

ภาคผนวก

ภาคผนวก ก

รายละเอียดข้อมูลการวิเคราะห์การระบายความร้อนในห้องเครื่องกำเนิดไฟฟ้าใต้ดิน

1. ผลการปรับปรุงครั้งที่ 3

RESULTS

General Info

Iterations: 258

Warnings: A vortex crosses the pressure opening Boundary Condition : Pressure Outlet1 ; Inlet
flow/outlet flow=5.56598

Boundary Condition : Pressure Inlet2 ; Inlet flow/outlet flow=0.724519

Calculation Mesh

Basic Mesh Dimensions

Number of cells in X	16
Number of cells in Y	8
Number of cells in Z	18

Number of Cells

Total Cells	841240
Fluid Cells	275753
Solid Cells	56021
Partial Cells	509466
Irregular Cells	87496

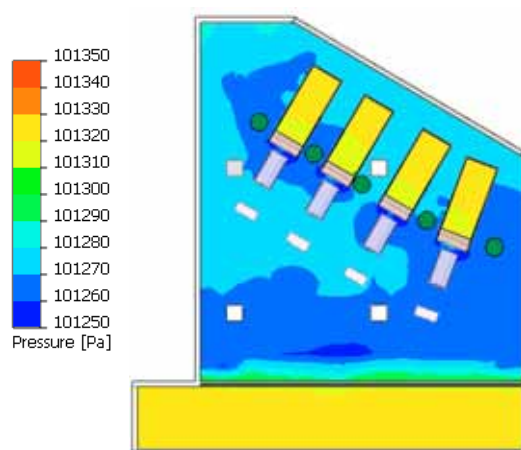
Maximum refinement level: 7

Goals

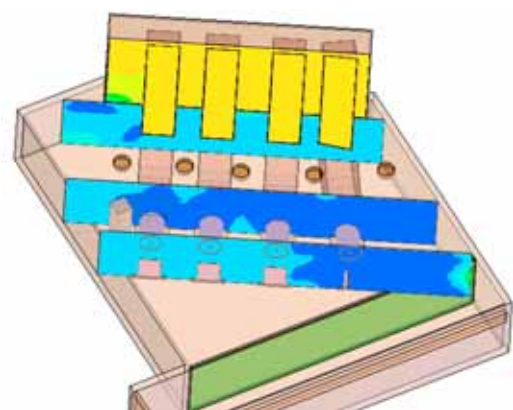
Name	Unit	Value	Progress	Use in convergence	Delta	Criteria
GG Average Velocity1	m/s	1.23428	100	On	0.09465509	0.28436201
GG Average Temp Fluid	K	322.523	100	On	0.11352843	80.4214201

Min/Max Table

Name	Minimum	Maximum
Pressure [Pa]	99020.8	101827
Temperature [K]	317.912	2998.63
Density [kg/m ³]	0.117633	1.10972
Velocity [m/s]	0	22.6194
X-velocity [m/s]	-12.559	17.5981
Y-velocity [m/s]	-21.0766	13.5693
Z-velocity [m/s]	-15.7626	12.3635
Mach Number []	0	0.0625554
Heat Transfer Coefficient [w/m ² /K]	0	5738.32
Shear Stress [Pa]	0	6.54634
Heat Flux [W/m ²]	0	10013
Air Mass Fraction []	1	1
Air Volume Fraction []	1	1
Fluid Temperature [K]	317.912	2998.63

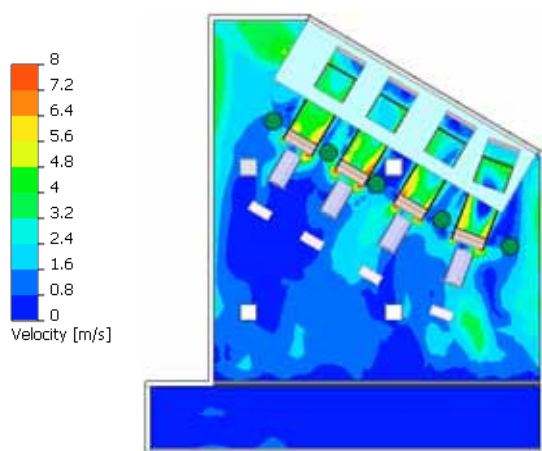


มุมมองด้านบน

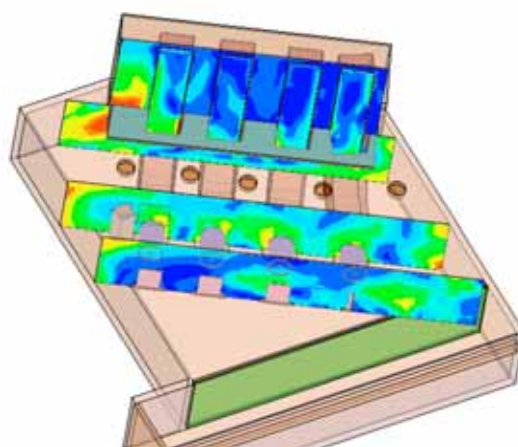


มุมมองภาพตัดด้านหน้า

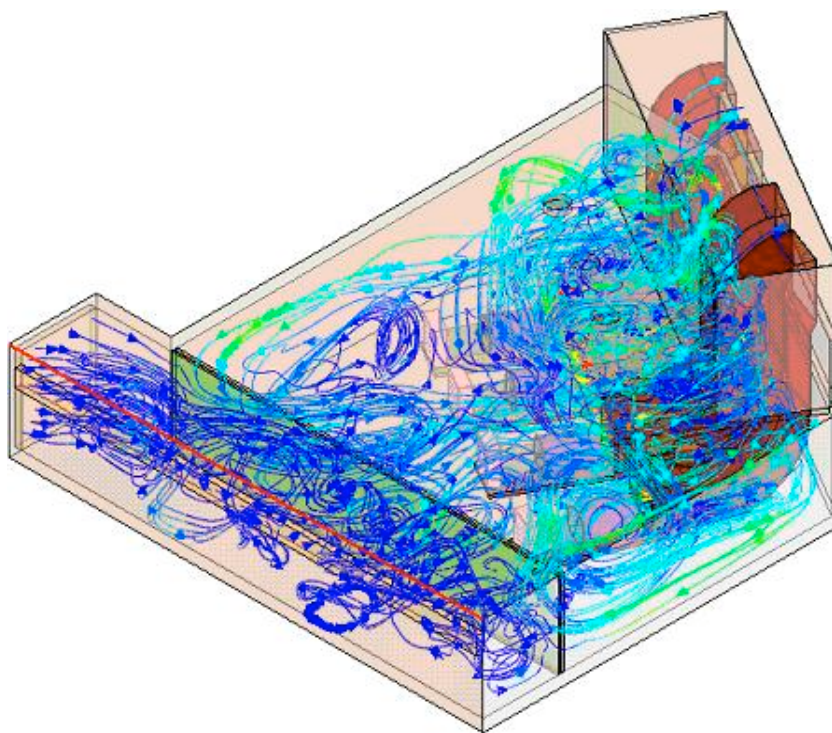
ภาพผนวกที่ ก1 แสดงความดันที่เกิดจากการไหลของการปรับปรุงครั้งที่ 3



มุมมองด้านบน



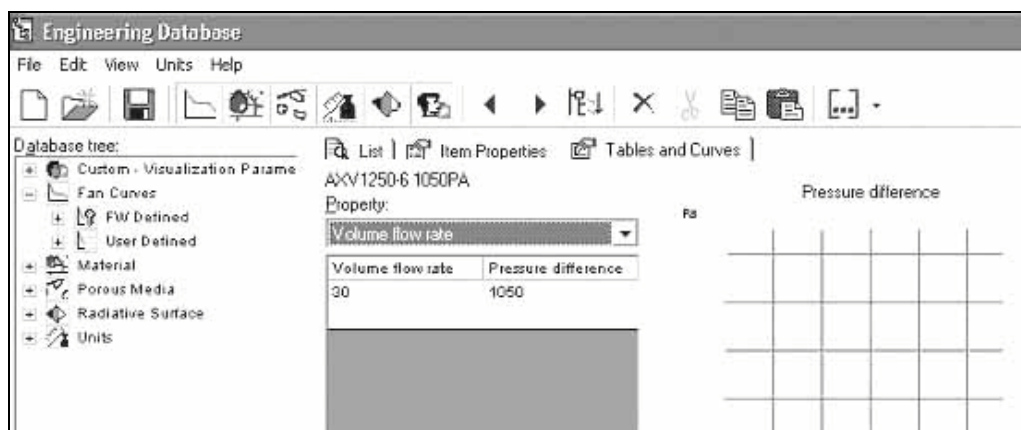
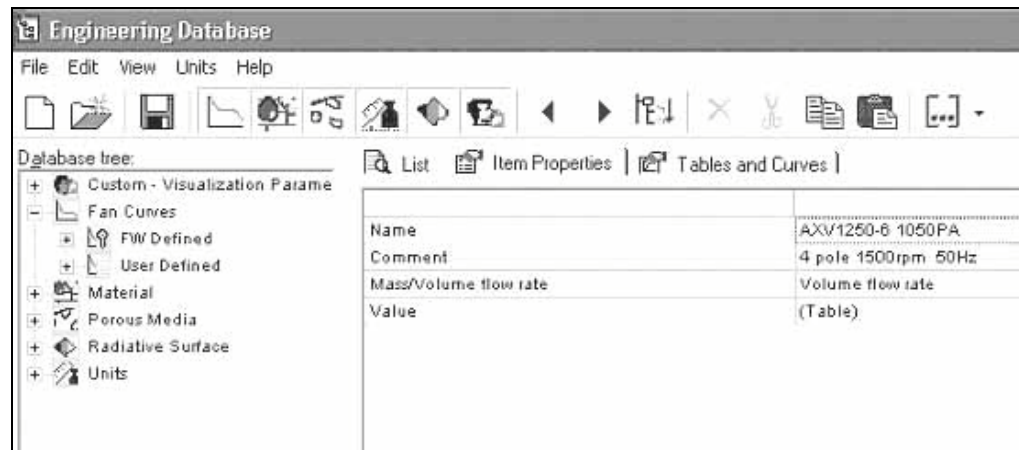
มุมมองภาพตัดด้านหน้า



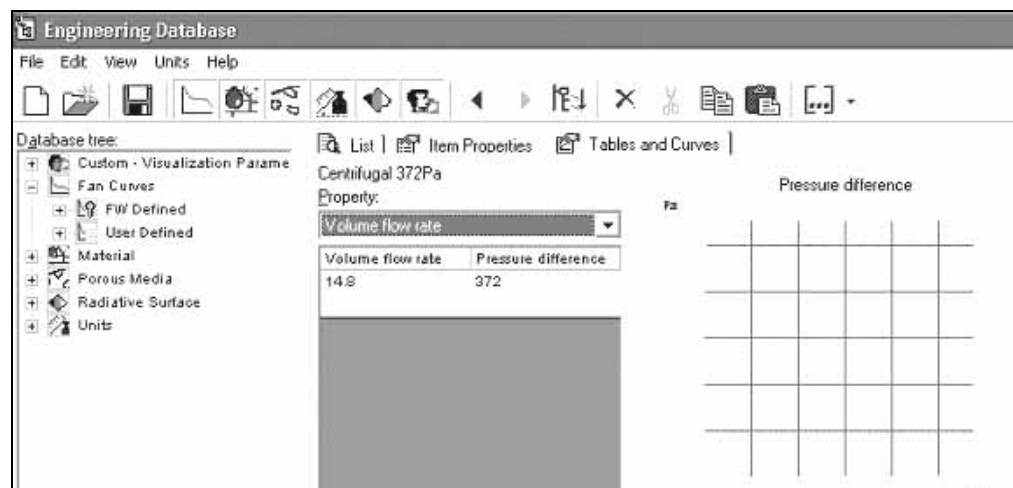
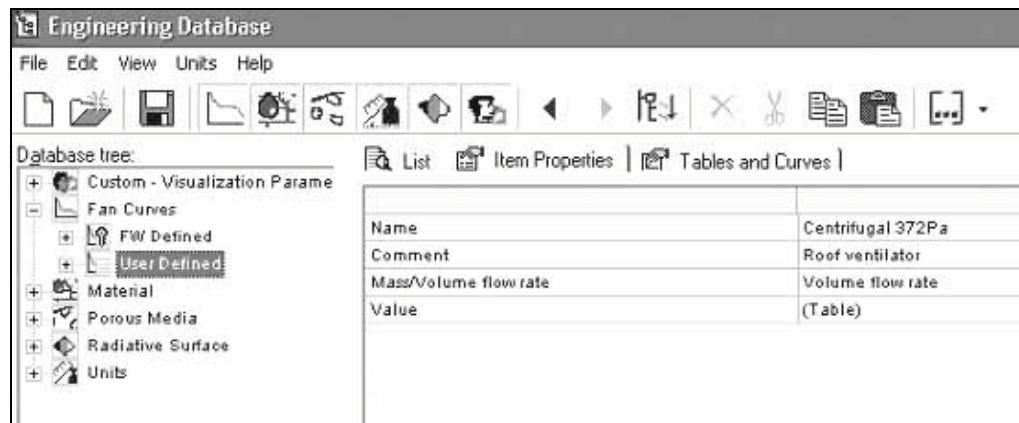
เส้นแสดงการไหลของอากาศ

ภาพผนวกที่ ก2 แสดงความเร็วการไหลของการปรับปรุงครั้งที่ 3

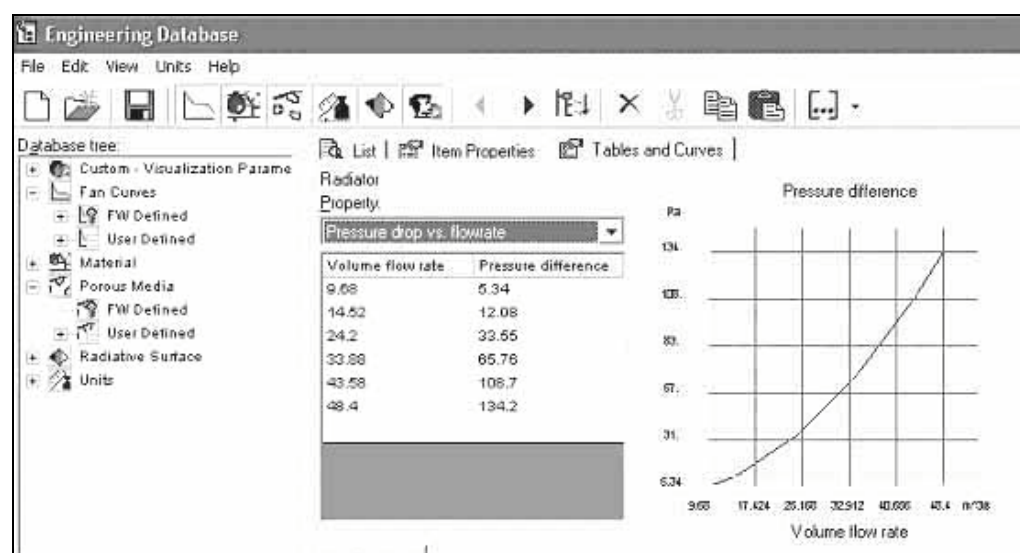
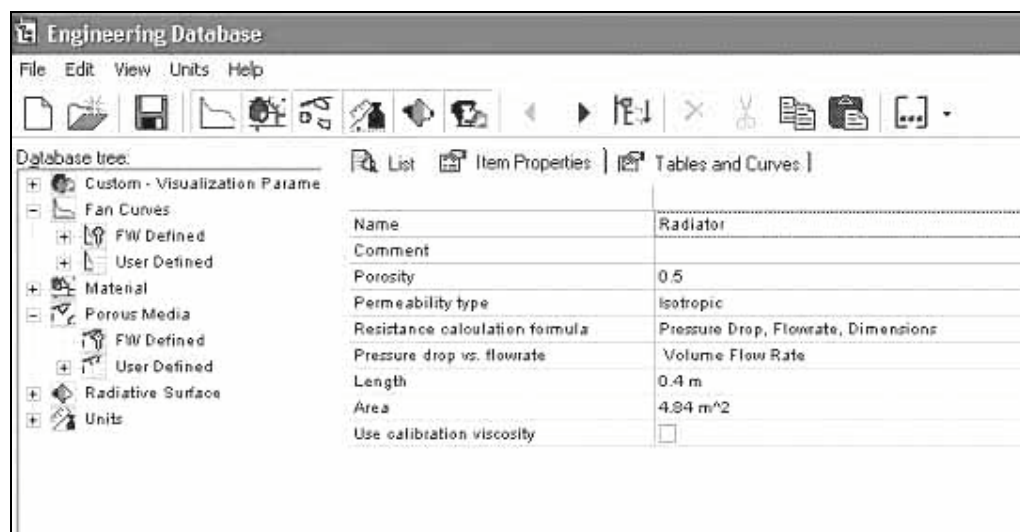
2. ข้อมูลพัดลม และวัสดุพรุน



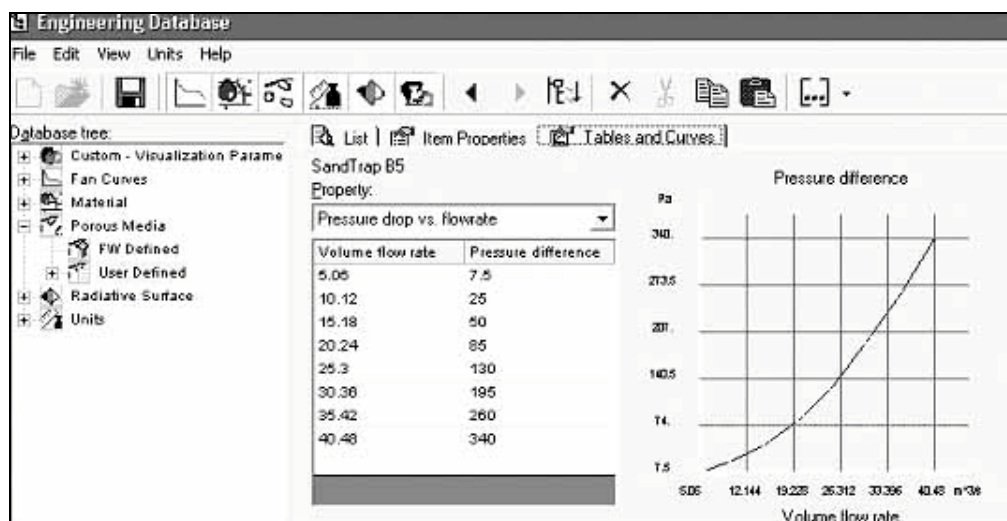
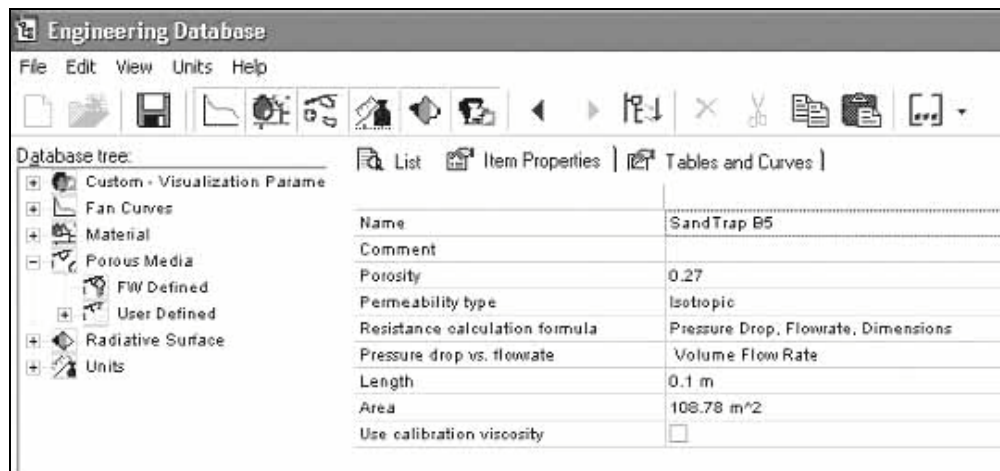
ภาพผนวกที่ ก3 แสดงการป้อนข้อมูลพัดลมของเครื่องกำเนิดไฟฟ้า



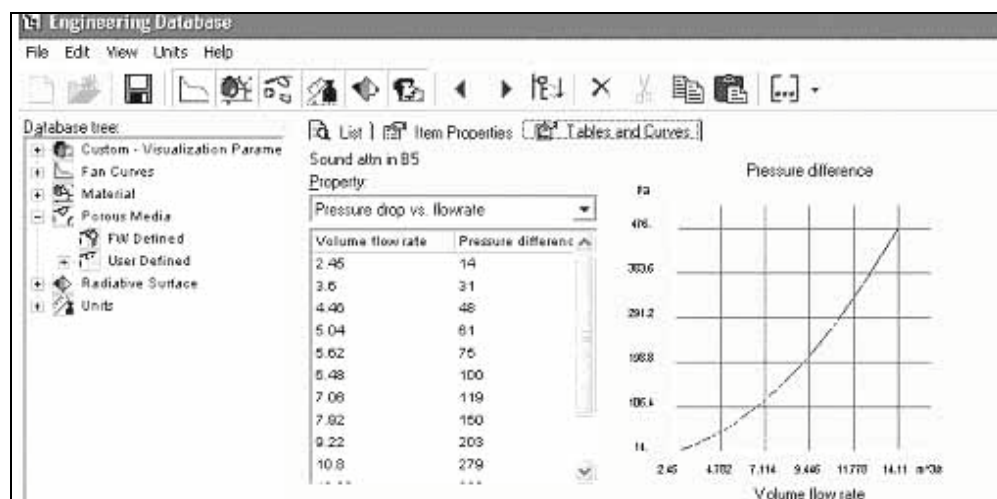
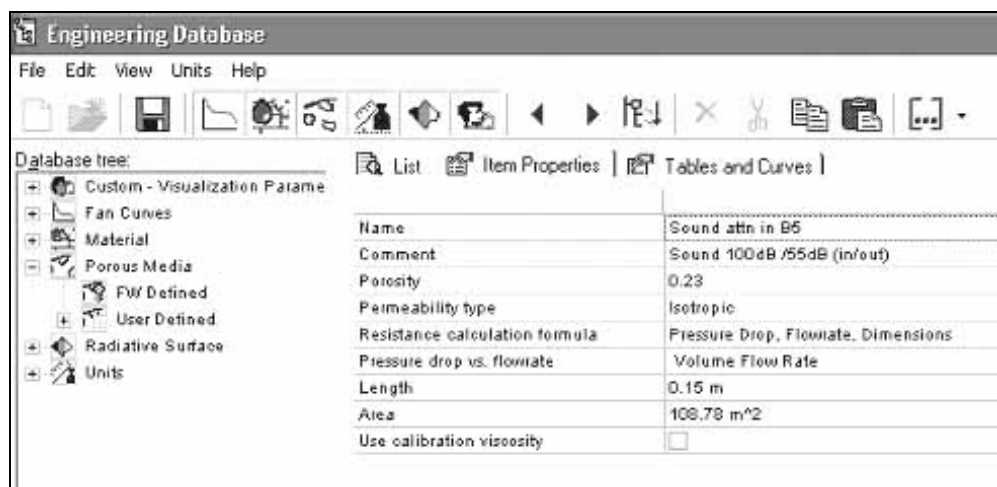
ภาพผนวกที่ ก4 แสดงการป้อนข้อมูลพัฒนาระบายอากาศที่ติดตั้งบนเพดาน



ภาพผนวกที่ ๕ แสดงข้อมูลรังผึ้งระบายความร้อน

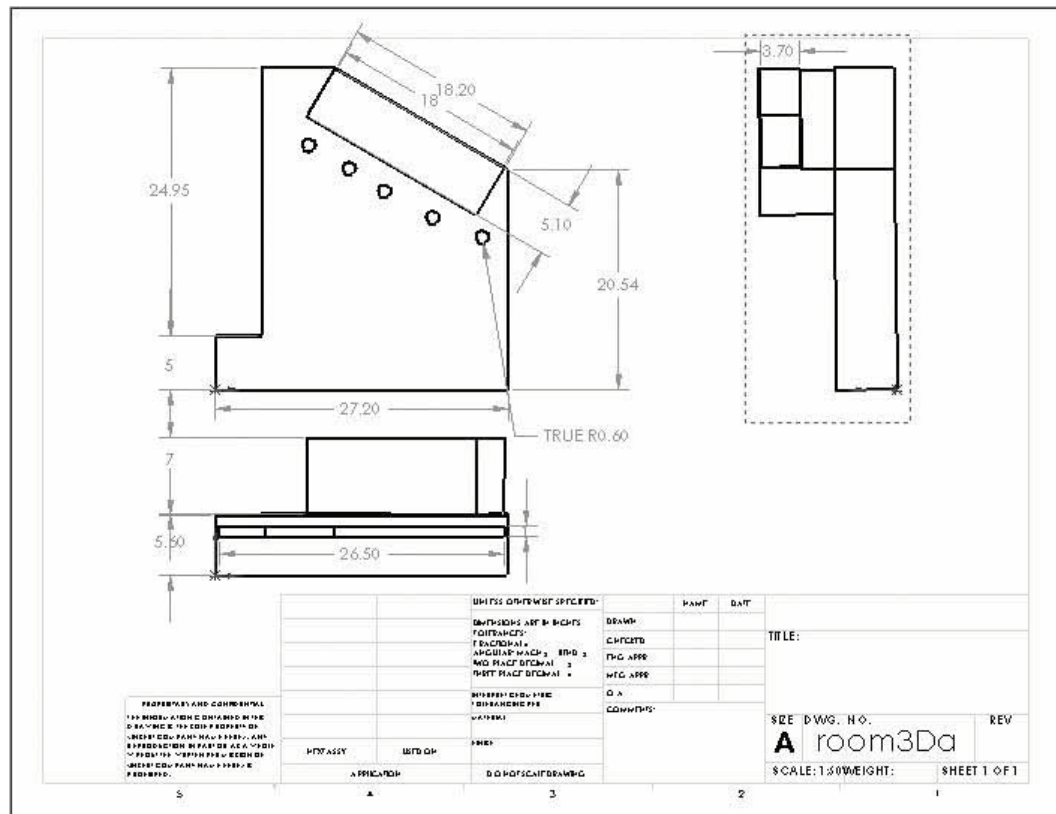


ภาพผนวกที่ 6 แสดงข้อมูลแฟงดักทราย



ภาพผนวกที่ ก7 แสดงข้อมูลแรงกดทอนเสียง

3. ขนาด และมิติของห้อง

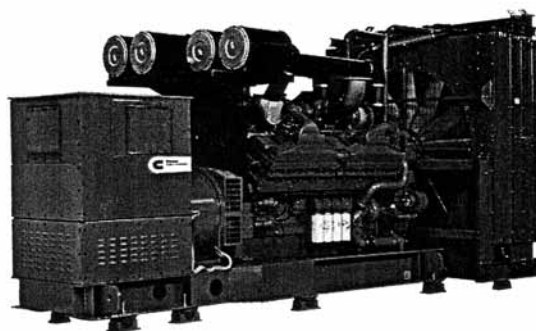


ภาพผนวกที่ ก8 แสดงขนาดและมิติของห้องของการปรับปรุงครั้งที่ 3

4. ข้อมูลทางเทคนิคของเครื่องกำเนิดไฟฟ้า และวัสดุ

4.1 ข้อมูลทางเทคนิคของเครื่องกำเนิดไฟฟ้า

Technical Data

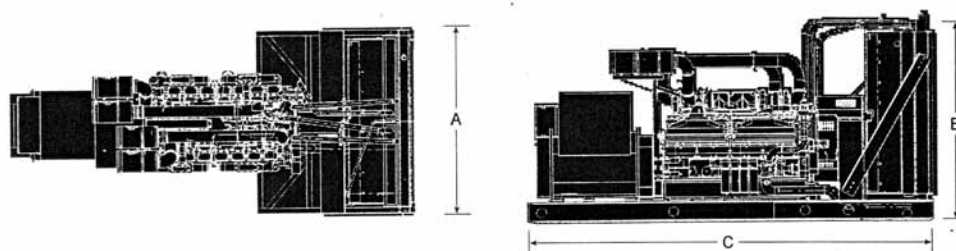


Generating Sets - 50 Hz

	Standby	Prime	Standby	Prime	Standby	Prime
Ratings kW (kVA)	1500 (1875)	1350 (1688)	1650 (2063)	1500 (1875)	1800 (2250)	1626 (2032)
Model	1500 DQKB	1350 DQKB	1650 DQKC	1500 DQKC	1800 DQKD	1626 DQKD
Engine Model	QSK60G2	QSK60G2	QSK60G3	QSK60G3	QSK60G4	QSK60G4
Aspiration	Turbocharged and Aftercooled	Turbocharged and Aftercooled	Turbocharged and Aftercooled	Turbocharged and Aftercooled	Turbocharged and Aftercooled	Turbocharged and Aftercooled
Gross Engine Power Output	1,630 kWm	1,455 kWm	1,790 kWm	1,615 kWm	1,915 kWm	1,730 kWm
BMEP	2,165 kPa	1,931 kPa	2,389 kPa	2,159 kPa	2,544 kPa	2,299 kPa
Bore	159 mm	159 mm	159 mm	159 mm	159 mm	159 mm
Stroke	190 mm	190 mm	190 mm	190 mm	190 mm	190 mm
Piston Speed	9.5 m/s	9.5 m/s	9.5 m/s	9.5 m/s	9.5 m/s	9.5 m/s
Compression Ratio	14.5:1	14.5:1	14.5:1	14.5:1	14.5:1	14.5:1
Lube Oil Capacity	280 Litres	280 Litres	280 Litres	280 Litres	280 Litres	280 Litres
Overspeed Limit	1,850 ± 50 rpm	1,850 ± 50 rpm	1,850 ± 50 rpm	1,850 ± 50 rpm	1,850 ± 50 rpm	1,850 ± 50 rpm
Fuel Consumption Load	1/4 1/2 3/4 Full	1/4 1/2 3/4 Full	1/4 1/2 3/4 Full	1/4 1/2 3/4 Full	1/4 1/2 3/4 Full	1/4 1/2 3/4 Full
Fuel Consumption L/hr	113 200 280 371	106 178 252 331	119 202 293 393	111 187 266 356	125 220 325 427	114 200 291 394
Maximum Fuel Inlet Restriction	203 mm Hg	203 mm Hg	8.4 kPa (63 mm Hg)	8.4 kPa (63 mm Hg)	13.5 kPa (101 mm Hg)	13.5 kPa (101 mm Hg)
Maximum Fuel Return Restriction	229 mm Hg	229 mm Hg	30.4 kPa (228 mm Hg)	30.4 kPa (228 mm Hg)	30.5 kPa (229 mm Hg)	30.5 kPa (229 mm Hg)
Maximum Fuel Inlet Temperature	70°C	70°C	70°C	70°C	70°C	70°C
Maximum Fuel Return Temperature 71°C	71°C	71°C	71°C	71°C	71°C	71°C
Coolant Capacity (with radiator)	407 Litres	407 Litres	410 Litres	410 Litres	621 Litres	621 Litres
Coolant Flow Rate (engine jacket) 1438 L/Min	1440 L/Min	1440 L/Min	1438 L/Min	1438 L/Min	1438 L/Min	1438 L/Min
Coolant Flow Rate (aftercooler)	N/A	N/A	413 L/Min	413 L/Min	413 L/Min	413 L/Min
Heat Rejection to Eng Jacket Coolant	740 kWm	660 kWm	460 kWm	420 kWm	500 kWm	450 kWm
Heat Rejection to Exhaust	1185 kWm	1055 kWm	1195 kWm	1050 kWm	1325 kWm	1180 kWm
Heat Rejection to Aftercooler Coolant	N/A	N/A	405 kWm	355 kWm	455 kWm	400 kWm
Heat Rejection to Fuel	35 kWm	35 kWm	35 kWm	35 kWm	35 kWm	35 kWm
Heat Radiated to Ambient	150 kWm	135 kWm	160 kWm	145 kWm	175 kWm	160 kWm
Max Coolant Friction Head (JW)	48 kPa	48 kPa	69 kPa	69 kPa	69 kPa	69 kPa
Max Coolant Friction Head (aftercooler)	N/A	N/A	35 kPa	35 kPa	35 kPa	35 kPa
Maximum Coolant Static Head	18.3 m	18.3 m	18.3 m	18.3 m	18.3 m	18.3 m
Heat Ex. Max Raw Water Flow (JW/AC)	N.A.	N.A.	1,363 L/Min	1,363 L/Min	1,363 L/Min	1,363 L/Min
Heat Ex. Max Raw Water Press (JW/AC/Fuel)	N.A.	N.A.	1,034 kPa	1,034 kPa	1,034 kPa	1,034 kPa
Heat Ex. Max Raw Water Flow (Fuel)	N.A.	N.A.	144 L/Min	144 L/Min	144 L/Min	144 L/Min
Max Top Tank Temp (engine jacket)	104°C	100°C	104°C	100°C	104°C	100°C
Max Inlet Temp (aftercooler)	N/A	N/A	65°C	65°C	65°C	65°C
Combustion Air	123.3 m ³ /min	115.2 m ³ /min	139 m ³ /min	125 m ³ /min	144 m ³ /min	136 m ³ /min
Maximum Air Cleaner Restriction	6.2 kPa	6.2 kPa	6.2 kPa	6.2 kPa	6.2 kPa	6.2 kPa
Alternator Cooling Air	250 m ³ /min	246 m ³ /min	250 m ³ /min	250 m ³ /min	246 m ³ /min	246 m ³ /min
Radiator Cooling Air	1345 m ³ /min	1346 m ³ /min	1584 m ³ /min	1584 m ³ /min	1869 m ³ /min	1869 m ³ /min
Max Static Restriction	125 Pa	125 Pa	125 Pa	125 Pa	125 Pa	125 Pa
Exhaust Gas Flow (Full Load)	291 m ³ /min	265 m ³ /min	334 m ³ /min	303 m ³ /min	337 m ³ /min	311 m ³ /min
Exhaust Gas Temperature	465°C	445°C	515°C	505°C	450°C	430°C
Maximum Back Pressure	51 mm Hg	51 mm Hg	6.7 kPa	6.7 kPa	6.7 kPa	6.7 kPa

Data subject to factory verification.
N/A - Not applicable to this model.
N.A. - Data not available.

Dimensions and Weights – 50 Hz



Model	Dim "A"	Dim B	Dim C	Dry Weight*
1350 DQKB	2250 mm	2590 mm	5590 mm	14594 kg
1500 DQKC	2286 mm	2590 mm	5780 mm	14834 kg
1626 DQKD	2286 mm	2590 mm	5780 mm	15150 kg
1500 DQKB	2250 mm	2590 mm	5590 mm	14594 kg
1650 DQKC	2286 mm	2590 mm	5780 mm	14834 kg
1800 DQKD	2286 mm	2590 mm	5780 mm	15150 kg

*Weight given is with standard low voltage alternator. Genset is shipped filled with engine oil and coolant.
 Dimensions and weights are for **guidance** only. Do not use for installation design. Ask for certified drawings on your specific application.
 Specifications may change without notice.



Sound Data

2000DQKH 50Hz

Sound Pressure Levels dB(A)

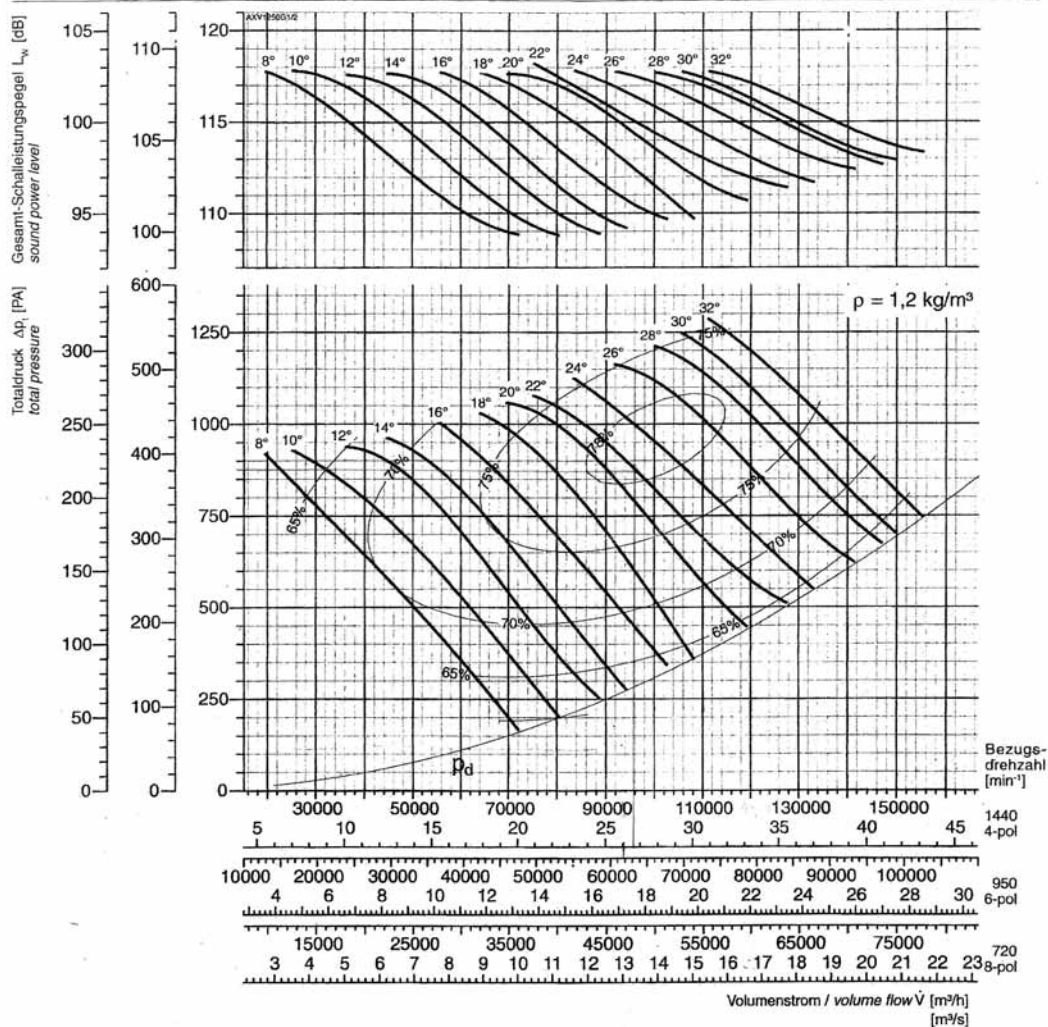
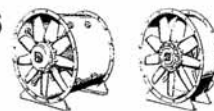
Configuration		Distance (meter)	Position (Note 1)								8 Position Average
			1	2	3	4	5	6	7	8	
Unhoused – Radiator Cooled (Note 2 & 3)	Infinite Exhaust	7	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
		10	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
		16	89	91	89	90	90	89	88	91	90
Unhoused – Remote Cooled (Note 3 & 4)	Infinite Exhaust	7	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
		10	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
		16	77	87	87	88	86	88	87	87	87

Note:

- Position 1 faces the engine front at 23 feet (7 m) from the center of the generator set. The positions proceed around the generator set in a counter-clockwise direction in 45° increments.
- Data based on full rated load with standard radiator-fan package.
- Sound data for generator set with infinite exhaust do not include exhaust noise.
- Sound data with remote-cooled sets are based on rated load without fan noise.
- Sound pressure levels per ANSI S1.13-1971 as applicable.
- Reference sound pressure is 10 µPa.
- Sound pressure levels are subject to instrumentation, measurement, installation and generator set variability.

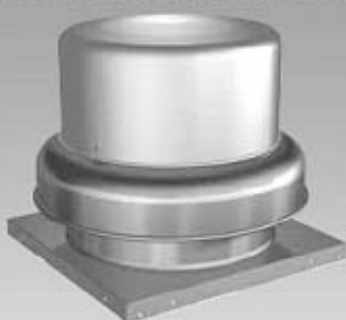
4.2 ประสิทธิภาพพัฒนาของเครื่องกำเนิดไฟฟ้า

Ventilator-Kennlinie Performance curve

50 Hz AXV 1250-6


4.3 ประสิทธิภาพพัดลมระบายอากาศ

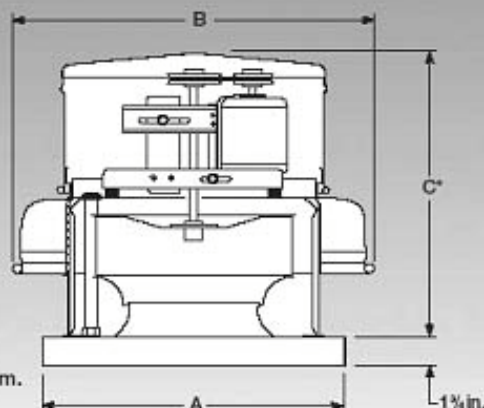
Roof Exhaust Belt Drive – GB



Model GB Centrifugal Roof Exhaust fans are belt drive. These fans are specifically designed for roof mounted applications exhausting relatively clean air. Fan wheels are centrifugal, backward inclined, and constructed of aluminum. Adjustable motor pulleys allow for final system balancing.

PERFORMANCE

Performance capabilities range from 78 cfm to 43,221 cfm and up to 3.25 in. wg of static pressure.



GB CONDENSED PERFORMANCE RANGES & DIMENSIONAL DATA

■ Performance for available IN STOCK SIZES is shown on pages 8 & 9

MODEL	A	B	C*	ROOF OPENING	IN STOCK SIZES (■)	MIN/MAX RPM	SONES @ 0 in.	PERFORMANCE IN INCHES WG								
								0	.25	.5	.75	1	1.25	1.5	1.75	2.0
GB-071	19	24 1/4	23 1/4	14 1/4 x 14 1/4	■	630	1.3	137								
						1710	11.1	372	334	292	245	198				
						630	2.4	315								
GB-081	19	24 1/4	23 1/4	14 1/4 x 14 1/4	■	1710	12.5	856	784	710	629	480				
						660	3.1	500								
						1710	13.4	1295	1179	1061	934	785				
GB-101	19	24 1/4	23 1/4	14 1/4 x 14 1/4	■	830	4.5	703	420							
						1800	13.2	1525	1418	1320	1208	1064	793			
						595	3.3	721								
GB-121	19	24 1/4	23 1/4	14 1/4 x 14 1/4	■	1725	17.4	2093	1984	1871	1743	1600	1426			
						540	4.2	766								
						1685	16.9	2391	2278	2157	2020	1857	1654			
GB-141	22	28 3/4	23 1/4	18 1/4 x 18 1/4	■	450	3.9	834								
						1705	24	3163	3020	2883	2739	2574	2370			
						425	4.2	1255								
GB-161	22	28 3/4	23 1/4	18 1/4 x 18 1/4	■	1375	21	4062	3815	3571	3304	3007	2609	2073		
						495	4.3	1924	1150							
						1460	26	5677	5514	5335	5155	4938	4698	4426	4123	3755
GB-200	30	35 1/4	28	20 1/4 x 20 1/4	■	440	6.5	2434								
						1200	24	6640	6336	5968	5650	5274	4828	4177	3077	
						330	6.6	2507								
GB-220	34	42 1/4	31 1/4	26 1/4 x 26 1/4	■	985	23	7484	7212	6898	6568	6106	5547	4883		
						300	4.5	2754								
						910	24	8355	7916	7467	6932	6240	5388	3707		
GB-260	40	50	36	32 1/4 x 32 1/4	■	270	7.7	3467								
						835	23	10784	10292	9794	9225	8606	7932	7157	6024	4294
						250	9.7	4049								
GB-300	40	50	36	32 1/4 x 32 1/4	■	890	28	14416	13897	13335	12716	12072	11379	10636	9568	7963
						255	5.2	6159								
						700	28	16908	16185	15408	14564	13624	12640	11538	10184	
GB-360	46	58 1/4	38 1/4	38 1/4 x 38 1/4	■	215	4.8	5750								
						685	30	18321	17560	16711	15773	14710	13534	12119		
						180	2.5	7417								
GB-420	52	65 1/4	44	44 1/4 x 44 1/4	■	600	30	24724	23765	22709	21620	20103	18584	16580		
						150	5.6	9015								
						485	31	28148	27622	26016	24290	22106	19516			
GB-480	58	73 1/4	47 1/4	50 1/4 x 50 1/4	■	160	5.9	12893								
						480	33	37068	34991	32805	30342	27917	25310			
						160	6.3	14160								
GB-540	64	83	50 1/4	56 1/4 x 56 1/4	■	505	40	44694	43221	41157	38813	36503	33869	31293	26758	

*May be greater depending on motor. All dimensions in inches. Dimension A - given is the inside dimensions of the curb cap.

The roof curb should be 1 1/2 in. less than the curb cap to allow for roofing and flashing.

Performance shown is for installation type A: Free inlet, free outlet. Power rating (BHP) does not include drive losses. Performance ratings include the effects of a birdscreen in the airstream. The sound ratings shown are loudness values in fan cfm at 5 ft. (1.5m) in a hemispherical free field calculated per AMCA Standard 301. Values shown are for installation type A: Free inlet fan cfm levels. The AMCA Certified Ratings Seal applies to some ratings only.



Greenheck Fan Corporation certifies that the GB models shown herein are licensed to bear the AMCA Seal. The ratings shown are based on tests and procedures performed in accordance with AMCA Publication 211 and AMCA Publication 311 and comply with the requirements of the AMCA Certified Ratings Program.



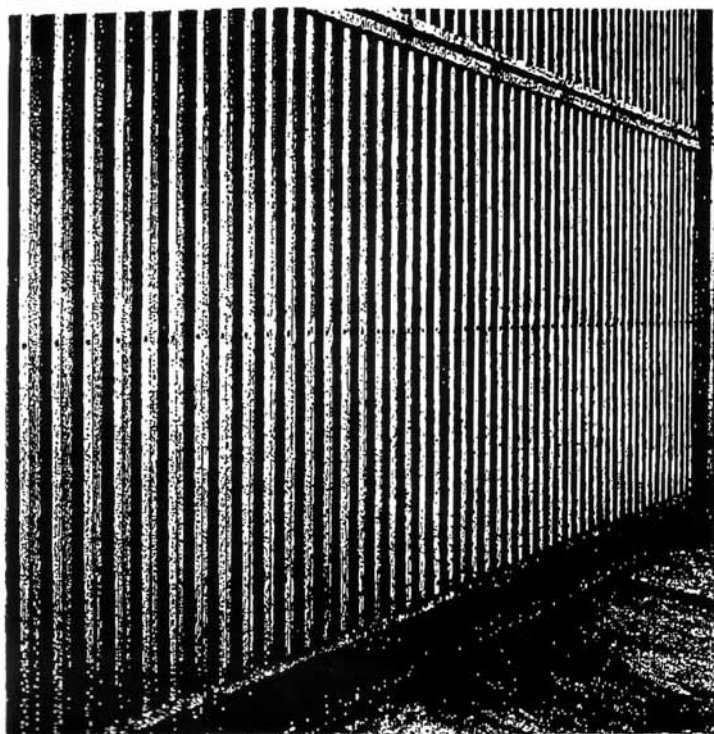
UL/CUL 706
E40001 - GB

For complete product information refer to catalog Model G and GB, or contact your local representative.

GREENHECK

4.4 แผงคัดทราย และความดันลด

Model-Vertical Channel (Sand Removal) VC/VS

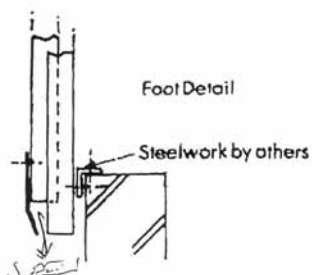


Type

Vertical Channel Louvre
(Versacor APM) for sand removal.



Plan



Foot Detail

Steelwork by others

Application

Vertical channel louvres for sand removal are site assembled louvres manufactured from Robertson Versacor APM and bolted onto steel angle supports.

The units are designed for large or small openings.

They may be used for any of the following applications:

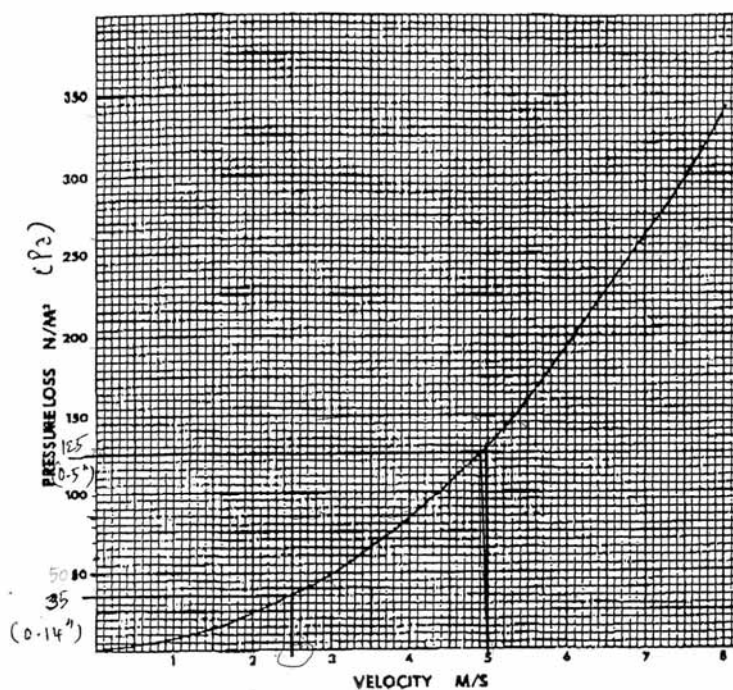
1. Where a vertical line is desirable.
2. To match bold line of box rib section cladding.
3. Any area where sight line is critical from several angles.
4. High resistance against weather penetration on high exposures.
5. Where sand removal is important.
6. Long continuous Louvre run.

The choice of Robertson Versacor APM not only provides maximum resistance to corrosion but also enables the designer to blend or contrast the louvres with surrounding areas to provide an architecturally acceptable appearance.

Optional Extras

Birdscreens.

PRESSURE LOSS CURVE

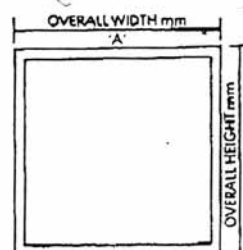


NOTE: FOR VELOCITIES THROUGH THE GEOMETRIC FREE AREA

Robertson



HEIGHT mm in	WIDTH mm					
	1380	1610	1840	2070	2300	2530
40	0.255	0.255	0.255	0.255	0.255	0.255
50	0.261	0.261	0.261	0.261	0.261	0.261
60	0.266	0.266	0.266	0.266	0.266	0.266
70	0.269	0.269	0.269	0.269	0.269	0.269
80	0.271	0.271	0.271	0.271	0.271	0.271
90	0.273	0.273	0.273	0.273	0.273	0.273
100	0.274	0.274	0.274	0.274	0.274	0.274
110	0.275	0.275	0.275	0.275	0.275	0.275
120	0.276	0.276	0.276	0.276	0.276	0.276



GEOMETRIC FREE AREA FACTOR (FA)

= GEOMETRIC FREE AREA

A x B

GROSS LOUVER AREA
= NET AIR INLET AREA m²

FA

Further technical information is available on request.

4.5 แผงลดทอนเสียง และความดันลด



RECTANGULAR DUCT SILENCER

SUPREME FREQUENCY NOISE ATTENUATION

TYPE

SF

Duct Silencer		0.045	0.09	0.18	0.36	0.72	1.44	2.89	5.77	11.54
Face Area (SQ.m.)										
Self Noise Correction										
Factor, dB		-9	-6	-3	0	+3	+6	+9	+12	+15

Silencer Length (mm)	Static Pressure Drop, (Pa)														
900	11	23	35	45	56	75	88	111	151	207	272	353			
1,200	11	24	37	48	59	79	93	118	159	219	288	374			
1,500	12	25	39	49	61	82	97	122	165	227	298	387			
1,800	12	27	41	52	65	86	102	128	174	239	314	406			
2,100	13	27	42	54	67	89	105	133	180	247	324	421			
2,400	13	29	45	57	71	95	112	141	191	263	345	449			
3,000	14	31	48	61	75	100	119	150	203	279	365	476			

Module Size width & Height (mm) x (mm)	Weight In kg per linear meter	Face Area sq.m.	Air Flow (cu.m./s.)														
300 x 300	20	0.09	0.15	0.23	0.28	0.32	0.35	0.41	0.44	0.50	0.58	0.68	0.77	0.88			
300 x 450	26	0.14	0.24	0.35	0.43	0.49	0.55	0.63	0.69	0.77	0.90	1.05	1.20	1.37			
300 x 600	31	0.18	0.31	0.45	0.56	0.63	0.70	0.81	0.88	0.99	1.15	1.35	1.55	1.76			
300 x 750	36	0.23	0.39	0.58	0.71	0.81	0.90	1.04	1.13	1.27	1.47	1.73	1.98	2.25			
300 x 900	45	0.27	0.46	0.68	0.84	0.95	1.05	1.22	1.32	1.49	1.73	2.03	2.32	2.65			
300 x 1,050	50	0.32	0.54	0.80	0.99	1.12	1.25	1.44	1.57	1.75	2.05	2.40	2.75	3.14			
300 x 1,200	56	0.36	0.61	0.90	1.12	1.26	1.40	1.62	1.76	1.98	2.30	2.70	3.10	3.53			
600 x 450	43	0.27	0.46	0.68	0.84	0.95	1.05	1.22	1.32	1.49	1.73	2.03	2.32	2.65			
600 x 600	52	0.36	0.61	0.90	1.12	1.26	1.40	1.62	1.76	1.98	2.30	2.70	3.10	3.53			
600 x 750	62	0.45	0.77	1.13	1.40	1.58	1.76	2.03	2.21	2.48	2.88	3.38	3.87	4.41			
600 x 900	71	0.54	0.92	1.35	1.67	1.89	2.11	2.43	2.65	2.97	3.46	4.05	4.64	5.29			
600 x 1,050	80	0.63	1.07	1.58	1.95	2.21	2.40	2.84	3.09	3.47	4.03	4.73	5.42	6.17			
600 x 1,200	89	0.72	1.22	1.80	2.23	2.52	2.81	3.24	3.53	3.96	4.31	5.40	6.19	7.06			
1,200 x 750	124	0.9	1.53	2.25	2.79	3.15	3.51	4.05	4.41	4.95	5.76	6.75	7.74	8.82			
1,200 x 900	142	1.08	1.84	2.70	3.36	3.78	4.21	4.88	5.29	5.94	6.91	8.10	9.29	10.58			
1,200 x 1,050	160	1.26	2.14	3.15	3.91	4.41	4.91	5.67	6.17	6.93	8.06	9.48	10.84	12.35			
1,200 x 1,200	178	1.44	2.45	3.60	4.46	5.03	5.62	6.48	7.06	7.92	9.22	10.80	12.38	14.11			

Silencer entering Face Velocity, (m/s)	1.7	2.5	3.1	3.5	3.9	4.5	4.9	5.5	6.4	7.5	8.6	9.8
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