Engineering Data

The following pages of data and physical properties are provided as references in the use and application of Spiral pipe and fittings.

The complexity of air system design engineering has changed dramatically since the 1950's even though the basic formulas have still remained the same. There have been significant additional theories added with new extremely complex and systematic formulas needed to satisfy these computations and provide for further enhancement of the overall systems of today. We have tried to give you the basic information needed for both methods. The old rule of thumb method seems to be the simplest method for smaller and moderate jobs. For complex jobs, we still recommend a certified engineer.

The new method of static loss calculations is far too complex for the average Joe. Therefore, we have given you the quick reference chart approach to simplify and speed up the process.

Basic Definitions

The following are used to describe airflow and will be used extensively in this catalog. Standard air is defined at standard atmospheric pressure (14.7 psia), room temperature (70^0 F) and zero water content; its value is normally taken to be 0.075 lbs/ ft^3.

The volumetric flow rate, many times referred to as "volumes," is defined as the volume or quantity of air that passes a given location per unit of time, i.e. (cfm). It is related to the average velocity and the flow cross-section area in ft^2 by the equation

Q=VA

where Q = volumetric flow rate or cfm,
V= average velocity or fpm, and
A= cross-sectional area in ft^2.

Given any two of these three quantities, the third can readily be determined as follows:

Q=VA or V=Q/A or A=Q/V

There are three different but mathematically related pressures associated with a moving air stream. Static pressure (SP) is defined as the pressure in the duct that tends to burst or collapse the duct and is expressed in inches of water gage (˝wg).

Velocity pressure (VP) is defined as that pressure required to accelerate air from zero velocity to some velocity (V) and is proportional to the kinetic energy of the air stream. Using standard air, the relationship between V and VP is given by

$$V = 4005\sqrt{VP} \quad \textbf{or} \quad VP = \left(\frac{V}{4005}\right)^2$$

VP will only be exerted in the direction of airflow and is always positive.

Total pressure (TP) is defined as the algebraic sum of the static and velocity pressures or TP=SP+VP. Total pressure can be positive or negative with respect to atmospheric pressure and is a measure of energy content of the air stream, always dropping as the flow proceeds downstream through a duct. The only place it will rise is across the fan. Total pressure can be measured with a pitot tube pointing directly upstream and connected to a manometer.

Principles of air flow

Two basic principles of fluid mechanics govern the flow of air in industrial ventilation systems: conservation of mass and conservation of energy. These are essentially bookkeeping laws which state that all mass and all energy must be completely accounted for and it is important to know what simplifying assumptions are included in the principles discussed below:

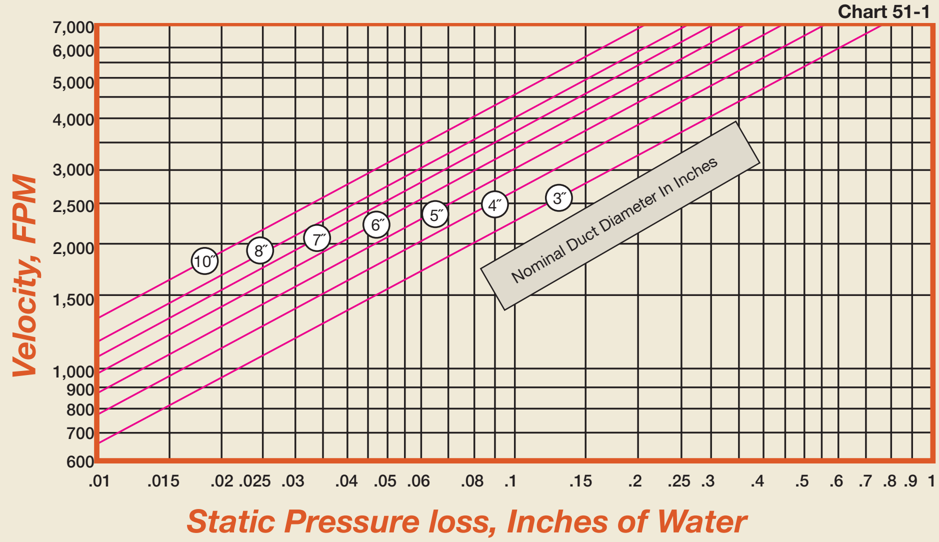
1. Heat transfer effects are neglected. However, if the temperature inside the duct is significantly different than the air temperature surrounding the duct, heat transfer will occur. This will lead to changes in the duct air temperature and hence in the volumetric flow rate.
2. Compressiblity effects are neglected. However, if the overall pressure drop from the start of the system to the fan is greater than about 20 ˝wg, then the density needs to be accounted for.
3. The air is assumed to be dry. Water vapor in the air stream will lower the air density, and correction for this effect, if present, should be made.
4. The weight and volume of the contaminant in the air stream is ignored. This is permissible for the contaminant concentrations in typical exhaust ventilation systems. For high concentrations of solids or significant amounts of some gases other than air, corrections for this effect should be included. ***(Continued on page 54)***

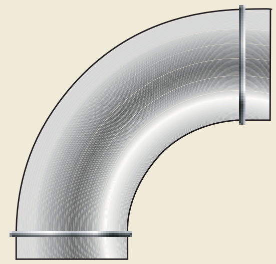
Engineering Data

Static Pressure (SP) Loss for 90° and 45° Die-Formed Elbows

Static Pressure Loss of Die-Formed 90° Elbows

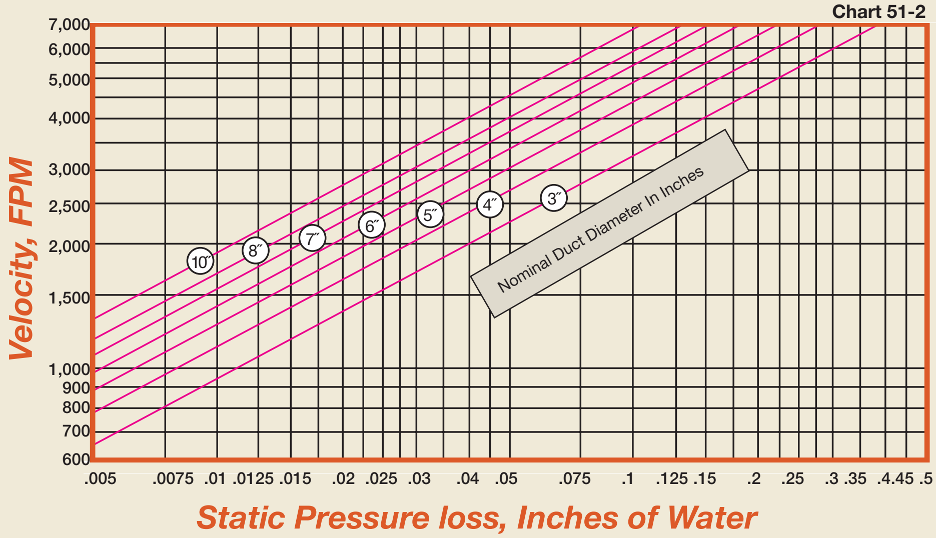
Chart 51-1





Static Pressure Loss of Die-Formed 45° Elbows

Chart 51-2



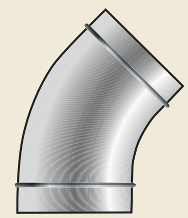


Table 51-1: Duct Pressure Loss Results for Stamped (1.5CLR) Elbows @ 4000 ft/min with .999 (VP)

Size	3”	4”	5”	6”	7”	8”	9”	10”	12”	14”	Elbow Loss Factor
Straight Duct Loss (inches Water):	10.15	7.04	5.31	4.22	3.49	2.95	2.55	2.24	1.79	1.48	
Total Duct Loss (˝wg) 90⁰ Stamped	10.30	7.18	5.46	4.37	3.63	3.01	2.70	2.39	1.94	1.63	0.15
Total Duct Loss (˝wg) 45⁰ Stamped	10.22	7.11	5.38	4.30	3.56	3.14	2.62	2.32	1.86	1.56	0.075
Flow Rate: SCFM	192.5	342.3	534.8	770.2	1068	1396	1732.5	2140	3080	4194	

Based per 100 feet duct length • viscosity (cP).018 • Inlet pressure (psig) 0 • Temp (F) 70° • Galvanized metal roughness (ft) .0005 • Flow region Turbulent, 4000fpm • friction factor 0.02 • velocity pressure .999

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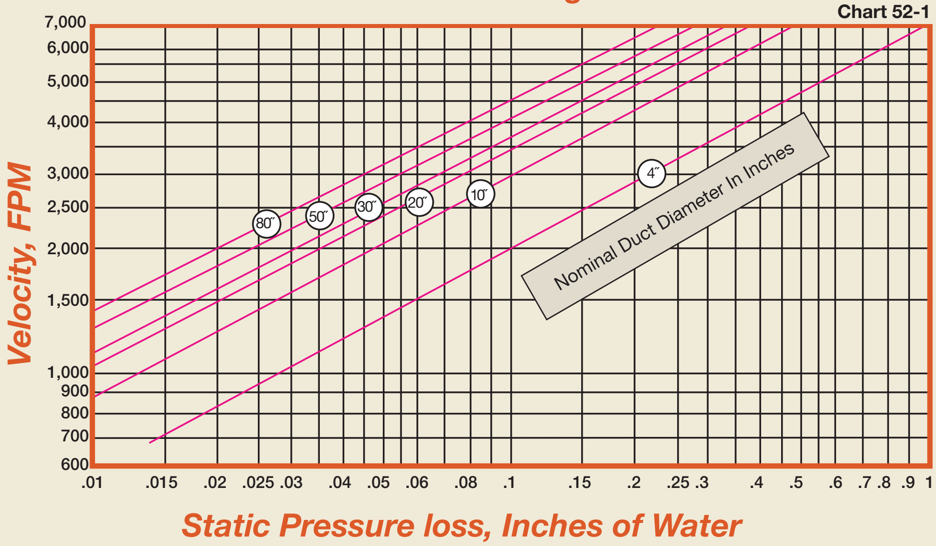
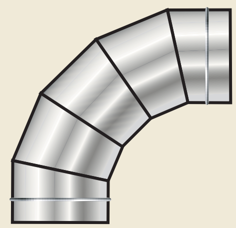
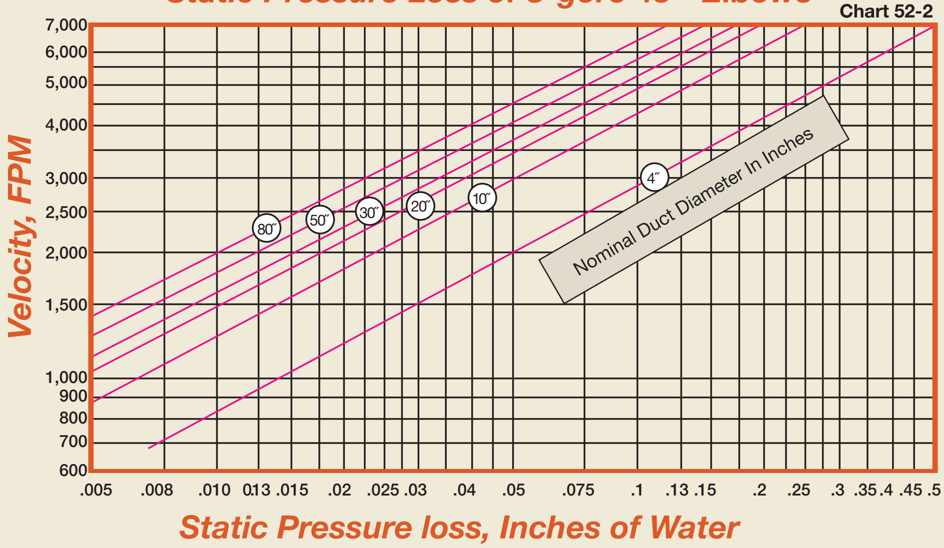
Static Pressure (SP) Loss for 90° and 45°, 5-Gore and 3-Gore Elbows

Static Pressure Loss of 5-gore 90° Elbows





Static Pressure Loss of 3-gore 45 ° Elbows



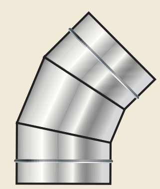


Table 52-1: Duct Pressure Loss Results for Gored (1.5CLR) Elbows @ 4000 ft/min with .999 (VP)

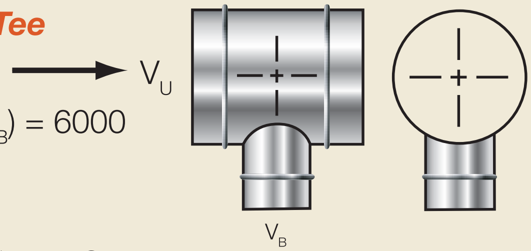
Size	3"	4"	5"	6"	7"	8"	9"	10"	12"	14"	Elbow Loss Factor
Straight Duct Loss (inches Water):	10.15	7.04	5.31	4.22	3.49	2.95	2.55	2.24	1.79	1.48	
Total Duct Loss ("wg) 90⁰ 5 Gore	10.39	7.25	5.55	4.46	3.72	3.19	2.79	2.48	2.03	1.72	0.24
Total Duct Loss ("wg) 45⁰ 3 Gore	10.32	7.21	5.48	4.39	3.65	3.21	2.72	2.41	1.96	1.65	0.17
Flow Rate: SCFM	192.5	342.3	534.8	770.2	1068	1396	1732	2140	3080	4194	

Based per 100 feet duct length • viscosity (cP).018 • Inlet pressure (psig) 0 • Temp (F) 70° • Galvanized metal roughness (ft) .0005 • Flow region Turbulent, 4000fpm • friction factor 0.02 • velocity pressure .999

Engineering Data

Static Pressure (SP) Loss in 90° Tees & Conical Tees

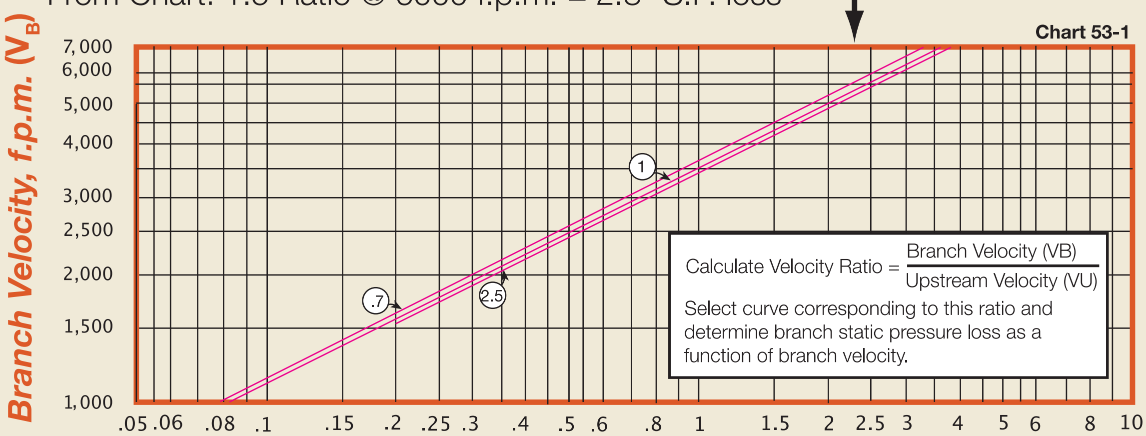
Static Pressure loss in 90° Tee



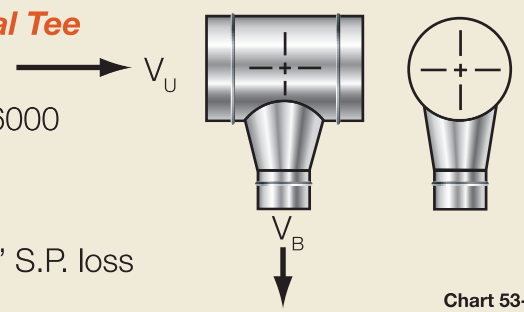
Example: Main (V_U) = 4000, Branch (V_B) = 6000

Velocity Ratio = $\frac{V_B}{V_U} = \frac{6000}{4000} = 1.5$

From Chart: 1.5 Ratio @ 6000 f.p.m. ≅ 2.8" S.P. loss



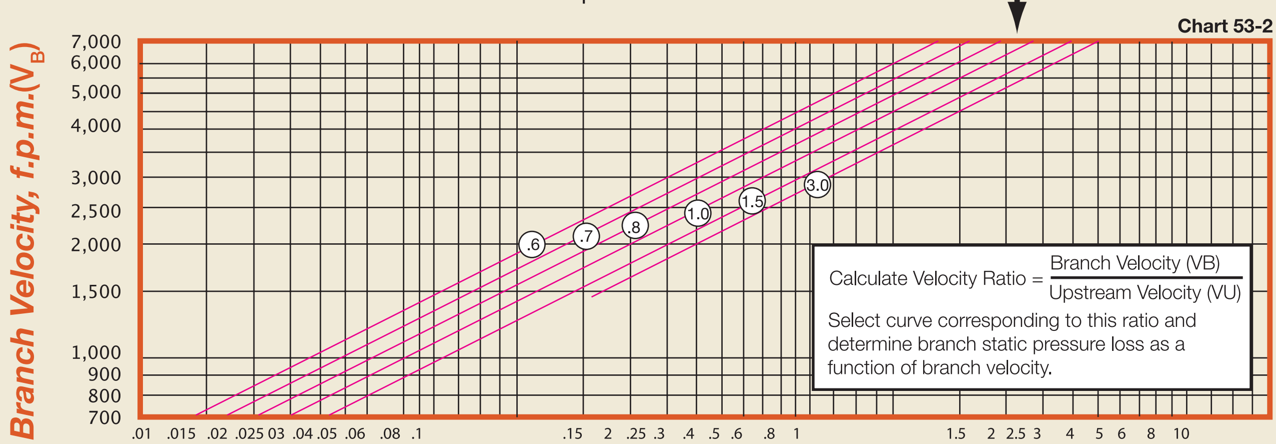
Static Pressure loss in 90° Conical Tee



Example: Main (V_U) = 4000, Branch (V_B) = 6000

Velocity Ratio = $\frac{V_B}{V_U} = \frac{6000}{4000} = 1.5$

From Chart: 1.5 Ratio @ 6000 f.p.m. ≅ 2.3" S.P. loss



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Static Pressure (SP) Loss in 45° Laterals & Branch Entry Loss

Static Pressure loss in 45° Laterals

Example: Main (V_U) = 4000, Branch (V_B) = 6000

$$\text{Velocity Ratio} = \frac{V_B}{V_U} = \frac{6000}{4000} = 1.5$$

From Chart: 1.5 Ratio @ 6000 f.p.m. ≅ 1.9" S.P. loss

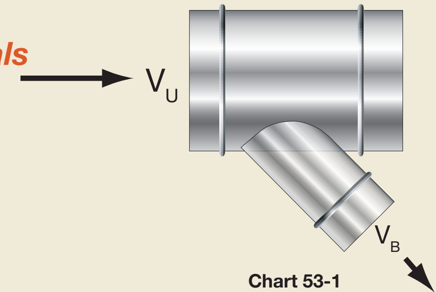
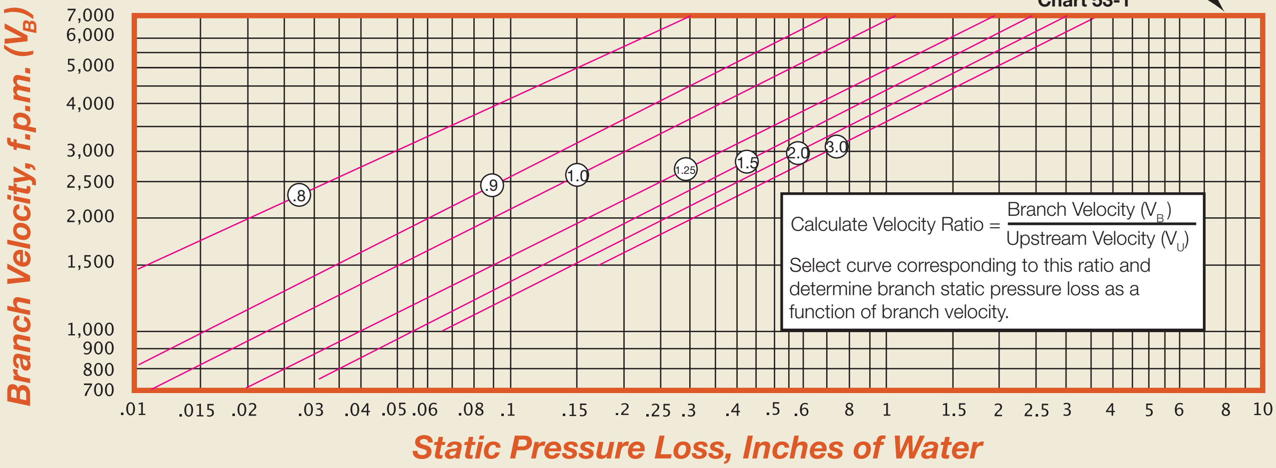
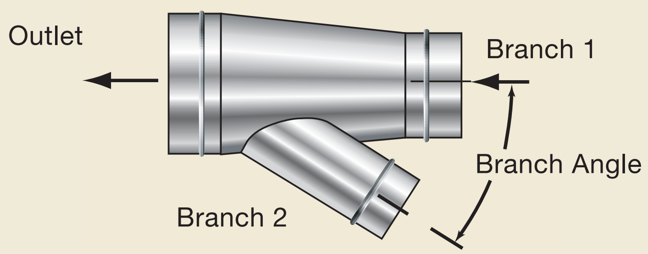


Chart 53-1



Branch Entries



Note that branch entry loss is assumed to occur in the branch for calculations. Enlargement regain should not be included in branch entry enlargements. Any losses due to acceleration of combined flow should be added to the calculations in the outlet pipe.

Table 54-1: Equivalent Resistance in Feet of Straight Duct

Size	30⁰	45⁰	Size	30⁰	45⁰
3"	3	4	**20"**	18	28
4"	4	6	**22"**	20	31
5"	5	7	**24"**	22	34
6"	6	9	**26"**	24	37
7"	6	10	**28"**	26	40
8"	7	11	**30"**	28	43
9"	8	13	**32"**	29	45
10"	9	14	**34"**	31	48
12"	11	17	**36"**	33	51
14"	13	20	**38"**	35	54
16"	15	23	**40"**	37	57
18"	17	26	**42"**	39	60

(Continued from page 50)

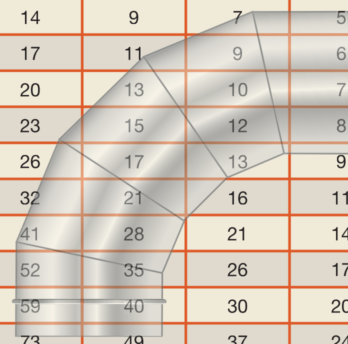
Conservation of mass requires that the net change of mass flow rate must be zero. If the effects discussed on page 51 are negligible, then the density will be constant and the net change of volumetric flow rate (Q) must be zero. Therefore, the flow rate that enters a hood must be the same as the flow rate that passes through the duct leading from the hood. At a branch entry, the sum of the two flow rates that enter the fitting must be equivalent to the total leaving the fitting.

Engineering Data

Equivalent Resistance & Friction Loss Quick Reference Charts

Table 55-1: Elbow Equivalent Resistance In Feet Of Straight Pipe By Center Line Radius (CLR)

	1.5 CLR				2.0 CLR				2.5 CLR			
Size	90⁰ Elbow	60⁰ Elbow	45⁰ Elbow	30⁰ Elbow	90⁰ Elbow	60⁰ Elbow	45⁰ Elbow	30⁰ Elbow	90⁰ Elbow	60⁰ Elbow	45⁰ Elbow	30⁰ Elbow
3"	5	3	3	2	3	2	2	1	3	2	2	1
4"	6	4	3	2	4	3	2	1	4	3	2	1
5"	9	6	5	3	6	4	3	2	5	3	3	2
6"	12	8	6	4	7	5	4	2	6	4	3	2
8"	13	9	7	4	9	6	5	3	7	5	4	2
10"	15	10	8	5	10	7	5	3	8	5	4	3
12"	20	13	10	7	14	9	7	5	11	7	6	4
14"	25	17	13	8	17	11	9	6	14	9	7	5
16"	30	20	15	10	21	14	11	7	17	11	9	6
18"	36	24	18	12	24	16	12	8	20	13	10	7
20"	41	28	21	14	28	19	14	9	23	15	12	8
22"	46	31	23	15	32	21	16	11	26	17	13	9
24"	57	38	29	19	40	27	20	13	32	21	16	11
30"	74	50	37	24	51	34	26	17	41	28	21	14
36"	93	62	47	31	64	43	32	21	52	35	26	17
40"	105	70	53	35	72	48	36	24	59	40	30	20
48"	130	87	65	43	89	60	45	29	73	49	37	24



Losses in Elbows and Fittings. When an air stream undergoes change of either direction or velocity, a dynamic loss occurs. Unlike friction losses in straight duct, fitting losses are due to internal turbulance rather than skin friction. Hence roughness of material has but slight effect over a wide range of moderately smooth materials. Fitting losses can be expressed as equivalent length of straight duct; or as a fraction of velocity pressure; or directly in inches of water gage (˝wg).

Table 55-2: Friction Loss In Inches Of Water (˝WG) Per 100 Feet Of Spiral Pipe

Duct Dia.	Velocity FPM				Duct Dia.	Velocity FPM				Duct Dia.	Velocity FPM			
	3500	4000	4500	5000		3500	4000	4500	5000		3500	4000	4500	5000
3"	7.75	9.99	12.50	15.27	17"	0.93	1.20	1.51	1.84	44"	0.29	0.38	0.47	0.58
4"	5.46	7.03	8.80	10.75	18"	0.87	1.12	1.40	1.72	46"	0.28	0.36	0.45	0.55
5"	4.16	5.36	6.70	8.19	20"	0.77	0.99	1.23	1.51	48"	0.26	0.34	0.42	0.52
6"	3.33	4.29	5.36	6.55	22"	0.68	0.88	1.01	1.34	50"	0.25	0.32	0.40	0.49
7"	2.76	3.55	4.44	5.43	24"	0.61	0.79	0.99	1.21	52"	0.24	0.31	0.38	0.47
8"	2.34	3.02	3.78	4.61	26"	0.56	0.72	0.90	1.01	54"	0.23	0.29	0.37	0.45
9"	2.03	2.62	3.27	4.00	28"	0.51	0.65	0.82	1.00	56"	0.22	0.28	0.35	0.43
10"	1.78	2.30	2.88	3.51	30"	0.47	0.60	0.75	0.92	58"	0.21	0.27	0.34	0.41
11"	1.59	2.05	2.56	3.13	32"	0.43	0.56	0.70	0.85	60"	0.20	0.26	0.32	0.39
12"	1.43	1.84	2.30	2.81	34"	0.40	0.52	0.65	0.79					
13"	1.30	1.67	2.09	2.55	36"	0.37	0.48	0.60	0.74					
14"	1.18	1.53	1.91	2.33	38"	0.35	0.45	0.56	0.69					
15"	1.09	1.40	1.75	2.14	40"	0.33	0.42	0.53	0.65					
16"	1.01	1.30	1.62	1.98	42"	0.31	0.40	0.50	0.61					

$$h_f = 2.74 \frac{(V/1000)^{1.9}}{D^{1.22}}$$

h_f = Friction losses in a duct, "wg.
V = Duct Velocity, fpm
D = Duct Diameter, Inches

This equation gives the friction losses, expressed as "wg per 100 feet of pipe, for standard air of 0.075 lbm/ft³ density flowing through average, clean, round galvanized pipe having approximately 40 slip joints per 100 feet (k = 0.0005 ft.).

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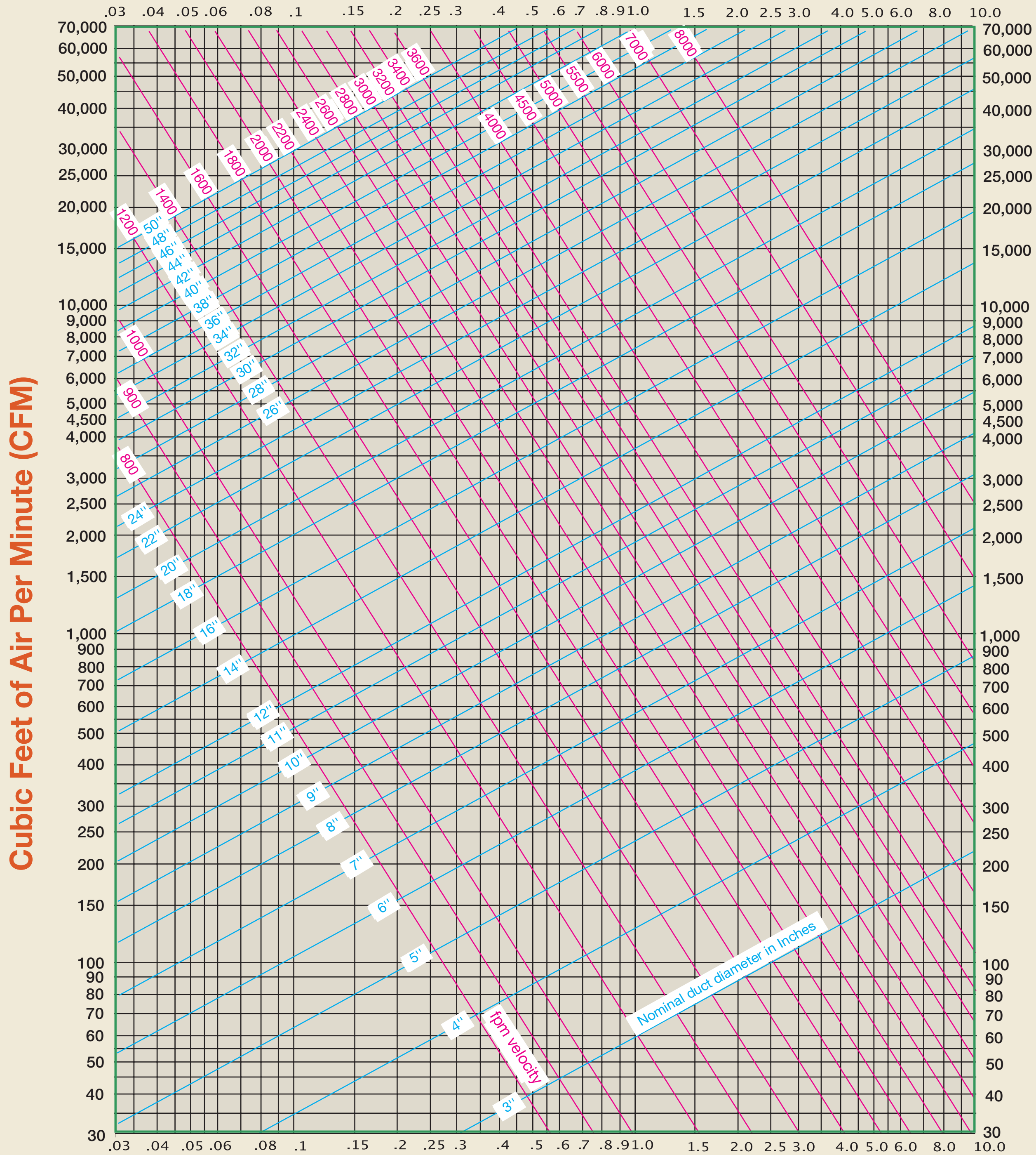
Static Pressure (Friction) Loss of Spiral Pipe

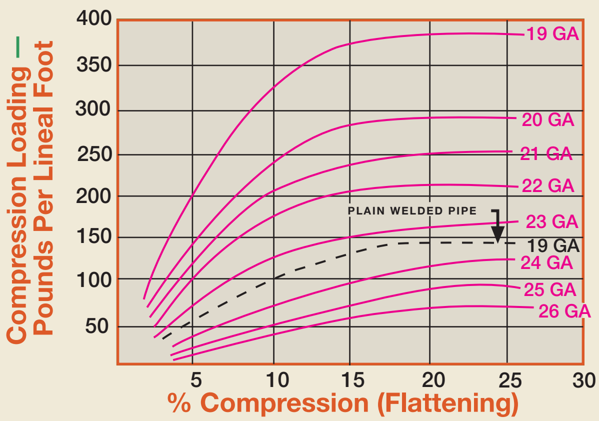


Static Pressure (Friction) Loss in Inches of Water Per 100'

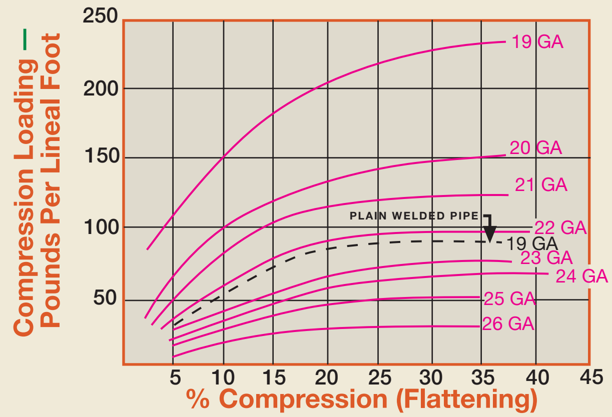
Engineering Data

Compression & Deflection Properties of Spiral Pipe, Static Pressure (SP) Loss in Flexible Rubber Hose

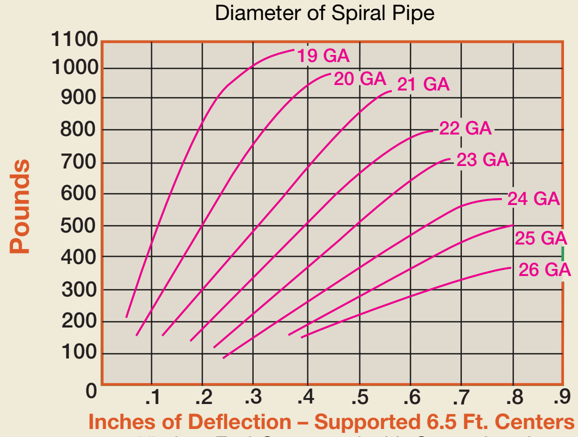
Physical Properties of Spiral Pipe



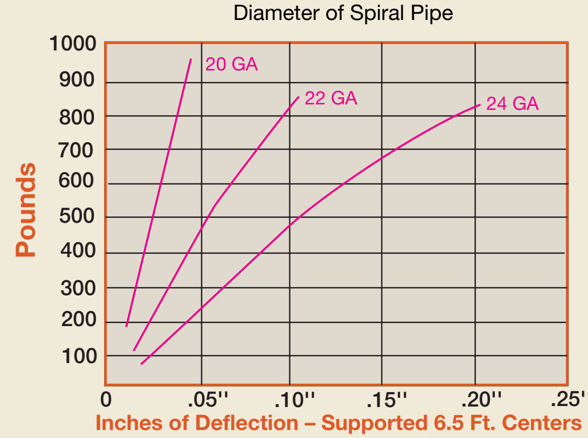
Compression Loading 8" Diameter of Spiral Pipe



Compression Loading 12" Diameter of Spiral Pipe



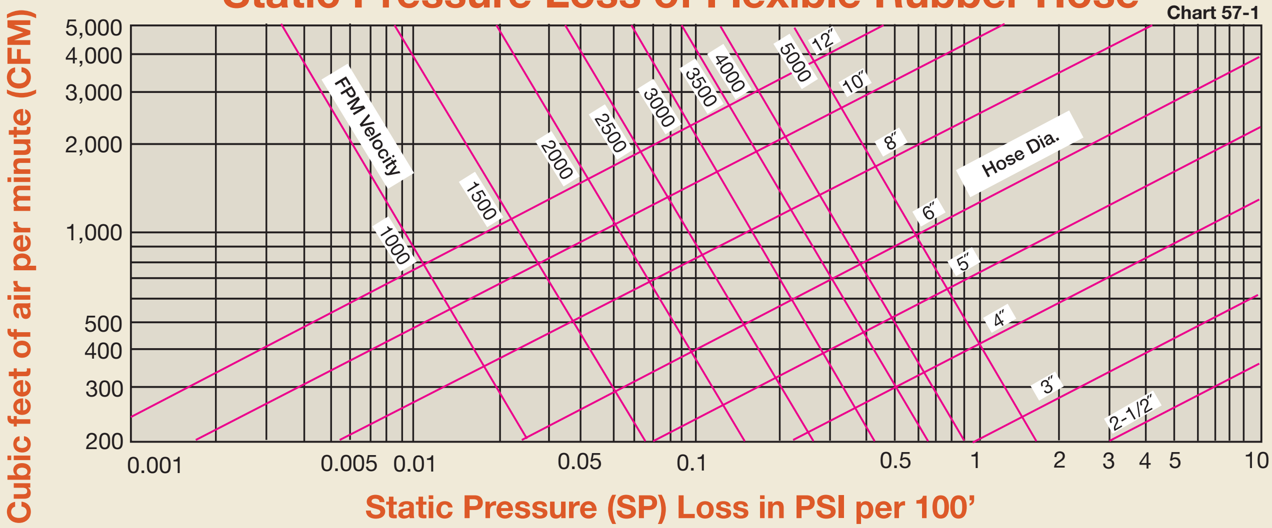
8" pipe, End-Supported with Center Load



12" pipe, End-Supported with Center Load

Static Pressure Loss of Flexible Rubber Hose

Chart 57-1



To convert to inches of water gage multiply by 27.7

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Diameter, Gauge & StrengthProperties; Collapsing & Bursting Pressures

Diameters, Gauge, and Strength Properties of Spiral Pipe

Nominal Diameter (inches)	Steel Guage		Bursting Pressure (Seam Failure) P.S.I		Internal Negative Pressure To Collapse Standard Pipe	
	Std.	Max.	Std.	Max.	In. ˝wg	PSI
3	24	22	*	*	**	**
4	24	20	500	*	**	**
5	24	18	350	*	**	**
6	24	18	275	*	**	**
7	24	18	220	*	**	**
8	24	18	175	460	**	**
9	24	18	150	375	304	11.0
10	24	18	135	325	193	7.0
11	24	18	115	275	111	4.0
12	24	18	95	240	83	3.0
13	24	18	85	220	66	2.4
14	24	18	80	185	47	1.7
15	24	18	72	170	44	1.6
16	24	18	65	160	39	1.4
17	24	18	58	145	36	1.3
18	24	18	53	140	35	1.25
20	24	18	47	120	33	1.2
22	24	18	41	100	33	1.2
24	22	18	48	87	33	1.2
26	22	18	42	78	***	***
28	22	18	37	68	***	***
30	22	18	33	60	***	***
32	22	18	30	55	***	***
34	22	18	28	52	***	***
36	22	18	27	48	***	***
42	22	18	29	37	***	***
48	22	18	25	32	***	***

*Did not fail at 500 PSI   ** Did not fail at -14.7 PSI (-407 in. H_2O)
*** Less than 1.2 PSI

Calculation of wall thickness to diameter ratio: $\left(\frac{T}{D}\right)$

Example: For 24 gauge steel and duct diameter of 13".

$$\left(\frac{T}{D}\right) = .0296/13 = .0023$$

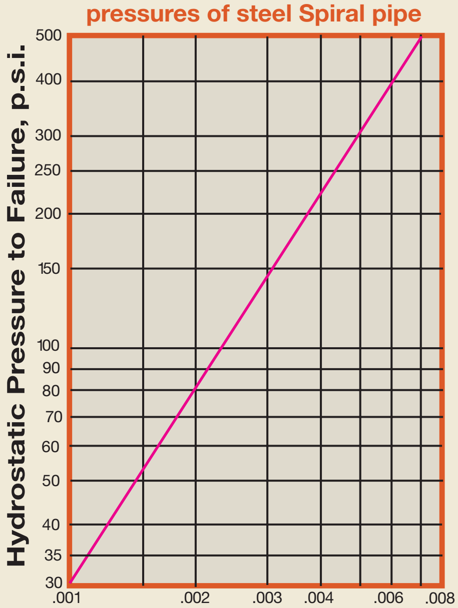
Above reference, for lower charts, to predict bursting and collapsing pressures.

Gauge	Mean Thickness
16	.0635
18	.0516
20	.0396
22	.0336
24	.0276
26	.0217

1 PSI = 27.7 ˝wg   1 ˝wg = .0361 PSI

Properties are approximate, based on both empirical and extrapolated data

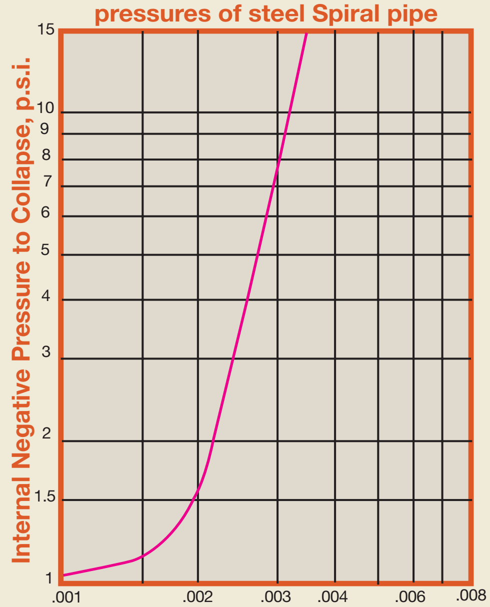
Chart to predict bursting pressures of steel Spiral pipe



Ratio of Wall Thickness to Diameter $\left(\frac{T}{D}\right)$

Refer to upper right corner of page for more details

Chart to predict collapsing pressures of steel Spiral pipe



Ratio of Wall Thickness to Diameter $\left(\frac{T}{D}\right)$

Refer to upper right corner of page for more details

Capacity of Round Pipe 3 to 60 Inches Diameter, 300 to 2400 FPM

Q = VA

Q = CFM
V = VELOCITY
A = AREA IN FT^2

			EXHAUST GRILLES					EHAUST RISERS AND VENT STACKS									EXHAUST MAINS			GASES AND FUMES		
					SUPPLY FLUES AND RISERS																	
										HORIZONTAL SUPPLY DUCTS												
Velocity FPM			300	350	400	450	500	550	600	650	700	750	800	900	1000	1200	1400	1500	1800	2000	2200	2400
Dia. In.	AREA Sq. In.	AREA Sq. Ft.	QUANTITY OF AIR FLOWING, IN CFM																			
3”	7.069	0.0491	15	17	20	22	25	27	29	32	34	37	39	44	49	59	69	74	88	98	108	118
4”	12.566	0.0873	26	31	35	39	44	48	52	57	61	65	70	79	87	105	122	131	157	175	192	209
5”	19.635	0.1364	41	48	55	61	68	75	82	89	95	102	109	123	136	164	191	205	245	273	300	327
6”	28.274	0.1964	59	69	79	88	98	108	118	128	137	147	157	177	196	236	275	295	353	393	432	471
7”	38.485	0.2673	80	94	107	120	134	147	160	174	187	200	214	241	267	321	374	401	481	535	588	641
8”	50.266	0.3491	105	122	140	157	175	192	209	227	244	262	279	314	349	419	489	524	628	698	768	838
9”	63.617	0.4418	133	155	177	199	221	243	265	287	309	331	353	398	442	530	619	663	795	884	972	1060
10”	78.540	0.5454	164	191	218	245	273	300	327	355	382	409	436	491	545	655	764	818	982	1091	1200	1309
12”	113.098	0.7854	236	275	314	353	393	432	471	511	550	589	628	707	785	942	1100	1178	1414	1571	1728	1885
14”	153.938	1.0690	321	374	428	481	535	588	641	695	748	802	855	962	1069	1283	1497	1604	1924	2138	2352	2566
15”	176.715	1.2272	368	430	491	552	614	675	736	798	859	920	982	1104	1227	1473	1718	1841	2209	2454	2700	2945
16”	201.062	1.3963	419	489	559	628	698	768	838	908	977	1047	1117	1257	1396	1676	1955	2094	2513	2793	3072	3351
17”	226.981	1.5763	473	552	631	709	788	867	946	1025	1103	1182	1261	1419	1576	1892	2207	2364	2837	3153	3468	3783
18”	254.470	1.7672	530	619	707	795	884	972	1060	1149	1237	1325	1414	1590	1767	2121	2474	2651	3181	3534	3888	4241
20”	314.160	2.1817	655	764	873	982	1091	1200	1309	1418	1527	1636	1745	1964	2182	2618	3054	3273	3927	4363	4800	5236
22”	380.134	2.6398	792	924	1056	1188	1320	1452	1584	1716	1848	1980	2112	2376	2640	3168	3696	3960	4752	5280	5808	6336
24”	452.390	3.1416	942	1100	1257	1414	1571	1728	1885	2042	2199	2356	2513	2827	3142	3770	4398	4712	5655	6283	6912	7540
26”	530.930	3.6870	1106	1290	1475	1659	1844	2028	2212	2397	2581	2765	2950	3318	3687	4424	5162	5531	6637	7374	8111	8849
28”	615.754	4.2761	1283	1497	1710	1924	2138	2352	2566	2779	2993	3207	3421	3848	4276	5131	5986	6414	7697	8552	9407	10263
30”	706.860	4.9088	1473	1718	1964	2209	2454	2700	2945	3191	3436	3682	3927	4418	4909	5891	6872	7363	8836	9818	10799	11781
32”	804.250	5.5851	1676	1955	2234	2513	2793	3072	3351	3630	3910	4189	4468	5027	5585	6702	7819	8378	10053	11170	12287	13404
34”	907.922	6.3050	1892	2207	2522	2837	3153	3468	3783	4098	4414	4729	5044	5675	6305	7566	8827	9458	11349	12610	13871	15132
36”	1017.878	7.0686	2121	2474	2827	3181	3534	3888	4241	4595	4948	5301	5655	6362	7069	8482	9896	10603	12723	14137	15551	16965
38”	1134.118	7.8758	2363	2757	3150	3544	3938	4332	4725	5119	5513	5907	6301	7088	7876	9451	11026	11814	14176	15752	17327	18902
40”	1256.640	8.7267	2618	3054	3491	3927	4363	4800	5236	5672	6109	6545	6981	7854	8727	10472	12217	13090	15708	17453	19199	20944
42”	1385.446	9.6212	2886	3367	3848	4330	4811	5292	5773	6254	6735	7216	7697	8659	9621	11545	13470	14432	17318	19242	21167	23091
44”	1520.534	10.5593	3168	3696	4224	4752	5280	5808	6336	6864	7391	7919	8447	9503	10559	12671	14783	15839	19007	21119	23230	25342
46”	1661.906	11.5410	3462	4039	4616	5193	5771	6348	6925	7502	8079	8656	9233	10387	11541	13849	16157	17312	20774	23082	25390	27698
48”	1809.562	12.5664	3770	4398	5027	5655	6283	6912	7540	8168	8796	9425	10053	11310	12566	15080	17593	18850	22620	25133	27646	30159
50”	1963.500	13.6354	4091	4772	5454	6136	6818	7499	8181	8863	9545	10227	10908	12272	13635	16363	19090	20453	24544	27271	29998	32725
52”	2123.722	14.7481	4424	5162	5899	6637	7374	8111	8849	9586	10324	11061	11798	13273	14748	17698	20647	22122	26547	29496	32446	35395
54”	2290.226	15.9044	4771	5567	6362	7157	7952	8747	9543	10338	11133	11928	12723	14314	15904	19085	22266	23857	28628	31809	34990	38170
56”	2463.014	17.1043	5131	5986	6842	7697	8552	9407	10263	11118	11973	12828	13683	15394	17104	20525	23946	25656	30788	34209	37629	41050
58”	2642.086	18.3478	5504	6422	7339	8257	9174	10091	11009	11926	12843	13761	14678	16513	18348	22017	25687	27522	33026	36696	40365	44035
60”	2827.440	19.6350	5891	6872	7854	8836	9818	10799	11781	12763	13745	14726	15708	17672	19635	23562	27489	29453	35343	39270	43197	47124

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Capacity of Round Pipe 3 to 60 Inches Diameter, 2500 to 7000 FPM

Q = VA Q = CFM V = VELOCITY A = AREA IN FT²			GAS & FUMES			LINT, BAKELITE POWDER, COTTON, FLOOR						PULVERIZED COAL, FOUNDRY DUST, METAL DUST , OATS, RUBBER BUFFINGS, DRY SAWDUST AND SHAVINGS, WOOD DUST			ALUMINUM DUST, COTTON SEED, KNOTS, BARK, PAPER TRIM, GREEN SHAVINGS, WOOD CHIPS, WOOL			BARLEY, CORN, GRANITE DUST, HOG WASTE, RYE,WET SAWDUST, SUGAR, WHEAT, WOOD BLOCK AND FIBER			CEMENT DUST, SALT, SAND	
Velocity FPM			2500	2600	2800	3000	3200	3400	3600	3800	4000	4200	4400	4600	4800	5000	5200	5600	6000	6400	6800	7000
Dia. In.	AREA		QUANTITY OF AIR FLOWING, IN CFM																			
	Sq. In.	Sq. Ft.																				
3"	7.069	0.0491	123	128	137	147	157	167	177	187	196	206	216	226	236	245	255	275	295	314	334	344
4"	12.566	0.0873	218	227	244	262	279	297	314	332	349	367	384	401	419	436	454	489	524	559	593	611
5"	19.635	0.1364	341	355	382	409	436	464	491	518	545	573	600	627	655	682	709	764	818	873	927	954
6"	28.274	0.1964	491	511	550	589	628	668	707	746	785	825	864	903	942	982	1021	1100	1178	1257	1335	1374
7"	38.485	0.2673	668	695	748	802	855	909	962	1016	1069	1122	1176	1229	1283	1336	1390	1497	1604	1710	1817	1871
8"	50.266	0.3491	873	908	977	1047	1117	1187	1257	1326	1396	1466	1536	1606	1676	1745	1815	1955	2094	2234	2374	2443
9"	63.617	0.4418	1104	1149	1237	1325	1414	1502	1590	1679	1767	1856	1944	2032	2121	2209	2297	2474	2651	2827	3004	3093
10"	78.540	0.5454	1364	1418	1527	1636	1745	1854	1964	2073	2182	2291	2400	2509	2618	2727	2836	3054	3273	3491	3709	3818
12"	113.098	0.7854	1964	2042	2199	2356	2513	2670	2827	2985	3142	3299	3456	3613	3770	3927	4084	4398	4712	5027	5341	5498
14"	153.938	1.0690	2673	2779	2993	3207	3421	3635	3848	4062	4276	4490	4704	4917	5131	5345	5559	5986	6414	6842	7269	7483
15"	176.715	1.2272	3068	3191	3436	3682	3927	4172	4418	4663	4909	5154	5400	5645	5891	6136	6381	6872	7363	7854	8345	8590
16"	201.062	1.3963	3491	3630	3910	4189	4468	4747	5027	5306	5585	5864	6144	6423	6702	6981	7261	7819	8378	8936	9495	9774
17"	226.981	1.5763	3941	4098	4414	4729	5044	5359	5675	5990	6305	6620	6936	7251	7566	7881	8197	8827	9458	10088	10719	11034
18"	254.470	1.7672	4418	4595	4948	5301	5655	6008	6362	6715	7069	7422	7775	8129	8482	8836	9189	9896	10603	11310	12017	12370
20"	314.160	2.1817	5454	5672	6109	6545	6981	7418	7854	8290	8727	9163	9599	10036	10472	10908	11345	12217	13090	13963	14835	15272
22"	380.134	2.6398	6600	6864	7391	7919	8447	8975	9503	10031	10559	11087	11615	12143	12671	13199	13727	14783	15839	16895	17951	18479
24"	452.390	3.1416	7854	8168	8796	9425	10053	10681	11310	11938	12566	13195	13823	14451	15080	15708	16336	17593	18850	20106	21363	21991
26"	530.930	3.6870	9218	9586	10324	11061	11798	12536	13273	14011	14748	15485	16223	16960	17698	18435	19172	20647	22122	23597	25072	25809
28"	615.754	4.2761	10690	11118	11973	12828	13683	14539	15394	16249	17104	17959	18815	19670	20525	21380	22236	23946	25656	27367	29077	29932
30"	706.860	4.9088	12272	12763	13745	14726	15708	16690	17672	18653	19635	20617	21599	22580	23562	24544	25526	27489	29453	31416	33380	34361
32"	804.250	5.5851	13963	14521	15638	16755	17872	18989	20106	21223	22340	23457	24574	25691	26808	27925	29042	31276	33510	35744	37978	39095
34"	907.922	6.3050	15763	16393	17654	18915	20176	21437	22698	23959	25220	26481	27742	29003	30264	31525	32786	35308	37830	40352	42874	44135
36"	1017.878	7.0686	17672	18378	19792	21206	22620	24033	25447	26861	28274	29688	31102	32516	33929	35343	36757	39584	42412	45239	48066	49480
38"	1134.118	7.8758	19690	20477	22052	23627	25203	26778	28353	29928	31503	33078	34654	36229	37804	39379	40954	44105	47255	50405	53556	55131
40"	1256.640	8.7267	21817	22689	24435	26180	27925	29671	31416	33161	34907	36652	38397	40143	41888	43633	45379	48869	52360	55851	59341	61087
42"	1385.446	9.6212	24053	25015	26939	28863	30788	32712	34636	36560	38485	40409	42333	44257	46182	48106	50030	53878	57727	61575	65424	67348
44"	1520.534	10.5593	26398	27454	29566	31678	33790	35902	38013	40125	42237	44349	46461	48573	50684	52796	54908	59132	63356	67579	71803	73915
46"	1661.906	11.5410	28853	30007	32315	34623	36931	39239	41548	43856	46164	48472	50780	53089	55397	57705	60013	64630	69246	73863	78479	80787
48"	1809.562	12.5664	31416	32673	35186	37699	40212	42726	45239	47752	50266	52779	55292	57805	60319	62832	65345	70372	75398	80425	85452	87965
50"	1963.500	13.6354	34089	35452	38179	40906	43633	46360	49088	51815	54542	57269	59996	62723	65450	68177	70904	76358	81813	87267	92721	95448
52"	2123.722	14.7481	36870	38345	41295	44244	47194	50143	53093	56043	58992	61942	64891	67841	70791	73740	76690	82589	88488	94388	100287	103236
54"	2290.226	15.9044	39761	41351	44532	47713	50894	54075	57256	60437	63617	66798	69979	73160	76341	79522	82703	89064	95426	101788	108150	111330
56"	2463.014	17.1043	42761	44471	47892	51313	54734	58155	61575	64996	68417	71838	75259	78680	82100	85521	88942	95784	102626	109467	116309	119730
58"	2642.086	18.3478	45870	47704	51374	55043	58713	62383	66052	69722	73391	77061	80730	84400	88070	91739	95409	102748	110087	117426	124765	128435
60"	2827.440	19.6350	49088	51051	54978	58905	62832	66759	70686	74613	78540	82467	86394	90321	94248	98175	102102	109956	117810	125664	133518	137445

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