Medical Vacuum System Sizing Program

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Pipe Sizing - Instructions for Use

While there are a number of methods that can be used to achieve the same result, the instructions written here are intended to make it easy for a novice to correctly size vacuum piping for a medical facility.

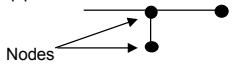
We have prepared a spreadsheet to help you with tabulating the total ΔP in your system. Worksheet ***Medical Vacuum Pipe Sizing***, on Tab 5, will calculate a running total ΔP through the system along a given run of pipe.

1) Begin by Sizing the entire vacuum system using the Medical Vacuum ***System Sizing*** equation on Tab 3.

2) Make a drawing of the piping system, similar to Figure 1 (Tab 4. ***Piping Sizing Diagram***). Some prefer isometric layouts to show all three axes.

3) For drops and risers, draw lines at 45 degrees: Towards the lower right for drops; towards the upper left for risers.

4) Mark ***Nodes*** at the beginning and end of any section of hard piping on which a terminal or other point of use is connected, and at any junction of two or more pipe intersections where loads (flow demand) are combined.



5) Start with the node at the inlet of the system, label it **N1**. Continue upstream on the main header until the first branch line intersection. Label this **N2**. Follow the *main* header upstream labeling each intersection. Do not include the farthest *branch* line to a terminal, or point of use (P.O.U.).

6) Label each P.O.U., starting with the P.O.U. in the branch line closest to the system. Label the farthest P.O.U. in the branch line **F1**, then work *towards* the main header, numbering each P.O.U. in successive numbers. Continue upstream to the next branch line and repeat. At each P.O.U., write the flow demand of the terminal or device. Refer to the **Flow (nlpm/scfm)** column on the *Vacuum Inlet Flows* worksheet (# 11).

7) Beginning at the farthest main or branch line in the piping network away from the vacuum system, label each section of pipe with the **total** flow of all terminals **upstream of** the piping section. Also, list the actual length of the section of pipe.

8) Wherever a fitting, valve, filter, or other element is in the piping, place a circle around the device. Once a pipe size is selected, the "Pipe Fittings Allowance" worksheet will be referenced in a later step.

9) Size the main header first. To establish an initial amount for the ΔP (Delta-P, or pressure difference—in a vacuum system it is actually a pressure rise, not a pressure drop) allowable for each section of the piping, count the total number of sections in the main header between nodes, then divide the total allowable ΔP for the facility (usually three or four in.Hg) by the number of sections. For a 4 in.Hg ΔP, divide 4 by the total number of sections, which yields the ΔP goal for *each* pipe section. For the example on Worksheet #4, ***Piping System Diagram***, the total number of sections in the main line is 5. 4/5 = 0.80 in.Hg ΔP. Individual sections of pipe may have higher or lower ΔP, but the total of all ΔPs should be equal to or less than the total ΔP of 4 in.Hg.

To calculate the actual ΔP for each section of pipe, use the total flow through that section done in step 7. Refer to one of the worksheets (7-9) listing the ΔP for the various pipe sizes. The ΔP shown is for 100 ft of pipe. If you are working in scfm, then read down the Standard Conditions/scfm column until you find the flow that you totaled in step 7. Read right until you find a ΔP that is closest to the ΔP you estimated in this step (10) for the pipe section . You may need to go to the next worksheet for a larger pipe size. To the actual pipe length, add the equivalent length (see worksheet 6, ***Pipe Fittings Allowance***) of all fittings including the downstream tee (or other fitting) in the section. Since the ΔP for pipe is proportional to length, you must divide the total equivalent pipe length by 100 to determine the ΔP you need (*e.g.*, for a section 50 ft lg, $\Delta P_{50} = \Delta P_{100} \lceil {}^{50}/_{100} \rceil$).

10) Size the branch line that has the most sections of pipe in the manner used in step 9, but include in the section count all sections of the main header between the beginning of the branch line and the vacuum source. The reason is that the total ΔP to the farthest terminal in any line must include **all** pipe sections between the terminal and the vacuum system. The allowable ΔP for each pipe section of branch line may be lower or higher than that in the main header as calculated in step 9.

11) Size the branch line that has the highest **flow** requirements in the manner of step 10. Even though the number of sections may be fewer, the pipe may be larger due to the higher flow. Sections of pipe with smaller flows or fewer terminals may not need to be calculated individually. Keep in mind that the smallest allowable size for hard pipe is 3/4 in., so if you are already working with 3/4 in. piping, there is no need to calculate each section individually.

12) Follow the piping towards the vacuum system; always entering all the data from any branch lines extending from the last upstream (away from the pump) node, starting from the terminal farthest in the branch line. For flow through tees, where flows enter from one end of the run, use the equivalent pipe length (EPL) for the run (see Tab 6, ***Pipe Fittings Allowance***). For the flow entering from the leg, enter the EPL for the side branch of the tee, even though data for the run may already have been entered for the same tee. This results in a slightly conservative result, but the effect on the total system is insignificant.

13) Static branch lines, which are used for pressure and temperature gauges, and other devices wherein there is no flow introduced, need not be included in the pipe sizing. The manufacturer should make recommendations as to connection size required.

14) Calculate the discharge pipe size for the flow calculated on Tab 3, ***System Sizing***.

Medical Vacuum System Sizing

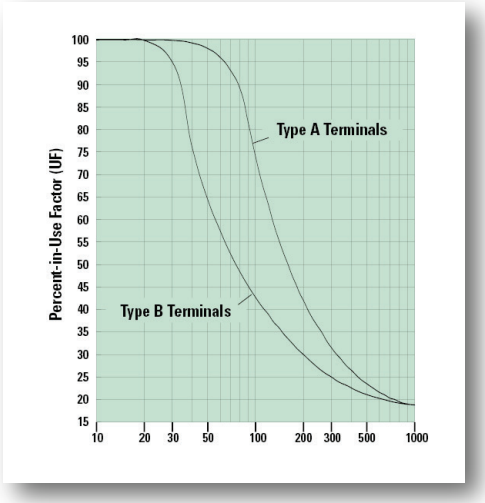
Vacuum Pump Size (SCFM*) = (A_N x A_{UF} x 0.25) + (B_N x B_{UF} x 0.25) + (OR_N x 1.5) + ($WAGD_N$x 1.8)**

= **74.25** **scfm**

Where:

A_N = Number of A Type Terminals	100
B_N = Number of B Type Terminals	200
OR_N = Number of Operating Rooms	10
$WAGD_N$ = Number of WAGD Terminals**	10
A_{UF} = Use Factor for A Type Terminals (*e.g.*, 23% = 0.23)	0.77
B_{UF} = Use Factor for B Type Terminals (*e.g.*, 23% = 0.23)	0.44

* SCFM at 19" Hg (or the lead vacuum switch set point).
** Add this factor only when the WAGD needs are being included in the Medical/Surgical system. When sizing dedicated WAGD systems, use 1.8 SCFM per terminal



Usage-Type A Terminals

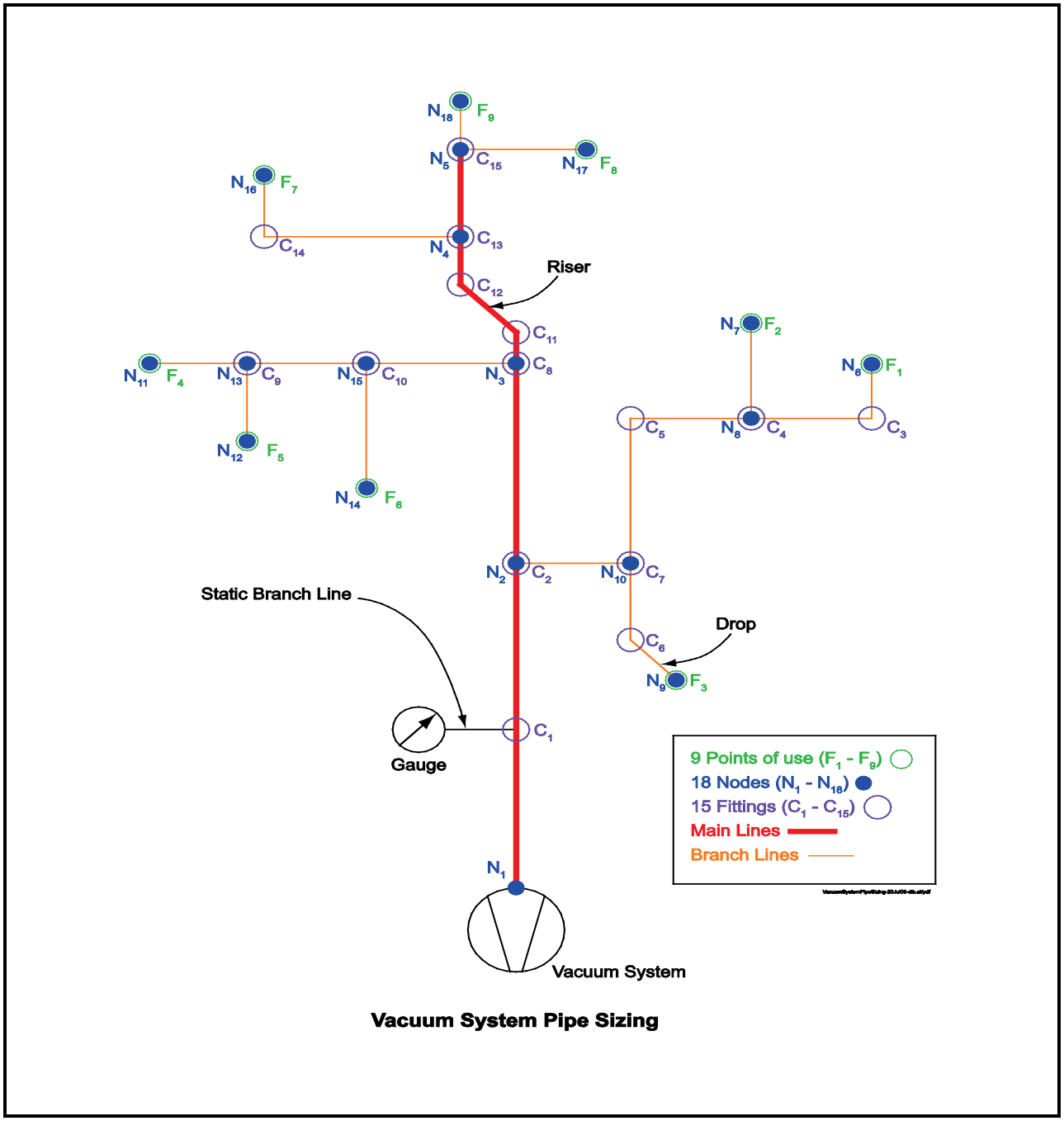
Location	Recommended No. of Terminals†	Unit
Operating Room-Major	3	Room
Operating Room-Minor	3	Room
Orthopedic Surgery	3	Room
Surgical Cystoscopy and Endoscopy	3	Room
Critical Care (General)	3	Bed
Isolation (Critical)	3	Bed
Intensive Care	3	Bed
Coronary Critical Care	2	Bed
Pediatric Critical Care	3	Bed
Newborn Intensive Care (Level 1, 2)	3	Bed
Cardio, Ortho, Neurological	3	Room
Post-Anesthesia Care Unit (PACU)	3	Bed
Caesarean/Delivery Room	3	Room
Recovery Room	3	Bed
Labor/Delivery/Recovery (LDR)	2	Patient
Birthing Rooms	2	Patient
Infant Resuscitation		Inlet
Triage Area (Definitive Emergency Care)	1	Room
Definitive Emergency Care, Exam/Treatment Room	1	Room
Definitive Emergency Care, Holding Area	1	Bed
Trauma/Cardiac Room	3	Room
Cardiac Catheterization Lab	2	Inlet
Special Procedures (Anesthetizing)	3	
Special Procedures (Non-Anesthetizing)	2	
Additional Anesthetizing locations	3	
Endoscopy/Cystoscopy	3	Room
Operating Room-Veterinary		Room
Operatory-Dental		Room

† May vary.

Usage-Type B Terminals

Location	Recommended No. of Terminals†	Unit
Patient Rooms (Medical and Surgical)	1 (Accessible to ea. bed)	Room
Examination and Treatment Room (Medical, Surgical, Postpartum Care)	1	Room
Isolation (Infectious and Protective; Medical and Surgical)	1	Bed
Security Room (Psychiatric, Medical, Surgical, Postpartum)	1	Bed
Newborn Nursery (Full-Term) Level 3, 4[1]	1	Bed
Pediatric Nursery	1	Bed
Pediatric and Adolescent	1	Bed
Seclusion Treatment Room	--	
Anesthesia Workroom	--	Inlet
Outpatient Recovery/Observation	3	Bed
Minor Procedures	1	Room
Postpartum Bedroom/Recovery	1	Patient
Labor Room	1	Patient
Labor/Delivery/Recovery/Postpartum (LDRP)	2	Patient
Initial Emergency Management	1 (per bed)	Room
Orthopedic and Cast Room	1	Room
Catheterization Labs	2	Inlet
Autopsy Room	1 (per workstation)	Inlet
Surgical Excision Room	1	Room
Dialysis Units	0.5/bed	Bed
Respiratory Care	Convenience	Inlet
Central Supply	Convenience	Inlet
Equipment Repair, Calibration	Convenience	Inlet
Demonstration (Inservice)/Teaching	Convenience	Inlet
EENT, EEG, ECG, EMG	1	Room
Decontamination	Convenience	Inlet
Animal Research	1	Inlet
Dental Treatment		Inlet

1 - In facilities with newborn intensive care units, terminal requirements in a newborn nursery (full-term, Level 3,4) may be reduced.



Vacuum System Pipe Sizing

Figure 1

Medical Vacuum Pipe Sizing Form

Start Node	End Node	Actual Pipe Length	Total Pipe Section Flow	Total Pipe Fittings Allowance (ft) *See Tab 6*	Pipe Size *See Tabs 7-9*	Pressure Loss per 100 ft (in.Hg) *See Tab 7-9*	Actual Pressure Loss (in.Hg)
N_n	N_n	feet	scfm	feet	inch	ΔP	ΔP
							0
							0
							0
							0
							0
							0
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							0
							0
							0
						Total:	0

Enter data in blue cells

Reference	Symbol	Description
Nn	N_1, N_2 … N_n	A node; a beginning or end point, or connection where two pipe lines join, indicated by a blue dot.

Equivalent Length of Straight Pipe (feet) — Copper Pipe										
Type of fitting	Size									
	¾"	1"	1¼"	1½"	2"	2½"	3"	4"	6"	8"
Elbow-45°	0.5	1	1	1.5	2	2.5	3.5	5	7	11
Elbow-90°	2	2.5	3	4	5.5	7	9	12.5	19	29
Tee-90°-Run			0.5	0.5	0.5	0.5	1	1	2	3
Tee-90°-Side Branch	3	4.5	5.5	7	9	12	15	21	34	50
Valve - Ball		5	0.5	0.5	0.5					
Valve - Gate					0.5	1	1.5	2	3.5	5
Valve - Butterfly					7.5	10	15.5	16	13.5	12.5
Valve - Check	3	4.5	5.5	6.5	9	11.5	14.5	18.5	26.5	39
Coupling			0.5	0.5	0.5	0.5	1	1	2	3

Air Flow at 19 in.HgV - Copper L Tube

Actual Conditions		Standard Conditions		Pressure Difference per 100 ft / Velocity													
At Pump Inlet		29.92 in.HgA; 68°F; 36% RH		Pipe Size - ¾"		Pipe Size - 1"		Pipe Size - 1¼"		Pipe Size - 1½"							
acfm	l/m	scfm	nl/m	ΔP	(ft/min)	ΔP	(ft/min)	ΔP	(ft/min)	ΔP	(ft/min)						
1.37	28.33	0.50	14.16	0.024	409												
2.74	77.62	1.00	28.33	0.079	853												
4.11	116.43	1.50	42.49	0.163	1213												
5.48	155.24	2.00	56.66	0.268	1636												
6.85	194.05	2.50	70.82	0.397	2019												
8.22	232.85	3.00	84.99	0.546	2443												
9.59	271.66	3.50	99.15	0.711	2908												
10.96	310.47	4.00	113.31	0.901	3282												
12.33	349.28	4.50	127.48	1.109	3680												
13.70	388.09	5.00	141.64	1.331	4100												
15.07	426.90	5.50	155.81	1.569	4543												
16.44	465.71	6.00	169.97	1.824	5008												
17.81	504.52	6.50	184.14	2.105	5332												
19.18	543.33	7.00	198.30	2.392	5835												
20.55	582.14	7.50	212.46	2.708	6183												
21.92	620.95	8.00	226.63	3.037	6542												
23.29	659.76	8.50	240.79	3.378	6910												
24.66	698.56	9.00	254.96	3.719	7481												
26.03	737.37	9.50	269.12	4.082	7875												
27.40	776.18	10.00	283.29	4.473	8279												
28.77	814.99	10.50	297.45	4.875	8693												
30.14	853.80	11.00	311.61	5.289	9117												
31.51	892.61	11.50	325.78	5.714	9551												
32.88	931.42	12.00	339.94			1.742	5732	0.64	3763	0.28	2659						
34.25	970.23	12.50	354.11			1.869	5995	0.687	3936	0.3	2781						
35.62	1009.04	13.00	368.27			1.999	6265	0.735	4113	0.321	2906						
36.99	1047.85	13.50	382.44			2.131	6540	0.784	4294	0.342	3034						
38.36	1086.66	14.00	396.60			2.266	6821	0.834	4478	0.366	3098						
39.73	1125.47	14.50	410.76			2.421	6964	0.892	4572	0.388	3230						
41.10	1164.27	15.00	424.93			2.561	7254	0.944	4763	0.412	3365						
42.47	1203.08	15.50	439.09			2.713	7550	0.996	4957	0.437	3433						
43.84	1241.89	16.00	453.26			2.868	7700	1.058	5056	0.461	3572						
45.21	1280.70	16.50	467.42			3.025	8005	1.112	5256	0.486	3713						
46.58	1319.51	17.00	481.59			3.099	8160	1.176	5357	0.513	3785						
47.95	1358.32	17.50	495.75			3.362	8474	1.237	5563	0.539	3931						
49.32	1397.13	18.00	509.92			3.528	8633	1.303	5668	0.568	4004						
50.69	1435.94	18.50	524.08			3.696	8956	1.361	5880	0.594	4154						
52.06	1474.75	19.00	538.24			3.882	9119	1.429	5987	0.624	4230						
53.43	1513.56	19.50	552.41			4.055	9451	1.494	6205	0.652	4384						
54.80	1552.37	20.00	566.57					1.565	6315	0.683	4462						
57.54	1629.98	21.00	594.90					1.698	6651	0.742	4700						
60.28	1707.60	22.00	623.23					1.84	6997	0.804	4943						
63.02	1785.22	23.00	651.56					1.989	7232	0.872	5110						
65.76	1862.84	24.00	679.89					2.139	7592	0.939	5364						
68.50	1940.46	25.00	708.22					2.301	7838	1.01	5537						
71.24	2018.08	26.00	736.54					2.467	8212	1.079	5802						
73.98	2095.69	27.00	764.87					2.638	8467	1.155	5982						
76.72	2173.31	28.00	793.20					2.801	8856	1.226	6257						
79.46	2250.93	29.00	821.53					2.991	9120	1.31	6443						
82.20	2328.55	30.00	849.86					3.159	9524	1.384	6729						
84.94	2406.17	31.00	878.19							1.465	6922						
87.68	2483.79	32.00	906.52							1.555	7119						
90.42	2561.40	33.00	934.84							1.639	7318						
93.16	2639.02	34.00	963.17							1.725	7622						
95.90	2716.64	35.00	991.50							1.812	7828						
98.64	2794.26	36.00	1019.83							1.908	8036						
101.38	2871.88	37.00	1048.16							1.998	8248						
104.12	2949.49	38.00	1076.49							2.098	8462						
106.86	3027.11	39.00	1104.82							2.2	8679						
109.60	3104.73	40.00	1133.14							2.293	8899						
112.34	3182.35	41.00	1161.47							2.398	9121						
115.08	3259.97	42.00	1189.80							2.505	9346						

For instructions for use,
refer to ***Instructions*** worksheet

Air Flow at 19 in.HgV - Copper L Tube

For instructions for use, refer to ***Instructions*** worksheet

PRESSURE LOSS IN INCHES OF MERCURY

Actual Conditions		Standard Conditions		Pressure Difference per 100 ft / Velocity							
At Pump Inlet		29.92 in.HgA; 68°F; 36% RH		Pipe Size - 2"		Pipe Size - 2½"		Pipe Size - 3"		Pipe Size - 4"	
acfm	l/m	scfm	nl/m	ΔP	(ft/min)	ΔP	(ft/min)	ΔP	(ft/min)	ΔP	(ft/min)
38.36	1086.66	14.00	396.60	0.098	1781						
39.73	1125.47	14.50	410.76	0.104	1857						
41.10	1164.27	15.00	424.93	0.111	1934						
42.47	1203.08	15.50	439.09	0.117	1974						
43.84	1241.89	16.00	453.26	0.124	2053						
45.21	1280.70	16.50	467.42	0.130	2135						
46.58	1319.51	17.00	481.59	0.138	2176						
47.95	1358.32	17.50	495.75	0.145	2260						
49.32	1397.13	18.00	509.92	0.152	2301						
50.69	1435.94	18.50	524.08	0.159	2388						
52.06	1474.75	19.00	538.24	0.167	2432						
53.43	1513.56	19.50	552.41	0.175	2520						
54.80	1552.37	20.00	566.57	0.183	2565						
57.54	1629.98	21.00	594.90	0.200	2702						
60.28	1707.60	22.00	623.23	0.216	2842						
63.02	1785.22	23.00	651.56	0.234	2938						
65.76	1862.84	24.00	679.89	0.252	3083						
68.50	1940.46	25.00	708.22	0.272	3183	0.097	2064				
71.24	2018.08	26.00	736.54	0.289	3335	0.104	2163				
73.98	2095.69	27.00	764.87	0.310	3439	0.111	2230				
76.72	2173.31	28.00	793.20	0.330	3596	0.118	2332				
79.46	2250.93	29.00	821.53	0.352	3704	0.126	2402				
82.20	2328.55	30.00	849.86	0.372	3868	0.133	2508				
84.94	2406.17	31.00	878.19	0.394	3979	0.141	2581				
87.68	2483.79	32.00	906.52	0.416	4092	0.149	2654				
90.42	2561.40	33.00	934.84	0.441	4207	0.157	2728				
93.16	2639.02	34.00	963.17	0.462	4381	0.166	2841				
95.90	2716.64	35.00	991.50	0.488	4500	0.174	2918				
98.64	2794.26	36.00	1019.83	0.512	4620	0.183	2996				
101.38	2871.88	37.00	1048.16	0.536	4741	0.192	3074				
104.12	2949.49	38.00	1076.49	0.564	4864	0.201	3154				
106.86	3027.11	39.00	1104.82	0.589	4989	0.211	3235				
109.60	3104.73	40.00	1133.14	0.617	5116	0.22	3317	0.095	2324		
112.34	3182.35	41.00	1161.47	0.642	5243	0.23	3400	0.099	2382		
115.08	3259.97	42.00	1189.80	0.671	5373	0.24	3482	0.103	2441		
117.82	3337.59	43.00	1218.13	0.700	5504	0.249	3569	0.108	2500		
120.56	3415.20	44.00	1246.46	0.727	5636	0.26	3655	0.112	2561		
123.30	3492.82	45.00	1274.79	0.756	5771	0.271	3742	0.116	2621		
126.04	3570.44	46.00	1303.12	0.788	5906	0.281	3830	0.121	2683		
128.78	3648.06	47.00	1331.44	0.815	6044	0.292	3919	0.125	2746		
131.52	3725.68	48.00	1359.77	0.846	6183	0.303	4009	0.13	2809		
134.26	3803.30	49.00	1388.10	0.878	6253	0.315	4055	0.135	2840		
137.00	3880.91	50.00	1416.43	0.910	6394	0.326	4147	0.14	2905		
142.48	4036.15	52.00	1473.09	0.975	6682	0.348	4333	0.15	3035		
147.96	4191.39	54.00	1529.75	1.042	6901	0.372	4475	0.16	3135		
153.44	4346.62	56.00	1586.40	1.111	7199	0.397	4669	0.17	3271		
158.92	4501.86	58.00	1643.06	1.180	7427	0.422	4816	0.181	3374		
164.40	4657.10	60.00	1699.72	1.251	7659	0.448	4967	0.192	3479		
169.88	4812.33	62.00	1756.37	1.324	7973	0.474	5170	0.203	3622		
175.36	4967.57	64.00	1813.03	1.404	8213	0.5	5326	0.215	3731		
180.84	5122.81	66.00	1869.69	1.478	8456	0.53	5483	0.228	3842		
186.32	5278.04	68.00	1926.35	1.562	8703	0.557	5644	0.239	3954		
191.79	5433.28	70.00	1983.00	1.639	8953	0.588	5806	0.251	4067		
197.27	5588.52	72.00	2039.66	1.726	9208	0.616	5971	0.265	4183		
202.75	5743.75	74.00	2096.32	1.805	9465	0.648	6138	0.277	4300	0.073	2446
208.23	5898.99	76.00	2152.97			0.677	6307	0.291	4418	0.076	2513
213.71	6054.23	78.00	2209.63			0.709	6479	0.304	4539	0.08	2582
219.19	6209.46	80.00	2266.29			0.739	6653	0.318	4661	0.083	2651
224.67	6364.70	82.00	2322.95			0.773	6829	0.331	4784	0.087	2721
230.15	6519.94	84.00	2379.60			0.807	7007	0.346	4909	0.091	2792
235.63	6675.17	86.00	2436.26			0.842	7127	0.361	4994	0.095	2840
241.11	6830.41	88.00	2492.92			0.877	7310	0.376	5122	0.098	2913
246.59	6985.65	90.00	2549.58			0.908	7495	0.39	5251	0.102	2986
252.07	7140.88	92.00	2606.23			0.945	7619	0.407	5338	0.106	3036
257.55	7296.12	94.00	2662.89			0.981	7808	0.421	5470	0.111	3111
263.03	7451.36	96.00	2719.55			1.018	7999	0.437	5603	0.114	3187
268.51	7606.59	98.00	2776.20			1.056	8127	0.453	5693	0.119	3238
273.99	7761.83	100.00	2832.86			1.094	8321	0.47	5830	0.123	3316
287.69	8149.92	105.00	2974.50			1.194	8718	0.513	6107	0.134	3474
301.39	8538.01	110.00	3116.15			1.297	9423	0.555	6392	0.145	3635
315.09	8926.10	115.00	3257.79			1.395	9538	0.6	6682	0.157	3800
328.79	9314.19	120.00	3399.43					0.647	6979	0.169	3970
342.49	9702.29	125.00	3541.08					0.695	7282	0.182	4142
356.19	10090.38	130.00	3682.72					0.744	7592	0.195	4318
369.89	10478.47	135.00	3824.36					0.794	7855	0.208	4468
383.59	10866.56	140.00	3966.01					0.845	8177	0.221	4651
397.29	11254.65	145.00	4107.65					0.902	8450	0.235	4806
410.99	11642.74	150.00	4249.29					0.955	8728	0.25	4964
424.69	12030.83	155.00	4390.93					1.014	9010	0.265	5124
438.39	12418.93	160.00	4532.58					1.069	9296	0.281	5287
452.09	12807.02	165.00	4674.22					1.13	9587	0.295	5453
465.79	13195.11	170.00	4815.86							0.312	5621
479.49	13583.20	175.00	4957.51							0.327	5791
493.19	13971.29	180.00	5099.15							0.344	5965
506.89	14359.38	185.00	5240.79							0.362	6140
520.59	14747.47	190.00	5382.44							0.378	6283
534.29	15135.56	195.00	5524.08							0.396	6463
547.99	15523.66	200.00	5665.72							0.414	6609
575.38	16299.84	210.00	5949.01							0.452	6943
602.78	17076.02	220.00	6232.29							0.49	7286
630.18	17852.20	230.00	6515.58							0.527	7637
657.58	18628.39	240.00	6798.87							0.571	7956
684.98	19404.57	250.00	7082.15							0.612	8282
712.38	20180.75	260.00	7365.44							0.655	8614
739.78	20956.94	270.00	7648.73							0.698	8953
767.18	21733.12	280.00	7932.01							0.746	9254
794.58	22509.30	290.00	8215.30							0.791	9605

Air Flow at 19 in.HgV - Copper L Tube

Actual Conditions		Standard Conditions		Press. Diff. per 100 ft / Velocity	
At Pump Inlet		29.92 in.HgA; 68°F; 36% RH		Pipe Size - 6"	
acfm	l/m	scfm	nl/m	ΔP	(ft/min)
602.78	17076.02	220.00	6232.29	0.072	3252
630.18	17852.20	230.00	6515.58	0.078	3409
657.58	18628.39	240.00	6798.87	0.084	3551
684.98	19404.57	250.00	7082.15	0.090	3697
712.38	20180.75	260.00	7365.44	0.097	3845
739.78	20956.94	270.00	7648.73	0.103	3996
767.18	21733.12	280.00	7932.01	0.110	4130
794.58	22509.30	290.00	8215.30	0.116	4287
821.98	23285.48	300.00	8498.58	0.124	4427
849.38	24061.67	310.00	8781.87	0.131	4589
876.78	24837.85	320.00	9065.16	0.139	4733
904.18	25614.03	330.00	9348.44	0.146	4879
931.58	26390.22	340.00	9631.73	0.154	5028
958.97	27166.40	350.00	9915.01	0.162	5178
986.37	27942.58	360.00	10198.30	0.170	5332
1013.77	28718.76	370.00	10481.59	0.178	5465
1041.17	29494.95	380.00	10764.87	0.187	5622
1068.57	30271.13	390.00	11048.16	0.196	5759
1095.97	31047.31	400.00	11331.44	0.205	5920
1164.47	32987.77	425.00	12039.66	0.227	6274
1232.97	34928.23	450.00	12747.88	0.252	6662
1301.47	36868.68	475.00	13456.09	0.277	7011
1369.96	38809.14	500.00	14164.31	0.304	7395
1438.46	40749.60	525.00	14872.52	0.331	7763
1506.96	42690.06	550.00	15580.74	0.358	8140
1575.46	44630.51	575.00	16288.95	0.387	8497
1643.96	46570.97	600.00	16997.17	0.416	8863
1712.45	48511.43	625.00	17705.38	0.448	9236
1780.95	50451.88	650.00	18413.60	0.479	9616
1849.45	52392.34	675.00	19121.81		
1917.95	54332.80	700.00	19830.03		
1986.45	56273.25	725.00	20538.24		
2054.94	58213.71	750.00	21246.46		
2123.44	60154.17	775.00	21954.67		
2191.94	62094.63	800.00	22662.89		
2260.44	64035.08	825.00	23371.10		
2328.94	65975.54	850.00	24079.32		
2397.44	67916.00	875.00	24787.54		
2465.93	69856.45	900.00	25495.75		
2534.43	71796.91	925.00	26203.97		
2602.93	73737.37	950.00	26912.18		
2671.43	75677.82	975.00	27620.40		
2739.93	77618.28	1000.00	28328.61		
2808.42	79558.74	1025.00	29036.83		
2876.92	81499.20	1050.00	29745.04		
2945.42	83439.65	1075.00	30453.26		
3013.92	85380.11	1100.00	31161.47		
3082.42	87320.57	1125.00	31869.69		

For instructions for use, refer to ***Instructions*** worksheet

Pipe Size - 8"	
ΔP	(ft/min)
0.073	4014
0.08	4234
0.088	4444
0.095	4660
0.103	4865
0.111	5074
0.119	5287
0.127	5506
0.136	5711
0.145	5920
0.154	6132
0.136	6349
0.173	6550
0.183	6774
0.194	6982
0.204	7193
0.214	7408
0.225	7626
0.236	7826
0.247	8050
0.258	8256
0.27	8465
0.284	9677
0.296	8890
0.308	9107
0.32	9304
0.332	9526

Discharge Air Flow (with Vacuum Pump Operating at 19 in.HgV)

Standard Conditions

29.92 in.HgA; 68°F; 36% RH

Pressure Difference per 100 ft / Velocity

scfm	nl/m	Pipe Size - 1" ΔP	Pipe Size - 1" (ft/min)	Pipe Size - 1¼" ΔP	Pipe Size - 1¼" (ft/min)	Pipe Size - 1½" ΔP	Pipe Size - 1½" (ft/min)
15.00	424.93	0.404	2322	0.149	1524	0.065	1077
20.00	566.57	0.669	3096	0.245	2032	0.108	1436
25.00	708.22	0.988	3856	0.364	2531	0.159	1789
30.00	849.86	1.359	4633	0.499	3041	0.219	2149
35.00	991.50	1.781	5406	0.655	3549	0.288	2507
40.00	1133.14			0.829	4045	0.362	2858
45.00	1274.79	Pipe Size - 2"		1.019	4573	0.446	3230
50.00	1416.43	ΔP	(ft/min)	1.22	5076	0.535	3586
55.00	1558.07	0.17	2276	1.439	5606	0.632	3960
60.00	1699.72	0.247	2717	1.677	6098	0.737	4308
65.00	1841.36	0.283	2946	1.938	6611	0.848	4670
70.00	1983.00	0.323	3154			0.968	5000
75.00	2124.65	0.364	3400	Pipe Size - 3"		1.088	5390
80.00	2266.29	0.408	3622	ΔP	(ft/min)	1.218	5743
85.00	2407.93	0.453	3853	0.056	1595	1.353	6108
90.00	2549.58	0.503	4055	0.062	1679	1.5	6430
95.00	2691.22	0.552	4298	0.068	1780	1.643	6815
100.00	2832.86	0.605	4512	0.074	1868	1.8	7154
105.00	2974.50	0.656	4732	0.081	1959	1.962	7502
110.00	3116.15	0.712	4994	0.088	2068		
120.00	3399.43	0.828	5420	0.102	2244	Pipe Size - 4"	
130.00	3682.72	0.956	5864	0.118	2428	ΔP	(ft/min)
140.00	3966.01	1.089	6325	0.134	2619	0.035	1489
150.00	4249.29	1.228	6805	0.151	2817	0.04	1602
160.00	4532.58	1.372	7255	0.169	3004	0.044	1708
170.00	4815.86	1.53	7673	0.189	3176	0.049	1807
180.00	5099.15	1.684	8150	0.208	3374	0.054	1919
190.00	5382.44	1.852	8593	0.228	3557	0.06	2023
200.00	5665.72	2.026	9047	0.249	3746	0.065	2031
225.00	6373.94			0.307	4203	0.081	2390
250.00	7082.15	Pipe Size - 6"		0.37	4687	0.097	2666
275.00	7790.37	ΔP	(ft/min)	0.436	5148	0.114	2928
300.00	8498.58	0.02	1429	0.506	5630	0.133	3202
325.00	9206.80	0.023	1543	0.506	6080	0.153	3458
350.00	9915.01	0.026	1661	0.667	6547	0.175	3724
375.00	10623.23	0.029	1784	0.75	7030	0.197	3999
400.00	11331.44	0.032	1904	0.842	7502	0.22	4267
425.00	12039.66	0.036	2020	0.842	7958	0.245	4526
450.00	12747.88	0.04	2139	1.029	8428	0.271	4793
475.00	13456.09	0.044	2254	1.139	8878	0.298	5049
500.00	14164.31	0.048	2379	1.244	9373	0.325	5331
525.00	14872.52	0.052	2491	1.351	9814	0.354	5581
550.00	15580.74	0.057	2614			0.383	5858
575.00	16288.95	0.061	2731	Pipe Size - 8"		0.416	6120
600.00	16997.17	0.066	2851	ΔP	(ft/min)	0.446	6388
625.00	17705.38	0.071	2973	0.019	1702	0.481	6662
650.00	18413.60	0.076	3088	0.02	1768	0.513	6920
675.00	19121.81	0.081	3205	0.022	1835	0.549	7183
700.00	19830.03	0.086	3325	0.023	1903	0.586	7450
725.00	20538.24	0.092	3446	0.024	1973	0.624	7726
750.00	21246.46	0.097	3560	0.026	2038	0.663	7976
775.00	21954.67	0.103	3659	0.027	2110	0.697	8258
800.00	22662.89	0.109	3803	0.029	2177	0.737	8521
825.00	23371.10	0.115	3922	0.031	2245	0.778	8788
850.00	24079.32	0.121	4043	0.032	2314	0.82	9059
875.00	24787.54	0.127	4154	0.034	2379	0.869	9309
900.00	25495.75	0.134	4279	0.036	2449	0.912	9588
925.00	26203.97	0.14	4393	0.037	2515	0.956	9845
950.00	26912.18	0.147	4510	0.039	2582		
1000.00	28328.61	0.162	4747	0.043	2717	For data on other pipe sizes, contact factory.	
1050.00	29745.04	0.176	4990	0.047	2857		
1100.00	31161.47	0.19	5226	0.051	2992		

Typical Inlet Flows		
Occupancy	**Unit**	**Flow (nlpm/scfm)**
Anesthesia Workroom	inlet	4.25 / 0.15
Animal Research	inlet	10.8 / 0.38
Autopsy	inlet	10.8 / 0.38
Blood Donors	inlet	2.8 / 0.1
Cardiac Catheterization	inlet	2.8 / 0.1
Cast Room	room	2.8 / 0.1
Critical Care	bed	43 / 1.5
Decontamination	inlet	14 / 0.5
Demonstration (Inservice)	inlet	2.8 / 0.1
Dental Treatment	inlet	57 / 2
Dental Operatory	room	57 / 2
Exam & Treatment	room	2.8 / 0.1
EENT. EEG, ECG, EMG	room	2.8 / 0.1
Emergency / Triage	room	85 / 3
Induction Room / Holding	bed	2.8 / 0.1
Intensive Care	bed	43 / 1.5
Isolation (Infectious Disease)	bed	2.8 / 0.1
Laboratory	iinlet	10.8 / 0.38
Minor Procedures	room	2.8 / 0.1
Obstetrics:		
Delivery Room	patient	28 / 1
Labor Room	patient	28 / 1
Labor/Delivery/Recovery (LDR)	patient	28 / 1
Labor/Delivery/Recovery/Postpartum (LDRP)	patient	28 / 1
Postpartum Room	patient	28 / 1
Postpartum Recovery	patient	21 / 0.75
Infant Resuscitation	inlet	14 / 0.5
Operating Rooms:		
Endoscopy/Cystoscopy	room	57 / 2
Major O.R.	room	100 / 3.5
Minor O.R.	room	57 / 2
Orthology/Neurology O.R.	room	100 / 3.5
Veterinary O.R.	room	57 / 2
Observation	bed	2.8 / 0.1
Pediatric:		
Pediatric ICU	bed	34 / 1.2
Neonatal ICU (level 3/4)	bed	14 / 0.5
Neonatal ICU (level 1/2)	bed	14 / 0.5
Nursery	bed	2.8 / 0.1
Pediatric and Adolescent	bed	2.8 / 0.1
Psychiatric / Secure	bed	2.8 / 0.1
Recovery (PACU) (per bed)	bed	21 / 0.75
Patient Room	room	2.8 / 0.1
Respiratory Therapy	inlet	14 / 0.5
Sterilization / Central Supply	inlet	14 / 0.5
Trauma Room	room	85 / 3

Air Flow at 19 in.HgV - Copper L Tube

Actual Conditions		Standard Conditions		Pressure Difference per 100 ft / Velocity									
At Pump Inlet		29.92 in.HgA, 68°F, 36% RH		Pipe Size - 2"		Pipe Size - 2½"		Pipe Size - 3"		Pipe Size - 4"		Pipe Size - 6"	
acfm	l/m	scfm	n/m	ΔP	(ft/min)	ΔP	(ft/min)	ΔP	(ft/min)	ΔP	(ft/min)	ΔP	(ft/min)
38.36	1086.66	14.00	396.60	0.098	1781	0.097	2084	0.095	2324	0.073	2446	0.072	3252
39.73	0.00	14.50	410.76	0.104	1857	0.104	2163	0.099	2382	0.076	2513	0.078	3409
41.10	0.00	15.00	424.93	0.111	1934	0.111	2230	0.103	2441	0.08	2582	0.084	3551
42.47	0.00	15.50	439.09	0.117	1974	0.118	2332	0.108	2500	0.083	2651	0.090	3697
43.84	0.00	16.00	453.26	0.124	2053	0.126	2402	0.112	2561	0.087	2721	0.097	3845
45.21	0.00	16.50	467.42	0.130	2135	0.133	2508	0.116	2621	0.091	2792	0.103	3996
46.58	0.00	17.00	481.59	0.138	2176	0.141	2581	0.121	2683	0.095	2840	0.110	4130
47.95	0.00	17.50	495.75	0.145	2260	0.149	2654	0.125	2746	0.098	2913	0.116	4287
49.32	0.00	18.00	509.92	0.152	2301	0.157	2728	0.13	2809	0.102	2986	0.124	4427
50.69	0.00	18.50	524.08	0.159	2388	0.166	2841	0.135	2840	0.106	3036	0.131	4589
52.06	0.00	19.00	538.24	0.167	2432	0.174	2918	0.14	2905	0.111	3111	0.139	4733
53.43	0.00	19.50	552.41	0.175	2520	0.183	2996	0.15	3035	0.114	3187	0.146	4879
54.80	0.00	20.00	566.57	0.183	2565	0.192	3074	0.16	3135	0.119	3238	0.154	5028
57.54	0.00	21.00	594.90	0.200	2702	0.201	3154	0.17	3271	0.123	3316	0.162	5178
60.28	0.00	22.00	623.23	0.216	2842	0.211	3235	0.181	3374	0.134	3474	0.170	5332
63.02	0.00	23.00	651.56	0.234	2938	0.22	3317	0.192	3479	0.145	3635	0.178	5465
65.76	0.00	24.00	679.89	0.252	3083	0.23	3400	0.203	3622	0.157	3800	0.187	5622
68.50	0.00	25.00	708.22	0.272	3183	0.24	3482	0.215	3731	0.169	3970	0.196	5759
71.24	0.00	26.00	736.54	0.289	3335	0.249	3569	0.228	3842	0.182	4142	0.205	5920
73.98	0.00	27.00	764.87	0.310	3439	0.26	3655	0.239	3954	0.195	4318	0.227	6274
76.72	0.00	28.00	793.20	0.330	3596	0.271	3742	0.251	4067	0.208	4468	0.252	6662
79.46	0.00	29.00	821.53	0.352	3704	0.281	3830	0.265	4183	0.221	4651	0.277	7011
82.20	0.00	30.00	849.86	0.372	3868	0.292	3919	0.277	4300	0.235	4806	0.304	7395
84.94	0.00	31.00	878.19	0.394	3979	0.303	4009	0.291	4418	0.25	4964	0.331	7763
87.68	0.00	32.00	906.52	0.416	4092	0.315	4055	0.304	4539	0.265	5124	0.358	8140
90.42	0.00	33.00	934.84	0.441	4207	0.326	4147	0.318	4661	0.281	5287	0.387	8497
93.16	0.00	34.00	963.17	0.462	4381	0.348	4333	0.331	4784	0.295	5453	0.416	8863
95.90	0.00	35.00	991.50	0.488	4500	0.372	4475	0.346	4909	0.312	5621	0.448	9236
98.64	0.00	36.00	1019.83	0.512	4620	0.397	4669	0.361	4994	0.327	5791	0.479	9616
101.38	0.00	37.00	1048.16	0.536	4741	0.422	4816	0.376	5122	0.344	5965		
104.12	0.00	38.00	1076.49	0.564	4864	0.448	4967	0.39	5251	0.362	6140		
106.86	0.00	39.00	1104.82	0.589	4989	0.474	5170	0.407	5338	0.378	6283		
109.60	0.00	40.00	1133.14	0.617	5116	0.5	5326	0.421	5470	0.396	6463		
112.34	0.00	41.00	1161.47	0.642	5243	0.526	5483	0.437	5603	0.414	6609		
115.08	0.00	42.00	1189.80	0.671	5373	0.557	5644	0.453	5693	0.452	6943		
117.82	0.00	43.00	1218.13	0.700	5504	0.588	5806	0.47	5830	0.49	7286		
120.56	0.00	44.00	1246.46	0.727	5636	0.616	5971	0.513	6107	0.527	7637		
123.30	0.00	45.00	1274.79	0.756	5771	0.648	6138	0.555	6392	0.571	7956		
126.04	0.00	46.00	1303.12	0.788	5906	0.677	6307	0.6	6682	0.612	8282		
128.78	0.00	47.00	1331.44	0.815	6044	0.709	6479	0.647	6979	0.655	8614		
131.52	0.00	48.00	1359.77	0.846	6183	0.739	6653	0.695	7282	0.698	8953		
134.26	0.00	49.00	1388.10	0.878	6253	0.773	6829	0.744	7592	0.746	9254		
137.00	0.00	50.00	1416.43	0.910	6394	0.807	7007	0.794	7855	0.791	9605		
142.48	0.00	52.00	1473.09	0.975	6682	0.842	7127	0.845	8177				
147.96	0.00	54.00	1529.75	1.042	6901	0.877	7310	0.902	8450				
153.44	0.00	56.00	1586.40	1.111	7199	0.908	7495	0.955	8728				
158.92	0.00	58.00	1643.06	1.180	7427	0.945	7619	1.014	9010				
164.40	0.00	60.00	1699.72	1.251	7659	0.981	7808	1.069	9296				
169.88	0.00	62.00	1756.37	1.324	7973	1.018	7999	1.13	9587				
175.36	0.00	64.00	1813.03	1.404	8213	1.056	8127						
180.84	0.00	66.00	1869.69	1.478	8456	1.094	8321						
186.32	0.00	68.00	1926.35	1.562	8703	1.194	8718						
191.79	0.00	70.00	1983.00	1.639	8953	1.297	9423						
197.27	0.00	72.00	2039.66	1.726	9208	1.395	9538						
202.75	0.00	74.00	2096.32	1.805	9465								
208.23	0.00	76.00	2152.97										
213.71	0.00	78.00	2209.63										
219.19	0.00	80.00	2266.29										
224.67	0.00	82.00	2322.95										
230.15	0.00	84.00	2379.60										
235.63	0.00	86.00	2436.26										
241.11	0.00	88.00	2492.92										
246.59	0.00	90.00	2549.58										
252.07	0.00	92.00	2606.23										
257.55	0.00	94.00	2662.89										
263.03	0.00	96.00	2719.55										
268.51	0.00	98.00	2776.20										
273.99	0.00	100.00	2832.86										
287.69	0.00	105.00	2974.50										
301.39	0.00	110.00	3116.15										
315.09	0.00	115.00	3257.79										
328.79	0.00	120.00	3399.43										
342.49	0.00	125.00	3541.08										
356.19	0.00	130.00	3682.72										
369.89	0.00	135.00	3824.36										
383.59	0.00	140.00	3966.01										
397.29	0.00	145.00	4107.65										
410.99	0.00	150.00	4249.29										
424.69	0.00	155.00	4390.93										
438.39	0.00	160.00	4532.58										
452.09	0.00	165.00	4674.22										
465.79	0.00	170.00	4815.86										
479.49	0.00	175.00	4957.51										
493.19	0.00	180.00	5099.15										
506.89	0.00	185.00	5240.79										
520.59	0.00	190.00	5382.44										
534.29	0.00	195.00	5524.08										
547.99	0.00	200.00	5665.72										
575.38	0.00	210.00	5949.01										
602.78	0.00	220.00	6232.29										
630.18	0.00	230.00	6515.58										
657.58	0.00	240.00	6798.87										
684.98	0.00	250.00	7082.15										
712.38	0.00	260.00	7365.44										
739.78	0.00	270.00	7648.73										
767.18	0.00	280.00	7932.01										
794.58	0.00	290.00	8215.30										

For instructions for use, refer to ***Instructions*** worksheet

PRESSURE LOSS IN INCHES OF MERCURY

Air Flow at 19 in.HgV - Copper L Tube

Actual Conditions		Standard Conditions		Press. Diff. per 100 ft / Velocity			
At Pump Inlet		29.92 in.HgA, 68°F, 36% RH		Pipe Size - 6"		Pipe Size - 8"	
acfm	l/m	scfm	n/m	ΔP	(ft/min)	ΔP	(ft/min)
602.78	17076.02	220.00	6232.29	0.072	3252	0.073	4014
630.18	0.00	230.00	6515.58	0.078	3409	0.08	4234
657.58	0.00	240.00	6798.87	0.084	3551	0.088	4444
684.98	0.00	250.00	7082.15	0.090	3697	0.095	4660
712.38	0.00	260.00	7365.44	0.097	3845	0.103	4865
739.78	0.00	270.00	7648.73	0.103	3996	0.111	5074
767.18	0.00	280.00	7932.01	0.110	4130	0.119	5287
794.58	0.00	290.00	8215.30	0.116	4287	0.127	5506
821.98	0.00	300.00	8498.58	0.124	4427	0.136	5711
849.38	0.00	310.00	8781.87	0.131	4589	0.145	5920
876.78	0.00	320.00	9065.16	0.139	4733	0.154	6132
904.18	0.00	330.00	9348.44	0.146	4879	0.136	6349
931.58	0.00	340.00	9631.73	0.154	5028	0.173	6550
958.97	0.00	350.00	9915.01	0.162	5178	0.183	6774
986.37	0.00	360.00	10198.30	0.170	5332	0.194	6982
1013.77	0.00	370.00	10481.59	0.178	5465	0.204	7193
1041.17	0.00	380.00	10764.87	0.187	5622	0.214	7408
1068.57	0.00	390.00	11048.16	0.196	5759	0.225	7626
1095.97	0.00	400.00	11331.44	0.205	5920	0.236	7826
1164.47	0.00	425.00	12039.66	0.227	6274	0.247	8050
1232.97	0.00	450.00	12747.88	0.252	6662	0.258	8256
1301.47	0.00	475.00	13456.09	0.277	7011	0.27	8465
1369.96	0.00	500.00	14164.31	0.304	7395	0.284	9677
1438.46	0.00	525.00	14872.52	0.331	7763	0.296	8890
1506.96	0.00	550.00	15580.74	0.358	8140	0.308	9107
1575.46	0.00	575.00	16288.95	0.387	8497	0.32	9304
1643.96	0.00	600.00	16997.17	0.416	8863	0.332	9526
1712.45	0.00	625.00	17705.38	0.448	9236		
1780.95	0.00	650.00	18413.60	0.479	9616		
1849.45	0.00	675.00	19121.81				
1917.95	0.00	700.00	19830.03				
1986.45	0.00	725.00	20538.24				
2054.94	0.00	750.00	21246.46				
2123.44	0.00	775.00	21954.67				
2191.94	0.00	800.00	22662.89				
2260.44	0.00	825.00	23371.10				
2328.94	0.00	850.00	24079.32				
2397.44	0.00	875.00	24787.54				
2465.93	0.00	900.00	25495.75				
2534.43	0.00	925.00	26203.97				
2602.93	0.00	950.00	26912.18				
2671.43	0.00	975.00	27620.40				
2739.93	0.00	1000.00	28328.61				
2808.42	0.00	1025.00	29036.83				
2876.92	0.00	1050.00	29745.04				
2945.42	0.00	1075.00	30453.26				
3013.92	0.00	1100.00	31161.47				
3082.42	0.00	1125.00	31869.69				

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