild seasons, and hotter temperatures in the winter. The supply-air temperatures must be optimized at all times to eliminate mixing penalties and provide good room air circulation. Full use of outdoor-air economizer mode is possible.

Indoor Air Quality & Pressurization

Double-Duct units can meter the amount of outside air into each room, to provide ultimate in outside-air control to meet stringent Indoor Air Quality standards. One of the inlets is fed 100% outside air, pre-conditioned to an appropriate mild temperature. The flow rate through this duct is modulated to meet stringent outdoor-air requirements, or to satisfy zone-pressurization needs. The other airstream is independently controlled, and does the majority of the cooling/heating work.

Low Life-Cycle Cost

Double-Duct terminals can provide constant-volume variable-temperature discharge air to the space, by mixing appropriate quantities of air from the two ducts. If a sophisticated control sequence is used, this can be done with little or no mixing energy-penalties. The first cost, operating cost and maintenance costs for this constant-volume system are often lower than for any other method.

Hot/Cold Discharge Problems

The hot and cold airstreams enter the box separately, and may operate simultaneously (at part-load), so for most applications it is necessary to provide positive mixing of the air before it leaves the terminal. Conventional double-duct terminal designs often fail to deal with the problems associated with discharge thermal stratification. Boxes that do not have effective mixing sections supply inadequately-mixed warm air to diffusers on the right side of the discharge duct, and cold air to diffusers on the left side. This creates major thermal-control problems, especially if the diffusers serve separate areas.

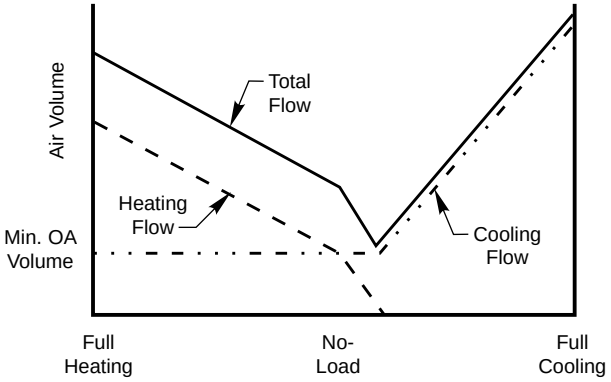
Laminar Flow & Cross-V™ Mixing

Warren's DT Terminal Unit has been specifically designed to meet these discharge-mixing needs. Zebra® valves provide consistent laminar flow patterns with flat velocity profiles at all points of operation, which keeps air from "piling up" on the top, bottom or sides of the unit. Furthermore, the DT unit has Cross-V™ mixing blades which cause the two airstreams to move over, under, around and through one another, blending into a homogenous temperature at the box discharge. This blade and damper design minimizes static-pressure drop and noise generation.

SEQUENCE OF OPERATION

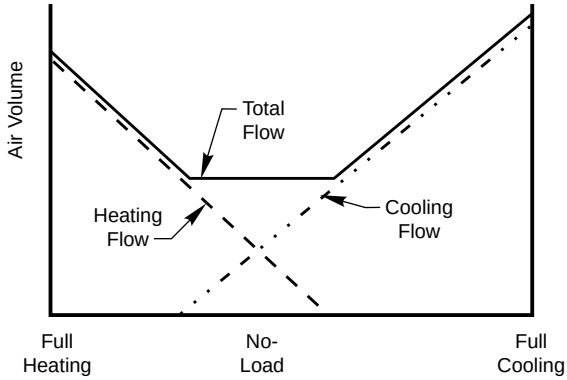
VAV CLG TO MIN-OA, VAV HTG:

This is one of the most energy-efficient control methods, which also provides good IAQ. The cold AHU has Outdoor Air (uses economizer in the winter), but the hot AHU does not, so no return-air heat is wasted. The hot valve begins to open when the cold valve reaches the MinOA flow, and fully-neutralizes the cold supply at the No-Load point. The MinOA remains constant. Cold &/or hot supply-reset can be used to save more energy (see gray lines above).



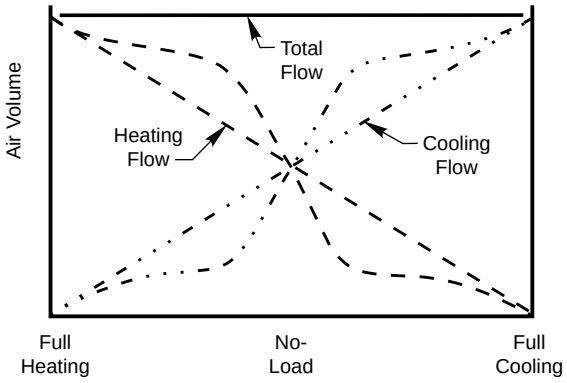
VAV CLG, VAV HTG TO MINIMUM:

This approach is used to eliminate most of the energy waste of the Constant-Volume method, by shutting off the cold valve before high heat loads appear (and vice-versa for the hot valve). At the “No-Load” intersection, the two supples neutralize one another, and provide a significant amount of air to the space to maintain good air distribution. Some outside air should be in both the hot & cold ducts. Supply-temp reset is not very useful here.



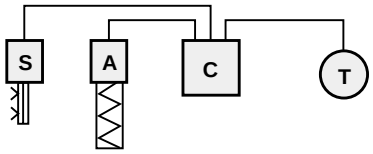
CLASSIC CONSTANT-VOLUME:

This original concept for Double-Duct terminals provides a constant flow of air to the space at varying temperature. Each damper is “true VAV”, as is the duct & fan system that feeds it. Significant energy-savings are possible if controls are used to reset the cold and hot supply temps to barely satisfy the worst-case demand at any given moment. The gray lines show how such a reset alters the flow — more air is needed when the supply-temp is milder.



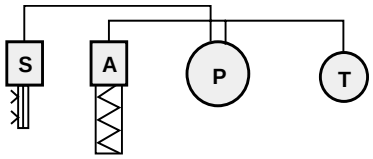
BASIC CONTROL MODES

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

- Constant or Variable discharge volume
- Control hot duct from inlet or discharge
- Separate min & max hot & cold flow setpoints
- Hot duct changeover to return or cold air
- Night-mode “pure VAV” operation
- Single or dual controller-cards

SUGGESTED SPECIFICATIONS

Furnish and install Warren Double-Duct Terminal Units (Model DT) of the sizes and capacities shown on the plans. Sound power generated by the terminal unit shall not exceed values shown on the schedules.

All assemblies shall be constructed of heavy gauge galvanized steel, with gauges conforming to the requirements of UL 1995. The assemblies shall be so formed and constructed to have the strength and rigidity to withstand normal handling and operational integrity. The assemblies shall be fully lined internally with 1/2" thick dual density fiberglass insulation or engineered polymer foam insulation (EPFI), per UL 181 and NFPA 90A. There shall be no raw edges of insulation exposed to upstream air flow.

The primary air valves shall use 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.

Crossed mixing baffles shall be provided on the top and bottom of the unit, downstream of the valves, followed by an end-cap with an opening that has approximately half of the cross-sectional area of the unit. Thermal mixing efficiency shall meet specified values.

OPTIONS:

- Custom Access Panel
- Perforated Metal Lining
- Multiple Outlet Plenums
- Tedlar Lining
- Foil Lining
- Sound Attenuator

Warren DT terminal units can be customized to meet very stringent thermal-mixing applications, by altering the geometry of the Cross-V™ mixing blades. Some additional static pressure drop and noise may be created. Contact the factory.

CONTROLLERS

DT units are available as system-pressure independent or system-pressure dependent, controlled by room thermostats that vary the air volume &/or temperature delivered to the space to achieve desired setpoint conditions. Pressure-independent models maintain flow rates regardless of system pressure changes. Pressure dependent models may have intermittent variations in flow due to system pressure fluctuations, unless proper duct-design procedures are used.

NC-Oversizing vs Controllability

Since noise criteria (NC) is a major consideration when selecting the required terminal unit, care should be taken to choose the proper unit (without oversizing) to obtain optimum controllability.

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

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.

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

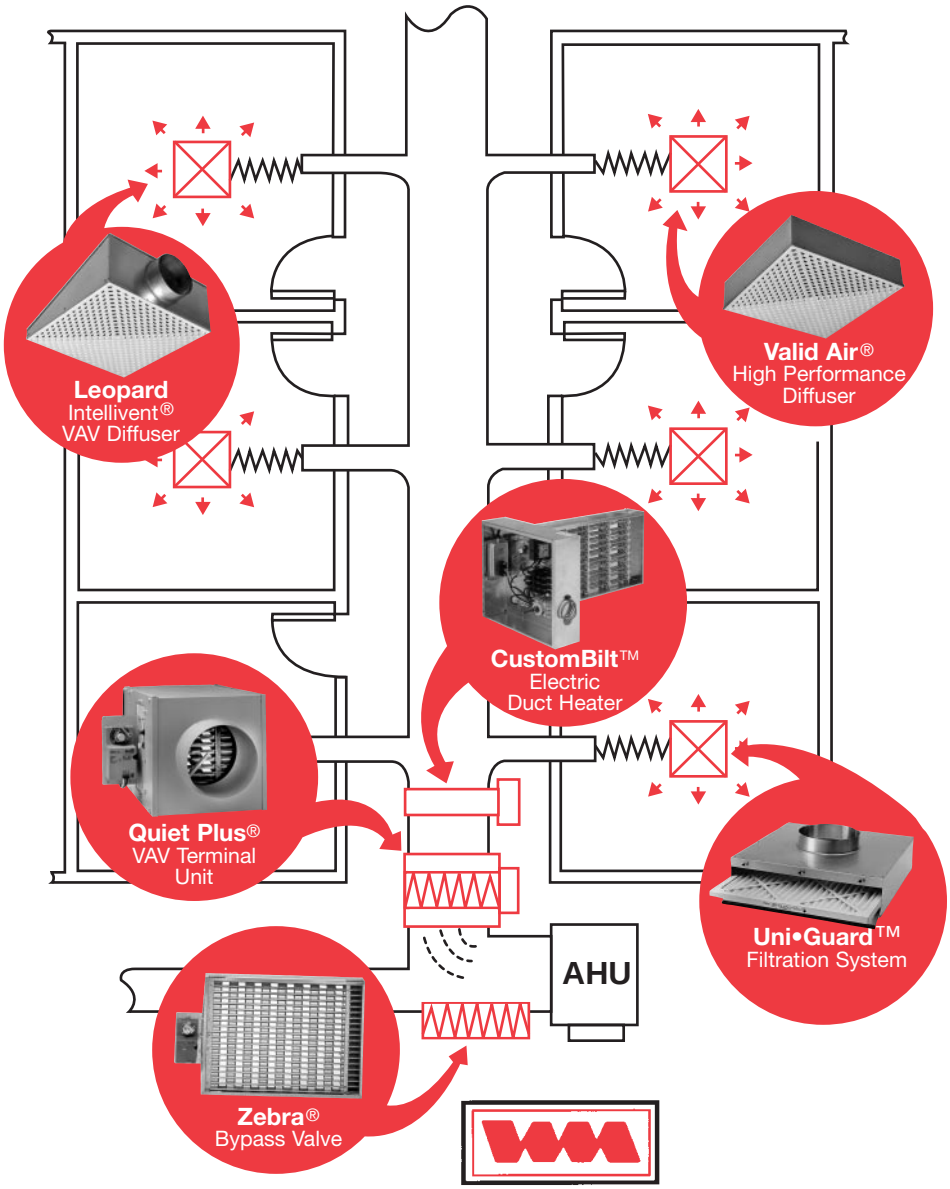
Valid Air®
High Performance Diffusers
- Increased Air Circulation
- Draft-Free, Dump-Proof Air Flow

Custombuilt™
Electric Duct Heaters
- Safety Tested, Economical

Quiet Plus®
VAV Terminal Units
- Ultra Quiet Operation
- Precise Control

Zebra®
Precision Air Valves
- Laminar Air Flow
- Low Noise Levels

UNI•GUARD™
Individual Room Filtration System
- Improved IAQ



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