

ALPENA PUBLIC SAFETY BUILDING VAV BOX UPGRADE CONTRACTOR'S SCOPE PHASE 2

The following are requirements for upgrading the Alpena Public Safety Building VAV Box Upgrade Project – Phase 2. The Mechanical Contractor (Prime Contractor) shall include the work scope described below.

1. The Mechanical Contractor shall be Prime Contractor, and shall be responsible for subcontracting all necessary Subcontractors required to complete the project including but not limited to Temperature Contractor and Electrical Contractor.
2. The Prime Contractor shall adhere to the City of Alpena bidding documents and specifications as provided by the City of Alpena, and attached as part of this document.
3. The Prime Contractor shall provide a Base Bid that includes pricing for all services described in this document and Specifications. The Base Bid pricing shall include the cost for fully installed and operating systems meeting the description of the bidding documents.
4. The Base Bid or Add Alternate pricing from the Prime Contractor must not include deductions, changes, or deletions of the equipment. The Contractor may provide deductive alternates as line items to the bid form.
5. Provide all necessary permits, plan review, etc., required to complete the project. The City of Alpena may request plan review for this project.

Demolition:

6. The Contractor must remove and dispose of the existing VAV boxes.
 - a. The Contractor must replace the existing VAV box 3-way control valves and autoflow valves and replace with new 2-way or 3-way control valves as noted below. Where an existing 3-way valve is removed and replaced with a new 2-way valve, the Contractor must cut back and cap the bypass water piping. See “Second Floor VAV Box Replacement Schedule” below for additional information.
 - b. The Contractor may leave the existing reheat coil isolation ball valves, but must remove the existing auto-flow valves, and replace with new circuit setters.
 - c. The Contractor must remove the existing VAV box controllers and associated wiring that shall no longer be used. The existing control wiring may be reused if possible, and removed or abandoned per 2014 NEC.
7. The Mechanical Contractor must procure and install new VAV boxes including:
 - a. New VAV box with hot water reheat coil.
 - b. New Bacnet protocol digital control board.
 - c. Install new control valve as noted in Table below (2-way 2-position, or 2-way modulating, as noted in Table-1 and Table-2 listed below.) New control valves shall be selected and provided by Control Solutions Inc.
8. The Mechanical Contractor must sub-contract Control Solutions Inc. to provide new VAV box temperature control work including:
 - a. VAV box digital control board.

- b. New 2-way 2-position or 2-way modulating control valves and actuators.
- c. New 3-way, 2-position or 3-way modulating control valves and actuators.
- d. New wall mounted digital thermostats with temperature display and limited programmable temperature adjustment (+/- 4 deg. F).
- e. Temperature control wiring.
- f. VAV box integration into the existing Tridium building control system.
- g. The new temperature control work parameters and control points include:
 - i. The new VAV box control points shall include at a minimum: discharge air temperature, damper position, heating, cooling, and ventilation mode.
 - ii. Wall controller room temperature point.
 - iii. There are three (3) damper positions that the box must be balanced to:
 - 1. Minimum Position: Outdoor Air Temperature OA%.
 - 2. Heating Design Airflow: approximately 30% of maximum Cooling Design Airflow.
 - 3. Cooling Design Airflow: The maximum VAV box airflow for cooling.
- h. The sequence of operations of the VAV box shall be the following:
 - i. The Temperature Control Contractor shall coordinate the Occupied / Unoccupied periods with Mike Kieliszewski and Bob Adrian. Given the use of the building a typical Unoccupied period may not be needed.
 - ii. The VAV box shall modulate to maintain space cooling temperature. When space temperature is satisfied the VAV box damper shall close to the minimum position.
 - iii. On a call for heat the VAV box damper shall close to 30% of the cooling airflow and the 2-way or 3-way valve shall open or modulate to achieve and maintain space heating temperature.
 - iv. When the space temperature is satisfied the VAV box damper shall close to the minimum position to provide fresh air ventilation.
- i. To ensure minimum flow is maintained provide two (2) 3/4" bypass valves with full-port ball valves. Install one valve between the HWS and HWR piping where original VB-10 is eliminated, and one between the HWS and HWR piping where VB-6 is eliminated.
- j. Control Solutions shall integrate the new VAV box sequences into the existing Tridium Building Control System.
- k. Control Solutions shall coordinate the final sequence of operations with the Engineer, and provide shop drawings of the updated VAV box and air handler sequence of operations for final coordination and approval.

TABLE-1: Second Floor VAV Box Replacement Schedule											
Rooms	Original VAV Box Tag	New VAV Box Tag (Titus Model #)	Room Areas (sf)	VAV Box Size	Min. Airflow CFM (OA %)	Heating Design Airflow (CFM)	Cooling Design Airflow (CFM)	Total Airflow CFM (Max. Box Airflow)	Min. Heat Capacity MBH (Rows)	G P M	Valve Size/Type
Bunk Room 203	VB-1	VAV-201 (DESV-10)	1215	10"	340 (25%)	675 (50%)	1345	1345 (1400)	35.0 (2-Row)	4.0	1/2" 2way/2pos
Locker 217	VB-2	VAV-202 (DESV-8)	300	8"	275 (50%)	275 (50%)	300	650 (900)	10.5 (1-Row)	1.0	1/2" 2way/2pos.
Laundry 216			100				100				
Corridor 213			250				250				
Dining Room 219	VB-3	VAV-203 (DESV-10)	780	10"	300 (25%)	360 (30%)	1400	1400 (1400)	16.0 (1-Row)	3.0	1/2" 2-way/mod
Kitchen 220	VB-4	VAV-204 (DESV-8)	270	8"	125 (20%)	190 (30%)	525	625 (900)	7.5 (1-Row)	1.0	1/2" 2way/2pos
Pantry 221			65				100				
Corridor	VB-5	VAV-205 (DESV-12)	215	12"	340 (20%)	510 (30%)	200	1700 (2000)	20.0 (1-Row)	3.0	1/2" 2way/mod
Classroom 229			925				1500				
Evidence Process 235	VB-6	VAV-206 (DESV-10)	195	10"	225 (25%)	450 (50%)	300	900 (1400)	17.0 (2-Row)	2.0	1/2" 2way/mod
Evidence Storage 236	VB-7		400				600				
Bathroom 227	VB-8	VAV-207 (DESV-6)	370	6"	175 (50%)	175 (50%)	200	350 (500)	7.0 (1-Row)	1.0	1/2" 2way/2pos
Bathroom 228			235				150				
Work-out Room 226	VB-9	VAV-208 (DESV-12)	880	12"	450 (25%)	600 (30%)	1600	1750 (2000)	22.0 (1-Row)	3.0	1/2" 2way/mod
CR Storage 225			190				150				
	VB-10		This VAV box original served Pantry 221 has been eliminated. See plans for new Pantry 221 supply air duct.								
	VB-11		VAV Box tag VB-11 was skipped over, and never used as a tag as part of the original project.								
Records Library 211	VB-12	VAV-209 (DESV-8)	342	8"	115 (20%)	175 (30%)	575	575 (900)	8.0	1.0	1/2" 2way/2pos
Day Room 210	VB-13	VAV-210 (DESV-8)	412	8"	120 (20%)	180 (30%)	600	600 (900)	8.0	1.0	1/2" 2way/2pos

Day Room 209	VB-14	VAV-211 (DESV-8)	412	8"	120 (20%)	180 (30%)	600	600 (900)	8.0	1.0	1/2" 2way/2pos
Men's Toilet 214 (orig. W.Tlt.)	VB-15	VAV-212 DESV-8)	215	8"	215 (50%)	215 (50%)	200	425 (900)	8.5	1.0	1/2" 2-way/2pos
Women's Toilet 207 (orig. M.Tlt.)			175				150				
Pole Hall 204			90				75				
	VB-16		This VAV box original served W. Tlt 214, but has been eliminated.								

9. Add Alternate #M-1: Bunk Room Duct and Diffuser Modifications:

- a. Add six (6) new SD-1, 12"x12" supply air diffusers to the Bunk Room 203.
 - i. SD-1: Titus model Omni, 12"x12", 6" neck, lay-in frame
 - ii. Cut existing lay-in ceiling tile, and provide new secondary t-bars as needed for proper and complete installation.
- b. Demo existing ductwork as shown on plans.
- c. Relocate existing return air grilles and modify ductwork as shown on plans.
- d. Add new ductwork, and modify existing supply air ductwork as shown on plans.
- e. Add new volume dampers as shown on plans.
- f. Note: Replacement of VAV-201 and associated piping and valve work shall be included in the Base Bid, and must not be included as part of Add Alternate #M-1.

10. Add Alternate #M-2: Classroom Duct and Diffuser Modifications:

- a. Modify ductwork and relocate existing diffusers as shown on plans.
 - i. Install new round volume dampers at branch duct.
- b. Add two (2) new SD-2, 24"x24", supply air diffusers to Classroom 229.
 - i. SD-2: Titus model Omni, 24"x24", 10" neck, lay-in frame.
 - ii. Add / modify existing t-bars as needed for proper installation.
- c. Remove (2) return air grilles and associated ductwork, and cap at main.
- d. Add one (1) 48"x24" return air grille with (2) new 12" round flex duct connections.
 - i. RG-1: Titus model 50F 48"x24", egg crate, lay-in ceiling model.
 - ii. Remove existing t-bar as needed for installation.

11. Add Alternate #M-3: First Floor VAV Box Addition

- a. Install one (1) new DECV-8, cooling only VAV boxes to serve Stairwell #2.
- b. Install 8" round to 12" round transition and 12" flex duct and connect to the existing supply air register located above the door in Stairwell #2.
- c. Control Solutions to include new single thermostat, located in Stairwell #2, and wire and integrate to existing TCS.

12. Eliminate the existing VAV box, VB-10, that serves Pantry 221.
 - a. Eliminate the existing SA duct that supplies the existing SA diffuser located in Pantry 221. The diffusers will be reused.
 - b. Tie in new 6" round SA duct with volume damper to existing 12x10 SA duct that serves Kitchen 220, and duct to the existing SA diffuser located in Pantry 221.

13. Eliminate the existing VAV box, VB-6, that serves Evidence Room 235. Remove all associated SA ductwork, but leave SA diffuser in place, and prepare to re-duct, and reuse.
 - a. Install new VAV-206 with new 14x12 SA main duct.
 - i. Tie in new 10" round SA duct with volume damper and duct to existing SA diffuser in Evidence Processing Room 235. Balance to 300 CFM
 - ii. Tie in existing 10x10 SA duct (field verify actual duct size) to new 14x12 SA main duct. Balance each existing diffuser to 300 CFM each (600 CFM total).
 - iii. Install single new thermostat to serve new VAV-206 in Evidence Storage Room 236. See plans for location.

14. **Add Alternate #M-4: Evidence Room Exhaust System Addition:**
 - a. Add single exhaust fan in Evidence Storage Room 236. This new fan will exhaust all supply air delivered into Evidence Processing Room 235 and Evidence Storage Room 236.
 - b. Remove existing RA grilles located in Evidence Processing Room 235 and Evidence Storage Room 236. Cut back and remove existing RA branch duct to main and cap.
 - c. Install the new exhaust fan in the southeast corner of Storage Room 236 where shown on plans. Include, ductwork, louver, power, etc., as needed for complete installation.
 - d. The exhaust fan shall be Loren Cook model GC-822 cabinet fan, 900 CFM at 0.25 in wg, and 4.0 sones. 115V, FLA = 2.3A. Include backdraft damper.
 - e. Install new 24"x16" stationary, extruded, aluminum louver with drainable blades. Ruskin model ELF6375DXH, 6" thick, 24"x16", no flange, Ruskin #43 Light Stone color (provide color swatch with submittals).
 - f. Duct new fan to louver using 20x8 exhaust ductwork, with transition to 24x16 louver. Seal all seams using duct seal.
 - g. The Mechanical Contractor shall subcontract an Electrical Contractor to wire new exhaust fan to nearest available circuit, or back to electrical panel EM or panel D located in second floor Electrical Room 232. All work shall comply with 2014 NEC.
 - h. By Code the exhaust shall run continuously 24-7-365, and shall only be controlled by standard electrical disconnect switch. Locate the electrical disconnect next to the fan, above the ceiling.
 - i. The space VAV box shall be controlled to modulate airflow between the following minimum and maximum airflow rates and modes:
 - i. Minimum position when there is not a call for heating or cooling shall be 25% (225 CFM). In the minimum position the two spaces will be put under a negative pressure, while the exhaust fan can operate under a constant volume.
 - ii. Heating Mode: upon a call for heat the damper shall move to 50% (450 CFM) and the heating coil shall modulate to maintain the space temperature to +/- 1.0 deg. F of the heating set point. In heating mode the two spaces will be put under a negative pressure.

- iii. Cooling Mode: upon a call for cooling the damper shall modulate between the minimum position and the maximum position (900 CFM adj.) to maintain the space cooling set point to +/- 1.0 deg. F of the cooling set point.
15. Eliminate the VAV box that currently serves what is labeled as Women's Toilet 214. (Note that the original drawings list room 214 as Women's Toilet 214, and room 207 as Men's Toilet 207. This is incorrect, and it has been corrected on the plans provided.)
- a. Men's Toilet Room 214 will now be supplied by VB-15 (new VAV-214).
 - b. Install new 8" round SA duct with volume damper to supply the existing supply air diffuser located in Men's Toilet 214.
16. VAV Box Specifications:
- a. The new VAV boxes shall be Titus model DESV or equal.
 - b. Each VAV box shall include a single row coil, balanced as noted in Table-1 and Table-2 above.
 - c. The new control valves shall be Belimo 2-way, 2-position or modulating Table-1 and Table-2, 1/2", sweat or NPT as preferred by contractor, characterized control valve, stainless steel ball and stem.
 - d. Contractor may contact Engineer for CV calculations.
 - e. 2-10 VDC or 4-20mA.
17. Hot water coil piping notes:
- a. The existing VAV box with HW coils shall be removed. Isolate HW coil using existing isolation valves.
 - b. Install new strainers on inlet of coil.
 - c. Install new 2-way, 2-position or 2-way-modulating valves as noted in Table-1.
18. Drawing attachment notes:
- a. Enlarged copies of the original mechanical HVAC drawings are included as part of the bid package. The demolition, new VAV boxes, new diffusers and grilles, and piping have been highlighted. Refer to drawings for original VAV box, ductwork, and diffuser design.
 - b. Field verify all existing VAV box, ductwork, and diffuser locations.
 - c. During construction note and document any diffusers or ductwork that have been undersized, and contact engineer for instructions.

ATTACHMENTS:

1. 24"x36" Enlarged Second Floor VAV and Ductwork Schematic
2. 24"x36" Enlarged Second Floor VAV and Piping Schematic
3. Titus VAV Box Cut Sheet
4. 23 36 00 Air Terminal Units Specification

END OF ALPENA PUBLIC SAFETY BUILDING VAV BOX UPGRADE - PHASE 2.

PESV, AESV, DESV / HOT WATER COIL CAPACITY, MBH / 1- AND 2-ROW

Rows	gpm	Head Loss	Airflow, cfm									
			50	100	150	200	250	300	350	400	450	
One-Row	1.0	0.48	3.7	5.6	6.8	7.8	8.6	9.3	9.9	10.4	10.8	
	2.0	1.82	3.8	5.9	7.3	8.5	9.5	10.3	11.0	11.6	12.2	
	4.0	6.98	3.9	6.1	7.6	8.9	10.0	10.9	11.7	12.4	13.1	
	5.0	10.75	3.9	6.1	7.7	9.0	10.1	11.0	11.8	12.6	13.3	
	Airside ΔPs		0.01	0.01	0.02	0.04	0.05	0.07	0.10	0.12	0.15	
Two-Row	1.0	0.12	5.0	8.1	10.3	12.0	13.4	14.5	15.5	16.3	17.0	
	3.0	1.04	5.4	9.0	11.9	14.2	16.2	17.9	19.4	20.7	22.0	
	5.0	2.80	5.4	9.2	12.2	14.7	16.9	18.8	20.5	22.0	23.4	
	7.0	5.38	5.5	9.3	12.4	15.0	17.3	19.2	21.0	22.6	24.1	
	Airside ΔPs		0.01	0.03	0.05	0.08	0.12	0.16	0.21	0.26	0.32	

Rows	gpm	Head Loss	Airflow, cfm								
			100	200	300	400	500	600	700	800	900
One-Row	1.0	0.64	6.2	8.9	10.7	12.1	13.1	14.0	14.7	15.3	15.9
	2.0	2.46	6.6	9.7	11.8	13.5	14.8	16.0	16.9	17.8	18.5
	3.0	5.38	6.7	10.0	12.3	14.1	15.5	16.8	17.9	18.8	19.7
	4.0	9.39	6.8	10.1	12.5	14.4	15.9	17.2	18.4	19.4	20.3
Airside ΔPs		0.01	0.02	0.05	0.07	0.11	0.15	0.19	0.24	0.30	
Two-Row	1.0	0.17	8.8	13.4	16.3	18.5	20.2	21.5	22.6	23.6	24.4
	3.0	1.40	9.7	15.6	20.0	23.4	26.3	28.6	30.7	32.5	34.1
	5.0	3.77	9.9	16.2	21.0	24.8	28.0	30.8	33.2	35.3	37.2
	7.0	7.24	10.0	16.5	21.4	25.5	28.8	31.8	34.4	36.7	38.8
Airside ΔPs		0.02	0.05	0.10	0.16	0.23	0.32	0.41	0.51	0.62	

Rows	gpm	Head Loss	Airflow, cfm								
			200	300	400	500	600	700	800	900	1000
One-Row	2.0	0.41	11.0	13.5	15.4	17.0	18.3	19.5	20.5	21.3	22.1
	3.0	0.90	11.4	14.1	16.3	18.1	19.6	20.9	22.0	23.0	23.9
	5.0	2.41	11.8	14.7	17.1	19.0	20.7	22.2	23.5	24.6	25.7
	6.0	3.43	11.9	14.9	17.3	19.3	21.0	22.5	23.9	25.1	26.2
Airside ΔPs		0.01	0.02	0.04	0.06	0.08	0.10	0.13	0.15	0.19	
Two-Row	2.0	0.47	16.4	21.0	24.5	27.4	29.8	31.8	33.6	35.1	36.5
	4.0	1.84	17.6	23.0	27.3	31.0	34.2	36.9	39.4	41.5	43.5
	6.0	4.08	18.0	23.8	28.5	32.5	36.0	39.1	41.8	44.3	46.6
	8.0	5.00	18.3	24.2	29.1	33.3	37.0	40.3	43.2	45.9	48.3
Airside ΔPs		0.03	0.05	0.09	0.12	0.17	0.22	0.27	0.33	0.40	

Rows	gpm	Head Loss	Airflow, cfm								
			300	500	700	900	1100	1300	1500	1700	1900
One-Row	2.0	0.54	15.5	19.8	22.9	25.2	27.1	28.7	30.1	31.2	32.3
	3.0	1.19	16.2	21.0	24.5	27.2	29.5	31.4	33.0	34.5	35.7
	5.0	3.18	16.9	22.1	26.0	29.1	31.7	34.0	35.9	37.6	39.2
	6.0	4.52	17.0	22.4	26.5	29.7	32.4	34.7	36.7	38.5	40.1
Airside ΔPs		0.01	0.03	0.06	0.09	0.13	0.17	0.22	0.27	0.33	
Two-Row	2.0	0.55	23.2	30.8	36.2	40.2	43.5	46.1	48.3	50.2	51.9
	4.0	2.15	25.3	34.8	41.9	47.6	52.3	56.3	59.7	62.7	65.4
	6.0	4.75	26.1	36.4	44.3	50.7	56.1	60.8	64.8	68.4	71.6
	8.0	6.16	26.5	37.2	45.6	52.5	58.3	63.3	67.8	71.7	75.3
Airside ΔPs		0.03	0.07	0.13	0.20	0.27	0.36	0.46	0.57	0.68	

PESV, AESV, DESV / HOT WATER COIL CAPACITY, MBH / 1- AND 2-ROW

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Size	Rows	gpm	Head Loss	Airflow, cfm								
				400	700	1000	1300	1600	1900	2200	2500	2800
Size 14	One-Row	2.0	0.43	20.4	26.3	30.3	33.2	35.5	27.4	39.0	40.4	41.5
		3.0	0.96	21.6	28.4	33.2	36.8	39.7	42.0	44.1	45.9	47.4
		5.0	2.63	22.7	30.5	36.0	40.3	43.8	47.8	49.3	51.6	53.6
		6.0	3.77	23.1	31.0	36.8	41.3	45.0	48.2	50.9	53.3	55.4
		Airside ΔPs		0.01	0.03	0.06	0.09	0.13	0.17	0.22	0.27	0.33
	Two-Row	2.0	0.39	30.1	40.3	47.0	51.8	55.5	58.5	60.9	62.9	64.7
		4.0	1.51	33.5	47.1	56.8	64.3	70.3	75.3	79.6	83.2	86.4
		6.0	3.36	34.9	49.9	61.1	69.9	77.2	83.3	88.6	93.2	97.3
		8.0	3.95	35.6	51.5	63.5	73.1	81.1	88.0	93.9	99.2	103.8
		Airside ΔPs		0.03	0.07	0.12	0.19	0.27	0.36	0.46	0.57	0.69
Size 16	One-Row	3.0	1.07	29.5	37.4	42.8	47.0	50.4	53.1	55.5	57.5	59.3
		5.0	2.92	31.4	40.6	47.2	52.3	56.5	60.1	63.1	65.8	68.2
		7.0	5.65	32.4	42.1	49.3	55.0	59.7	63.7	67.1	70.2	72.9
		9.0	6.48	32.9	43.1	50.6	56.6	61.6	65.9	69.6	72.9	75.9
		Airside ΔPs		0.02	0.04	0.07	0.10	0.14	0.19	0.24	0.30	0.36
	Two-Row	3.0	0.53	43.1	55.9	64.7	71.1	76.1	80.1	83.4	86.2	88.6
		5.0	1.46	47.0	63.1	74.6	83.5	90.7	96.6	101.6	105.9	109.7
		7.0	2.84	49.0	66.8	80.0	90.3	98.8	106.0	112.1	117.5	122.2
		9.0	2.54	50.2	69.0	83.3	94.6	104.1	112.1	119.0	125.1	130.5
		Airside ΔPs		0.04	0.08	0.14	0.22	0.30	0.40	0.51	0.63	0.76
Size 24 x 16	One-Row	3.0	1.31	35.3	49.4	58.3	64.7	69.6	73.5	76.8	79.6	82.0
		5.0	3.57	37.6	54.2	65.2	73.4	79.9	85.3	89.9	93.8	97.3
		7.0	6.89	38.7	56.5	68.7	77.9	85.4	91.6	96.9	101.5	105.6
		9.0	8.50	39.3	58.0	70.8	80.7	88.7	95.5	101.3	106.4	110.9
		Airside ΔPs		0.01	0.02	0.05	0.08	0.11	0.15	0.20	0.25	0.30
	Two-Row	3.0	0.59	48.8	70.9	84.3	93.4	100.1	105.3	109.4	112.8	115.7
		5.0	1.63	53.1	81.0	99.4	112.9	123.3	131.6	138.5	144.3	149.3
		7.0	3.17	55.2	86.2	107.6	123.8	136.6	147.1	155.9	163.5	170.0
		9.0	3.06	56.4	89.4	112.8	130.8	145.3	157.3	167.5	176.4	184.2
		Airside ΔPs		0.02	0.05	0.10	0.16	0.24	0.32	0.42	0.52	0.63

- All coil performance in accordance with AHRI 410-2001
- Heating capacities are in MBH
- Data based on 180°F entering water and 55°F entering air
- For temperature differentials other than 125°, multiply MBH by correction factors below
- Head loss is in feet of water
- Always supply water to lowest connection pipe to prevent air entrapment
- Air temperature rise = 927 x MBH/cfm
- Water temperature drop = 2.04 x MBH/gpm
- Connection size is 1/2" OD male solder for 1-row coil sizes 04-08. All other coils have 7/8" OD male solder.
- Coils are not intended for steam applications and are labeled for a maximum water temperature of 200°F
- Coils are tested for leakage at test pressure of 500 psi
- Water volumes less than those shown may result in laminar flow and reduced heating capacity. If possible reduce the number of coil rows to increase water velocity into turbulent range.

Correction Factors for Other Entering Conditions

ΔT	50	60	70	80	90	100	110	125	140	150
Factor	0.40	0.48	0.56	0.64	0.72	0.80	0.88	1.00	1.12	1.20

Note: Airside ΔPs reflects the air pressure drop of the hot water coil

PESV, AESV, DESV / HOT WATER COIL CAPACITY, MBH / 3- AND 4-ROW

	Rows	gpm	Head Loss	Airflow, cfm									
				50	100	150	200	250	300	350	400	450	
Sizes 4-5-6	Three-Row	2.0	0.70	6.1	10.8	14.4	17.5	20.0	22.3	24.2	25.9	27.4	
		3.0	1.54	6.1	11.0	14.9	18.2	21.0	23.5	25.7	27.6	29.4	
		5.0	4.14	6.2	11.1	15.2	18.8	21.8	24.6	27.0	29.2	31.3	
		6.0	5.90	6.2	11.2	15.3	18.9	22.1	24.9	27.4	29.7	31.8	
	Airside ΔPs				0.01	0.04	0.08	0.12	0.18	0.24	0.31	0.39	0.47
	Four-Row	3.0	1.11	6.5	11.9	16.5	20.5	23.9	26.8	29.5	34.8	34.0	
		4.0	1.95	6.5	12.1	16.8	20.9	24.5	27.7	30.6	33.1	35.5	
		6.0	4.33	6.5	12.2	17.1	21.4	25.2	25.6	31.7	34.5	37.1	
		8.0	5.42	6.5	12.2	17.2	21.6	25.5	29.1	32.3	35.3	38.0	
	Airside ΔPs				0.02	0.05	0.10	0.16	0.24	0.32	0.41	0.52	0.63
Sizes 7-8	Rows	gpm	Head Loss	Airflow, cfm									
				100	200	300	400	500	600	700	800	900	
	Three-Row	2.0	0.50	11.2	18.6	23.8	27.9	31.1	33.7	35.9	37.8	39.4	
		4.0	1.95	11.6	19.8	26.0	31.1	35.3	38.8	41.9	44.7	47.1	
		6.0	4.33	11.7	20.2	26.9	32.3	37.0	41.0	44.5	47.6	50.4	
		8.0	5.42	11.7	20.4	27.3	33.0	37.9	42.1	45.9	49.2	52.2	
	Airside ΔPs				0.02	0.08	0.15	0.24	0.35	0.47	0.61	0.77	0.93
	Four-Row	4.0	1.40	12.4	22.1	29.6	35.0	40.9	45.3	49.1	52.4	55.3	
		6.0	3.12	12.5	22.5	30.6	37.3	43.0	48.0	52.4	56.3	59.7	
		8.0	3.53	12.6	22.7	31.1	38.1	44.2	49.5	54.2	58.4	62.2	
10.0		5.46	12.6	22.9	31.4	38.6	44.9	50.4	55.4	59.8	63.8		
Airside ΔPs				0.03	0.10	0.20	0.32	0.47	0.63	0.82	1.02	1.25	
Sizes 9-10	Rows	gpm	Head Loss	Airflow, cfm									
				200	300	400	500	600	700	800	900	1000	
	Three-Row	3.0	0.80	21.0	27.9	33.4	38.0	41.8	45.2	48.1	50.7	52.9	
		5.0	2.19	21.6	29.2	35.5	40.8	45.5	49.6	53.2	56.5	59.4	
		7.0	4.26	21.9	29.8	36.5	42.2	47.2	51.7	55.7	59.4	62.7	
		9.0	4.49	22.1	30.2	37.0	43.0	48.3	53.0	57.3	61.2	64.7	
	Airside ΔPs				0.04	0.08	0.13	0.19	0.25	0.33	0.41	0.50	0.59
	Four-Row	4.0	1.16	23.5	32.2	39.4	45.6	50.9	55.5	59.6	63.2	66.5	
		5.0	1.80	23.7	32.7	40.4	46.9	52.6	57.7	62.2	66.2	69.8	
		8.0	2.75	24.1	33.6	41.8	49.0	55.4	61.2	66.4	71.1	75.5	
10.0		4.25	24.2	33.9	42.3	49.8	56.4	62.4	67.9	72.9	77.5		
Airside ΔPs				0.05	0.11	0.17	0.25	0.34	0.43	0.54	0.66	0.79	
Size 12	Rows	gpm	Head Loss	Airflow, cfm									
				300	500	700	900	1100	1300	1500	1700	1900	
	Three-Row	3.0	0.91	30.3	42.2	50.9	57.6	63.0	67.4	71.1	74.3	77.0	
		4.0	1.61	31.0	44.0	53.8	61.5	67.8	73.1	77.6	81.5	84.9	
		6.0	3.57	31.8	45.9	56.9	65.8	73.3	79.7	85.2	90.1	94.5	
		8.0	4.32	32.2	46.9	58.5	68.2	76.3	83.4	89.6	95.1	100.0	
	Airside ΔPs				0.05	0.11	0.19	0.29	0.41	0.54	0.69	0.85	1.02
	Four-Row	4.5	1.63	34.6	50.5	62.9	72.7	80.8	87.6	93.4	98.4	102.8	
		5.0	2.01	34.8	51.1	63.9	74.2	82.7	89.9	96.0	101.4	106.1	
		7.0	2.88	35.1	52.6	66.5	78.0	87.7	96.1	103.4	109.8	115.6	
9.0		4.11	35.6	53.4	68.0	80.3	90.8	99.9	107.9	115.1	121.5		
Airside ΔPs				0.06	0.15	0.26	0.39	0.55	0.72	0.92	1.13	1.36	

PESV, AESV, DESV / HOT WATER COIL CAPACITY, MBH / 3- AND 4-ROW

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Size	Rows	gpm	Head Loss	Airflow, cfm								
				400	700	1000	1300	1600	1900	2200	2500	2800
Size 14	Three-Row	4.0	1.30	41.3	59.8	73.0	83.0	90.9	97.3	102.7	107.3	111.1
		5.0	2.01	42.1	61.8	76.3	87.6	96.6	104.1	110.4	115.8	120.5
		6.0	2.88	42.6	63.2	78.6	90.8	100.7	109.0	116.1	122.2	127.6
		8.0	3.27	43.3	65.0	81.7	95.2	106.3	115.8	124.0	131.2	137.5
		Airside ΔPs		0.04	0.10	0.19	0.29	0.41	0.54	0.69	0.86	1.04
	Four-Row	6.0	2.06	46.7	71.1	89.5	104.0	115.7	125.5	133.7	140.8	146.9
		7.0	2.79	47.1	72.2	91.6	107.1	119.8	130.4	139.5	147.4	154.2
		8.0	2.03	47.4	73.1	93.3	109.5	123.0	134.4	144.1	152.7	160.2
		10.0	3.15	47.8	74.4	95.6	113.0	127.7	140.2	151.1	160.7	169.2
		Airside ΔPs		0.05	0.14	0.25	0.38	0.54	0.72	0.93	1.15	1.39
Size 16	Rows	gpm	Head Loss	Airflow, cfm								
				600	1000	1400	1800	2200	2600	3000	3400	3800
	Three-Row	6.0	1.71	58.5	80.9	97.0	109.3	119.2	127.3	134.0	139.9	144.9
		8.0	1.51	60.1	84.4	102.5	116.7	128.3	138.0	146.2	153.4	159.6
		10.0	2.35	61.1	86.7	106.1	121.6	134.4	145.3	154.6	162.7	169.9
		12.0	3.36	61.8	88.2	108.6	125.1	138.8	150.5	160.7	169.6	177.5
	Airside ΔPs		0.06	0.14	0.24	0.37	0.51	0.68	0.86	1.06	1.28	
	Four-Row	9.0	1.58	67.4	97.6	120.6	138.8	153.7	166.2	176.8	185.9	193.9
		10.0	1.95	67.9	98.8	122.6	141.6	157.3	170.5	181.8	191.6	200.2
		11.0	2.36	68.3	99.7	124.2	144.0	160.3	174.1	186.0	196.4	205.6
12.0		2.80	68.6	100.5	125.6	146.0	162.9	177.3	189.8	200.7	210.3	
Airside ΔPs		0.08	0.18	0.32	0.49	0.68	0.90	1.15	1.42	1.71		
Size 24 x 16	Rows	gpm	Head Loss	Airflow, cfm								
				600	1200	1800	2400	3000	3600	4200	4800	5400
	Three-Row	6.0	1.86	65.0	103.8	129.6	148.2	162.3	173.5	182.5	190.1	196.5
		8.0	1.76	66.4	108.6	138.0	160.0	177.3	191.2	202.8	212.6	221.1
		10.0	2.74	67.2	111.5	143.4	167.9	187.4	203.4	216.9	228.5	238.6
		12.0	3.92	67.8	113.6	147.2	173.4	194.7	212.3	227.3	240.3	251.6
	Airside ΔPs		0.03	0.09	0.17	0.27	0.40	0.54	0.70	0.88	1.07	
	Four-Row	9.0	1.80	72.6	124.0	161.1	189.2	211.2	229.0	243.6	256.0	266.7
		10.0	2.22	73.0	125.5	164.1	193.6	217.1	236.2	252.1	265.6	277.2
		11.0	2.68	73.3	126.7	166.5	197.3	222.0	242.3	259.3	273.9	286.4
12.0		3.18	73.5	127.7	168.6	200.5	226.3	247.6	265.6	281.1	294.5	
Airside ΔPs		0.04	0.12	0.23	0.37	0.53	0.72	0.93	1.17	1.42		

- All coil performance in accordance with AHRI 410-2001
- Heating capacities are in MBH
- Data based on 180°F entering water and 55°F entering air
- For temperature differentials other than 125°, multiply MBH by correction factors below
- Head loss is in feet of water
- Always supply water to lowest connection pipe to prevent air entrapment
- Air temperature rise = 927 x MBH/cfm
- Water temperature drop = 2.04 x MBH/gpm
- Connection size is 1/2" OD male solder for 1-row coil sizes 04-08. All other coils have 7/8" OD male solder.
- Coils are not intended for steam applications and are labeled for a maximum water temperature of 200°F
- Coils are tested for leakage at test pressure of 500 psi
- Water volumes less than those shown may result in laminar flow and reduced heating capacity. If possible reduce the number of coil rows to increase water velocity into turbulent range.

Correction Factors for Other Entering Conditions

ΔT	50	60	70	80	90	100	110	125	140	150
Factor	0.40	0.48	0.56	0.64	0.72	0.80	0.88	1.00	1.12	1.20

Note: Airside ΔPs reflects the air pressure drop of the hot water coil

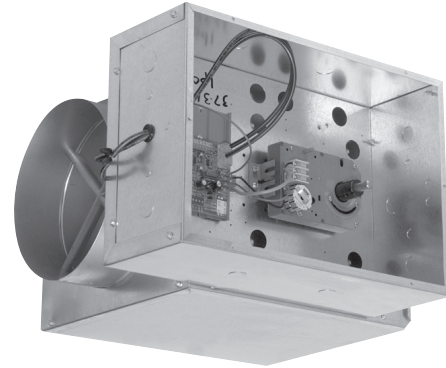
RECOMMENDED PRIMARY AIR CFM RANGES / ALL TERMINALS

Control Types:

- PESV / Pneumatic
- AESV / Analog Electronic
- DESV / Digital Electronic

QUICK SELECTION PROCEDURE

1. Select unit inlet size based upon acoustic parameters and/or maximum pressure drop requirements, using pages M15-M16
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.



M

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	30*-225	30-225
5	0-350	65*-270	120-350	85*-270	120-350	65*-350	65-350	40*-350	40-350
6	0-500	80*-330	150-500	105*-330	150-500	80*-500	80-500	45*-500	45-500
7	0-650	105*-425	190-650	135*-425	190-650	105*-650	105-650	70*-650	70-650
8	0-900	145*-590	265-900	190*-590	265-900	145*-900	145-900	90*-900	90-900
9	0-1050	175*-700	315-1050	225*-700	315-1050	175*-1050	175-1050	120*-1050	120-1050
10	0-1400	230*-925	415-1400	300*-925	415-1400	230*-1400	230-1400	145*-1400	145-1400
12	0-2000	325*-1330	600-2000	425*-1330	600-2000	325*-2000	325-2000	190*-2000	190-2000
14	0-3000	450*-1800	810-3000	575*-1800	810-3000	450*-3000	450-3000	300*-3000	300-3000
16	0-4000	580*-2350	1100-4000	750*-2350	1100-4000	580*-4000	580-4000	385*-4000	385-4000
24 x 16	0-8000	1400*-5200	2600-8000	1800*-5200	2600-8000	1400*-7500	1400-7500	720*-7500	720-7500

*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

single / dual duct terminals

PESV, AESV, DESV / RADIATED SOUND PERFORMANCE

Size	CFM	Min ΔPs	Octave Band Sound Power, Lw																											
			0.5" ΔPs							1.0" ΔPs							1.5" ΔPs							2.0" ΔPs						
			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
4	100	0.02	49	45	36	33	31	26	11	52	48	39	36	35	31	15	53	50	41	37	37	34	17	55	51	43	38	39	36	18
	125	0.03	52	49	39	36	32	27	16	55	52	42	38	36	32	20	57	54	44	40	39	36	22	58	55	45	41	40	38	23
	150	0.04	55	52	41	37	34	28	20	58	55	44	40	38	34	23	60	57	46	41	40	37	25	61	58	47	42	42	39	27
	175	0.06	58	55	42	39	35	29	23	61	58	46	42	39	34	27	63	59	48	43	41	38	28	64	61	49	44	43	40	30
	200	0.08	60	57	44	40	36	30	25	63	60	47	43	40	35	29	65	62	49	44	42	38	31	66	63	51	45	44	41	33
5	150	0.01	49	44	36	32	31	25	10	53	49	41	36	35	30	16	55	51	43	38	37	33	18	57	53	45	39	39	35	21
	200	0.02	53	48	39	35	34	27	15	56	53	44	38	37	32	21	59	55	46	40	40	35	23	60	57	48	42	41	37	25
	250	0.03	55	52	41	37	35	29	20	59	56	46	40	39	34	24	62	59	49	42	41	37	28	63	61	51	44	43	39	30
	300	0.04	58	54	43	39	37	30	22	62	59	48	42	41	35	28	64	61	50	44	43	38	30	65	63	52	45	44	40	33
	350	0.06	60	56	45	40	38	31	24	63	61	49	43	42	36	30	66	63	52	45	44	39	33	67	65	54	47	45	41	35
6	300	0.07	55	49	40	35	32	28	16	59	54	45	39	37	33	22	61	57	48	41	39	36	25	63	59	50	42	41	38	28
	350	0.10	57	52	42	37	34	29	20	60	57	47	41	38	34	25	62	59	50	43	40	37	28	64	62	52	44	42	39	31
	400	0.13	58	53	44	39	35	30	21	61	58	49	42	39	35	27	63	61	52	44	42	38	30	65	63	54	46	43	40	33
	450	0.16	59	55	45	40	36	31	23	62	60	50	44	40	36	29	64	63	53	46	43	39	33	66	65	55	47	45	41	35
	500	0.20	59	56	47	42	37	32	24	63	61	51	45	41	37	30	65	64	54	47	44	40	34	67	67	56	49	46	42	37
7	450	0.07	59	48	42	38	33	24	20	61	54	48	42	38	30	23	62	57	51	45	41	33	25	63	59	53	46	43	35	28
	500	0.09	60	50	43	39	34	24	22	62	55	49	43	39	30	24	63	58	52	46	42	34	27	64	60	54	48	44	36	29
	550	0.10	60	51	44	40	35	25	22	63	57	50	45	40	31	25	64	59	53	47	43	34	28	66	62	55	49	45	37	31
	600	0.12	61	53	45	42	35	25	23	63	58	51	46	41	31	27	65	61	54	48	44	35	30	66	63	56	50	46	37	33
	650	0.15	62	54	46	43	36	26	24	64	59	52	47	41	32	28	65	62	55	49	44	35	31	66	64	57	51	46	38	34
8	600	0.02	59	50	44	40	38	32	20	62	55	49	43	43	39	24	64	58	52	46	45	44	27	65	60	54	47	47	47	29
	650	0.02	60	51	44	41	39	32	22	63	56	50	44	44	40	25	65	59	53	47	46	45	28	66	61	55	48	48	48	30
	700	0.02	60	52	45	42	40	33	22	63	57	50	45	44	41	25	65	60	53	47	47	45	29	67	62	56	49	49	48	31
	750	0.02	61	53	46	43	40	34	23	64	58	51	46	45	41	27	66	61	54	48	48	46	30	67	63	56	50	50	49	33
	800	0.03	62	54	47	43	41	34	24	65	59	52	47	46	42	28	66	62	55	49	48	47	31	68	64	57	51	50	50	34
9	800	0.04	58	47	43	36	34	30	19	61	53	49	42	40	35	23	62	57	52	46	44	38	26	63	59	55	48	47	40	29
	850	0.04	58	48	43	37	34	31	19	61	54	49	43	41	35	23	63	58	53	46	45	38	27	64	60	55	49	47	40	29
	900	0.05	59	49	44	37	35	31	20	62	55	50	43	41	35	24	64	58	53	47	45	38	27	65	61	56	49	48	40	30
	950	0.06	59	50	44	37	35	31	20	62	56	50	43	42	36	24	64	59	54	47	45	38	28	65	62	56	49	48	40	31
	1000	0.06	60	50	44	38	36	31	22	63	56	50	44	42	36	25	65	60	54	47	46	39	29	66	62	57	50	48	40	31
10	900	0.01	60	50	47	45	42	29	22	63	57	53	50	48	37	27	65	60	57	53	52	41	31	67	63	59	56	54	44	34
	1000	0.01	60	51	48	46	43	30	22	64	58	54	51	49	38	28	66	61	57	54	53	42	31	67	64	59	56	55	45	34
	1100	0.01	61	52	48	47	44	32	23	65	58	54	52	50	39	28	67	62	57	55	54	43	31	68	64	60	57	56	46	35
	1200	0.01	62	53	48	47	45	32	24	65	59	54	53	51	40	28	67	63	58	56	55	44	33	69	65	60	58	57	47	35
	1300	0.01	63	54	49	48	45	33	25	66	60	55	53	52	41	29	68	63	58	56	55	45	33	69	66	61	58	58	48	36
12	1200	0.01	58	50	47	41	37	30	20	62	56	52	47	43	37	26	64	59	56	50	46	41	30	66	61	58	53	49	43	32
	1400	0.01	60	52	48	42	38	32	22	63	57	54	48	45	39	28	65	60	57	52	48	42	31	67	63	60	54	51	45	35
	1600	0.01	61	53	50	43	40	34	24	64	59	55	49	46	40	29	66	62	59	53	50	44	34	68	64	61	55	52	47	36
	1800	0.01	61	55	51	44	41	35	25	65	60	56	50	48	41	30	67	63	60	54	51	45	35	69	65	62	56	54	48	37
	2000	0.01	62	56	52	45	43	36	26	66	61	57	51	49	43	31	68	64	61	55	52	47	36	69	67	63	57	55	49	38
14	1500	0.02	56	51	45	43	40	36	18	60	56	50	48	45	41	24	62	59	53	51	48	45	28	64	61	55	53	50	47	30
	1800	0.03	58	53	46	44	41	36	21	62	58	51	49	46	42	27	64	60	54	52	49	45	29	66	63	56	54	51	48	33
	2100	0.04	59	54	47	45	42	37	22	63	59	52	50	47	43	28	66	62	55	53	50	46	31	67	64	58	55	52	49	34
	2400	0.05	60	55	48	46	43	38	23	64	60	53	51	48	43	29	67	63	56	54	51	47	33	69	65	58	56	53	49	35
	2700	0.06	62	56	49	47	44	38	24	66	61	54	52	49	44	30	68	64	57	55	52	47	34	70	66	59	57	54	50	36
16	2000	0.02	55	48	43	41	39	31	36	59	53	47	45	44	38	21	61	56	50	47	47	41	24	63	58	52	49	49	44	27
	2400	0.02	57	51	45	43	41	33	18	61	56	49	47	46	39	24	64	59	52	49	49	43	28	65	61	54	51	51	46	30
	2800	0.03	59	53	46	44	42	34	21	63	58	51	48	47	41	27	66	61	54	50	50	45	30	67	63	55	52	52	48	33
	3200	0.04	61	55	48	46	44	36	23	65	60	52	50	49	42	29	67	62	55	52	52	46	31	69	64	57	53	54	49	34
	3600	0.05	62	56	49	47	45	37	24	66	61	54	51	50	44	30	69	64	56	53	53	48	34	71	66	58	55	55	50	36

PERFORMANCE DATA

single / dual duct terminals

PESV, AESV, DESV / DISCHARGE SOUND PERFORMANCE

Size	CFM	Min ΔPs	Octave Band Sound Power, Lw																															
			0.5" ΔPs								1.0" ΔPs								1.5" ΔPs								2.0" ΔPs							
			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				
4	100	0.02	70	56	47	42	40	33	28	71	59	51	46	47	41	29	72	61	54	49	50	46	30	73	62	56	51	53	49	31				
	125	0.03	72	60	50	44	42	35	30	73	63	54	49	49	43	31	74	64	57	52	52	47	33	75	65	59	54	55	51	34				
	150	0.04	73	63	52	47	44	36	31	75	65	57	51	50	44	34	76	67	60	54	54	49	35	76	68	61	56	57	52	35				
	175	0.06	75	65	54	48	45	37	34	76	68	59	53	51	45	35	77	69	62	56	55	50	36	78	71	64	58	58	53	38				
	200	0.08	76	67	56	50	46	38	35	77	70	61	55	53	46	36	78	72	63	58	56	51	38	79	73	65	60	59	54	39				
5	150	0.01	68	53	47	43	41	34	25	70	58	52	47	47	42	28	72	60	55	50	51	46	30	73	62	58	52	53	49	31				
	200	0.02	71	57	50	46	43	36	29	73	61	56	51	49	44	31	75	64	59	53	53	48	34	76	66	61	55	55	51	35				
	250	0.03	73	60	53	49	45	38	31	75	65	58	53	51	45	34	77	67	61	56	55	50	36	78	69	63	58	57	53	38				
	300	0.04	74	62	55	51	47	39	31	77	67	60	55	53	46	34	78	70	63	58	56	51	34	79	72	66	60	59	54	35				
	350	0.06	76	64	57	52	48	40	29	78	69	62	57	54	47	33	80	72	65	60	57	52	36	81	74	67	61	60	55	38				
6	300	0.07	68	60	54	50	45	39	21	72	65	59	54	51	46	26	75	68	62	57	54	50	30	77	70	64	58	56	53	33				
	350	0.10	69	62	55	52	47	40	22	74	67	61	56	52	47	29	76	70	64	59	55	51	31	78	72	66	60	58	54	34				
	400	0.13	71	63	57	54	48	41	25	75	69	62	58	53	48	30	78	72	65	60	57	52	34	79	74	67	62	59	55	35				
	450	0.16	72	65	58	55	49	42	26	76	70	64	59	54	49	31	79	73	67	62	58	53	35	81	76	69	63	60	56	38				
	500	0.20	73	66	60	56	50	43	28	77	72	65	61	55	50	33	80	75	68	63	59	54	36	82	77	70	65	61	57	39				
7	450	0.07	71	61	54	51	47	40	25	74	66	59	54	51	46	29	75	70	61	56	54	49	30	77	72	63	58	56	52	33				
	500	0.09	71	62	55	52	48	40	25	74	68	60	56	52	47	29	76	71	63	58	55	50	31	77	74	64	59	57	53	34				
	550	0.10	72	64	56	54	49	41	26	75	69	61	57	53	48	30	76	73	64	59	56	51	33	78	75	65	60	58	54	36				
	600	0.12	72	65	57	55	49	42	26	75	70	62	58	54	48	30	77	74	64	60	57	52	34	78	76	66	61	59	55	37				
	650	0.15	72	66	58	56	50	43	26	75	72	63	59	55	49	32	77	75	65	61	58	53	36	79	77	67	62	59	55	38				
8	600	0.02	73	63	56	52	48	40	28	76	69	60	55	52	47	31	78	72	62	56	55	51	34	79	75	64	57	57	54	36				
	650	0.02	74	64	57	53	48	41	29	77	70	61	56	53	47	33	78	73	63	57	55	51	34	79	76	65	58	57	54	37				
	700	0.02	74	65	57	54	49	41	29	77	71	61	56	53	48	33	79	74	64	58	56	52	35	80	77	65	59	58	55	38				
	750	0.02	75	66	58	54	49	42	28	77	72	62	57	54	48	31	79	75	64	58	56	52	34	80	78	66	60	58	55	38				
	800	0.03	75	67	58	55	50	42	28	78	73	63	58	54	49	32	79	76	65	59	57	53	36	81	78	67	60	59	56	38				
9	800	0.04	73	61	57	53	49	43	25	76	66	61	57	54	49	29	77	69	63	59	57	53	30	78	71	65	60	59	56	31				
	850	0.04	74	62	57	53	49	43	26	76	67	61	57	54	50	29	78	70	63	59	57	54	31	79	72	65	61	59	56	33				
	900	0.05	74	63	58	54	50	43	26	77	68	62	57	55	50	30	79	70	64	59	57	54	33	80	72	66	61	59	57	34				
	950	0.06	75	63	58	54	50	44	28	78	68	62	58	55	50	31	79	71	64	60	58	54	33	80	73	66	61	60	57	34				
	1000	0.06	75	64	59	55	50	44	28	78	69	62	58	55	50	31	80	72	65	60	58	54	34	81	74	66	62	60	57	35				
10	900	0.01	75	62	58	55	50	44	28	77	67	62	59	55	50	30	78	70	65	61	58	54	31	79	73	67	63	61	57	33				
	1000	0.01	76	63	59	56	50	44	29	78	68	63	60	56	51	31	79	71	66	62	59	55	33	80	74	68	64	61	57	34				
	1100	0.01	76	63	59	57	51	45	29	79	69	64	61	56	51	33	80	72	66	63	60	55	34	81	74	68	65	62	58	35				
	1200	0.01	77	64	60	57	52	45	30	79	70	64	61	57	52	33	81	73	67	64	60	56	35	82	75	69	66	63	59	36				
	1300	0.01	78	65	61	58	52	46	31	80	70	65	62	58	53	34	81	74	68	65	61	56	35	82	76	69	66	63	59	36				
12	1200	0.01	73	64	60	55	53	46	25	76	69	64	59	57	52	29	78	72	66	62	60	56	31	79	74	68	64	62	59	33				
	1400	0.01	74	65	62	56	54	47	26	77	71	66	61	59	53	30	79	74	68	63	61	57	33	80	76	70	65	63	60	36				
	1600	0.01	75	66	63	57	55	48	28	78	72	67	62	59	55	31	80	75	69	64	62	58	34	81	77	71	66	64	61	37				
	1800	0.01	76	68	64	58	55	49	29	79	73	68	63	60	56	33	80	76	71	65	63	59	36	81	78	72	67	65	62	38				
	2000	0.01	76	69	65	59	56	50	29	79	74	69	64	61	56	33	81	77	72	66	64	60	37	82	79	73	68	66	63	39				
14	1500	0.02	69	57	56	53	50	44	20	72	63	56	59	57	53	24	74	67	56	62	62	59	26	76	69	56	65	65	62	29				
	1800	0.03	70	59	58	53	50	44	21	73	65	58	59	58	53	25	75	68	58	63	62	59	28	77	71	58	65	65	63	30				
	2100	0.04	71	60	59	54	51	44	22	74	66	59	60	58	54	26	76	69	59	63	63	59	29	78	72	59	66	66	63	31				
	2400	0.05	72	61	60	54	51	44	24	75	67	60	60	59	54	28	77	70	60	64	63	59	30	78	73	60	66	66	63	32				
	2700	0.06	72	62	61	54	51	45	24	76	68	61	61	59	54	29	78	71	61	64	63	60	31	79	74	61	67	66	63	33				
16	2000	0.02	68	59	57	54	52	45	19	71	63	57	58	56	51	22	73	66	57	61	59	54	25	74	68	57	63	61	57	26				
	2400	0.02	70	62	59	55	53	46	21	73	66	59	60	58	52	25	75	68	59	62	61	56	28	76	70	59	64	62	58	29				
	2800	0.03	71	64	61	57	55	48	22	75	68	61	61	59	54	28	77	70	61	64	62	57	30	78	72	61	66	64	60	31				
	3200	0.04	73	65	63	58	56	49	25	76	69	63	62	60	55	29	78	72	63	65	63	59	31	79	73	63	67	65	61	33				
	3600	0.05	74	67	65	59	57	50	26	77	71	65	63	61	56	30	79	73	65	66	64	60	33	81	75	65	68	66	62	35				
40	3900																																	

PESV, AESV, DESV / HOT WATER COIL CAPACITY, MBH / 1- AND 2-ROW

	Rows	gpm	Head Loss	Airflow, cfm								
				50	100	150	200	250	300	350	400	450
Sizes 4-5-6	One-Row	1.0	0.48	3.7	5.6	6.8	7.8	8.6	9.3	9.9	10.4	10.8
		2.0	1.82	3.8	5.9	7.3	8.5	9.5	10.3	11.0	11.6	12.2
		4.0	6.98	3.9	6.1	7.6	8.9	10.0	10.9	11.7	12.4	13.1
		5.0	10.75	3.9	6.1	7.7	9.0	10.1	11.0	11.8	12.6	13.3
		Airside ΔPs		0.01	0.01	0.02	0.04	0.05	0.07	0.10	0.12	0.15
	Two-Row	1.0	0.12	5.0	8.1	10.3	12.0	13.4	14.5	15.5	16.3	17.0
		3.0	1.04	5.4	9.0	11.9	14.2	16.2	17.9	19.4	20.7	22.0
		5.0	2.80	5.4	9.2	12.2	14.7	16.9	18.8	20.5	22.0	23.4
		7.0	5.38	5.5	9.3	12.4	15.0	17.3	19.2	21.0	22.6	24.1
		Airside ΔPs		0.01	0.03	0.05	0.08	0.12	0.16	0.21	0.26	0.32
Sizes 7-8	One-Row	1.0	0.64	6.2	8.9	10.7	12.1	13.1	14.0	14.7	15.3	15.9
		2.0	2.46	6.6	9.7	11.8	13.5	14.8	16.0	16.9	17.8	18.5
		3.0	5.38	6.7	10.0	12.3	14.1	15.5	16.8	17.9	18.8	19.7
		4.0	9.39	6.8	10.1	12.5	14.4	15.9	17.2	18.4	19.4	20.3
		Airside ΔPs		0.01	0.02	0.05	0.07	0.11	0.15	0.19	0.24	0.30
	Two-Row	1.0	0.17	8.8	13.4	16.3	18.5	20.2	21.5	22.6	23.6	24.4
		3.0	1.40	9.7	15.6	20.0	23.4	26.3	28.6	30.7	32.5	34.1
		5.0	3.77	9.9	16.2	21.0	24.8	28.0	30.8	33.2	35.3	37.2
		7.0	7.24	10.0	16.5	21.4	25.5	28.8	31.8	34.4	36.7	38.8
		Airside ΔPs		0.02	0.05	0.10	0.16	0.23	0.32	0.41	0.51	0.62
Sizes 9-10	One-Row	2.0	0.41	11.0	13.5	15.4	17.0	18.3	19.5	20.5	21.3	22.1
		3.0	0.90	11.4	14.1	16.3	18.1	19.6	20.9	22.0	23.0	23.9
		5.0	2.41	11.8	14.7	17.1	19.0	20.7	22.2	23.5	24.6	25.7
		6.0	3.43	11.9	14.9	17.3	19.3	21.0	22.5	23.9	25.1	26.2
		Airside ΔPs		0.01	0.02	0.04	0.06	0.08	0.10	0.13	0.15	0.19
	Two-Row	2.0	0.47	16.4	21.0	24.5	27.4	29.8	31.8	33.6	35.1	36.5
		4.0	1.84	17.6	23.0	27.3	31.0	34.2	36.9	39.4	41.5	43.5
		6.0	4.08	18.0	23.8	28.5	32.5	36.0	39.1	41.8	44.3	46.6
		8.0	5.00	18.3	24.2	29.1	33.3	37.0	40.3	43.2	45.9	48.3
		Airside ΔPs		0.03	0.05	0.09	0.12	0.17	0.22	0.27	0.33	0.40
Size 12	One-Row	2.0	0.54	15.5	19.8	22.9	25.2	27.1	28.7	30.1	31.2	32.3
		3.0	1.19	16.2	21.0	24.5	27.2	29.5	31.4	33.0	34.5	35.7
		5.0	3.18	16.9	22.1	26.0	29.1	31.7	34.0	35.9	37.6	39.2
		6.0	4.52	17.0	22.4	26.5	29.7	32.4	34.7	36.7	38.5	40.1
		Airside ΔPs		0.01	0.03	0.06	0.09	0.13	0.17	0.22	0.27	0.33
	Two-Row	2.0	0.55	23.2	30.8	36.2	40.2	43.5	46.1	48.3	50.2	51.9
		4.0	2.15	25.3	34.8	41.9	47.6	52.3	56.3	59.7	62.7	65.4
		6.0	4.75	26.1	36.4	44.3	50.7	56.1	60.8	64.8	68.4	71.6
		8.0	6.16	26.5	37.2	45.6	52.5	58.3	63.3	67.8	71.7	75.3
		Airside ΔPs		0.03	0.07	0.13	0.20	0.27	0.36	0.46	0.57	0.68

PESV, AESV, DESV / HOT WATER COIL CAPACITY, MBH / 1- AND 2-ROW

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Size	Rows	gpm	Head Loss	Airflow, cfm								
				400	700	1000	1300	1600	1900	2200	2500	2800
Size 14	One-Row	2.0	0.43	20.4	26.3	30.3	33.2	35.5	27.4	39.0	40.4	41.5
		3.0	0.96	21.6	28.4	33.2	36.8	39.7	42.0	44.1	45.9	47.4
		5.0	2.63	22.7	30.5	36.0	40.3	43.8	47.8	49.3	51.6	53.6
		6.0	3.77	23.1	31.0	36.8	41.3	45.0	48.2	50.9	53.3	55.4
		Airside ΔPs		0.01	0.03	0.06	0.09	0.13	0.17	0.22	0.27	0.33
	Two-Row	2.0	0.39	30.1	40.3	47.0	51.8	55.5	58.5	60.9	62.9	64.7
		4.0	1.51	33.5	47.1	56.8	64.3	70.3	75.3	79.6	83.2	86.4
		6.0	3.36	34.9	49.9	61.1	69.9	77.2	83.3	88.6	93.2	97.3
		8.0	3.95	35.6	51.5	63.5	73.1	81.1	88.0	93.9	99.2	103.8
		Airside ΔPs		0.03	0.07	0.12	0.19	0.27	0.36	0.46	0.57	0.69
Size 16	One-Row	3.0	1.07	29.5	37.4	42.8	47.0	50.4	53.1	55.5	57.5	59.3
		5.0	2.92	31.4	40.6	47.2	52.3	56.5	60.1	63.1	65.8	68.2
		7.0	5.65	32.4	42.1	49.3	55.0	59.7	63.7	67.1	70.2	72.9
		9.0	6.48	32.9	43.1	50.6	56.6	61.6	65.9	69.6	72.9	75.9
		Airside ΔPs		0.02	0.04	0.07	0.10	0.14	0.19	0.24	0.30	0.36
	Two-Row	3.0	0.53	43.1	55.9	64.7	71.1	76.1	80.1	83.4	86.2	88.6
		5.0	1.46	47.0	63.1	74.6	83.5	90.7	96.6	101.6	105.9	109.7
		7.0	2.84	49.0	66.8	80.0	90.3	98.8	106.0	112.1	117.5	122.2
		9.0	2.54	50.2	69.0	83.3	94.6	104.1	112.1	119.0	125.1	130.5
		Airside ΔPs		0.04	0.08	0.14	0.22	0.30	0.40	0.51	0.63	0.76
Size 24 x 16	One-Row	3.0	1.31	35.3	49.4	58.3	64.7	69.6	73.5	76.8	79.6	82.0
		5.0	3.57	37.6	54.2	65.2	73.4	79.9	85.3	89.9	93.8	97.3
		7.0	6.89	38.7	56.5	68.7	77.9	85.4	91.6	96.9	101.5	105.6
		9.0	8.50	39.3	58.0	70.8	80.7	88.7	95.5	101.3	106.4	110.9
		Airside ΔPs		0.01	0.02	0.05	0.08	0.11	0.15	0.20	0.25	0.30
	Two-Row	3.0	0.59	48.8	70.9	84.3	93.4	100.1	105.3	109.4	112.8	115.7
		5.0	1.63	53.1	81.0	99.4	112.9	123.3	131.6	138.5	144.3	149.3
		7.0	3.17	55.2	86.2	107.6	123.8	136.6	147.1	155.9	163.5	170.0
		9.0	3.06	56.4	89.4	112.8	130.8	145.3	157.3	167.5	176.4	184.2
		Airside ΔPs		0.02	0.05	0.10	0.16	0.24	0.32	0.42	0.52	0.63

- All coil performance in accordance with AHRI 410-2001
- Heating capacities are in MBH
- Data based on 180°F entering water and 55°F entering air
- For temperature differentials other than 125°, multiply MBH by correction factors below
- Head loss is in feet of water
- Always supply water to lowest connection pipe to prevent air entrapment
- Air temperature rise = 927 x MBH/cfm
- Water temperature drop = 2.04 x MBH/gpm
- Connection size is 1/2" OD male solder for 1-row coil sizes 04-08. All other coils have 7/8" OD male solder.
- Coils are not intended for steam applications and are labeled for a maximum water temperature of 200°F
- Coils are tested for leakage at test pressure of 500 psi
- Water volumes less than those shown may result in laminar flow and reduced heating capacity. If possible reduce the number of coil rows to increase water velocity into turbulent range.

Correction Factors for Other Entering Conditions

ΔT	50	60	70	80	90	100	110	125	140	150
Factor	0.40	0.48	0.56	0.64	0.72	0.80	0.88	1.00	1.12	1.20

Note: Airside ΔPs reflects the air pressure drop of the hot water coil

PESV, AESV, DESV / HOT WATER COIL CAPACITY, MBH / 3- AND 4-ROW

	Rows	gpm	Head Loss	Airflow, cfm								
				50	100	150	200	250	300	350	400	450
Sizes 4-5-6	Three-Row	2.0	0.70	6.1	10.8	14.4	17.5	20.0	22.3	24.2	25.9	27.4
		3.0	1.54	6.1	11.0	14.9	18.2	21.0	23.5	25.7	27.6	29.4
		5.0	4.14	6.2	11.1	15.2	18.8	21.8	24.6	27.0	29.2	31.3
		6.0	5.90	6.2	11.2	15.3	18.9	22.1	24.9	27.4	29.7	31.8
		Airside ΔPs		0.01	0.04	0.08	0.12	0.18	0.24	0.31	0.39	0.47
	Four-Row	3.0	1.11	6.5	11.9	16.5	20.5	23.9	26.8	29.5	34.8	34.0
		4.0	1.95	6.5	12.1	16.8	20.9	24.5	27.7	30.6	33.1	35.5
		6.0	4.33	6.5	12.2	17.1	21.4	25.2	25.6	31.7	34.5	37.1
		8.0	5.42	6.5	12.2	17.2	21.6	25.5	29.1	32.3	35.3	38.0
		Airside ΔPs		0.02	0.05	0.10	0.16	0.24	0.32	0.41	0.52	0.63
Sizes 7-8	Three-Row	2.0	0.50	11.2	18.6	23.8	27.9	31.1	33.7	35.9	37.8	39.4
		4.0	1.95	11.6	19.8	26.0	31.1	35.3	38.8	41.9	44.7	47.1
		6.0	4.33	11.7	20.2	26.9	32.3	37.0	41.0	44.5	47.6	50.4
		8.0	5.42	11.7	20.4	27.3	33.0	37.9	42.1	45.9	49.2	52.2
		Airside ΔPs		0.02	0.08	0.15	0.24	0.35	0.47	0.61	0.77	0.93
	Four-Row	4.0	1.40	12.4	22.1	29.6	35.0	40.9	45.3	49.1	52.4	55.3
		6.0	3.12	12.5	22.5	30.6	37.3	43.0	48.0	52.4	56.3	59.7
		8.0	3.53	12.6	22.7	31.1	38.1	44.2	49.5	54.2	58.4	62.2
		10.0	5.46	12.6	22.9	31.4	38.6	44.9	50.4	55.4	59.8	63.8
		Airside ΔPs		0.03	0.10	0.20	0.32	0.47	0.63	0.82	1.02	1.25
Sizes 9-10	Three-Row	3.0	0.80	21.0	27.9	33.4	38.0	41.8	45.2	48.1	50.7	52.9
		5.0	2.19	21.6	29.2	35.5	40.8	45.5	49.6	53.2	56.5	59.4
		7.0	4.26	21.9	29.8	36.5	42.2	47.2	51.7	55.7	59.4	62.7
		9.0	4.49	22.1	30.2	37.0	43.0	48.3	53.0	57.3	61.2	64.7
		Airside ΔPs		0.04	0.08	0.13	0.19	0.25	0.33	0.41	0.50	0.59
	Four-Row	4.0	1.16	23.5	32.2	39.4	45.6	50.9	55.5	59.6	63.2	66.5
		5.0	1.80	23.7	32.7	40.4	46.9	52.6	57.7	62.2	66.2	69.8
		8.0	2.75	24.1	33.6	41.8	49.0	55.4	61.2	66.4	71.1	75.5
		10.0	4.25	24.2	33.9	42.3	49.8	56.4	62.4	67.9	72.9	77.5
		Airside ΔPs		0.05	0.11	0.17	0.25	0.34	0.43	0.54	0.66	0.79
Size 12	Three-Row	3.0	0.91	30.3	42.2	50.9	57.6	63.0	67.4	71.1	74.3	77.0
		4.0	1.61	31.0	44.0	53.8	61.5	67.8	73.1	77.6	81.5	84.9
		6.0	3.57	31.8	45.9	56.9	65.8	73.3	79.7	85.2	90.1	94.5
		8.0	4.32	32.2	46.9	58.5	68.2	76.3	83.4	89.6	95.1	100.0
		Airside ΔPs		0.05	0.11	0.19	0.29	0.41	0.54	0.69	0.85	1.02
	Four-Row	4.5	1.63	34.6	50.5	62.9	72.7	80.8	87.6	93.4	98.4	102.8
		5.0	2.01	34.8	51.1	63.9	74.2	82.7	89.9	96.0	101.4	106.1
		7.0	2.88	35.1	52.6	66.5	78.0	87.7	96.1	103.4	109.8	115.6
		9.0	4.11	35.6	53.4	68.0	80.3	90.8	99.9	107.9	115.1	121.5
		Airside ΔPs		0.06	0.15	0.26	0.39	0.55	0.72	0.92	1.13	1.36

PESV, AESV, DESV / HOT WATER COIL CAPACITY, MBH / 3- AND 4-ROW

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Size	Rows	gpm	Head Loss	Airflow, cfm								
				400	700	1000	1300	1600	1900	2200	2500	2800
Size 14	Three-Row	4.0	1.30	41.3	59.8	73.0	83.0	90.9	97.3	102.7	107.3	111.1
		5.0	2.01	42.1	61.8	76.3	87.6	96.6	104.1	110.4	115.8	120.5
		6.0	2.88	42.6	63.2	78.6	90.8	100.7	109.0	116.1	122.2	127.6
		8.0	3.27	43.3	65.0	81.7	95.2	106.3	115.8	124.0	131.2	137.5
		Airside ΔPs		0.04	0.10	0.19	0.29	0.41	0.54	0.69	0.86	1.04
	Four-Row	6.0	2.06	46.7	71.1	89.5	104.0	115.7	125.5	133.7	140.8	146.9
		7.0	2.79	47.1	72.2	91.6	107.1	119.8	130.4	139.5	147.4	154.2
		8.0	2.03	47.4	73.1	93.3	109.5	123.0	134.4	144.1	152.7	160.2
		10.0	3.15	47.8	74.4	95.6	113.0	127.7	140.2	151.1	160.7	169.2
		Airside ΔPs		0.05	0.14	0.25	0.38	0.54	0.72	0.93	1.15	1.39
Size 16	Three-Row	6.0	1.71	58.5	80.9	97.0	109.3	119.2	127.3	134.0	139.9	144.9
		8.0	1.51	60.1	84.4	102.5	116.7	128.3	138.0	146.2	153.4	159.6
		10.0	2.35	61.1	86.7	106.1	121.6	134.4	145.3	154.6	162.7	169.9
		12.0	3.36	61.8	88.2	108.6	125.1	138.8	150.5	160.7	169.6	177.5
		Airside ΔPs		0.06	0.14	0.24	0.37	0.51	0.68	0.86	1.06	1.28
	Four-Row	9.0	1.58	67.4	97.6	120.6	138.8	153.7	166.2	176.8	185.9	193.9
		10.0	1.95	67.9	98.8	122.6	141.6	157.3	170.5	181.8	191.6	200.2
		11.0	2.36	68.3	99.7	124.2	144.0	160.3	174.1	186.0	196.4	205.6
		12.0	2.80	68.6	100.5	125.6	146.0	162.9	177.3	189.8	200.7	210.3
		Airside ΔPs		0.08	0.18	0.32	0.49	0.68	0.90	1.15	1.42	1.71
Size 24 x 16	Three-Row	6.0	1.86	65.0	103.8	129.6	148.2	162.3	173.5	182.5	190.1	196.5
		8.0	1.76	66.4	108.6	138.0	160.0	177.3	191.2	202.8	212.6	221.1
		10.0	2.74	67.2	111.5	143.4	167.9	187.4	203.4	216.9	228.5	238.6
		12.0	3.92	67.8	113.6	147.2	173.4	194.7	212.3	227.3	240.3	251.6
		Airside ΔPs		0.03	0.09	0.17	0.27	0.40	0.54	0.70	0.88	1.07
	Four-Row	9.0	1.80	72.6	124.0	161.1	189.2	211.2	229.0	243.6	256.0	266.7
		10.0	2.22	73.0	125.5	164.1	193.6	217.1	236.2	252.1	265.6	277.2
		11.0	2.68	73.3	126.7	166.5	197.3	222.0	242.3	259.3	273.9	286.4
		12.0	3.18	73.5	127.7	168.6	200.5	226.3	247.6	265.6	281.1	294.5
		Airside ΔPs		0.04	0.12	0.23	0.37	0.53	0.72	0.93	1.17	1.42

- All coil performance in accordance with AHRI 410-2001
- Heating capacities are in MBH
- Data based on 180°F entering water and 55°F entering air
- For temperature differentials other than 125°, multiply MBH by correction factors below
- Head loss is in feet of water
- Always supply water to lowest connection pipe to prevent air entrapment
- Air temperature rise = 927 x MBH/cfm
- Water temperature drop = 2.04 x MBH/gpm
- Connection size is 1/2" OD male solder for 1-row coil sizes 04-08. All other coils have 7/8" OD male solder.
- Coils are not intended for steam applications and are labeled for a maximum water temperature of 200°F
- Coils are tested for leakage at test pressure of 500 psi
- Water volumes less than those shown may result in laminar flow and reduced heating capacity. If possible reduce the number of coil rows to increase water velocity into turbulent range.

Correction Factors for Other Entering Conditions

ΔT	50	60	70	80	90	100	110	125	140	150
Factor	0.40	0.48	0.56	0.64	0.72	0.80	0.88	1.00	1.12	1.20

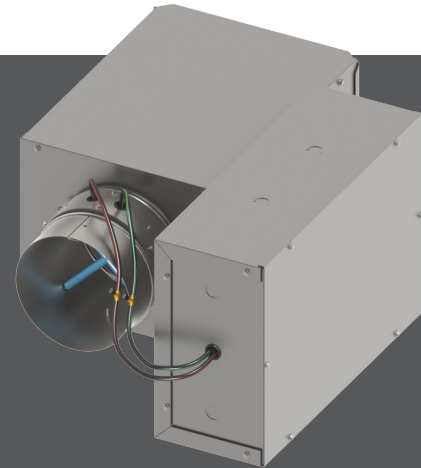
Note: Airside ΔPs reflects the air pressure drop of the hot water coil

M

PERFORMANCE DATA

ESV

- ESV can be installed horizontally, vertically or at any angle; unit operation is not affected by position
- Choice of right or left hand control location
- Standard AeroCross multi-point center averaging velocity sensor (except EESV)
- Standard dual density insulation
- Controls supplied by Titus are factory calibrated for a quicker start-up
- Standard 22-gauge casing with slip and drive connection



ESV

AVAILABLE MODELS:

- PESV / Pneumatic
- EESV / Electric
- AESV / Analog Electronic
- DESV / Digital Electronic

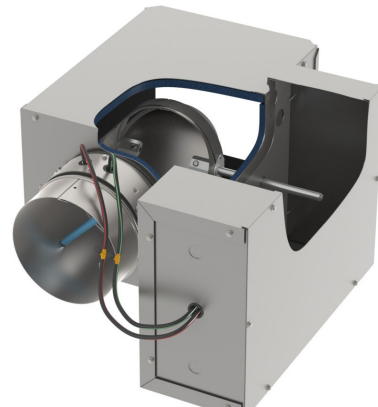
OVERVIEW

Single Duct terminals are the fundamental building blocks for Variable Air Volume (VAV) systems. Their primary function is to regulate airflow to a zone, in response to zone temperature requirements. The Titus ESV is unique as it incorporates many design features that increase performance, decrease service and installation costs, and offer increased value, over and above this basic function.



See website for Specifications

ESV cutaway view



SECTION 23 36 00**AIR TERMINAL UNITS****PART 1 GENERAL****1.01 SECTION INCLUDES**

- A. Variable volume terminal units.
- B. Integral heating coils.

1.02 SUBMITTALS

- A. Product Data: Provide data indicating configuration, general assembly, and materials used in fabrication. Include catalog performance ratings that indicate air flow, static pressure, and NC designation. Include electrical characteristics and connection requirements.
- B. Shop Drawings: Indicate configuration, general assembly, and materials used in fabrication, and electrical characteristics and connection requirements.

PART 2 PRODUCTS**2.01 MANUFACTURED UNITS**

- A. Ceiling mounted variable air volume supply air control terminals for connection to single duct, central air systems, with digital variable volume controls.

2.02 SINGLE DUCT VARIABLE VOLUME UNITS

- A. Terminals shall be certified under the ARI Standard 880 Certification Program and carry the ARI Seal. Noncertified terminals may be submitted after testing at an independent testing laboratory under conditions selected by the engineering consultant in full compliance with ARI Standard 880. These tests must be witnessed by the engineering consultant with all costs to be borne by the terminal manufacturer. Testing does not ensure acceptance.
- B. The terminal casing shall be minimum 22-gauge galvanized steel, internally lined with ½-inch dual density insulation which complies with UL 181 and NFPA 90A. All exposed insulation edges shall be coated with NFPA 90A approved sealant to prevent entrainment of fibers in the airstream. The discharge connection shall be slip and drive construction for attachment to metal ductwork. The casing shall be constructed to hold leakage to the maximum values shown in the casing leakage table.
- C. The damper shall be heavy gauge steel with shaft rotating in Delrin self-lubricating bearings. Nylon bearings are not acceptable. Shaft shall be clearly marked on the end to indicate damper position. Stickers or other removable markings are not acceptable. The damper shall incorporate a mechanical stop to prevent overstroking and a synthetic seal to limit close-off leakage to the maximum values shown in the Damper Leakage table.
- D. For inlet diameters 4" or greater, the differential pressure airflow sensor shall traverse the duct along two perpendicular diameters. Cylindrically shaped inlets shall utilize the equal cross sectional area or log-linear traverse method. Single axis sensor shall not be acceptable for duct diameters 4" or larger. A minimum of 12 total pressure sensing points shall be utilized. The total pressure inputs shall be averaged using a pressure chamber located at the center of the sensor. A sensor that delivers the differential pressure signal from one end of the sensor is not acceptable. The sensor shall output an amplified differential pressure signal that is at least 2.5 times the equivalent velocity pressure signal obtained from a conventional pitot tube. The sensor shall develop a differential pressure of 0.03" w.g. at an air velocity of < 450 FPM. Documentation shall be submitted which substantiates this requirement. Balancing taps and airflow calibration charts shall be provided for field airflow measurements.

- E. Actuators shall be capable of supplying at least 35-inch lbs. of torque to the damper shaft and shall be mounted externally for service access. Terminals with internal actuator mounting or linkage connection must include gasketed access panel, removable without disturbing ductwork. Casing with access panel shall be constructed to hold leakage to the maximum values shown in the Casing Leakage table.
- F. At an inlet velocity of 2000 fpm, the minimum static pressure required to operate any terminal size shall not exceed 0.13-inch wg for the basic terminal.
- G. Hot Water Reheat Coils shall be enclosed in a minimum 20-gauge galvanized steel casing with slip and drive construction for attachment to metal ductwork. Coils shall be factory installed on the terminal discharge. Fins shall be rippled and corrugated heavy gauge aluminum, mechanically bonded to tubes. Tubes shall be copper with minimum wall thickness of 0.016-inch with male solder header connections. Coils shall be leak tested to 300 psi with minimum burst pressure of 1800 psi at ambient temperature. Number of coil rows and circuits shall be selected to provide performance as required per the plans. Coil performance data shall be based on tests run in accordance with ARI Standard 410. Install access door upstream of coil.
- H. The VAV box digital control board must be approved and/or provided by Control Solutions Inc.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Support units individually from structure. Do not support from adjacent ductwork.
- C. Reuse of existing VAV box hangers is approved, given structural integrity of existing hangers is acceptable for continued use.
- D. Existing piping HWS and HWR isolation ball valves shall remain.
- E. Drain existing VAV box coil and remove. Install new VAV box with new HW coil. Install new 2-way control valve (see Table-1 for 2-position or modulating), and cap bypass piping leg at main branch.

END OF SECTION