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Acutherm
1766 Sabre Street
Hayward CA 94545

February 23, 2007

Dear Sir,

Re: Results of Energy Study

This summarizes the results of an engineering study undertaken to compare the energy impact of using small versus large variable air volume (VAV) control zones, and the relative performance of Acutherm's low pressure variable air volume diffuser (Therma-Fuser) versus that of a medium pressure terminal VAV box (0.4 in. w.g. total pressure drop when sized for approximately 3:1 one, or 25% design flow, minimum turndown).

The energy model was built using VisualDOE and analyzed by the DOE2.1E engine to represent a typical 8 story, 154,000 square foot building. Schedules were set that simulate 15% of private offices being unoccupied on any given day.

Overall, the Therma-Fuser system saved between 15% and 47% (depending on climate zone) of the annual HVAC energy costs of the VAV box system. The greatest savings were in climates where significant reheat is required. See the table below.

Use of smaller VAV zones (individual temperature control) reduced the energy requirement of the building regardless of the VAV device used (between 1% and 15% savings) due to reduced overall airflow and overcooling. The area of private offices is 27% of the total area of the building modeled. Savings are expected to be larger for buildings with more private offices and with higher rates of unoccupied private offices.

Use of the Therma-Fuser system offers energy savings across climate zones, primarily due to the following characteristics:
1. Lower minimum turndown capability (between 10% and 28% savings). The typical VAV box can turn down to 25% of the design airflow; better VAV box turndown is possible but at the cost of higher pressure drop or poorer resolution control approaches not supported by many VAV box manufacturers. The Therma-Fuser diffuser control approach allows controlled turndown to the minimum ventilation requirement of the space, reducing the need for reheat.
2. Lower pressure drop (between 2% and 7% savings). The Therma-Fuser system eliminates the use of a pressure-differential flow meter and damper as typically used in VAV boxes, reducing the fan pressure required for operation. Also, elimination of the VAV box often simplifies duct layout and recommended operating pressures are significantly lower for Therma-Fuser diffusers than VAV boxes.

Annual Energy Savings $ and % of Therma-Fuser System vs. VAV Box System

Weather File	Chicago		Los Angeles		Philadelphia		San Antonio		Seattle	
Small Zones Versus Large Zones	$1,055	1%	$8,039	15%	$2,538	3%	$7,196	11%	$567	1%
Lower Minimum Turndown Ratio	$7,952	10%	$13,395	25%	$15,269	16%	$12,350	18%	$16,822	28%
Lower Total System Pressure Drop (1.2" in w.g. Reduction)	$2,293	3%	$4,053	7%	$2,315	2%	$3,843	6%	$1,297	2%
Total Savings	**$11,301**	**15%**	**$25,488**	**47%**	**$20,124**	**21%**	**$23,390**	**34%**	**$18,686**	**31%**

The results show savings across the board for smaller zones, lower minimum turndown ratios, and lower pressure drop systems – all features of a Therma-Fuser diffuser system. For more details of the results, including the impact of a 0.4 in w.g. pressure drop reduction, and of the energy model see my report of February 26, 2007.

Sincerely,

John Weale, P.E.

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JOHN HILDRUM WEALE
31845
EXP. 9/07
MECHANICAL
STATE OF CALIFORNIA

ENERGY EFFICIENT DESIGN

Therma-Fuser Diffuser Energy Modeling Analysis

Oakland, California

February 26, 2007

Prepared by

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Executive Summary

This summarizes the results of an engineering study undertaken to compare the energy impact of using small versus large variable air volume (VAV) control zones, and the relative performance of Acutherm's low pressure variable air volume diffuser (Therma-Fuser) versus that of a medium pressure terminal VAV box (0.4 in. w.g. total pressure drop when sized for approximately 3:1 one, or 25% design flow, minimum turndown).

The energy model was built using VisualDOE and analyzed by the DOE2.1E engine to represent a typical 8 story, 154,000 square foot building. Schedules were set that simulate 15% of private offices being unoccupied on any given day.

Overall, the Therma-Fuser system saved between 15% and 47% (depending on climate zone) of the annual HVAC energy costs of the VAV box system. The greatest savings were in climates where significant reheat is required. See the table below.

Use of smaller VAV zones (individual temperature control) reduced the energy requirement of the building regardless of the VAV device used (between 1% and 15% savings) due to reduced overall airflow and overcooling. The area of private offices is 27% of the total area of the building modeled. Savings are expected to be larger for buildings with more private offices and with higher rates of unoccupied private offices.

Use of the Therma-Fuser system offers energy savings across climate zones, primarily due to the following characteristics:

1. Lower minimum turndown capability (between 10% and 28% savings). The typical VAV box can turn down to 25% of the design airflow; better VAV box turndown is possible but at the cost of higher pressure drop or poorer resolution control approaches not supported by many VAV box manufacturers. The Therma-Fuser diffuser control approach allows controlled turndown to the minimum ventilation requirement of the space, reducing the need for reheat.

2. Lower pressure drop (between 2% and 7% savings). The Therma-Fuser system eliminates the use of a pressure-differential flow meter and damper as typically used in VAV boxes, reducing the fan pressure required for operation. Also, elimination of the VAV box often simplifies duct layout and recommended operating pressures are significantly lower for Therma-Fuser diffusers than VAV boxes.

Summary Table of Results

Annual Energy Savings $ and % of Therma-Fuser System vs. VAV Box System										
Weather File	Chicago		Los Angeles		Philadelphia		San Antonio		Seattle	
Small Zones Versus Large Zones	$1,055	1%	$8,039	15%	$2,538	3%	$7,196	11%	$567	1%
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Total Savings	$11,301	**15%**	$25,488	**47%**	$20,124	**21%**	$23,390	**34%**	$18,686	**31%**

The results show savings across the board for smaller zones, lower minimum turndown ratios, and lower pressure drop systems – all features of a Therma-Fuser diffuser system.

Methodology

This engineering study was undertaken to compare the energy impact of using small versus large variable air volume (VAV) control zones, and the relative performance of Acutherm's low pressure variable air volume diffuser (Therma-Fuser™) versus that of a medium pressure terminal VAV box (0.4 in. w.g. total pressure drop when sized for approximately 3:1 one, or 25% design flow, minimum turndown).

The energy model was built using VisualDOE and analyzed by the DOE2.1E engine and represents a typical 8 story, 154,000 square foot building. Each floor was modeled as having a gross square footage of 19,200 with 5,200 square feet of private offices. The balance of the space was circulation hallways, open office, and a core service area containing restrooms, a breakroom, elevators, stairs and storage. Schedules were set that simulate 15% of offices being unoccupied on any given day. Results indicate energy savings are accrued by the Therma-Fuser system from higher turndown reducing reheat requirements, smaller VAV control zones reducing overall airflow and overcooling, and lower pressure drop fan systems.

The DOE2 building model models one floor in detail and uses a multiplier of 8 to simulate an 8 story building. Each floor is served by a single dedicated air handler with a 55°F supply air temperature, VFD drive, and an economizer when required by ASHRAE 90.1 – 2004 (Philadelphia and San Antonio climate zones do not have economizers). A single water-cooled chilled water plant serves the entire building. The drawing on the next page shows the typical floor layout used for the modeling. For the small zone model, each enclosed office was modeled as an individual zone, while open office areas were treated as one or two zones. The larger zone model combines 3 to 4 offices into a single zone that share a common exposure (North, South, East, West) and are served by a single VAV box.

Figure 1 shows the typical floor layout for the modeling; each room was given a zone for the small zone model. Figure 2 shows the zoning layout for the large zone VAV modeling; each zone was given a VAV box.

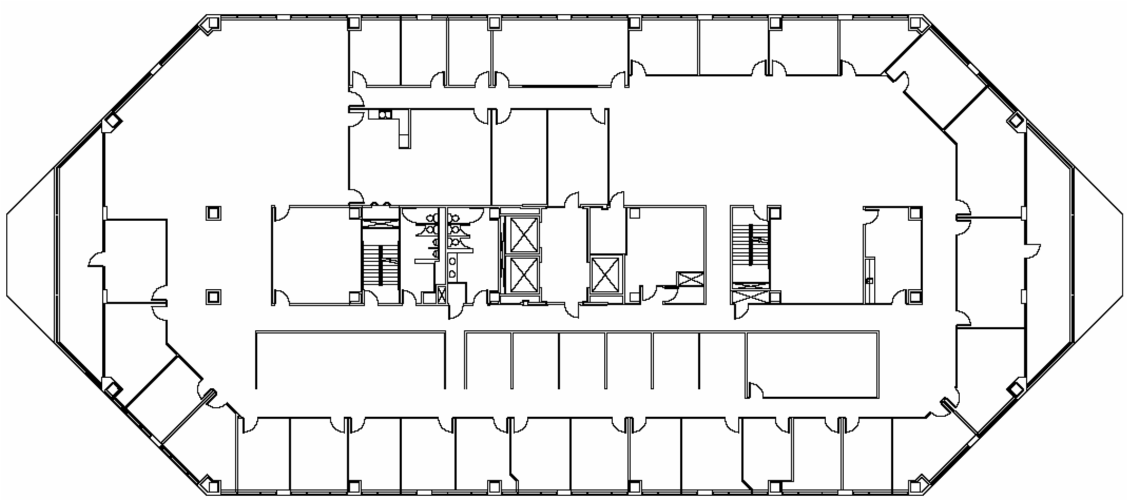


Fig. 1 Typical Floor Layout

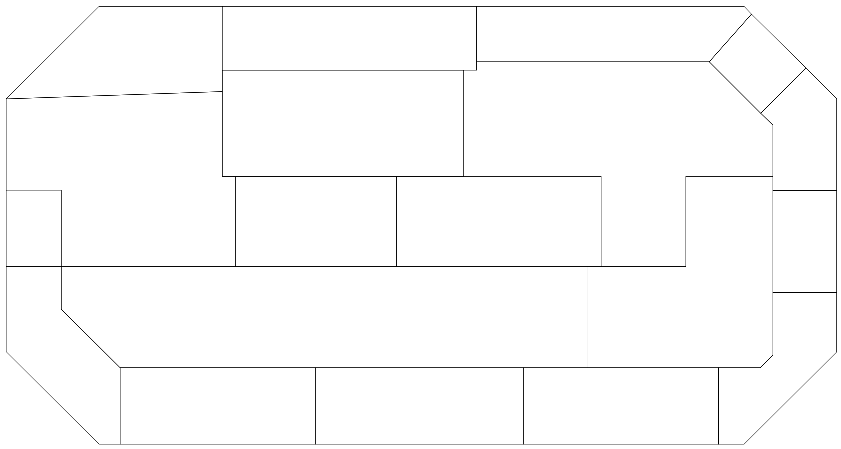


Fig. 2 Zoning for Large Zone Model

Schedules were set to simulate one unoccupied office per large VAV zone. Open office areas were modeled as a single zone that shared a single schedule. The same schedule profile was used for occupied offices every model: Loading up between 8-9am, loads drop for an hour at lunch, and then tail off for the evening at 5pm. To account for unoccupied offices in the large zone model, where a portion of a large zone could not be given an unique unoccupied schedule based on area, the overall lighting power density, equipment power density and occupant density were adjusted on an area-averaged basis to ensure that the total plug, lighting, and occupant loads were kept equal between all cases.

Five basic configurations were modeled:

Model A: A standard VAV box system with typical zones (large zone VAV modeling): The grouping together of offices onto a single VAV box represents how typical VAV systems are structured and modeled. The implicit assumption in this model is that all the spaces have identical schedules and the loads are all averaged equally – no single office in the zone is modeled as being at a different temperature or receiving a different portion of air than another. To allow this model to be comparable to the small zone models, the plug, lighting and occupant loads of any offices assigned the unoccupied scheduling in the small zone model were averaged on an air basis with the other spaces in the zone.

Model B: A standard VAV box (0.40 in w.g. box pressure drop, 25% minimum flow setting) serving small zones (one per office).

Model C: A Therma-Fuser system (minimum flow setting equal to ventilation minimum flow) with the same overall pressure drop as the standard VAV system, such as using a standard VAV system design and boxes as pressure control stations, with Therma-Fuser diffusers used to create individual zones.

Model D: A Therma-Fuser system (minimum flow setting equal to ventilation minimum flow) without the use of a pressure-differential airflow meter and damper as typically used in pressure independent VAV boxes (no box pressure drop).

Model E: A Therma-Fuser system (minimum flow setting equal to ventilation minimum flow) designed to overall lower pressure drop principles and no variable air volume control dampers or boxes other than the Therma-Fuser diffuser itself for a net total system pressure drop of 1.8 in w.g. (versus 3.0 in w.g. in the standard VAV box system).

The five models were then compared to isolate specific sources of energy savings:

Model A minus Model B: The primary difference is the smaller zones (individual temperature control). Energy savings are a result of the reduced air flow and reduced overcooling and reheat.

Model B minus Model C: The primary difference is the ventilation minimum flow of the Therma-Fuser diffuser vs. the 25% minimum flow of the box. Energy savings are a result of reduced reheat.

Model C minus Model D: The primary difference is the elimination of the pressure drop over the box. Energy savings are a result of lower required fan pressure.

Model D minus Model E: The primary difference is a lower total system pressure. Energy savings are a result of lower required fan pressure.

Model A minus Model E: Is the energy savings which is the combination of the measures above.

See Appendix A for a comparative table of results

Results

Results indicate that the use of smaller VAV zones reduced the energy requirement of the building regardless of the VAV device used. Smaller zones showed lower overall airflow demand and reduced overcooling, resulting in reduced energy usage. Use of the Therma-Fuser system, an inherently small-zone approach, appears to offer additional energy savings across climate zones, primarily due to the following characteristics:

1. Lower minimum turndown capability. The typical VAV box can turn down to 25% of the design airflow; better VAV box turndown is possible but at the cost of higher pressure drop or poorer resolution control and is not supported by some VAV box manufacturers. The Therma-Fuser integral control approach allows controlled turndown to the minimum ventilation requirement of the space, reducing the need for reheat.

2. Lower pressure drop. The Therma-Fuser system eliminates the use of a pressure-differential based flow meter and damper (as typically used in VAV boxes), reducing the fan pressure required for operation. Manufacturer recommended design is an inherently lower pressure drop system.

The results showed savings across the board for a low pressure drop Therma-Fuser system with the greatest savings in climates where significant reheat is required.

The following tables summarize the modeling results. The key differences are as follows:

1. Column B has smaller zones, resulting in greater resolution of control versus the large zoned results in column A.

2. Column B has a higher total fan system pressure drop than columns D and E, resulting in higher fan power.

3. Column B has a higher minimum allowable flow than columns C, D and E, where the minimum flow is equal to the ventilation airflow requirement; this results in higher reheat and energy costs.

4. Column B has a higher total airflow than column C, D and E systems due to the higher turndown. However, due to the square relationship between flow and fan power this has a negligible impact on total power and, in some cases, is masked by control granularity in the model. As modeled the lower turndown Therma-Fuser diffuser cases do not overcool rooms, so when a room is modeled as swinging from reheat to cooling the Therma-Fuser diffuser cases are modeled as requiring a small amount of additional airflow (and fan power) for that hour.

5. Columns A and B both have higher minimum flow ratios than columns C, D and E resulting in higher heating and cooling energy consumption due to reheat loads. The magnitude of reheat costs is driven by the number of unoccupied offices. A building with a higher percentage of unoccupied offices would be expected to show a greater heating and cooling savings difference between these cases due to further reheat avoidance.

Five different geographical locations, each with a different climate were modeled. Overall, the Therma-Fuser system resulted in significant savings over the annual HVAC energy cost of the VAV box system in each climate. Two of the zones, Los Angeles and San Antonio, have warmer winters and are not heating climates. These two climates produced substantial cooling energy savings, particularly through reduced reheat in this system configuration, and resulted in the greatest total energy savings. The other three zones, Chicago, Philadelphia and Seattle, have cooler winters with greater economizer operation requiring heating which reduced overall re-heat costs and therefore savings. Seattle appears to have larger moderate 'shoulder season' conditions that require reheat during non-economizer operation resulting in more total energy savings than Chicago, which has shorter shoulder season conditions.

Table: Results for Chicago

			Model				
			A 1 VAV Box per 3-4 Offices (25% min allowable flow)	B 1 VAV Box per Office (25% minimum allowable flow)	C 1 Therma-Fuser Diffuser per Office- Same Pressure System	D 1 Therma-Fuser Diffuser per Office- Low Pressure System	E 1 Therma-Fuser Diffuser per Office- Lowest Pressure System
1							
2	Fan	hp Required	179	180	180	156	108
3		Energy, kWh	75156	68484	68902	59727	41361
4	Cooling	Energy, kWh	205295	184553	164333	163596	162137
5	Heating	Energy, Therms	53566	55021	48660	48791	49055
6	Total HVAC	Electricity, kWh	280451	253037	233235	223323	203498
7		$*	65,415	64,039	57,486	56,692	55,106
8		$ % of A6	100%	98%	88%	87%	84%
9	Total Building	Electricity, kWh	1226802	1199396	1179595	1169682	1149858
10		$*	151,157	149,788	143,235	142,441	140,855
11		$ % of A9	100%	99%	95%	94%	93%

* Includes cost of natural gas for heating and reheat ($0.09/kWh, $0.97/therm Energy Information Administration)

Table: Results for Los Angeles

1			Model A 1 VAV Box per 3-4 Offices (25% min allowable flow)	 B 1 VAV Box per Office (25% minimum allowable flow)	 C 1 Therma-Fuser Diffuser per Office- Same Pressure System	 D 1 Therma-Fuser Diffuser per Office- Low Pressure System	 E 1 Therma-Fuser Diffuser per Office- Lowest Pressure System
2	Fan	hp Required	176	177	177	153	106
3	Fan	Energy, kWh	68867	63156	63475	55007	38079
4	Cooling	Energy, kWh	237517	191733	161309	160083	157621
5	Heating	Energy, Therms	12840	11928	1839	1846	1859
6	Total HVAC	Electricity, kWh	306384	254889	224784	215090	195700
7	Total HVAC	$*	37204.56	31886.01	21609.81	20742.6	19007.25
8	Total HVAC	$ % of A6	100%	86%	58%	56%	51%
9	Total Building	Electricity, kWh	1252737	1201248	1171143	1161449	1142058
10	Total Building	$*	122829	117510	107233	106366	104631
11	Total Building	$ % of A9	100%	96%	87%	87%	85%

* Includes cost of natural gas for heating and reheat ($0.14/kWh, $0.91/therm Energy Information Administration)

Table: Results for Philadelphia

1			Model: A 1 VAV Box per 3-4 Offices (25% min allowable flow)	B 1 VAV Box per Office (25% minimum allowable flow)	C 1 Therma-Fuser Diffuser per Office- Same Pressure System	D 1 Therma-Fuser Diffuser per Office- Low Pressure System	E 1 Therma-Fuser Diffuser per Office- Lowest Pressure System
2	Fan	hp Required	176	177	177	153	106
3		Energy, kWh	76263	67876	67990	58933	40807
4	Cooling	Energy, kWh	305245	270984	199861	198765	196619
5	Heating	Energy, Therms	43094	44036	37602	37707	37908
6	Total HVAC	Electricity, kWh	381508	338860	267851	257698	237426
7		$*	66656.22	63524.4	52308.09	51473.07	49799.34
8		$ % of A6	100%	95%	78%	77%	75%
9	Total Building	Electricity, kWh	1327858	1285219	1214210	1204057	1183786
10		$*	152366	149233	138017	137180	135508
11		$ % of A9	100%	98%	91%	90%	89%

* Includes cost of natural gas for heating and reheat ($0.09/kWh, $1.38/therm Energy Information Administration)

Table: Results for San Antonio

1			Model A 1 VAV Box per 3-4 Offices (25% min allowable flow)	B 1 VAV Box per Office (25% minimum allowable flow)	C 1 Therma-Fuser Diffuser per Office- Same Pressure System	D 1 Therma-Fuser Diffuser per Office- Low Pressure System	E 1 Therma-Fuser Diffuser per Office- Lowest Pressure System
2	Fan	hp Required	179	180	180	156	108
3		Energy, kWh	105796	82701	81147	70309	48650
4	Cooling	Energy, kWh	460937	415296	351013	348834	344489
5	Heating	Energy, Therms	11837	11504	5559	5578	5619
6	Total HVAC	Electricity, kWh	566733	497997	432160	419143	393139
7		$*	59883.72	53447.73	43063.65	41906.37	39596.76
8		$ % of A6	100%	89%	72%	70%	66%
9	Total Building	Electricity, kWh	1513084	1444357	1378519	1365502	1339498
10		$*	145455	139018	128634	127477	125167
11		$ % of A9	100%	96%	88%	88%	86%

* Includes cost of natural gas for heating and reheat ($0.10/kWh, $0.97/therm Energy Information Administration)

Table: Results for Seattle

1			Model A 1 VAV Box per 3-4 Offices (25% min allowable flow)	Model B 1 VAV Box per Office (25% minimum allowable flow)	Model C 1 Therma-Fuser Diffuser per Office- Same Pressure System	Model D 1 Therma-Fuser Diffuser per Office- Low Pressure System	Model E 1 Therma-Fuser Diffuser per Office- Lowest Pressure System
2	Fan	hp Required	174	175	175	152	105
3	Fan	Energy, kWh	64107	62721	62778	54414	37673
4	Cooling	Energy, kWh	114328	100630	82636	82012	80760
5	Heating	Energy, Therms	42190	42474	29242	29331	29512
6	Total HVAC	Electricity, kWh	178435	163351	145414	136426	118433
7	Total HVAC	$*	47701.65	46557.1	35018.76	34276.59	32792.97
8	Total HVAC	$ % of A6	100%	98%	73%	72%	69%
9	Total Building	Electricity, kWh	1124786	1109710	1091773	1082785	1064792
10	Total Building	$*	133427	132282	120743	120001	118518
11	Total Building	$ % of A9	100%	99%	90%	90%	89%

* Includes cost of natural gas for heating and reheat ($0.06/kWh, $1.19/therm Energy Information Administration)

Appendix A: Comparative Table of Results

Comparative Table of Results

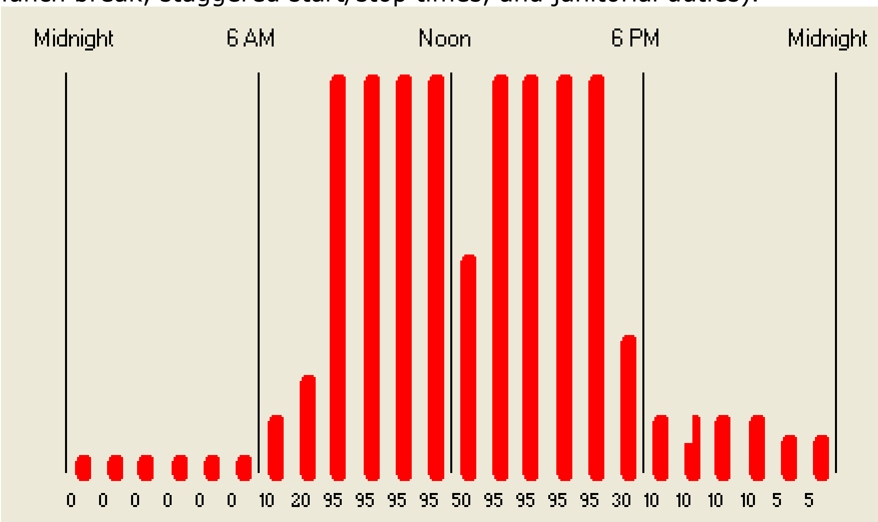
Region Summer Winter	Mid West Humid Cold				Pacific / CA Warm / Dry None				Atlantic Humid Cold				South Hot / Humid None				Pacific / NW Mild Cool			
City	**Chicago**				**Los Angeles**				**Philadelphia**				**San Antonio**				**Seattle**			
electricity=fan+cooling heating	kWh		Therms		kWh		Therms		kWh		Therms		kWh		Therms		kWh		Therms	
1 VAV Box per 3-4 offices	280451		53566		306384		12840		381508		43094		566733		11837		178435		42190	
1 Therma-Fuser diffuser per office lowest pressure sys	203498		49055		195700		1859		237426		37908		393139		5619		118433		29512	
Fan Savings	33795	12%	0		30788	10%	0		35456	9%			57146	10%			26434	15%		
Cooling Savings	43158	15%	0		79896	26%	0		108626	28%			116448	21%			33568	19%		
Heating Savings			4511	8%			10981	86%			5186	12%			6218	53%			12678	30%
Total Savings	76953	27%	4511	8%	110684	36%	10981	86%	144082	38%	5186	12%	173594	31%	6218	53%	60002	34%	12678	30%
Smaller VAV Zones																				
Fan Savings	6672	2%			5711	2%			8387	2%			23095	4%			1386	1%		
Cooling Savings	20742	7%			45784	15%			34261	9%			45641	8%			13698	8%		
Heating Savings			-1455	-3%			912	7%			-942	-2%			333	3%			-284	-1%
Total Savings	27414	10%	-1455	-3%	51495	17%	912	7%	42648	11%	-942	-2%	68736	12%	333	3%	15084	8%	-284	-1%
$ Savings	$2,467		-$1,411		$7,209		$830		$3,838		-$1,300		$6,874		$323		$905.04		-$338	
Total $ Savings			$1,056	1%			$8,039	15%			$2,538	3%			$7,197	11%			$567	1%
Lower Minimum Turndown																				
Fan Savings	-418	0%			-319	0%			-114	0%			1554	0%			-57	0%		
Cooling Savings	20220	7%			30424	10%			71123	19%			64283	11%			17994	10%		
Heating Savings			6361	12%			10089	79%			6434	15%			5945	50%			13232	31%
Total Savings	19802	7%	6361	12%	30105	10%	10089	79%	71009	19%	6434	15%	65837	12%	5945	50%	17937	10%	13232	31%
$ Savings	$1,782		$6,170		$4,215		$9,181		$6,391		$8,879		$6,584		$5,767		$1,076.22		$15,746	
Total $ Savings			$7,952	10%			$13,396	25%			$15,270	16%			$12,350	18%			$16,822	28%
Lower Pressure Drop System (0.8 in. w.g. reduction)																				
Fan Savings	18366	7%			16928	6%			18126	5%			21659	4%			16741	9%		
Cooling Savings	1459	1%			2462	1%			2146	1%			4345	1%			1252	1%		
Heating Savings			-264	0%			-13	0%			-201	0%			-41	0%			-181	0%
Total Savings	19825	7%	-264	0%	19390	6%	-13	0%	20272	5%	-201	0%	26004	5%	-41	0%	17993	10%	-181	0%
$ Savings	$1,784		-$256		$2,715		-$12		$1,824		-$277		$2,600		-$40		$1,079.58		-$215	
Total $ Savings			$1,528	2%			$2,703	5%			$1,547	2%			$2,561	4%			$864	1%
Eliminating Press Drop over Box (0.4 in. w.g. reduction)																				
Fan Savings	9175	3%			8468	3%			9057	2%			10838	2%			8364	5%		
Cooling Savings	737	0%			1226	0%			1096	0%			2179	0%			624	0%		
Heating Savings			-131	0%			-7	0%			-105	0%			-19	0%			-89	0%
Total Savings	9912	4%	-131	0%	9694	3%	-7	0%	10153	3%	-105	0%	13017	2%	-19	0%	8988	5%	-89	0%
$ Savings	$892		-$127		$1,357		-$6		$914		-$145		$1,302		-$18		$539.28		-$106	
Total $ Savings			$765	1%			$1,351	2%			$769	1%			$1,283	2%			$433	1%
Total Savings	**76953**	**27%**	**4511**	**8%**	**110684**	**36%**	**10981**	**86%**	**144082**	**38%**	**5186**	**12%**	**173594**	**31%**	**6218**	**53%**	**60002**	**34%**	**12678**	**30%**
$ Savings	**$6,926**		**$4,376**		**$15,496**		**$9,993**		**$12,967**		**$7,157**		**$17,359**		**$6,031**		**$3,600.12**		**$15,087**	
Total $ Savings			**$11,301**	**15%**			**$25,488**	**47%**			**$20,124**	**21%**			**$23,391**	**34%**			**$18,687**	**31%**
	Fan hp				Fan hp				Fan hp				Fan hp				Fan hp			
1 VAV Box per 3-4 offices	179				176				176				179				174			
1 Therma-Fuser diffuser per office lowest pressure sys	108				106				106				108				105			
Energy Costs* $/kWh $/Therm	$0.09		$0.97		$0.14		$0.91		$0.09		$1.38		$0.10		$0.97		$0.06		$1.19	

*Source - Energy Information Administration, kWh for Aug-06, Therm for Sep-06

Notes: Comparative Table of Results Interpretations

Smaller VAV Zones (or Individual Temperature Control and Occupancy Diversity) was modeled by comparing one VAV terminal for 3-4 rooms vs. one VAV terminal for each room. One VAV terminal for 3-4 rooms is typical of a VAV box system and a Therma-Fuser diffuser system provides one VAV terminal for each room. One VAV box per room provides an equivalent level of control as modeled in case B.

The DOE2 software does not recognize occupancy diversity within a zone and models using the widely accepted approach of averaging. Averaging the load on one VAV terminal for 3-4 rooms does not reflect the additional energy use for the actual operation: Occupants finding and adjusting the thermostat, opening windows, leaving doors open, bringing in fans or space heaters, etc. so that their specific office is comfortable, which usually results in overcooling of unoccupied offices. In the one VAV terminal for 3-4 rooms model, there is only one occupancy (hours conditioned) schedule. Since one room cannot be left empty, the total lighting, power and occupant load of the one-zone-per-room model is averaged between all four offices on a space weighted basis. This ensures that the total annual lighting, plug load, and occupancy loads served by the systems are equal, allowing for an accurate comparison to the smaller zoned models. The same sum occupant hours, lighting loads, and equipment loads per hour were maintained to ensure equivalent hourly loads (annual lighting and plug loads are consistent between the models). The one VAV terminal for each room model has a total of 49 rooms/zones per floor, and at any given time 8 offices are empty (16% of occupants are at meetings, absent, traveling, on break, an unassigned office, etc.). The average office weekday occupancy profile is shown below (fractional occupancy averages out over all offices to account for lunch break, staggered start/stop times, and janitorial duties).



Three of the climates show negative Therms with large negative values for Chicago and Philadelphia. With one VAV terminal for 3-4 rooms re-heating is used to prevent over cooling in the room with the thermostat, but unoccupied rooms are over cooled. This can save heating energy (less reheat). With one VAV terminal per one room, re-heating is used to prevent over cooling in each room thus more heating energy is used, especially in the colder climates, but greater net savings are realized in cooling energy and fan savings. Occupancy diversity and individual temperature control result in most of the total electrical energy savings.

Lower Minimum Turndown was modeled by comparing one VAV terminal with 25% minimum vs. one VAV terminal with 10% minimum using the same zoning, same medium pressure duct and same pressure drop systems. There is central heat at the air handler, but due to the nature of the DOE2 engine and the modeled building operation (one system per floor; interior zones always need cooling), essentially all heating is assigned to the zonal box level.

A 25% minimum flow is typical for a VAV box because a pressure independent VAV box operates by measuring flow. To measure flow accurately, a certain minimum velocity is required and to maintain the minimum velocity the box is limited to approximately 25% of design flow. A 25% minimum flow is also frequently adopted to prevent dumping by typical diffusers due to low velocities. (See Appendix B for sample VAV box data sheets.) 10% minimum flow is typical for a Therma-Fuser diffuser (the average Model TF maintains this through the venturi nozzles). 10% is typically not too low for a space-conditioning system serving multiple spaces because the required outdoor air quantity delivered by the space-conditioning system must be not less than the sum of the required outdoor ventilation rate to each space; the model required that the minimum airflow to any space be equal to or greater than 15 CFM per person regardless of turndown defined. Standards, such as California's Title 24 (see California 2005 Title 24 Nonresidential Manual, page 4-12 for details), often do not require that each space actually receive its calculated outdoor air quantity as 100% outside air. Instead, the actual supply to any given space may be any combination of re-circulated air, outdoor air, or air transferred directly from other spaces, provided: The total amount of outdoor air delivered by the space conditioning system(s) to all spaces is at least as large as the sum of the space design quantities and each space always receives a supply airflow, including re-circulated air and/or transfer air, no less than the calculated outdoor ventilation rate and when using transfer air, none of the spaces from which air is transferred has any unusual sources of contaminants. In both cases the model increases the minimum flow where required by code outdoor air requirements.

Most of the energy savings are from cooling and heating energy with the majority from heating due to reduced reheat. The majority (70%+) of the total $ energy savings in Chicago, Philadelphia and Seattle are due to turndown. Only half the total $ energy savings in Los Angeles and San Antonio are due to turndown, most likely because Los Angeles and San Antonio are not heating climates. In Chicago, Philadelphia and Seattle there are significant shoulder seasons where it is warm enough to require cooling power to make 55°F air, but cool enough that some perimeter zones (typically North facing) need to use energy to heat the air back up (reheat).

There are minimal to no fan energy savings as modeled probably because in the model when the typical VAV box is at minimum flow, spaces are sub cooled by a few degrees. The set point the reheat maintains is a few degrees lower than the cooling set point (deadband) and, in effect, the sub cooling results in some stored cooling energy for that modeled hour. The model performs one calculation per hour, accentuating this simulated flywheel effect.. As the model moves from reheat to cooling hours, the Therma-Fuser system has a higher airflow, and therefore a higher fan power, because it does not have the benefit of the stored cooling from a previous hour. While a lower net annual fan energy savings from lower net flow is not realized in the model, the total CFM delivered over the year is significantly lower in the Therma-Fuser models, indicating the lower turndown is being modeled. Fan energy is slightly higher when approaching peak loads when fan energy costs the most, but this is offset by the overall less air moved by the fan.

The higher minimum flow with reheat control of the VAV box results in increased fan and heating energy. The less total air moved by the Therma-Fuser system would be expected to result in longer filter life.

Lower Pressure System (0.8 in. w.g. reduction) was modeled by comparing one VAV unit per each room with a fan static of 2.6"wg vs. one VAV unit per each room with a fan static of 1.8"wg using the same zoning layout for an all low pressure system. The fan static of 2.6"wg is typical of that required by a Therma-Fuser diffuser system using PIM's or equivalent (as discussed below). The fan static of 1.8"wg is typical of that required by a Therma-Fuser diffuser system designed with all low pressure duct work, low pressure drop fittings, and no pressure control devices beyond the Therma-Fuser diffuser itself.

Most of the energy savings are from reducing the fan energy.

All climates show small negative Therms because all running fans generate waste heat, which is added to the system. The larger fan running at the higher static pressure generates more heat than a smaller fan running at lower static pressure. During heating conditions, the system with the smaller fan has to supply more heat relative to the system with the larger fan to make up for the reduced waste heat. The larger fan system saves some heating energy, but by displacing natural gas heating with electric (fan waste) heat at the greater expense of increased cooling and fan energy.

Lower pressure duct systems do not necessarily cost more. While the duct work will be a little larger, it is typically simpler, shorter runs with fewer fittings and installation labor required. The additional space requirements are modest. As a rule of thumb, pressure is approximately proportional to duct diameter to the fifth power ($P \sim D^5$). To design for low pressure, the duct diameter only increases by the fifth root of the pressure. This can be confirmed with a ductalator and is roughly described by the relationships below.

$A \sim D^2$, $A \sim V$, $V \sim D^2$, $P \sim V^2$, $\therefore P \sim D^4$, and P approx. $\sim {}^{perim}/_{A} = {}^{\pi D}/_{\pi(D/2)^2}$
$\therefore$ P approx. $\sim D^5$
Where: P=pressure, D=duct diameter, A=duct area, V=velocity, perim=perimeter of duct

Eliminate Pressure Drop Over Box Installation (0.4 in. w.g. reduction) was modeled by comparing one VAV terminal per each room with a fan static of 3"wg vs. one VAV terminal per each room with a fan static of 2.6"wg using the same zoning. The fan static of 3"wg is typical of that required by a VAV box system to accommodate the installation of a pressure independent VAV box and to maintain stable VAV box control per manufacturer's recommendations (See Appendix B for sample VAV box data sheets.) The fan static of 2.6"wg is typical of that required by a Therma-Fuser system using a pressure dependent flow device with active control (Acutherm PIM or equivalent) that does not utilized a pitot-based differential pressure flow measurement control device.

Most of the energy savings are from reducing the fan energy.

All climates show small negative Therms because a smaller fan generates less waste heat than a larger fan. (See discussion above.)

Other Benefits of a Therma-Fuser VAV Diffuser System over the larger zoned VAV unit system would be expected in addition to the energy savings. With no rooms over cooled or over heated (individual temperature control) and less sub cooling due to re-heat offset and greater turndown (One VAV unit for 3-4 rooms model averages which is a loss of comfort), better comfort would be expected. Providing a single VAV box per office would provide equivalent comfort, but at an expected significantly higher first and operating cost.

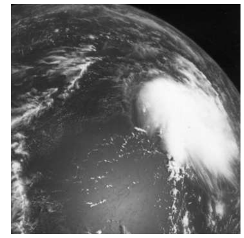
By operating at a reduced pressure, the Therma-Fuser diffuser system typically has a lower initial cost of the fan, fan motor, VSD and electrical support. With less total air over moved over the filter due to the lower turndown provided by the Therma-Fuser system, the filter life is increased, which should reduce the annual cost of replacement filters.

Appendix B: Typical VAV Box Performance Data

Single Duct Terminal Units

SL / SLV Series - Low Pressure

Single Duct – Mechanical Type



Product Information

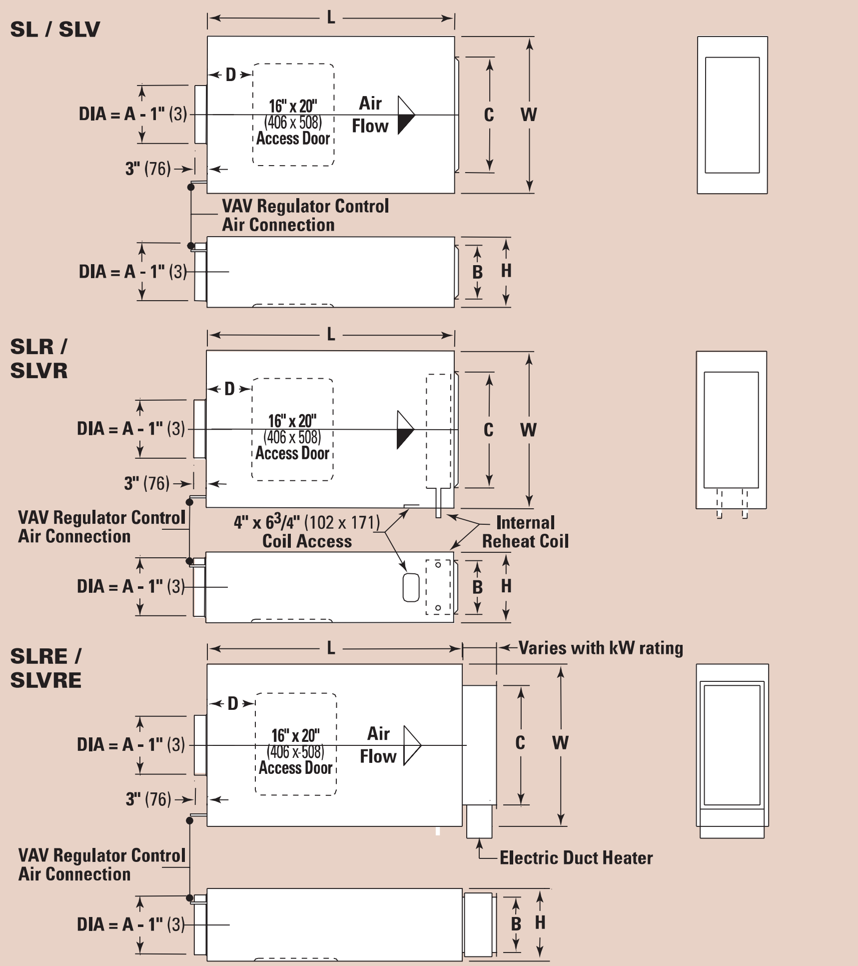
Models

Single Duct, Low Pressure

Constant Volume	**SL**
Variable Constant Volume	**SLV**
Constant Volume Heat Water Coil	**SLR**
Variable Constant Volume Heat Water Coil	**SLVR**
Constant Volume Electric Coil	**SLRE**
Variable Constant Volume Electric Coil	**SLVRE**

Features

- Minimum inlet static pressures of 0.5" W.G.
- Capacities ranging from 50 - 2000 CFM in 6 sizes.
- Design volume factory set to specified value within +/- 5% of setpoint (or 10 cfm below 200 cfm).
- Pressure independent operation from minimum operating static to 3" W.G.
- Leakage at regulator shut-off will not exceed 3% of maximum unit air volume at 3" W.G. inlet static pressure.
- Air volume reference scale provided to aid field adjustment.
- Terminals include a sound attenuator section.
- Unit casings constructed of 22 GA galvanized steel, insulated with 1/2" (13) thick insulation.
- Quick opening access panel is provided standard for inspection and service.
- Flanged rectangular outlet collar provided as standard.
- Optional 1-row or 2-row hot water coils are internally mounted. Coils are aluminum plate fin mechanically bonded to seamless copper tubes.
- Coil connections available either right or left hand.
- Optional electric coils are externally mounted. CSA certified flange type duct heater.



Dimensional Data — Imperial (inches) / Metric (mm)

Unit Size	W	L	H	A	B	C	D	Coil Connection 1 Row	Coil Connection 2 Row
5-2	25 (635)	35 (889)	10 (254)	5 (127)	6 (152)	16 (406)	7 1/4 (184)	1/2 (13)	1/2 (13)
6-3	25 (635)	35 (889)	10 (254)	6 (152)	6 (152)	18 (457)	7 1/4 (184)	1/2 (13)	1/2 (13)
8-6	32 (813)	47 (1194)	12 (305)	8 (203)	9 (229)	28 (711)	11(279)	1/2 (13)	1/2 (13)
10-12	32 (813)	47 (1194)	14 (356)	10 (254)	12 (305)	28 (711)	11 (279)	1/2 (13)	7/8 (22)
12-14	32 (813)	47 (1194)	14 (356)	12 (305)	12 (305)	28 (711)	11 (279)	1/2 (13)	7/8 (22)
14-14	32 (813)	47 (1194)	17 (432)	*	15 (381)	28 (711)	11 (279)	5/8 (16)	7/8 (22)

*Oval inlet 12 (305) x 15 1/8 (387)

Product Information Index

✓ Product Selection Checklist

1] Select Unit Inlet Size based on control and acoustic parameters.
2] Select Control type (Pneumatic, Electronic, Digital) based on system design.
3] Select Accessories (Multiple Outlets) as required.
4] Select Reheat Coil, if required.
5] Select Control Sequence based on system design.

All Metric dimensions ( ) are soft conversion.
Imperial dimensions are converted to metric and rounded to the nearest millimetre.

Typical Selection Guide

Unit Size	Airflow L/s	CFM	Basic Unit Pa	Basic Unit in. wg.	Minimum S.P. 1 Row Pa	1 Row in. wg.	2 Row Pa	2 Row in. wg.	Discharge NC 0.5 in.wg. 125 Pa	1.0 in.wg. 250 Pa	2.0 in.wg. 500 Pa	3.0 in.wg. 750 Pa	Radiated NC 0.5 in.wg. 125 Pa	1.0 in.wg. 250 Pa	2.0 in.wg. 500 Pa	3.0 in.wg. 750 Pa
5-2	24	50	124	0.50	124	0.50	127	0.51	--	--	--	--	--	--	--	--
	47	100	124	0.50	127	0.51	132	0.52	--	--	--	--	--	--	--	--
	71	150	124	0.50	129	0.52	134	0.54	--	--	--	--	--	--	--	--
	94	200	162	0.65	169	0.68	177	0.71	*	--	--	--	*	--	--	22
6-3	94	200	124	0.50	132	0.53	139	0.56	--	--	--	--	--	--	--	20
	118	250	124	0.50	136	0.55	147	0.59	--	--	--	20	--	--	--	22
	142	300	124	0.50	139	0.56	154	0.62	--	--	--	21	--	--	20	24
	165	350	154	0.62	173	0.70	193	0.78	*	--	--	21	*	22	21	25
	189	400	172	0.69	194	0.78	219	0.88	*	--	--	23	*	23	23	26
8-6	189	400	124	0.50	132	0.53	137	0.55	--	--	--	--	--	--	22	25
	236	500	124	0.50	134	0.54	144	0.58	--	--	--	--	--	--	25	28
	283	600	124	0.50	137	0.55	152	0.61	--	--	--	21	--	22	27	31
	330	700	124	0.50	139	0.56	159	0.64	--	--	20	23	--	24	30	33
	378	800	134	0.54	154	0.62	177	0.71	*	--	20	23	*	26	32	35
10-12	330	700	124	0.50	134	0.54	144	0.58	--	--	--	23	--	--	25	28
	378	800	124	0.50	137	0.54	147	0.59	--	--	21	24	--	21	26	31
	425	900	124	0.50	137	0.55	152	0.61	--	--	23	26	--	23	28	32
	472	1000	127	0.51	142	0.57	162	0.65	*	--	21	25	*	24	31	34
	519	1100	149	0.60	167	0.67	189	0.76	*	--	24	26	*	25	32	35
	566	1200	164	0.66	187	0.75	209	0.84	*	--	25	27	*	27	33	36
12-14	472	1000	124	0.50	139	0.56	159	0.64	--	--	24	28	--	26	34	39
	566	1200	124	0.50	147	0.59	169	0.68	--	--	26	31	21	28	37	42
	661	1400	132	0.53	159	0.64	192	0.77	*	--	25	30	*	30	38	43
	755	1600	157	0.63	192	0.77	226	0.92	*	--	26	31	*	31	39	44
14-14	566	1200	124	0.50	139	0.56	159	0.64	--	--	23	26	--	--	24	28
	661	1400	124	0.50	144	0.58	169	0.68	--	--	24	28	--	--	25	31
	755	1600	124	0.50	149	0.60	179	0.72	--	--	25	30	*	21	26	31
	850	1800	152	0.61	184	0.74	216	0.87	*	--	24	28	*	24	27	32
	944	2000	159	0.64	197	0.79	236	0.95	*	--	25	30	*	24	28	33

Performance Notes:

1. NC's are derived from sound power levels, which are obtained in accordance with ARI Standard 880-98 and ASHRAE Standard 130-1996.
2. Airflow is given in Cubic feet per minute, CFM; and Liters per second, L/s.
3. Dashes (--) indicate NC's less than 20.
4. Asteriks indicate minimum static pressure of unit exceeds the minimum operating pressure across the unit.
5. Minimum static pressure listed is the pressure loss for the bare unit only at the tabulated flow.
6. Pressure is given in Pascals, Pa and inches of water gauge, in.wg.
7. NC levels are calculated based on typical attenuation factors outlined in Appendix E, ARI Standard 885-98, "A Procedure for Estimating Occupied Space Sound Levels in the Application of Air Terminals and Air Outlets."

Radiated NC is based on a 5/8" mineral fiber tile ceiling per ARI 885-1998 attenuation values.

Radiated Sound is based on a 5/8" mineral fiber tile ceiling per ARI 885-1998 typical attenuation values;

Total Deduction	Octave Band Mid Frequency, HZ.					
	2	3	4	5	6	7
All Sizes	18	19	20	26	31	36

Discharge NC is based on environmental effect, duct lining effect, end reflection, flex duct effect and sound power division.

Discharge Sound

Total Deduction	Octave Band Mid Frequency, HZ.					
	2	3	4	5	6	7
< 300 cfm	24	28	39	53	59	40
300 - 700 cfm	27	29	40	51	53	39
> 700 cfm	29	30	41	51	52	39

For a detailed explanation of static and total pressure drop refer to page F-41.

LMHS DISCHARGE SOUND PERFORMANCE DATA

▼ LMHS, DISCHARGE SOUND DATA

Inlet Size	Flow Rate		Min Δ Ps		0.5" Δ Ps Octave Band Sound Power, Lw						0.5" Δ Ps Lp	1" Δ Ps Octave Band Sound Power, Lw						1" Δ Ps Lp	2" Δ Ps Octave Band Sound Power, Lw						2" Δ Ps Lp
	CFM	(L/s)	"WG	(Pa)	2	3	4	5	6	7	NC	2	3	4	5	6	7	NC	2	3	4	5	6	7	NC
4	40	(19)	0.007	(1.77)	42	32	29	28	24	19	-	43	34	32	32	27	25	-	44	35	36	36	31	31	-
	103	(49)	0.047	(11.79)	54	51	43	40	37	30	-	55	52	47	44	41	36	-	56	53	50	48	45	42	-
	167	(79)	0.124	(30.74)	61	60	50	46	44	36	-	62	62	54	50	48	42	20	63	63	57	54	52	47	22
	230	(109)	0.235	(58.51)	65	67	55	50	49	40	26	66	68	59	54	52	46	28	67	69	62	58	56	51	29
5	62	(29)	0.006	(1.53)	42	31	30	27	26	21	-	45	35	34	31	31	27	-	49	38	39	35	36	32	-
	161	(76)	0.042	(10.35)	55	49	44	40	37	31	-	58	53	48	44	42	37	-	61	56	53	48	46	43	-
	261	(123)	0.109	(27.07)	61	58	51	46	42	37	-	64	62	55	50	47	43	21	68	65	60	54	52	49	25
	360	(170)	0.207	(51.60)	65	64	56	50	46	41	23	68	68	60	54	51	47	27	72	71	65	59	55	52	31
6	90	(42)	0.005	(1.26)	41	40	29	27	29	24	-	44	45	34	31	34	31	-	47	50	40	35	39	38	-
	233	(110)	0.034	(8.46)	52	51	44	40	37	32	-	55	57	49	44	42	39	-	59	62	54	48	48	46	21
	377	(178)	0.089	(22.08)	57	57	51	46	41	36	-	61	63	57	51	47	43	20	64	68	62	55	52	50	26
	520	(245)	0.169	(42.05)	61	61	56	51	44	39	-	65	67	62	55	49	45	25	68	72	67	59	55	52	31
7	120	(57)	0.005	(1.18)	46	47	29	26	28	25	-	51	54	35	29	35	32	-	55	60	40	33	41	40	-
	330	(156)	0.036	(8.96)	55	55	44	42	38	33	-	59	61	50	46	44	41	-	64	68	55	49	50	48	26
	525	(248)	0.091	(22.67)	60	58	51	50	42	37	-	64	65	57	53	49	45	23	68	71	62	57	55	52	30
	700	(330)	0.162	(40.31)	62	60	55	54	45	40	-	66	67	61	58	51	47	24	70	73	66	61	57	55	32
8	160	(76)	0.005	(1.30)	47	44	39	32	34	29	-	50	50	45	36	39	36	-	53	55	51	41	45	43	-
	440	(208)	0.040	(9.83)	56	54	49	45	42	37	-	60	60	55	49	47	44	-	63	65	61	54	53	50	24
	675	(319)	0.093	(23.14)	60	58	53	50	45	40	-	63	64	59	55	51	47	22	67	70	65	59	56	53	29
	920	(434)	0.173	(42.98)	63	61	56	54	48	42	-	66	67	62	59	53	49	25	70	73	68	63	59	56	31
9	200	(94)	0.005	(1.23)	43	41	32	30	32	32	-	45	46	36	33	37	38	-	48	50	41	37	42	44	-
	550	(260)	0.037	(9.29)	55	52	46	44	41	39	-	58	57	51	47	47	45	-	61	62	55	51	52	51	-
	875	(413)	0.095	(23.52)	61	58	53	50	46	42	-	64	63	57	54	51	48	-	67	67	62	58	56	54	25
	1160	(547)	0.166	(41.34)	64	61	57	54	49	44	-	67	66	61	58	54	50	23	70	71	66	61	59	56	29
10	250	(118)	0.005	(1.29)	42	43	36	35	36	34	-	46	48	41	39	41	40	-	49	53	46	44	47	46	-
	675	(319)	0.038	(9.37)	54	53	48	46	44	41	-	58	58	53	51	49	47	-	61	63	58	55	55	53	21
	1075	(507)	0.096	(23.77)	60	58	54	51	48	44	-	63	63	59	56	53	50	-	66	68	64	60	59	56	25
	1430	(675)	0.169	(42.05)	64	61	58	55	50	46	-	67	66	63	59	55	52	23	70	70	68	64	61	58	28
12	360	(170)	0.005	(1.26)	43	42	34	36	37	37	-	47	47	38	40	42	43	-	50	52	42	45	47	49	-
	1000	(472)	0.039	(9.72)	57	53	49	47	46	44	-	60	58	54	51	51	50	-	64	63	58	56	56	56	20
	1550	(731)	0.094	(23.35)	63	58	56	52	50	47	-	66	63	60	56	55	53	20	70	68	65	61	60	59	26
	2060	(972)	0.166	(41.25)	67	61	60	55	53	48	-	70	67	64	59	57	54	24	74	72	69	64	62	60	30
14	480	(227)	0.005	(1.30)	39	38	31	35	34	36	-	42	43	34	39	39	41	-	46	47	37	42	43	47	-
	1375	(649)	0.043	(10.67)	56	53	50	48	46	44	-	59	57	54	52	51	50	-	63	61	57	56	55	55	-
	2125	(1003)	0.102	(25.48)	63	59	58	53	51	48	-	66	63	61	57	55	53	-	70	67	65	61	60	59	25
	2800	(1321)	0.178	(44.24)	68	62	63	57	54	50	-	71	67	66	61	59	55	24	74	71	70	65	63	61	29
16	630	(297)	0.005	(1.26)	33	27	18	27	28	26	-	36	31	21	31	32	31	-	40	35	25	35	37	37	-
	1775	(838)	0.040	(10.00)	54	48	44	45	44	41	-	57	52	48	49	48	46	-	61	57	51	53	53	52	-
	2725	(1286)	0.095	(23.57)	63	57	55	52	50	47	-	66	61	59	56	55	53	-	69	65	62	60	59	58	22
	3660	(1727)	0.171	(42.52)	69	63	63	57	55	52	-	72	67	66	61	59	57	24	75	71	70	65	64	62	30
22	1200	(566)	0.005	(1.29)	52	46	44	38	35	26	-	58	54	47	44	40	32	-	64	62	50	49	45	38	-
	3300	(1557)	0.039	(9.74)	63	58	59	53	50	44	-	69	66	62	59	55	50	23	75	74	65	64	61	57	32
	5200	(2454)	0.097	(24.18)	68	63	66	60	57	52	20	74	71	69	65	62	59	29	80	79	72	71	68	65	38
	7000	(3304)	0.176	(43.81)	71	67	71	64	61	58	24	77	75	74	70	67	64	33	83	83	77	75	72	70	43

▼ ARI CERTIFICATION RATING POINTS

Inlet Size	Rated CFM	Min. Δ Ps	Sound Power @ 1.5" Δ Ps					
			2	3	4	5	6	7
4	150	0.100	61	61	55	51	49	45
5	250	0.100	61	62	57	52	50	47
6	400	0.100	63	68	61	54	50	48
7	550	0.100	67	69	59	55	52	49
8	700	0.100	67	70	61	57	54	51
9	900	0.100	67	66	61	57	55	52
10	1100	0.100	67	66	61	58	56	53
12	1600	0.100	68	68	64	60	57	54
14	2100	0.100	69	68	64	61	58	56
16	2800	0.100	70	68	64	62	59	57

► *All sound data is based on tests conducted in accordance with ARI 880-98. ΔPs is the difference in static pressure from inlet to discharge. Sound power levels are in dB, re 10^{-12} watts. Discharge sound power is the sound emitted from the unit discharge. NC application data is from ARI Standard 885-98 Appendix E, as a function of flow rate shown. See K-Select for specific sound data for optional liners; 1/2", dual density liner shown. Dash (-) indicates a NC is less than 20. See Engineering section for reductions and definitions.*

ARI Standard 880

LMHS RADIATED SOUND PERFORMANCE DATA

▼ LMHS, RADIATED SOUND DATA

Inlet Size	Flow Rate		Min ∆ Ps		0.5" ∆ Ps Octave Band Sound Power, Lw						Lp	1" ∆ Ps Octave Band Sound Power, Lw						Lp	2" ∆ Ps Octave Band Sound Power, Lw						Lp
	CFM	(L/s)	"WG	(Pa)	2	3	4	5	6	7	NC	2	3	4	5	6	7	NC	2	3	4	5	6	7	NC
4	40	(19)	0.007	(1.77)	33	23	18	18	12	4	-	34	24	22	21	14	8	-	35	26	25	23	16	13	-
	103	(49)	0.047	(11.79)	48	40	32	31	28	20	-	49	41	35	33	30	24	-	50	43	38	35	32	29	-
	167	(79)	0.124	(30.74)	56	48	38	37	36	28	-	57	50	42	40	38	32	-	58	52	45	42	40	37	-
	230	(109)	0.235	(58.51)	61	54	43	42	41	33	24	62	56	46	44	43	38	25	63	57	50	46	45	42	26
5	62	(29)	0.006	(1.53)	37	19	14	11	6	3	-	42	24	19	14	10	9	-	48	29	24	17	14	15	-
	161	(76)	0.042	(10.35)	48	36	29	27	22	15	-	53	41	34	30	26	22	-	58	46	39	33	29	28	-
	261	(123)	0.109	(27.07)	53	45	36	34	30	22	-	58	49	41	38	34	28	-	63	54	46	41	37	34	26
	360	(170)	0.207	(51.60)	56	50	41	40	35	26	-	61	55	46	43	39	32	24	67	60	51	46	43	39	31
6	90	(42)	0.005	(1.26)	40	31	20	19	15	8	-	43	35	24	22	18	14	-	46	40	28	25	22	20	-
	233	(110)	0.034	(8.46)	50	43	35	32	28	22	-	53	47	39	35	32	27	-	56	52	43	39	36	33	-
	377	(178)	0.089	(22.08)	55	49	43	39	35	28	-	58	53	47	42	39	34	22	61	58	51	45	43	40	27
	520	(245)	0.169	(42.05)	58	53	48	44	40	33	22	61	57	52	47	43	39	26	64	62	56	50	47	44	32
7	120	(57)	0.005	(1.18)	36	38	21	14	9	3	-	39	44	27	19	13	8	-	43	50	33	23	17	14	-
	330	(156)	0.036	(8.96)	48	45	35	29	24	17	-	51	51	41	33	28	23	-	55	56	47	37	32	28	25
	525	(248)	0.091	(22.67)	53	48	41	36	31	23	-	57	54	47	40	35	29	22	61	59	53	44	39	35	29
	700	(330)	0.162	(40.31)	57	50	45	40	35	27	-	60	56	51	44	39	33	25	64	61	57	48	43	39	32
8	160	(76)	0.005	(1.30)	40	34	26	22	20	12	-	43	39	33	27	25	19	-	46	45	40	32	30	26	-
	440	(208)	0.040	(9.83)	50	43	37	33	30	22	-	53	49	44	38	35	29	-	56	54	51	43	40	36	25
	675	(319)	0.093	(23.14)	54	47	41	38	34	27	-	57	52	48	42	39	34	22	60	58	55	47	44	40	30
	920	(434)	0.173	(42.98)	57	49	44	41	37	30	-	60	55	51	46	42	37	26	63	61	58	51	47	44	33
9	200	(94)	0.005	(1.23)	36	31	19	20	18	15	-	40	37	23	24	24	23	-	43	43	28	28	29	32	-
	550	(260)	0.037	(9.29)	48	39	34	32	28	21	-	52	45	39	36	33	29	-	55	51	43	40	39	38	-
	875	(413)	0.095	(23.52)	54	43	41	37	32	23	-	57	49	46	41	38	32	-	61	55	50	45	43	40	24
	1160	(547)	0.166	(41.34)	57	45	46	41	35	25	-	61	51	50	45	40	33	24	64	57	54	49	46	42	29
10	250	(118)	0.005	(1.29)	29	29	16	14	8	-3	-	35	35	20	19	16	9	-	41	41	23	23	24	20	-
	675	(319)	0.038	(9.37)	42	38	36	29	21	9	-	48	44	39	34	29	21	-	54	50	43	38	37	32	-
	1075	(507)	0.096	(23.77)	48	42	45	36	27	15	-	54	48	48	41	35	26	22	60	54	52	45	43	38	26
	1430	(675)	0.169	(42.05)	52	44	51	40	30	18	25	58	51	54	45	39	30	29	64	57	58	50	47	41	32
12	360	(170)	0.005	(1.26)	36	41	26	21	19	12	-	40	45	30	25	23	18	-	45	50	35	29	28	24	-
	1000	(472)	0.039	(9.72)	47	46	39	35	32	24	-	51	50	43	39	36	30	-	56	55	48	43	41	35	23
	1550	(731)	0.094	(23.35)	52	48	44	40	37	29	-	56	52	49	44	42	35	23	60	57	54	48	47	40	28
	2060	(972)	0.166	(41.25)	55	49	48	44	41	32	22	59	54	53	48	46	38	27	63	59	57	52	50	44	32
14	480	(227)	0.005	(1.30)	31	31	19	23	22	20	-	36	37	23	26	25	25	-	41	42	26	30	29	29	-
	1375	(649)	0.043	(10.67)	45	41	37	35	34	30	-	49	47	40	38	37	35	-	54	52	43	42	41	39	20
	2125	(1003)	0.102	(25.48)	50	45	44	40	39	34	-	55	51	48	43	43	39	22	59	56	51	47	46	43	25
	2800	(1321)	0.178	(44.24)	53	48	49	43	42	37	23	58	53	52	47	46	41	27	63	59	55	50	49	46	30
16	630	(297)	0.005	(1.26)	35	33	26	26	23	17	-	39	38	31	31	30	25	-	44	44	36	36	37	33	-
	1775	(838)	0.040	(10.00)	48	43	40	37	32	25	-	52	49	45	42	39	33	-	57	54	50	47	46	41	24
	2725	(1286)	0.095	(23.57)	53	47	45	41	36	29	-	58	53	50	47	43	37	25	63	59	55	52	50	45	30
	3660	(1727)	0.171	(42.52)	57	50	49	45	38	31	23	62	56	54	50	46	39	29	66	62	59	55	53	47	34
22	1200	(566)	0.005	(1.29)	46	49	39	39	40	39	-	50	52	43	41	42	41	-	53	54	47	43	44	43	23
	3300	(1557)	0.039	(9.74)	55	55	50	48	49	48	24	59	58	54	50	51	50	28	63	61	58	52	53	52	32
	5200	(2454)	0.097	(24.18)	60	58	55	51	53	52	30	64	61	59	54	55	54	34	68	64	62	56	57	56	38
	7000	(3304)	0.176	(43.81)	63	60	58	54	56	55	33	67	63	62	56	58	57	37	70	66	66	58	60	59	41

▼ ARI CERTIFICATION RATING POINTS

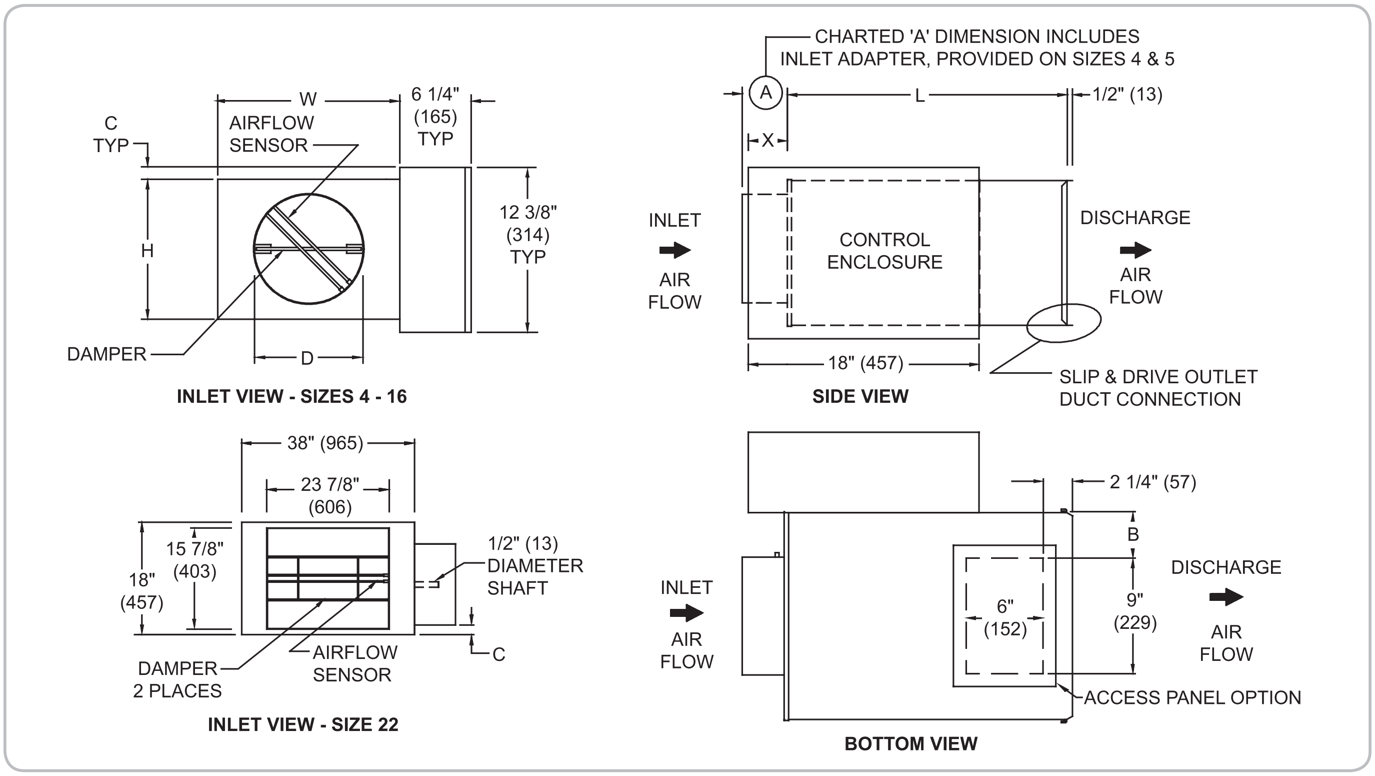
Inlet Size	Rated CFM	Min. ∆ Ps	Sound Power @ 1.5" ∆ Ps 2	3	4	5	6	7
4	150	0.100	58	50	43	38	35	31
5	250	0.100	59	53	45	38	35	32
6	400	0.100	60	58	50	39	36	33
7	550	0.100	60	58	50	41	36	34
8	700	0.100	60	59	50	42	37	35
9	900	0.100	60	56	50	42	39	35
10	1100	0.100	60	56	51	42	39	35
12	1600	0.100	60	57	51	47	44	36
14	2100	0.100	60	58	51	47	44	36
16	2800	0.100	62	59	53	49	44	40

► *All sound data is based on tests conducted in accordance with ARI 880-98. ∆Ps is the difference in static pressure from inlet to discharge. Sound power levels are in dB, re 10^{-12} watts. Radiated sound power is the sound transmitted through the casing walls. NC application data is from ARI Standard 885-98 Appendix E, as a function of flow rate shown. See K-Select for specific sound data for optional liners; 1/2", dual density liner shown. Dash (-) indicates a NC is less than 20. See Engineering section for reductions and definitions.*

ARI Standard 880

LMHS BASE UNIT DIMENSIONAL INFORMATION

▼ LMHS BASE UNIT, INLET, SIDE, & BOTTOM VIEWS



INLET VIEW - SIZES 4 - 16

SIDE VIEW

INLET VIEW - SIZE 22

BOTTOM VIEW

▼ LMHS BASE UNIT, DIMENSIONAL DETAILS

Inlet Size	Nominal Max CFM [L/s]	L	W	H	A	B	C	D	X
4	230 [109]	15 1/2" (394)	12" (305)	8" (203)	5 3/8" (136)	1 1/2" (38)	2 1/8" (54)	3 7/8" (98)	7 1/4" (184)
5	360 [170]	15 1/2" (394)	12" (305)	8" (203)	5 3/8" (136)	1 1/2" (38)	2 1/8" (54)	4 7/8" (124)	7 1/4" (184)
6	515 [243]	15 1/2" (394)	12" (305)	8" (203)	3 3/8" (86)	1 1/2" (38)	2 1/8" (54)	5 7/8" (149)	7 1/4" (184)
7	700 [330]	15 1/2" (394)	12" (305)	10" (254)	3 3/8" (86)	1 1/2" (38)	1 1/8" (29)	6 7/8" (175)	7 1/4" (184)
8	920 [434]	15 1/2" (394)	12" (305)	10" (254)	3 3/8" (86)	1 1/2" (38)	1 1/8" (29)	7 7/8" (200)	7 1/4" (184)
9	1160 [547]	15 1/2" (394)	14" (356)	12 1/2" (318)	3 3/8" (86)	2 1/2" (64)	-	8 7/8" (225)	5 1/4" (133)
10	1430 [675]	15 1/2" (394)	14" (356)	12 1/2" (318)	3 3/8" (86)	2 1/2" (64)	-	9 7/8" (251)	5 1/4" (133)
12	2060 [972]	15 1/2" (394)	16" (406)	15" (381)	3 3/8" (86)	3 1/2" (89)	-	11 7/8" (302)	5 1/4" (133)
14	2800 [1321]	15 1/2" (394)	20" (508)	17 1/2" (445)	3 3/8" (86)	5 1/2" (140)	-	13 7/8" (352)	3 1/4" (83)
16	3660 [1727]	15 1/2" (394)	24" (610)	18" (457)	3 3/8" (86)	7 1/2" (191)	-	15 7/8" (403)	3 1/4" (83)
22	7000 [3304]	15" (381)	38" (965)	18" (457)	4 1/4" (108)	14 1/2" (368)	1 1/8" (29)	See Above	5 1/4" (133)

► *Dimensions in ( ) are mm. Right-hand base unit with electronic control enclosure shown; left-hand is available.*

LMHS BASE UNIT FEATURES & OPTIONS

▼ STANDARD FEATURES

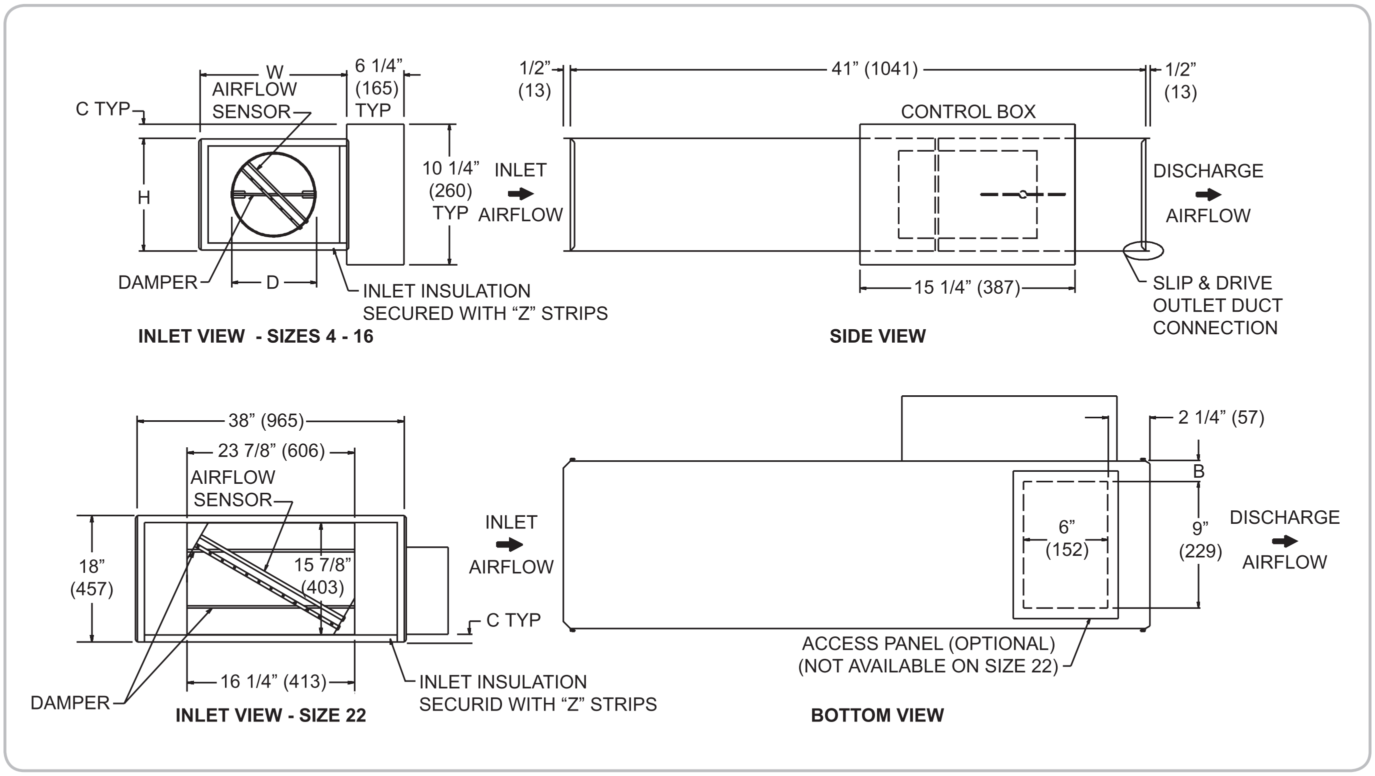
- 22 Gage Galvanized Steel Casing Construction
- NEMA 2 Steel Control Enclosure for Electric or Electronic Components
- 1/2" Thick Dual Density Fiberglass Insulation Meeting NFPA 90A and UL 181 Safety Requirements
- Linear Averaging Airflow Sensor
- Variety of Pneumatic, Analog, and Factory Mounted Digital Control Packages for Pressure Dependent and Pressure Independent Systems
- ETL Listed - Adherence to UL 429 for Electrically Operated Valves
- ARI Certified Sound Ratings

▼ OPTIONAL FEATURES

- 20 Gage Galvanized Steel Casing Construction
- Liners: Cellular Insulation, 1" Dual Density Fiberglass Insulation, Sterilwall, Steriliner, Perforated Doublewall, or No Liner
- Four Quadrant Center Averaging Airflow Sensor
- 24 Volt Transformer
- Disconnect Switch for Electronic Controls
- Dust Tight Control Enclosure
- Left-hand or Right-hand Control Enclosure
- Bottom Access Panel
- Cam Locks (Bottom Access Panel)
- Hanger Brackets

LMHS EXHAUST UNIT DIMENSIONAL INFORMATION

▼ LMHS EXHAUST UNIT, INLET, SIDE, & BOTTOM VIEWS



▼ LMHS EXHAUST UNIT, DIMENSIONAL DETAILS

Inlet Size	Nominal Max CFM [L/s]	W	H	B	C	D
4	230 [109]	12" (305)	8" (203)	1 1/2" (38)	2 1/8" (54)	3 7/8" (98)
5	360 [170]	12" (305)	8" (203)	1 1/2" (38)	2 1/8" (54)	4 7/8" (124)
6	520 [245]	12" (305)	8" (203)	1 1/2" (38)	2 1/8" (54)	5 7/8" (149)
7	710 [335]	12" (305)	10" (254)	1 1/2" (38)	1 1/8" (29)	6 7/8" (175)
8	925 [437]	12" (305)	10" (254)	1 1/2" (38)	1 1/8" (29)	7 7/8" (200)
9	1200 [566]	14" (356)	12 1/2" (318)	2 1/2" (64)	-	8 7/8" (225)
10	1450 [685]	14" (356)	12 1/2" (318)	2 1/2" (64)	-	9 7/8" (251)
12	2100 [991]	16" (406)	15" (381)	3 1/2" (89)	-	11 7/8" (302)
14	2900 [1369]	20" (508)	17 1/2" (445)	5 1/2" (140)	-	13 7/8" (352)
16	3700 [1746]	24" (610)	18" (457)	7 1/2" (191)	-	15 7/8" (403)
22	7100 [3351]	38" (965)	18" (457)	14 1/2" (368)	1 1/8" (29)	See Above

► *Dimensions in ( ) are mm. Right-hand base unit with electronic control enclosure shown; left-hand is available.*

LMHS EXHAUST UNIT FEATURES & OPTIONS

▼ STANDARD FEATURES

- 22 Gage Galvanized Steel Casing Construction
- NEMA 2 Steel Control Enclosure for Electric or Electronic Components
- 1/2” Thick Dual Density Fiberglass Insulation Meeting NFPA 90A And UL 181 Safety Requirements
- Linear Averaging Airflow Sensor
- Variety of Pneumatic, Analog, and Factory Mounted Digital Control Packages for Pressure Dependent and Pressure Independent Systems
- ETL Listed - Adherence to UL 429 for Electrically Operated Valves

▼ OPTIONAL FEATURES

- 20 Gage Galvanized Steel Casing Construction
- Liners: Cellular Insulation, 1” Dual Density Fiberglass Insulation, Sterilwall, Steriliner, Perforated Doublewall, or No Liner
- Four Quadrant Center Averaging Airflow Sensor
- 24 Volt Transformer
- Disconnect Switch for Electronic Controls
- Dust Tight Control Enclosure
- Left-hand or Right-hand Control Enclosure
- Bottom Access Panel
- Cam Locks (Bottom Access Panel)
- Hanger Brackets

LMHS UNIT CAPACIES

▼ LMHS, UNIT CAPACITIES

Inlet Size	Max. Primary Airflow - CFM	Min. Airflow, CFM	
		Standard*	Electric Heat **
4	230	40	55
5	360	62	85
6	515	89	110
7	700	121	140
8	920	159	190
9	1160	201	240
10	1430	248	300
12	2060	357	425
14	2800	486	580
16	3660	634	750
20	2100	420	425
22	7000	1212	1800

► *(*) Standard CFM value is based on a signal of 0.03" WG differential pressure of the inlet sensor. Minimum CFM may be 0.*
(**) Electric heat based on CFM necessary to trip airflow proving safety switch.

▼ SELECTION EXAMPLE - BASED ON CFM CRITERIA

A zone exists requiring VAV control. The maximum flow is to be 500 CFM; the minimum is to be 175 CFM, based on heat requirements. Use the above table to select a size 6. Note that size 7 will also be capable of controlling the required amount.

▼ AIRFLOW CAPACITY DETAILS

1. CFM ranges are factory set on all pressure independent pneumatic control sequences.
2. Factory set minimum CFMs are based on the controller's ability to accurately maintain flow setting.
   Factory will not set controls outside the ranges indicated.
3. Minimum CFM settings can be set at 0 CFM; however, ventilation requirements can be met by setting a minimum greater than zero. Krueger recommends a minimum set-point equal to 25% of the nominal flow rating of the terminal. Less than 25% may result in greater than +/- 5% control of unit flow.
4. Pressure dependent pneumatic or electric controls do not have the ability to control CFM settings. Therefore, the minimum setting is always zero. A set maximum flow rate is not possible.
5. Check the selected kW value to be sure it does not exceed the recommended 55°F temperature rise.

   Formula: $\Delta T = \frac{kW \times 3160}{CFM}$

   Discharge temperature must not exceed 120°.
6. The ASHRAE handbook of fundamentals states that discharge temperatures in excess of 90°F are likely to result in objectionable air temperature stratification in the space. Also, ventilation short circuiting may occur. ASHRAE Standard 62.1 limits discharge temperatures to 90°F or increasing the ventilation rate when heating from the ceiling.

LMHS PRODUCT DESCRIPTION

▼ CASING

- All LMHS unit casing panels are constructed of 22 gage galvanized steel with a 20 gage option.

▼ INLET COLLARS

- All round 22 gage inlet collars accommodate standard spiral and flex duct sizes.
- Left or right hand is determined by looking in the direction of airflow with the unit in the installed position.

▼ OUTLET CONNECTION

- All standard outlet connections are rectangular and require a slip and drive duct connection.
- Round and multi-outlet discharge options are available.

▼ DAMPER ASSEMBLY

- Unit sizes 4-16 utilize a round control damper. Unit sizes 20 and 22 have rectangular inlets. Size 20 utilizes a single blade damper design and size 22 has an opposed blade control damper. All damper assemblies utilize a solid 1/2" shaft that rotates in self lubricating Delrin® bearings.
- Damper blade incorporates a flexible gasket for tight airflow shutoff and operates over a full 90° rotation.
- The damper position is marked by an arrow embossment on the end of the damper shaft.

▼ CASING LINERS

Unit casing will be lined with 1/2" thick, 1 1/2 lb. dual density fiberglass insulation that meets UL 181 and NFPA 90A.

- **(Optional) 1" Thick Insulation:** Unit casing will be lined with 1" thick, 1 1/2 lb. dual density fiberglass insulation that meets UL 181 and NFPA 90A.
- **(Optional) Cellular Insulation:** Unit casing will be lined with glued and riveted 3/8" thick, 1 1/2 lb. density, smooth surface, polyolefin, closed-cell foam insulation for fiber free application. Cellular insulation meets UL 181 and NFPA 90A and does not support mold or bacteria growth.
- **(Optional) Steriliner Insulation:** Unit casing will be lined with 13/16" thick, 4 lb. density, rigid board insulation with nylon reinforced foil covering insulation fibers that meets UL 181 and NFPA 90A. Liner shall be attached to unit casing by insulation adhesive and full-seam-length Z-strips to enclose and seal the insulation cut edges.
- **(Optional) Sterilwall Insulation:** Unit casing will be lined with 1/2" or 1" thick, 1 1/2 lb. dual density fiberglass insulation, meeting UL 181 and NFPA 90A, enclosed between the unit casing and a non-perforated internal sheetmetal cover extending over the fiberglass insulation, as well as covering the liner cut edges.
- **(Optional) Perforated Doublewall Insulation:** Unit casing will be lined with 1/2", 1 1/2 lb. dual density fiberglass insulation meeting UL 181 and NFPA 90A, enclosed between the unit casing and a perforated internal sheetmetal cover extending over the fiberglass insulation, as well as covering the liner cut edges.
- **(Optional) No Liner:** Unit casing will be equipped with no internal insulation liner.
- See K-Select for acoustical impact of different liners.

Single Duct Air Terminal Units

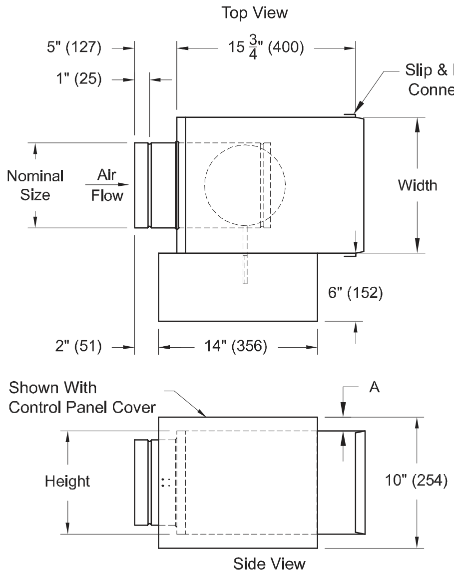
TH-500 - Air Terminal Dimensions

6" to 16" Case Sizes

Dimensions are in inches

High Performance Single Duct - Basic Unit

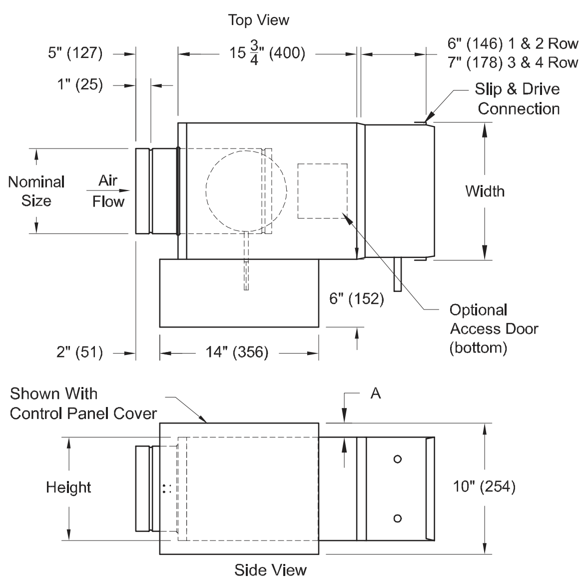
Model TH506 - *6" Inlet*
Model TH508 - *8" Inlet*
Model TH510 - *10" Inlet*
Model TH512 - *12" Inlet*
Model TH514 - *14" Inlet*
Model TH516 - *16" Inlet*



Model Number	Nominal Size In. (mm)	Height In. (mm)	Width In. (mm)	Dim. A In. (mm)	Unit Weight
TH506	6 Dia. (152)	8 (203)	12 (305)	2 (51)	12 lbs 5.4 kg
TH508	8 Dia. (203)	10 (254)	12 (305)	1 (25)	15 lbs 6.8 kg
TH510	10 Dia. (254)	12 1/2 (318)	14 (356)	-	18 lbs 8.2 kg
TH512	12 Dia. (305)	15 (381)	16 (406)	-	22 lbs 9.9 kg
TH514	14 Dia. (356)	17 1/2 (445)	20 (508)	-	24 lbs 11 kg
TH516	16 Dia. (406)	18 (457)	24 (610)	-	29 lbs 13 kg

High Performance Single Duct - With Hot Water Coils

Model TH506 - *6" Inlet*
Model TH508 - *8" Inlet*
Model TH510 - *10" Inlet*
Model TH512 - *12" Inlet*
Model TH514 - *14" Inlet*
Model TH516 - *16" Inlet*



Model Number	Nominal Size In. (mm)	Height In. (mm)	Width In. (mm)	Dim. A In. (mm)	Unit Weight with 1R HW Coil	2R HW Coil	3R HW Coil	4R HW Coil
TH506	6 Dia. (152)	8 (203)	12 (305)	2 (51)	16.7 (7.6)	17.7 (8)	21.2 (9.6)	22.5 (10.2)
TH508	8 Dia. (203)	10 (254)	12 (305)	1 (25)	20 (9.1)	21.6 (9.8)	26 (11.8)	27.7 (12.6)
TH510	10 Dia. (254)	12 1/2 (318)	14 (356)	-	24.3 (11)	26.6 (12)	32.4 (14.7)	24.8 (15.8)
TH512	12 Dia. (305)	15 (381)	16 (406)	-	31 (14.1)	34.3 (15.6)	40.1 (18.2)	43.4 (19.7)
TH514	14 Dia. (356)	17 1/2 (445)	20 (508)	-	34.1 (15.5)	38.9 (17.7)	48 (21.8)	52.8 (10.2)
TH516	16 Dia. (406)	18 (457)	24 (610)	-	42.3 (19.2)	48 (21.8)	53.7 (24.3)	59.4 (26.9)

TH-500 - Radiated Sound Power at Min., .5", & .75" Wg

Unit Size	Outlet Ps in. H20	CFM (L/s)		Min Ps in. H20 (Pa)		Min Ps								Inlet Pressure, Ps=0.5 inches of water (125 Pa)								Inlet Pressure, Ps=0.75 inches of water (185 Pa)							
						Octave Band Sound Power, Lw, dB						NC1 ARI 885-90	NC2 ARI 885-98	Octave Band Sound Power, Lw, dB						NC1 ARI 885-90	NC2 ARI 885-98	Octave Band Sound Power, Lw, dB						NC1 ARI 885-90	NC2 ARI 885-98
						2	3	4	5	6	7			2	3	4	5	6	7			2	3	4	5	6	7		
506 6 inch	0.25	**100**	**(47)**	**0.015**	**(3.8)**	**40**	**32**	**17**	**14**	**12**	**10**	**-**	**-**	**41**	**32**	**22**	**20**	**16**	**10**	**-**	**-**	**43**	**34**	**24**	**22**	**18**	**13**	**-**	**-**
		200	(94)	0.038	(9.5)	42	35	23	20	19	12	-	-	48	38	30	25	20	16	-	-	50	40	34	28	24	20	-	-
		250	**(118)**	**0.059**	**(14.8)**	**43**	**36**	**26**	**23**	**22**	**15**	**-**	**-**	**50**	**40**	**32**	**27**	**23**	**18**	**-**	**-**	**52**	**42**	**36**	**30**	**25**	**22**	**-**	**-**
		300	(142)	0.071	(17.6)	45	38	29	26	25	19	-	-	52	41	35	29	25	20	-	-	54	45	40	32	29	24	-	-
		400	**(189)**	**0.104**	**(25.8)**	**51**	**41**	**34**	**31**	**31**	**22**	**-**	**-**	**54**	**45**	**39**	**33**	**31**	**23**	**-**	**-**	**56**	**48**	**43**	**36**	**33**	**27**	**-**	**-**
		450	(212)	0.125	(31.0)	51	43	36	34	33	24	-	-	54	47	40	36	35	25	-	-	56	50	44	38	35	28	-	-
		500	**(236)**	**0.136**	**(33.9)**	**52**	**45**	**39**	**36**	**36**	**26**	**-**	**-**	**55**	**48**	**42**	**37**	**36**	**27**	**-**	**-**	**57**	**51**	**45**	**39**	**37**	**30**	**-**	**-**
		600	(283)	0.169	(42.1)	52	49	44	41	41	31	-	-	55	51	45	41	42	32	-	-	58	54	47	42	42	33	-	22
508 8 inch	0.25	**200**	**(94)**	**0.021**	**(5.3)**	**42**	**33**	**20**	**16**	**15**	**15**	**-**	**-**	**48**	**36**	**25**	**20**	**17**	**16**	**-**	**-**	**50**	**39**	**30**	**26**	**20**	**19**	**-**	**-**
		300	(142)	0.029	(7.2)	45	36	22	18	18	18	-	-	51	40	33	25	20	19	-	-	53	43	37	31	24	21	-	-
		500	**(236)**	**0.046**	**(11.4)**	**47**	**39**	**26**	**24**	**19**	**18**	**-**	**-**	**53**	**43**	**36**	**30**	**23**	**19**	**-**	**-**	**55**	**46**	**39**	**33**	**26**	**22**	**-**	**-**
		600	(283)	0.064	(15.9)	48	41	29	27	21	18	-	-	54	44	37	33	25	20	-	-	57	48	40	35	28	23	-	-
		700	**(330)**	**0.090**	**(22.4)**	**50**	**43**	**33**	**31**	**23**	**20**	**-**	**-**	**56**	**46**	**40**	**35**	**27**	**21**	**-**	**-**	**58**	**50**	**42**	**37**	**30**	**25**	**-**	**-**
		800	(378)	0.101	(25.2)	53	45	37	36	26	21	-	-	57	48	42	37	29	23	-	-	60	51	44	39	32	27	-	22
		900	**(425)**	**0.110**	**(27.4)**	**55**	**48**	**41**	**40**	**29**	**23**	**-**	**-**	**59**	**50**	**44**	**40**	**32**	**25**	**-**	**21**	**61**	**53**	**46**	**41**	**34**	**28**	**-**	**23**
		1000	(472)	0.128	(31.8)	55	50	45	42	32	26	-	-	60	52	46	42	34	27	-	22	62	54	48	44	36	30	21	25
		1100	**(519)**	**0.145**	**(36.0)**	**56**	**51**	**47**	**43**	**35**	**29**	**-**	**21**	**61**	**53**	**48**	**44**	**37**	**30**	**-**	**23**	**63**	**55**	**50**	**45**	**38**	**32**	**22**	**26**
510 10 inch	0.25	300	(142)	0.009	(2.2)	48	34	20	16	15	13	-	-	49	36	23	19	17	15	-	-	51	39	32	25	21	19	-	-
		400	**(189)**	**0.012**	**(2.9)**	**51**	**36**	**25**	**22**	**19**	**19**	**-**	**-**	**52**	**42**	**34**	**28**	**24**	**19**	**-**	**-**	**54**	**45**	**37**	**32**	**27**	**21**	**-**	**-**
		600	(283)	0.015	(3.8)	52	37	27	24	19	19	-	-	54	44	37	31	26	19	-	-	56	48	41	35	30	22	-	-
		800	**(378)**	**0.039**	**(9.6)**	**53**	**39**	**30**	**27**	**20**	**19**	**-**	**-**	**55**	**46**	**39**	**35**	**29**	**20**	**-**	**-**	**57**	**50**	**43**	**38**	**32**	**23**	**-**	**-**
		1000	(472)	0.046	(11.5)	53	40	33	31	23	19	-	-	57	49	42	38	31	22	-	-	58	51	45	40	34	25	-	-
		1200	**(566)**	**0.078**	**(19.4)**	**55**	**45**	**37**	**34**	**27**	**21**	**-**	**-**	**59**	**51**	**45**	**41**	**34**	**24**	**-**	**21**	**60**	**53**	**46**	**42**	**36**	**27**	**-**	**22**
		1400	(661)	0.109	(27.2)	55	48	42	39	31	23	-	-	62	54	48	44	37	28	21	25	64	55	48	45	38	30	23	27
		1600	**(755)**	**0.133**	**(33.1)**	**59**	**51**	**47**	**44**	**35**	**27**	**-**	**21**	**63**	**56**	**51**	**47**	**40**	**32**	**22**	**26**	**65**	**57**	**51**	**47**	**40**	**33**	**25**	**29**
		1700	(802)	0.151	(37.7)	61	53	49	46	37	30	-	23	65	58	53	50	42	33	25	29	66	59	54	51	43	35	26	30
512 12 inch	0.25	**450**	**(212)**	**0.022**	**(5.5)**	**51**	**35**	**22**	**19**	**15**	**13**	**-**	**-**	**53**	**41**	**30**	**22**	**19**	**16**	**-**	**-**	**54**	**43**	**33**	**26**	**20**	**19**	**-**	**-**
		800	(378)	0.031	(7.7)	54	39	29	24	19	18	-	-	56	46	38	31	27	21	-	-	57	49	42	34	29	24	-	-
		1000	**(472)**	**0.037**	**(9.3)**	**55**	**41**	**32**	**26**	**20**	**18**	**-**	**-**	**56**	**48**	**40**	**33**	**29**	**23**	**-**	**-**	**58**	**50**	**44**	**36**	**31**	**25**	**-**	**-**
		1200	(566)	0.044	(10.9)	56	44	35	28	22	19	-	-	57	49	42	35	31	24	-	-	58	51	45	38	33	27	-	-
		1450	**(684)**	**0.054**	**(13.5)**	**56**	**46**	**38**	**31**	**25**	**20**	**-**	**-**	**58**	**50**	**44**	**38**	**34**	**27**	**-**	**-**	**59**	**52**	**47**	**40**	**36**	**29**	**-**	**21**
		1700	(802)	0.074	(18.5)	57	48	42	34	28	22	-	-	59	51	47	40	37	29	-	21	61	53	49	42	38	31	-	23
		1950	**(920)**	**0.095**	**(23.6)**	**58**	**51**	**46**	**37**	**32**	**25**	**-**	**-**	**61**	**53**	**50**	**43**	**39**	**32**	**21**	**24**	**62**	**55**	**51**	**44**	**40**	**34**	**22**	**25**
		2200	(1038)	0.115	(28.7)	59	52	49	41	36	28	-	23	63	55	53	45	41	34	24	27	64	57	54	46	43	36	25	29
		2500	**(1180)**	**0.172**	**(42.8)**	**60**	**54**	**51**	**45**	**38**	**30**	**22**	**25**	**64**	**57**	**55**	**47**	**43**	**36**	**26**	**30**	**65**	**59**	**56**	**48**	**45**	**38**	**27**	**31**
514 14 inch	0.25	550	(260)	0.002	(0.5)	50	33	26	19	15	14	-	-	54	35	28	22	19	17	-	-	54	37	30	26	22	20	-	-
		925	**(437)**	**0.004**	**(1.0)**	**51**	**36**	**29**	**22**	**18**	**16**	**-**	**-**	**56**	**40**	**35**	**30**	**25**	**21**	**-**	**-**	**57**	**42**	**38**	**32**	**28**	**23**	**-**	**-**
		1300	(614)	0.024	(6.1)	54	40	31	26	22	19	-	-	59	49	44	38	36	34	-	21	59	51	45	38	37	34	-	21
		1600	**(755)**	**0.042**	**(10.6)**	**54**	**43**	**34**	**28**	**25**	**20**	**-**	**-**	**60**	**50**	**44**	**40**	**37**	**34**	**-**	**22**	**61**	**53**	**45**	**41**	**38**	**34**	**-**	**23**
		1900	(897)	0.061	(15.1)	55	46	39	32	28	22	-	-	61	52	45	41	38	35	-	23	62	53	46	41	38	36	21	25
		2200	**(1038)**	**0.079**	**(19.6)**	**55**	**49**	**44**	**36**	**31**	**24**	**-**	**-**	**62**	**53**	**46**	**41**	**39**	**35**	**21**	**25**	**62**	**54**	**47**	**41**	**40**	**36**	**21**	**25**
		2600	(1227)	0.103	(25.6)	57	52	46	40	35	28	-	-	62	55	47	43	41	36	21	25	62	56	47	43	41	36	21	25
		3000	**(1416)**	**0.127**	**(31.5)**	**59**	**55**	**49**	**44**	**38**	**32**	**-**	**24**	**63**	**58**	**50**	**45**	**43**	**38**	**24**	**27**	**64**	**59**	**50**	**46**	**43**	**38**	**25**	**28**
		3250	(1534)	0.138	(34.4)	60	57	53	46	40	34	24	27	64	60	54	48	44	39	26	29	65	60	55	49	45	40	26	30
516 16 inch	0.25	**750**	**(354)**	**0.004**	**(0.9)**	**51**	**36**	**27**	**22**	**16**	**13**	**-**	**-**	**54**	**39**	**30**	**24**	**19**	**17**	**-**	**-**	**54**	**41**	**33**	**28**	**21**	**19**	**-**	**-**
		1100	(519)	0.015	(3.8)	53	40	31	25	20	17	-	-	56	45	36	29	24	20	-	-	56	47	39	32	26	22	-	-
		1500	**(708)**	**0.026**	**(6.5)**	**55**	**45**	**35**	**28**	**24**	**21**	**-**	**-**	**58**	**51**	**41**	**35**	**31**	**26**	**-**	**-**	**58**	**53**	**44**	**38**	**33**	**28**	**-**	**21**
		1800	(850)	0.035	(8.7)	56	46	37	31	27	23	-	-	59	52	42	36	33	29	-	21	59	54	45	39	35	30	-	22
		2400	**(1133)**	**0.058**	**(14.4)**	**57**	**48**	**41**	**36**	**33**	**29**	**-**	**-**	**60**	**53**	**44**	**40**	**37**	**33**	**-**	**22**	**60**	**55**	**47**	**42**	**38**	**34**	**-**	**24**
		3200	(1510)	0.094	(23.5)	59	53	48	42	39	36	-	22	61	55	49	44	40	37	-	24	62	57	51	46	41	38	22	26
		3600	**(1699)**	**0.113**	**(28.1)**	**60**	**55**	**52**	**45**	**41**	**38**	**23**	**26**	**62**	**57**	**52**	**46**	**42**	**39**	**23**	**26**	**63**	**59**	**53**	**48**	**43**	**40**	**25**	**28**
		4000	(1888)	0.131	(32.7)	61	57	54	47	43	40	25	29	64	59	54	49	45	42	25	29	65	60	55	50	46	42	26	30
		4400	**(2077)**	**0.153**	**(38.0)**	**62**	**59**	**56**	**48**	**44**	**41**	**27**	**31**	**65**	**61**	**57**	**50**	**46**	**43**	**29**	**32**	**66**	**62**	**58**	**51**	**47**	**44**	**30**	**33**
520 20x16 inch	0.25	1100	(519)	0.006	(1.5)	53	39	29	26	23	18	-	-	54	44	33	29	26	21	-	-	55	46	34	30	29	24	-	-
		1600	**(755)**	**0.013**	**(3.3)**	**55**	**43**	**35**	**34**	**29**	**22**	**-**	**-**	**56**	**49**	**42**	**38**	**31**	**28**	**-**	**-**	**57**	**52**	**45**	**40**	**33**	**30**	**-**	**-**
		1900	(897)	0.018	(4.5)	56	47	40	40	34	27	-	-	57	53	49	45	41	35	-	23	58	56	51	47	41	35	22	25
		2500	**(1180)**	**0.031**	**(7.7)**	**57**	**51**	**45**	**45**	**39**	**32**	**-**	**-**	**59**	**57**	**53**	**48**	**43**	**37**	**24**	**27**	**60**	**58**	**54**	**49**	**43**	**37**	**25**	**29**
		3200	(1510)	0.051	(12.7)	59	56	50	49	45	37	21	25	62	61	58	51	45	40	30	33	63	61	58	53	46	40	30	33
		3900	**(1841)**	**0.076**	**(18.9)**	**61**	**60**	**55**	**53**	**46**	**41**	**26**	**30**	**64**	**64**	**61**	**54**	**47**	**43**	**33**	**36**	**65**	**64**	**61**	**56**	**49**	**43**	**33**	**36**
		4600	(2171)	0.106	(26.4)	63	63	57	56	49	44	29	33	66	64	63	57	50	45	35	38	67	64	63	58	52	46	35	38
		5300	**(2502)**	**0.140**	**(34.9)**	**65**	**64**	**58**	**57**	**53**	**47**	**31**	**34**	**67**	**67**	**65**	**60**	**54**	**47**	**37**	**41**	**70**	**67**	**65**	**60**	**56**	**49**	**37**	**41**
		6200	(2926)	0.200	(49.7)	67	66	60	59	57	50	33	37	69	68	67	62	58	51	39	43	71	69	68	63	58	52	41	44
524 24x16 inch	0.25	**1250**	**(590)**	**0.006**	**(1.4)**	**53**	**39**	**32**	**28**	**22**	**19**	**-**	**-**	**55**	**42**	**36**	**30**	**25**	**20**	**-**	**-**	**56**	**44**	**38**	**32**	**28**	**22**	**-**	**-**
		1600	(755)	0.009	(2.3)	54	42	38	36	30	24	-	-	57	50	45	38	32	25	-	-	58	52	48	39	35	28	-	22
		2000	**(944)**	**0.014**	**(3.5)**	**56**	**46**	**42**	**42**	**32**	**27**	**-**	**-**	**59**	**55**	**50**	**43**	**35**	**28**	**21**	**24**	**60**	**57**	**53**	**47**	**39**	**32**	**24**	**27**
		3000	(1416)	0.031	(7.7)	59	53	50	51	41	35	23	24	63	59	56	51	42	35	27	31	64	62	59	53	45	39	31	34
		4000	**(1888)**	**0.056**	**(13.9)**	**62**	**59**	**56**	**56**	**48**	**42**	**28**	**31**	**66**	**64**	**62**	**58**	**49**	**42**	**34**	**37**	**68**	**65**	**63**	**59**	**51**	**45**	**35**	**38**
		5000	(2360)	0.087	(21.7)	66	64	59	60	53	47	32	34	70	68	66	63	55	48	38	42	72	68	67	63	56	50	39	43
		6000	**(2832)**	**0.125**	**(31.1)**	**69**	**66**	**61**	**61**	**56**	**50**	**34**	**37**	**73**	**70**	**68**	**63**	**58**	**51**	**41**	**44**	**74**	**71**	**69**	**64**	**59**	**53**	**42**	**45**
		6500	(3068)	0.152	(37.8)	70	67	62	61	57	51	34	38	74	72	69	65	59	53	42	45	75	72	70	66	61	55	43	46
		7200	**(3398)**	**0.186**	**(46.4)**	**72**	**68**	**64**	**63**	**58**	**53**	**36**	**39**	**76**	**73**	**71**	**67**	**60**	**55**	**44**	**47**	**76**	**74**	**72**	**68**	**62**	**57**	**45**	**48**

See Page TH-27 For NC Calculations

NC CALCULATIONS

The current ARI Standard for NC calculations is ARI 885-98. Other terminal manufacturers may catalog performance based on ARI 885-90. Using this older, obsolete standard will provide lower NC levels compared to the 1998 standard. To allow for fair and accurate performance comparisons, METALAIRE publishes the NC levels for both the 1990 standard and the 1998 current standard.

TH-500 - ARI Rating Points at 1.5" Inlet Pressure

ARI Certified Radiated Sound Power, 1.5" Inlet Static Pressure								
Unit Size	Min Ps	CFM	Octave Band					
			2	3	4	5	6	7
506	0.10	400	57	53	47	40	37	33
508	0.09	700	62	59	49	43	37	32
510	0.05	1100	60	56	51	44	38	34
512	0.05	1600	64	59	55	48	43	37
514	0.07	2100	63	58	49	44	42	39
516	0.08	2800	64	64	58	51	48	45
520	0.09	4400	70	66	64	61	54	47
524	0.09	5300	76	71	70	65	59	53

ARI Certified Discharge Sound Power, 1.5" Inlet Static Pressure								
Unit Size	Min Ps	CFM	Octave Band					
			2	3	4	5	6	7
506	0.10	400	65	66	61	57	52	49
508	0.09	700	66	67	61	59	55	50
510	0.05	1100	69	70	63	61	55	52
512	0.05	1600	68	70	68	61	57	54
514	0.07	2100	71	72	67	65	62	58
516	0.08	2800	73	74	73	66	61	56
520	0.09	4400	79	82	81	76	73	68
524	0.09	5300	86	83	83	78	74	70

ARI PERFORMANCE CERTIFIED ARI Standard 880

STATEMENT OF STANDARD TEST CONFORMITY

METALAIRE tests all TH-500 air terminal units for engineering performance in accordance with the following standards: American National Standards Institute (ANSI)/American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE)/International Organization for Standardization (ISO)/ Air-Conditioning & Refrigeration Institute (ARI).

- **ARI Standard 880-98 Standard for Air Terminals**
- **ANSI/ASHRAE 130-1996 Methods of Testing for Rating Ducted Air Terminal Units**
- **ASHRAE Standard 41.1-1986 (RA 91) Standard Method for Temperature Measurement**
- **ASHRAE Standard 41.2-1987 Standard Methods for Laboratory Air Measurements**
- **ASHRAE Standard 41.3-1989 Standard Methods for Pressure Measurement**
- **ISO 5219-1984 Air distribution and air diffusion - Laboratory aerodynamic testing and rating of air terminal devices**

Casing Leakage, CFM				
Inlet Size	0.25" △Ps	0.50" △Ps	1.00" △Ps	1.50" △Ps
6	2	3	4	5
8	2	3	5	6
10	3	4	6	8
12	3	5	7	9
14	4	6	9	11
16	5	7	10	12
20	5	7	10	12
24	6	8	12	14

Damper Leakage, CFM			
Inlet Size	1.5" △Ps	3.0" △Ps	6.0" △Ps
6	3	4	7
8	3	4	7
10	4	5	7
12	4	5	7
14	4	6	8
16	4	6	8
20	N/A	N/A	N/A
24	N/A	N/A	N/A

Selection Recommendations for TH-500			
Inlet Size	Minimum CFM	Minimum CFM with Electric Heat	CFM @1"
6	105	165	600
8	190	220	1100
10	290	350	1700
12	430	500	2500
14	550	775	3250
16	750	975	4400
20	1100	1400	6200
24	1250	1800	7200

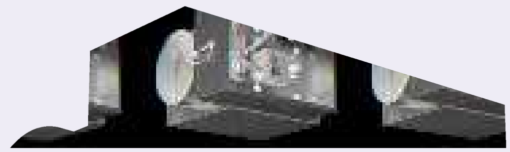
Notes:
1. Minimum CFM (without electric heat) is based on a signal velocity pressure of 0.03 in w.c..
2. The minimum CFM with electric heat values reported and a minimum of 0.03" downstream static pressure will provide sufficient total pressure to operate the airflow switch. For performance below these CFM values, please consult the factory.
3. Maximum CFM is based on a signal velocity pressure of 1.0 in w.c..
4. For Selections outside the above ranges, contact your local METALAIRE Representative.

Performance Data

Recommended Primary Air cfm Ranges • All Terminals

Control Types:
- PESV • Pneumatic
- AESV • Analog electronic
- DESV • Digital electronic

AESV



Quick Selection Procedure
1. Select unit inlet size based upon acoustic parameters and/or maximum pressure drop requirements, using pages Q12–Q13.
2. Check inlet size selection against cfm control limits based on control type shown on this page.
3. Select accessories (multi-outlets, attenuators) as required.
4. Select reheat coil, if required. Make your selection using the actual heating flow rate, not cooling.

Inlet Size	Total cfm Range	cfm Ranges of Minimum and Maximum Settings							
		PESV - Pneumatic TITUS II Controller		PESV - Pneumatic TITUS I Controller		AESV - Analog Electronic TA1 Controller		DESV - Digital Typical Controller	
		Minimum	Maximum	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum
4	0-225	45*-170	80-225	55*-170	80-225	45*-225	45-225	45*-225	45-225
5	0-350	65*-270	120-350	85*-270	120-350	65*-350	65-350	65*-350	65-350
6	0-500	80*-330	150-500	105*-330	150-500	80*-500	80-500	80*-500	80-500
7	0-650	105*-425	190-650	135*-425	190-650	105*-650	105-650	105*-650	105-650
8	0-900	145*-590	265-900	190*-590	265-900	145*-900	145-900	145*-900	145-900
9	0-1050	175*-700	315-1050	225*-700	315-1050	175*-1050	175-1050	175*-1050	175-1050
10	0-1400	230*-925	415-1400	300*-925	415-1400	230*-1400	230-1400	230*-1400	230-1400
12	0-2000	325*-1330	600-2000	425*-1330	600-2000	325*-2000	325-2000	325*-2000	325-2000
14	0-3000	450*-1800	810-3000	575*-1800	810-3000	450*-3000	450-3000	450*-3000	450-3000
16	0-4000	580*-2350	1100-4000	750*-2350	1100-4000	580*-4000	580-4000	580*-4000	580-4000
24x16	0-8000	1400*-5200	2600-8000	1800*-5200	2600-8000	1400*-7500	1400-7500	1400*-7500	1400-7500

*Factory cfm settings (except zero) will not be made below this range because control accuracy is reduced.
On pressure dependent units, minimum cfm is always zero and there is no maximum.

Note: On controls mounted by TITUS but supplied by others (FMA or Factory Mounting Authorization), these values are guidelines only. Controls mounted on an FMA basis are calibrated in the field.

Performance Data (continued)

PESV, AESV, DESV • Minimum Pressures

Inlet Size	cfm	Velocity Pressure VP	Basic Unit ∆Ps	Basic + Atten. ∆Ps	Basic + Multi-out. ∆Ps	Basic + Round Out. ∆Ps	Basic + 1 Row Coil ∆Ps	Basic + 2 Row Coil ∆Ps	Basic + 3 Row Coil ∆Ps	Basic + 4 Row Coil ∆Ps	Basic + Elec. Coil. ∆Ps
4	100	0.080	0.020	0.021	0.022	0.023	0.027	0.034	0.041	0.048	0.020
	150	0.181	0.044	0.048	0.049	0.052	0.061	0.078	0.093	0.109	0.044
	200	0.322	0.078	0.084	0.088	0.092	0.108	0.138	0.165	0.193	0.078
	225	0.407	0.099	0.107	0.111	0.116	0.137	0.175	0.209	0.244	0.099
5	150	0.072	0.011	0.014	0.016	0.018	0.028	0.044	0.060	0.075	0.011
	200	0.129	0.019	0.025	0.029	0.032	0.049	0.079	0.106	0.134	0.019
	300	0.289	0.043	0.057	0.064	0.073	0.111	0.177	0.239	0.301	0.043
	350	0.394	0.059	0.077	0.088	0.099	0.151	0.241	0.325	0.410	0.059
6	200	0.059	0.033	0.038	0.044	0.060	0.063	0.092	0.120	0.147	0.033
	300	0.133	0.073	0.085	0.098	0.134	0.141	0.207	0.269	0.331	0.073
	400	0.236	0.130	0.151	0.175	0.238	0.250	0.368	0.478	0.588	0.130
	500	0.369	0.203	0.236	0.273	0.372	0.391	0.575	0.747	0.919	0.203
7	300	0.070	0.031	0.036	0.044	0.055	0.066	0.098	0.131	0.163	0.031
	400	0.125	0.055	0.064	0.079	0.098	0.118	0.175	0.232	0.290	0.055
	600	0.282	0.124	0.145	0.177	0.220	0.265	0.394	0.523	0.653	0.124
	650	0.331	0.145	0.170	0.208	0.259	0.311	0.462	0.613	0.766	0.145
8	350	0.052	0.005	0.009	0.015	0.031	0.053	0.097	0.141	0.185	0.042
	500	0.105	0.011	0.019	0.030	0.064	0.109	0.198	0.288	0.378	0.086
	700	0.207	0.021	0.038	0.059	0.126	0.213	0.388	0.564	0.741	0.169
	900	0.342	0.035	0.062	0.097	0.208	0.353	0.642	0.932	1.225	0.279
9	500	0.069	0.015	0.021	0.031	0.045	0.063	0.108	0.152	0.197	0.141
	650	0.117	0.026	0.035	0.052	0.076	0.107	0.182	0.258	0.334	0.237
	800	0.177	0.040	0.053	0.078	0.115	0.162	0.276	0.390	0.505	0.360
	1050	0.306	0.068	0.092	0.134	0.198	0.279	0.476	0.672	0.871	0.620
10	600	0.060	0.001	0.006	0.012	0.030	0.069	0.134	0.198	0.263	0.090
	800	0.107	0.001	0.011	0.022	0.054	0.124	0.238	0.352	0.467	0.160
	1100	0.203	0.002	0.021	0.041	0.102	0.234	0.449	0.665	0.883	0.303
	1400	0.328	0.003	0.035	0.066	0.165	0.378	0.728	1.077	1.430	0.491
12	900	0.064	0.001	0.006	0.014	0.033	0.080	0.150	0.222	0.292	0.101
	1200	0.113	0.001	0.011	0.025	0.058	0.142	0.266	0.394	0.519	0.180
	1500	0.177	0.002	0.016	0.039	0.091	0.222	0.416	0.616	0.811	0.281
	2000	0.314	0.003	0.029	0.070	0.162	0.395	0.740	1.095	1.441	0.500
14	1200	0.063	0.013	0.018	0.029	0.046	0.077	0.137	0.195	0.254	0.094
	1600	0.113	0.023	0.032	0.052	0.082	0.138	0.243	0.347	0.451	0.166
	2000	0.176	0.036	0.050	0.082	0.128	0.215	0.379	0.543	0.705	0.260
	3000	0.396	0.080	0.112	0.184	0.289	0.484	0.854	1.221	1.587	0.584
16	1500	0.056	0.009	0.014	0.027	0.039	0.078	0.140	0.203	0.264	0.125
	2000	0.100	0.015	0.025	0.047	0.070	0.139	0.249	0.360	0.469	0.221
	3000	0.225	0.034	0.056	0.107	0.156	0.312	0.560	0.811	1.056	0.498
	4000	0.401	0.060	0.099	0.190	0.278	0.555	0.996	1.441	1.878	0.886
24x16	2500	0.038	0.013	0.014	NA	NA	0.091	0.161	0.233	0.303	0.242
	4000	0.096	0.033	0.035	NA	NA	0.233	0.411	0.595	0.776	0.619
	6000	0.216	0.073	0.079	NA	NA	0.523	0.925	1.340	1.746	1.392
	8000	0.384	0.130	0.140	NA	NA	0.931	1.644	2.382	3.103	2.475

- ∆Ps is the difference in static pressure across the assembly.
- To obtain total pressure (Pt), add the velocity pressure for a given cfm to the static pressure drop (∆Ps) of the desired ESV configuration.

Example: Pt for a Size 8 ESV Basic Unit @ 700 cfm = 0.207 + 0.021 = 0.228

Appendix C: DOE2.1E Output

Provided in electronic format

1Green Design Tools DOE-2.1E-119 Tue Dec 5 10:03:47 2006LDL RUN 1
Base Case Work\ThermaFuser\R6\Chicago VAV.gph VisualDOE 4.1.2
REPORT- LS-D BUILDING MONTHLY LOADS SUMMARY WEATHER FILE- Chicago IL TMY2

	COOLING						HEATING						ELEC	
MONTH	COOLING ENERGY (MBTU)	TIME OF MAX DY	HR	DRY-BULB TEMP	WET-BULB TEMP	MAXIMUM COOLING LOAD (KBTU/HR)	HEATING ENERGY (MBTU)	TIME OF MAX DY	HR	DRY-BULB TEMP	WET-BULB TEMP	MAXIMUM HEATING LOAD (KBTU/HR)	ELEC-TRICAL ENERGY (KWH)	MAXIMUM ELEC LOAD (KW)
JAN	813.66486	17	14	52.F	44.F	2092.529	-13.338	27	1	-3.F	-4.F	-272.193	79910.	292.355
FEB	763.41125	17	15	44.F	36.F	2232.625	-5.890	4	6	7.F	6.F	-97.298	72764.	292.355
MAR	903.07043	31	16	72.F	54.F	2266.675	-1.946	8	5	20.F	17.F	-48.776	82899.	292.355
APR	927.96521	28	16	71.F	53.F	2368[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	-20.708	74063.	292.355
MAY	1094.38232	4	16	86.F	59.F	2460[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.000	82899.	292.355
JUN	1121.57703	15	16	89.F	70.F	2454[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.000	79521.	292.355
JUL	1177.41968	7	16	90.F	71.F	2542[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.000	77442.	292.355
AUG	1169.31067	30	16	82.F	65.F	2488[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.000	82899.	292.355
SEP	1075.42041	5	15	87.F	66.F	2483[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.000	77052.	292.355
OCT	1013.96210	10	15	70.F	54.F	2339.095	-0.004	2	3	32.F	29.F	-1.148	79910.	292.355
NOV	896.92596	2	15	75.F	67.F	2265.730	-0.419	28	5	28.F	25.F	-19.722	79521.	292.355
DEC	815.46338	11	15	51.F	44.F	2055.152	-10.944	31	24	-6.F	-7.F	-296.202	77442.	292.355
TOTAL	11772.574						-32.656						946320.	
MAX						2542.326						-296.202		292.355

DOE2.1E Sample Output

Complete Output Files Available Electronically.

Please contact Acutherm.

1Green Design Tools DOE-2.1E-119 Tue Dec 5 10:03:47 2006SDL RUN 1
Base Case Work\ThermaFuser\R6\Chicago VAV.gph VisualDOE 4.1.2
REPORT- SV-A SYSTEM DESIGN PARAMETERS System_3020 WEATHER FILE- Chicago IL TMY2

SYSTEM NAME	SYSTEM TYPE	ALTITUDE MULTIPLIER	FLOOR AREA (SQFT)	MAX PEOPLE
System_3020	VAVS	1.000	307311.1	853.