ENGINEERING DATA MANUAL, NO. 2695

(Formerly Dunham-Bush)

THE PURPOSE OF THIS MANUAL is to provide helpful engineering data to those who specify, sell and install heating systems and equipment. It is supplementary material to Dunham-Bush Product Application Manuals which cover the selection and application of radiation, unit heaters, pumps, specialties, control equipment, etc.

STEAM DATA

Since a pound of steam at atmospheric pressure (14.7 pounds per square inch) occupies a space of more than 26 cubic feet, and a pound of water occupies only about 28 cubic inches, it follows that if a vessel, such as a steam boiler containing water and steam, is closed so that the steam is confined and each pound is not allowed to expand to this 26 cubic feet, a pressure above that of the atmosphere will be produced. The water will now boil at a higher temperature corresponding to the higher pressure.

On the other hand, if a vessel containing steam at atmospheric pressure is closed, and the fire checked, the temperature of the steam will be lowered, and each pound will tend to occupy less than 26 cubic feet. This it cannot do because, owing to the elastic quality of steam, it completely fills the available space at a lesser density, and a partial vacuum is the result. This partial vacuum permits the water to boil at a lower temperature than 212 degrees.

For every pressure of the steam there is a definite temperature at which the water will boil. (See following table.)

3695 44th Street SE - Grand Rapids, MI 49512 - (P) 616-971-3420 - www.mepcollc.com

PROPERTIES OF SATURATED STEAM

Vacuum Inches of Mercury	Absolute Pressure Lbs. per Sq. Inch	Boiling Point, or Steam Temp.	Volume of 1 Lb. of Steam Cu. Ft.	Heat of the Liquid Btu.	Latent Heat of Evap. Btu.	Total Heat of Steam Btu.
29	.452	76.62	706.	44.66	1048.6	1093.2
28	.944	99.93	351.5	67.90	1035.6	1103.6
27	1.435	114.22	236.8	82.15	1027.7	1109.8
26	1.926	124.77	179.5	92.67	1021.7	1114.4
25	2.417	133.22	145.0	101.10	1017.0	1118.1
24	2.908	140.31	121.9	108.18	1012.9	1121.1
23	3.399	146.45	105.4	114.31	1009.4	1123.8
22	3.890	151.87	92.9	119.73	1006.3	1126.0
21	4.382	156.75	83.1	124.61	1003.5	1128.1
20	4.873	161.19	75.2	129.05	1001.0	1130.0
19	5.364	165.24	68.7	133.10	998.6	1131.7
18	5.855	169.00	63.3	136.86	996.4	1133.3
17	6.346	172.51	58.7	140.38	994.3	1134.7
16	6.837	175.80	54.7	143.67	992.4	1136.1
15	7.329	178.91	51.3	146.79	990.6	1137.4
14	7.82	181.82	48.30	149.71	988.8	1138.5
13	8.31	184.61	45.61	152.50	987.1	1139.6
12	8.80	187.21	43.27	155.11	985.6	1140.7
11	9.29	189.75	41.12	157.66	984.0	1141.7
10	9.78	192.19	39.16	160.10	982.6	1142.7
9	10.28	194.50	37.41	162.42	981.2	1143.6
8	10.77	196.73	35.81	164.65	979.9	1144.5
7	11.26	198.87	34.35	166.81	978.5	1145.3
6	11.75	200.96	32.99	168.90	977.2	1146.2
5	12.24	202.92	31.77	170.87	976.0	1146.9
4	12.73	204.85	30.62	172.81	974.8	1147.6
3	13.22	206.70	29.56	174.67	973.7	1148.4
2	13.71	208.50	28.58	176.48	972.5	1149.1
1	14.20	210.25	27.67	178.24	971.4	1149.7
Pounds Gauge						
0	14.70	212.0	26.79	180.00	970.4	1150.4
1	15.70	215.3	25.20	183.3	968.2	1151.6
2	16.70	218.5	23.78	186.6	966.2	1152.8
4	18.70	224.4	21.40	192.5	962.4	1154.9
6	20.70	229.8	19.45	198.0	958.8	1156.8
8	22.70	234.8	17.85	203.0	955.5	1158.6
10	24.70	239.4	16.49	207.7	952.5	1160.2
15	29.70	249.8	13.87	218.2	945.5	1163.7
25	39.70	266.8	10.57	235.6	933.6	1169.2
50	64.70	297.7	6.68	267.2	911.2	1178.4
75	89.70	320.1	4.91	290.3	894.2	1184.4
100	114.70	337.9	3.891	308.8	880.0	1188.8
125	139.70	352.9	3.225	324.4	867.8	1192.2

NOTE: A cubic inch of water evaporated is converted into 1 cubic foot of steam (approximately).

The density of steam at atmospheric pressure is 0.03732 lbs. per cu. ft.

26.79 cubic feet of steam weigh 1 pound;

13.817 cubic feet of air weigh 1 pound.

STEAM DATA

FLOW OF STEAM IN PIPES

P = loss in pressure in pounds per square inch.
D = inside diameter of pipe in inches.
L = length of pipe in feet.
d = weight of 1 cu ft of steam.
W = pounds of steam per hour.

$$W = 5220\sqrt{\frac{PdD^5}{\left(1+\frac{3.6}{D}\right)L}}$$

$$P = 0.0000000367\left(1+\frac{3.6}{D}\right)\frac{W^2 L}{dD^5}$$

PRESSURE LOSS IN OUNCES	COL. 1 $5220\sqrt{\frac{P}{100}}$	PIPE SIZE Nominal	PIPE SIZE Actual Internal Diameter	INTERNAL AREA OF PIPE SQ. IN.	COL. 2 $\sqrt{\frac{D^5}{1+\frac{3.6}{D}}}$	AVG. STEAM PRESS. PSIG.	COL. 3 $\sqrt{d}$	LGTH. OF PIPE IN FEET	COL. 4 $\sqrt{\frac{100}{L}}$
0.25	65.28	1	1.049	0.864	0.536	—1.0[a]	0.187	20	2.240
0.50	92.28	1¼	1.380	1.496	1.178	—0.5[a]	0.190	40	1.580
1.00	130.5	1½	1.610	2.036	1.828	0.0	0.193	60	1.290
2	184.6	2	2.067	3.356	3.710	0.3	0.195	80	1.120
3	226.0	2½	2.469	4.788	6.109	1.3	0.201	100	1.000
4	261.0	3	3.068	7.393	11.183	2.3	0.207	120	0.912
5	291.8	3½	3.548	9.887	16.705	5.3	0.223	140	0.841
6	319.7	4	4.026	12.730	23.631	10.3	0.248	160	0.793
7	345.3	4½	4.506	15.947	32.134	15.3	0.270	180	0.741
8	369.1	5	5.047	20.006	43.719	20.3	0.290	200	0.710
10	412.7	6	6.065	28.886	71.762	30.3	0.326	250	0.632
12	452.0	7	7.023	38.743	106.278	40.3	0.358	300	0.578
14	488.3	8	7.981	50.027	149.382	50.3	0.388	350	0.538
16	522.0	9	8.941	62.786	201.833	60.3	0.415	400	0.500
20	583.6	10	10.020	78.854	272.592	75.3	0.452	450	0.477
24	639.3	12	12.000	113.098	437.503	100.3	0.507	500	0.447
28	690.5	14	13.250	137.880	566.693	125.3	0.557	600	0.407
32	738.2	16	15.250	182.655	816.872	150.3	0.603	700	0.378
40	825.4					175.3	0.645	800	0.354
48	904.1					200.3	0.685	900	0.333
80	1167.2							1000	0.316
160	1650.7							1200	0.289
320	2334.5							1500	0.258
480	2859.1							2000	0.224

Column 1 × 2 × 3 × 4 = lb of steam per hour that will flow through a straight pipe for a given condition.

Example: 16 oz. drop (1 pound)—3" pipe—10.3 lb. press—200 ft. equivalent length.
522.0 × 11 183 × 0.248 × 0.710 = 1028 lbs. per hour × 4[b] = 4112 sq. ft. equivalent radiation.

Table does not allow for entrained water in low-pressure steam, condensation in covered pipe and roughness in commercial pipe as found in practice.

[a] Pounds per square inch gage = 2.04 in. Vacuum, Mercury Column.
[b] The factor 4 is the approximate equivalent in square feet of steam radiation of 1 lb of steam per hour.

WATER DATA

Doubling the diameter of a pipe increases its capacity 4 times. Friction of liquids in pipes increases as the square of the velocity.

To find the pressure in pounds per square inch of a column of water multiply the height of the column in feet by .434. Approximately every foot elevation is equal to ½ pound pressure per square inch; this allows for ordinary friction.

WEIGHT OF ONE CUBIC FOOT OF PURE WATER

At 32 degrees Fahr. (freezing point) ..... 62.418 lbs.
At 39.1 degrees Fahr. (maximum density) ..... 62.425 lbs.
At 62 degrees Fahr. (standard temperature) ..... 62.355 lbs.
At 212 deg. Fahr. (boiling point, under 1 atmosphere) ..... 59.76 lbs.
Imperial gallon = 277.418 cubic in. of water at 62° Fahr. ..... 10. lbs.
U. S. gallon = 231 cubic in. of water at 62°F. ..... 8.3356 lbs.
Water expands in bulk from 40 degrees to
212 degrees ..... = Approximately 4.3%
A cubic inch of water evaporated under ordinary atmospheric pressure is converted into 1 cubic foot of steam (approximately).

PRESSRE FOR DIFFERENT HEADS OF WATER AT 62° F.

1 foot head = 0.43302 lb. per sq. in. 1 inch head = 0.5774 ounces per sq. in.

Inches of Water to Ounces per Square Inch

Head, inches....	1	2	3	4	5	6	7	8	9	10	11	12
Pressure, ounces.	.577	1.15	1.73	2.31	2.89	3.46	4.04	4.62	5.20	5.77	6.35	6.93

HEAD OF WATER AT 62° F. CORRESPINDING TO DIFFERENT PRESSURES

pound per sq. in. = 2.3095 feet head. 1 ounce per sq. in. = 1.732 of water

Ounces per Square Inch to Inches of Water

Pressure, ounces	1	2	3	4	5	6	7	8
Head, inches	1.73	3.46	5.20	6.93	8.66	10.39	12.12	13.85
Pressure, ounces	9	10	11	12	13	14	15	16
Head, inches	15.59	17.32	19.05	20.78	22.52	24.25	25.98	27.71

WATER DATA

FRICTION OF WATER IN PIPES

Loss of Head in feet due to friction, per 100 feet of new, smooth, wrought iron pipe

Multiply the friction loss in feet by 0.433 to give equivalent loss of pressure in pounds.

G. P. M.	PIPE SIZE (Inches)												
	½	¾	1	1¼	1½	2	2½	3	4	5	6	8	10
5	29.00	7.50	2.32	0.60	0.28	0.09	0.05	....	....	....	....	....	....
10	.....	27.10	8.40	2.18	1.02	0.36	0.12	0.05	.....	.....	....	....	....
15	.....	57.00	18.90	4.65	2.25	0.81	0.25	0.11	.....	.....	....	....	....
20	.....	97.00	30.10	7.90	3.70	1.29	0.43	0.18	.....	.....	....	....	....
25	.....	.....	45.50	11.90	5.60	1.96	0.66	0.27	.....	.....	....	....	....
30	.....	.....	64.00	16.90	7.80	2.73	0.92	0.38	.....	.....	....	....	....
40	.....	.....	109.00	28.50	13.30	4.68	1.57	0.65	0.16	.....	....	....	....
50	.....	.....	.....	43.20	20.20	7.10	2.38	0.98	0.24	.....	....	....	....
75	.....	.....	.....	.....	42.70	14.90	5.07	2.11	0.52	0.17	....	....	....
100	.....	.....	.....	.....	73.00	25.60	8.60	3.52	0.88	0.29	0.10	....	....
125	.....	.....	.....	.....	.....	38.90	13.01	5.40	1.33	0.46	0.20	....	....
150	.....	.....	.....	.....	.....	54.00	18.72	7.72	1.82	0.63	0.23	....	....
175	.....	.....	.....	.....	.....	92.10	23.70	9.75	2.40	0.84	0.34	....	....
200	.....	.....	.....	.....	.....	.....	30.90	12.80	3.12	1.06	0.44	....	....
225	.....	.....	.....	.....	.....	.....	44.30	16.00	4.72	1.33	0.53	....	....
250	.....	.....	.....	.....	.....	.....	.....	19.70	4.80	1.60	0.66	....	....
275	.....	.....	.....	.....	.....	.....	.....	23.60	5.71	1.94	0.82	....	....
300	.....	.....	.....	.....	.....	.....	.....	27.10	6.70	2.25	0.92	....	....
350	.....	.....	.....	.....	.....	.....	.....	.....	8.44	2.92	1.15	0.28	....
400	.....	.....	.....	.....	.....	.....	.....	.....	10.92	3.72	1.50	0.37	....
450	.....	.....	.....	.....	.....	.....	.....	.....	13.88	4.62	1.87	0.46	....
475	.....	.....	.....	.....	.....	.....	.....	.....	14.34	5.06	2.16	0.49	....
500	.....	.....	.....	.....	.....	.....	.....	.....	17.16	5.55	2.22	0.57	....
550	.....	.....	.....	.....	.....	.....	.....	.....	.....	9.60	3.93	0.97	....
600	.....	.....	.....	.....	.....	.....	.....	.....	.....	9.90	4.12	1.06	....
650	.....	.....	.....	.....	.....	.....	.....	.....	.....	10.20	4.25	1.10	....
700	.....	.....	.....	.....	.....	.....	.....	.....	.....	10.90	4.82	1.17	....
750	.....	.....	.....	.....	.....	.....	.....	.....	.....	11.28	5.11	1.22	0.42
1000	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	8.98	2.17	0.74
1500	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	....	4.84	1.62
2000	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	....	8.70	2.84

FRICTION OF WATER IN 90° ELBOWS AND THE EQUIVALENT NUMBER OF FEET OF STAIGHT PIPE

Size of Elbow, inches..	½	¾	1	1¼	1½	2	2½	3	4	5	6
Friction Equiv. Feet Straight Pipe.....	5	6	6	8	8	8	11	15	16	18	18

3695 44th Street SE - Grand Rapids, MI 49512 - (P) 616-971-3420 - www.mepcollc.com

PIPING DATA

THERMAL EXPANSION OF PIPE IN INCHES PER 100 FT.

Saturated Steam			Elongation in Inches per 100 Ft. from −20 F up			
Vacuum Inches of Hg.	Pressure Pounds per Square Inch Gage	Temperature Degrees Fahrenheit	Cast-Iron Pipe	Steel Pipe	Wrought-Iron Pipe	Copper Pipe
		20	0	0	0	0
		0	0.127	0.145	0.152	0.204
		20	0.255	0.293	0.306	0.442
		40	0.390	0.430	0.465	0.655
29.39	.....	60	0.518	0.593	0.620	0.888
28.89	.....	80	0.649	0.725	0.780	1.100
27.99	.....	100	0.787	0.898	0.939	1.338
26.48	.....	120	0.926	1.055	1.110	1.570
24.04	.....	140	1.051	1.209	1.265	1.794
20.27	.....	160	1.200	1.368	1.427	2.008
14.63	.....	180	1.345	1.528	1.597	2.255
6.45	.....	200	1.495	1.691	1.778	2.500
	2.5	220	1.634	1.852	1.936	2.720
	10.3	240	1.780	2.020	2.110	2.960
	20.7	260	1.931	2.183	2.279	3.189
	34.5	280	2.085	2.350	2.465	3.422
	52.3	300	2.233	2.519	2.630	3.665
	74.9	320	2.395	2.690	2.800	3.900
	103.3	340	2.543	2.862	2.988	4.145
	138.3	360	2.700	3.029	3.175	4.380
	180.9	380	2.859	3.211	3.350	4.628
	232.4	400	3.008	3.375	3.521	4.870
	293.7	420	3.182	3.566	3.720	5.118
	366.1	440	3.345	3.740	3.900	5.358
	451.3	460	3.511	3.929	4.096	5.612
	550.3	480	3.683	4.100	4.280	5.855
	664.3	500	3.847	4.296	4.477	6.110
	795.3	520	4.020	4.487	4.677	6.352
	945.3	540	4.190	4.670	4.866	6.614
	1115.3	560	4.365	4.860	5.057	6.850
	1308.3	580	4.541	5.051	5.268	7.123
	1525.3	600	4.725	5.247	5.455	7.338
	1768.3	620	4.896	5.437	5.660	7.636
	2041.3	640	5.082	5.627	5.850	7.893
	2346.3	660	5.260	5.831	6.067	8.153
	2705	680	5.442	6.020	6.260	8.400
	3080	700	5.629	6.229	6.481	8.676
		720	5.808	6.425	6.673	8.912
		740	6.006	6.635	6.899	9.203
		760	6.200	6.833	7.100	9.460
		780	6.389	7.046	7.314	9.736
		800	6.587	7.250	7.508	9.992
		820	6.779	7.464	7.757	10.272
		840	6.970	7.662	7.952	10.512
		860	7.176	7.888	8.195	10.814
		880	7.375	8,098	8.400	11.175
		900	7.579	8.313	8.639	11.360
		920	7.795	8.545	8.867	11.625
		940	7.989	8.755	9.089	11.911
		960	8.200	8.975	9.300	12.180
		980	8.406	9.196	9.547	12.473
		1000	8.617	9.421	9.776	12.747

To obtain the amount of expansion between any two temperatures, take the difference between the figures in the table for those temperatures. For example, if a steel pipe is installed at a temperature of 60 F. and is to operate at 300 F. the expansion would be 2.519 0.593 = 1.926 in.

EQUATION OF PIPES

NUMBER OF PIPES REQUIRED TO EQUAL ONE LARGER PIPE

It is frequently desired to know what number of pipes of a given size are equal in carrying capacity to one pipe of a larger size. At the same velocity of flow the volume delivered by two pipes of different sizes is proportional to the squares of their diameters; thus, one 4-inch pipe will deliver the same volume as four 2-inch pipes. With the same head, however, the velocity is less in the smaller pipe, and the volume delivered varies about as the square root of the fifth power (i.e., as the 2.5 power). The following table has been calculated on this basis. The figure opposite the intersection of any two sizes is the number of the smaller-sized pipes required to equal one of the larger. Thus, one 4-inch pipe is equal to 5.7 2-inch pipes.

Diameter Inches	1	2	3	4	5	6	7	8	9	10	12	14	16	18	20	24
2	5.7	1														
3	15.6	2.8	1													
4	32	5.7	2.1	1												
5	55.9	9.9	3.6	1.7	1											
6	88.2	15.6	5.7	2.8	1.6	1										
7	130	22.9	8.3	4.1	2.3	1.5	1									
8	181	32	11.7	5.7	3.2	2.1	1.4	1								
9	243	43	15.6	7.6	4.3	2.8	1.9	1.3	1							
10	316	55.9	20.3	9.9	5.7	3.6	2.4	1.7	1.3	1						
11	401	70.9	25.7	12.5	7.2	4.6	3.1	2.2	1.7	1.3						
12	499	88.2	32	15.6	8.9	5.7	3.8	2.8	2.1	1.6	1					
13	609	108	39.1	19	10.9	7.1	4.7	3.4	2.5	1.9	1.2					
14	733	130	47	22.9	13.1	8.3	5.7	4.1	3.0	2.3	1.5	1				
15	871	154	55.9	27.2	15.6	9.9	6.7	4.8	3.6	2.8	1.7	1.2				
16	.....	181	65.7	32	18.3	11.7	7.9	5.7	4.2	3.2	2.1	1.4	1			
17	.....	211	76.4	37.2	21.3	13.5	9.2	6.6	4.9	3.8	2.4	1.6	1.2			
18	.....	243	88.2	43	24.6	15.6	10.6	7.6	5.7	4.3	2.8	1.9	1.3	1		
19	.....	278	101	49.1	28.1	17.8	12.1	8.7	6.5	5	3.2	2.1	1.5	1.1		
20	.....	316	115	55.9	32	20.3	13.8	9.9	7.4	5.7	3.6	2.4	1.7	1.3	1	
22	.....	401	146	70.9	40.6	25.7	17.5	12.5	9.3	7.2	4.6	3.1	2.2	1.7	1.3	
24	.....	499	181	88.2	50.5	32	21.8	15.6	11.6	8.9	5.7	3.8	2.8	2.1	1.6	1
26	.....	609	221	108	61.7	39.1	26.6	19	14.2	10.9	7.1	4.7	3.4	2.5	1.9	1.2
28	.....	733	266	130	74.2	47	32	22.9	17.1	13.1	8.3	5.7	4.1	3	2.3	1.5
30	.....	871	316	154	88.2	55.9	38	27.2	20.3	15.6	9.9	6.7	4.8	3.6	2.8	1.7
36	.....	.....	499	243	130	88.2	60	43	32	24.6	15.6	10.6	7.6	5.7	4.3	2.8
42	.....	.....	733	357	205	130	88.2	63.2	47	36.2	19	15.6	11.2	8.3	6.4	4.1
48	.....	.....	.....	499	286	181	123	88.2	62.7	50.5	32	21.8	15.6	11.6	8.9	5.7
54	.....	.....	.....	670	383	243	165	118	88.2	67.8	43	29.2	20.9	15.6	12	7.6
60	.....	.....	.....	871	499	316	215	154	115	88.2	55.9	38	27.2	20.3	15.6	9.9

3695 44th Street SE - Grand Rapids, MI 49512 - (P) 616-971-3420 - www.mepcollc.com

HEAT LOSSES FROM PIPING

The following Tables are reprinted from the A.S.H.V.E. Guide.

HEAT LOSSES FROM HORIZONTAL BARE STEEL PIPES. Expressed in Btu per hour per linear foot per degree Fahrenheit difference in temperature between the pipe and surrounding still air at 70° F.

Nominal Pipe Size (Inches)	HOT WATER				STEAM		
	120 F	150 F	180 F	210 F	227.1 F (5 Lb.)	297.7 F (50 Lb.)	337.9 F (100 Lb.)
	TEMPERATURE DIFFERENCE						
	50 F	80 F	110 F	140 F	157.1 F	227.7 F	267.9 F
½	0.455	0.495	0.546	0.584	0.612	0.706	0.760
¾	0.555	0.605	0.666	0.715	0.748	0.866	0.933
1	0.684	0.743	0.819	0.877	0.919	1.065	1.147
1¼	0.847	0.919	1.014	1.086	1.138	1.324	1.425
1½	0.958	1.041	1.148	1.230	1.288	1.492	1.633
2	1.180	1.281	1.412	1.512	1.578	1.840	1.987
2½	1.400	1.532	1.683	1.796	1.883	2.190	2.363
3	1.680	1.825	2.010	2.153	2.260	2.630	2.840
3½	1.900	2.064	2.221	2.433	2.552	2.974	3.215
4	2.118	2.302	2.534	2.717	2.850	3.320	3.590
5	2.580	2.804	3.084	3.303	3.470	4.050	4.385
6	3.036	3.294	3.626	3.886	4.074	4.765	5.160
8	3.880	4.215	4.638	4.960	5.210	6.100	6.610
10	4.760	5.180	5.680	6.090	6.410	7.490	8.115
12	5.590	6.070	6.670	7.145	7.500	8.800	9.530

HEAT LOSS FROM HORIZONTAL TARNISHED COPPER PIPE. Expressed in Btu per hour per linear foot per degree Fahrenheit between the pipe and surrounding still air at 70° F.

Nominal Pipe Size (Inches)	HOT WATER (Type K Copper Tube)				STEAM (Standard Pipe Size Pipe)		
	120 F	150 F	180 F	210 F	227.1 F (5 Lb.)	297.7 F (50 Lb.)	337.9 F (100 Lb.)
	TEMPERATURE DIFFERENCE						
	50 F	80 F	110 F	140 F	157.1 F	227.7 F	267.9 F
½	0.250	0.287	0.300	0.321	0.433	0.500	0.530
¾	0.340	0.381	0.409	0.429	0.533	0.543	0.654
1	0.440	0.475	0.509	0.536	0.636	0.746	0.803
1¼	0.500	0.559	0.618	0.622	0.764	0.878	0.934
1½	0.580	0.656	0.710	0.750	0.904	1.053	1.120
2	0.730	0.825	0.890	0.957	1.101	1.273	1.364
2½	0.880	1.000	1.091	1.143	1.305	1.490	1.605
3	1.040	1.175	1.272	1.343	1.560	1.800	1.940
3½	1.180	1.350	1.454	1.535	1.750	2.020	2.170
4	1.460	1.500	1.635	1.715	1.941	2.240	2.430
4½	.....	.....	.....	.....	2.131	2.465	2.650
5	1.600	1.812	1.980	2.071	2.387	2.770	2.990
6	1.840	2.125	2.270	2.430	2.740	3.210	3.440
8	2.400	2.685	2.910	3.110	3.310	4.050	4.370

PIPE AND FITTING DIMENSIONS

DIMENSIONS OF STANDARD WEIGHT WROUGHT IRON AND STEEL PIPE

Nominal Inside Diam.	Actual Outside Diam.	Actual Inside Diam.	Thickness of Metal	Internal Circumference	External Circumference	Length of Pipe per sq. ft. Inside Surface	Length of Pipe per sq. ft. Outside Surface	Internal Area		External Area		Length of Pipe cont g 1 cu. ft.	U. S. Gallons per Ft. of Pipe	Weight of Pipe per Lin. Ft.	Weight of Water per Lin. Ft. of Pipe	No. of Threads per Inch	Length of Perf. Thread
Ins.	Ins.	Ins.	Ins.	Ins.	Ins.	Feet	Feet	Sq. Ins.	Sq. Ft.	Sq. Ins.	Sq. Ft.	Feet	Gals.	Lbs.	Lbs.	No.	Ins.
⅛	.405	.270	.068	.848	1.272	14.151	9.434	.057	.0004	.128	.0009	2500.0	.0029	.24	.024	27	.19
¼	.540	.364	.088	1.144	1.696	10.500	7.075	.104	.0007	.229	.0016	1383.280	.0054	.42	.045	18	29
⅜	.675	.493	.091	1.552	1.552	2.121	5.658	.191	.0013	.357	.0025	754.322	.0099	.56	.083	18	.30
½	.840	.622	.109	1.957	2.639	6.132	4.547	.304	.0021	.554	.0038	473.840	.0158	.84	.132	14	.39
¾	1.050	.824	.113	2.589	3.299	4.635	3.638	.533	.0037	.866	.0060	270.016	.0277	1.12	.231	14	.40
1	1.315	1.048	.134	3.292	4.131	3.645	2.904	.861	.0060	1.358	.0094	167.246	.0447	1.67	.373	11½	.51
1¼	1.660	1.380	.140	4.335	5.215	2.768	2.301	1.496	.0104	2.164	.0150	96.257	.0777	2.24	.648	11½	.54
1½	1.900	1.610	.145	5.058	5.969	2.372	2.010	2.036	.0141	2.835	.0197	70.727	.1058	2.68	.882	11½	.55
2	2.375	2.067	.154	6.434	7.461	1.848	1.608	3.356	.0233	4.430	.0308	42.908	.1743	3.61	1.453	11½	.58
2½	2.875	2.468	.204	7.753	9.032	1.548	1.329	4.780	.0332	6.492	.0451	30.337	.2483	5.74	2.070	8	.89
3	3.500	3.067	.217	9.635	10.996	1.245	1.091	7.383	.0513	9.621	.0668	19.504	.3835	7.54	3.197	8	.95
3½	4.000	3.548	.226	11.146	12.566	1.077	0.955	9.887	.0687	12.566	.0875	14.567	.5136	9.00	4.291	8	1.00
4	4.500	4.026	.237	12.648	14.137	0.949	.849	12.730	.0884	15.904	.1104	11.312	.6613	10.66	5.512	8	1.05
5	5.563	5.045	.259	15.849	17.475	.757	.687	19.986	.1388	24.301	.1688	7.205	1.038	14.50	8.652	8	1.16
6	6.625	6.065	.280	19.054	20.813	.630	.577	28.890	.2006	34.472	.2394	4.984	1.500	18.76	12.503	8	1.26
8	8.625	7.981	.322	25.076	27.096	.479	.443	50.027	.3474	58.426	.4057	2.876	2.599	28.18	21.664	8	1.46
10	10.75	10.018	.366	31.476	33.772	.381	.355	78.823	.5474	90.763	.6303	1.827	4.095	40.06	34.134	8	1.68
12	12.75	12.000	.375	37.699	40.055	.318	.300	113.098	.7854	127.677	.8867	1.273	5.875	49.00	48.972	8	1.88
13	14	13.25	.375	41.626	43.982	.288	.273	137.887	.9577	153.938	1.0690	1.044	7.163	54.00	59.708	8	2.09
14	15	14.25	.375	44.768	47.124	.268	.255	159.485	1.1075	176.715	1.2272	0.900	8.285	58.00	69.060	8	2.10
15	16	15.25	.375	47.909	50.266	.250	.239	182.665	1.2685	201.062	1.3963	.793	9.489	62.00	79.097	8	2.20
.....	18	17.25	.375	54.193	56.549	.221	.212	239.706	1.6229	254.470	1.7671	.616	12.141	70.00	101.203	.....	.....
.....	20	19.25	.375	60.476	62.832	.198	.191	291.040	2.0211	314.159	2.1817	.495	15.119	78.00	126.026	.....	.....
.....	22	21.25	.375	66.759	69.115	.180	.174	354.657	2.4629	380.134	2.6398	.406	18.424	85.00	153.575	.....	.....
.....	24	23.25	.375	73.042	75.398	.164	.159	424.558	2.9483	452.390	3.1416	.339	22.055	93.00	183.842	.....	.....

NOTE: Pipe from ⅛ inch to 1 inch inclusive is butt-welded, and proved to 300 lbs. per sq. in. Pipe 1¼ inch and larger is lap-welded, and proved to 500 lbs. per sq. inch

3695 44th Street SE - Grand Rapids, MI 49512 - (P) 616-971-3420 - www.mepcollc.com

PIPE AND FITTING DIMENSIONS

SQUARE FEET OF ACTUAL SURFACE FOR VARIOUS LENGTHS OF PIPE

On all lengths over one foot, fractions less than tenths are added to or dropped. For equivalent direct radiation multiply actual surface by 1.25.

Length of Pipe	PIPE SIZE (Inches)										
	¾	1	1¼	1½	2	2½	3	4	5	6	8
1	.275	.346	.434	.494	.622	.753	.916	1.175	1.455	1.739	2.257
2	.5	.7	.9	1.	1.2	1.5	1.8	2.4	2.9	3.5	4.5
3	.8	1.	1.3	1.5	1.9	2.3	2.7	3.5	4.4	5.2	6.8
4	1.1	1.4	1.7	2.	2.5	3.	3.6	4.7	5.8	7.	9.
5	1.4	1.7	2.2	2.4	3.1	3.8	4.6	5.8	7.3	7.7	11.3
6	1.6	2.1	2.6	2.9	3.7	4.5	5.5	7.	8.7	10.5	13.5
7	1.9	2.4	3.	3.4	4.4	5.3	6.4	8.2	10.2	12.1	15.8
8	2.2	2.8	3.5	3.9	5.	6.	7.3	9.4	11.6	13.9	18.
9	2.5	3.1	3.9	4.4	5.6	6.8	8.2	10.6	13.1	15.7	20.3
10	2.7	3.5	4.3	4.9	6.2	7.5	9.1	11.8	14.6	17.4	22.6
11	3.	3.8	4.8	5.4	6.8	8.3	10.	12.9	16.	19.1	24.9
12	3.3	4.1	5.2	5.9	7.5	9.	11.	14.1	17.4	20.9	27.1
13	3.6	4.5	5.6	6.4	8.1	9.8	11.9	15.3	18.9	22.6	29.4
14	3.8	4.8	6.1	6.9	8.7	10.5	12.8	16.5	20.3	24.3	31.6
15	4.1	5.2	6.5	7.4	9.3	11.3	13.7	17.6	21.8	26.1	33.9
16	4.4	5.5	6.9	7.9	10.	12.	14.6	18.8	23.2	27.8	36.1
17	4.7	5.9	7.4	8.4	10.6	12.8	15.5	20.	24.7	29.5	38.4
18	5.	6.2	7.8	8.9	11.2	13.5	16.5	21.2	26.2	31.3	40.6
19	5.2	6.6	8.3	9.4	11.8	14.3	17.4	22.3	27.6	33.1	42.9
20	5.5	6.9	8.7	9.9	12.5	15.	18.3	23.5	29.1	34.8	45.2
21	5.8	7.3	9.1	10.4	13.	15.8	19.2	24.7	30.5	36.5	47.4
22	6.	7.6	9.6	10.9	13.7	16.5	20.2	25.9	32.	38.3	49.7
23	6.3	8.	10.	11.3	14.3	17.3	21.1	27.	33.5	40.	52.
24	6.6	8.3	10.4	11.9	14.9	18.	22.	28.2	34.9	41.7	54.2
25	6.9	8.6	10.9	12.3	15.6	18.8	22.9	29.3	36.3	43.5	56.4
26	7.1	9.	11.3	12.8	16.2	19.5	23.8	30.5	37.8	45.2	58.6
27	7.4	9.4	11.7	13.3	16.8	20.3	24.7	31.7	39.3	47.	61.
28	7.7	9.7	12.2	13.8	17.4	21.	25.6	32.9	40.7	48.7	63.2
29	8.	10.	12.6	14.3	18.	21.8	26.6	34.1	42.2	50.4	65.5
30	8.3	10.4	13.	14.8	18.7	22.5	27.5	35.3	43.6	52.1	67.7
31	8.5	10.7	13.5	15.3	19.3	23.3	28.4	36.4	45.1	53.9	70.
32	8.8	11.1	13.9	15.8	19.9	24.1	29.3	37.6	46.5	55.6	72.2
33	9.1	11.4	14.3	16.3	20.5	24.8	30.2	38.8	48.	57.4	74.4
34	9.4	11.7	14.7	16.8	21.2	25.6	31.1	40.	49.5	59.1	76.7
35	9.6	12.1	15.2	17.3	21.8	26.3	32.	41.1	50.9	60.8	79.
36	9.9	12.5	15.6	17.8	22.4	27.	33.	42.3	52.4	62.6	81.3
37	10.2	12.8	16.1	18.3	23.	27.8	33.9	43.5	53.8	64.3	83.5
38	10.5	13.2	16.5	18.8	23.7	28.5	34.8	44.6	55.2	66.	85.8
39	10.7	13.5	16.9	19.3	24.3	29.3	35.7	45.8	56.7	67.8	88.
40	11.	13.8	17.4	19.8	24.9	30.1	36.6	47.	58.2	69.5	90.2
41	11.3	14.2	17.8	20.3	25.5	30.8	37.6	48.2	59.6	71.3	92.5
42	11.5	14.5	18.2	20.8	26.1	31.6	38.5	49.4	61.1	73.	94.8
43	11.8	14.9	18.7	21.3	26.8	32.3	39.4	50.6	62.5	74.8	97.
44	12.1	15.2	19.1	21.8	27.4	33.1	40.3	51.7	64.	76.5	99.3
45	12.4	15.6	19.5	22.2	28.	33.8	41.2	52.9	65.5	78.2	101.6
46	12.7	15.9	20.	22.7	28.6	34.6	42.2	54.	67.	80.	103.8
47	12.9	16.3	20.4	23.2	29.2	35.3	43.	55.2	68.4	81.7	106.
48	13.2	16.6	20.8	23.7	29.9	36.1	43.9	56.4	69.8	83.5	108.4
49	13.5	17.	21.3	24.2	30.5	36.8	44.8	57.6	71.2	85.1	110.5
50	13.8	17.3	21.7	24.7	31.1	37.6	45.8	58.7	72.7	87.	112.8

PIPE AND FITING DIMENSIONS

STANDARD COMPANION FLANGES AND BOLTS

(For Working Pressure up to 125 Lbs.)
DIMENSIONS

Size Inches	Diam. of Flange Inches	Bolt Circle Inches	No. of Bolts	Size of Bolts Inches	Length of Bolts
¾	3½	2½	4	⅜	1⅜
1	4¼	3⅛	4	½	1½
1¼	4⅝	3½	4	½	1½
1½	5	3⅞	4	½	1¾
2	6	4¾	4	⅝	2
2½	7	5½	4	⅝	2¼
3	7½	6	4	⅝	2¼
3½	8½	7	8	⅝	2½
4	9	7½	8	⅝	2¾
5	10	8½	8	¾	2¾
6	11	9½	8	¾	3
8	13½	11¾	8	¾	3¼
10	16	14¼	12	⅞	3½
12	19	17	12	⅞	3½
14	21	18¾	12	1	4
16	23½	21¼	16	1	4¼

Bolt holes are in multiples of four so that flanges may be made to face any quarter and bolt holes straddle the center line. Bolt holes are drilled ⅛ inch larger than nominal diameter of bolts.

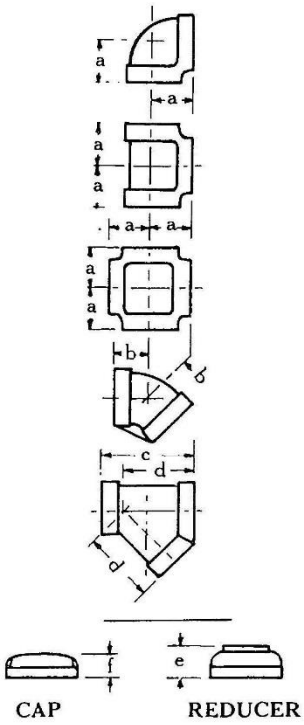
3695 44th Street SE - Grand Rapids, MI 49512 - (P) 616-971-3420 - www.mepcollc.com

PIPE FITTINGS AND DIMENSIONS

PIPE FITTINS AND CONNECTIONS

Size Inches	A	B	C	D	E	F
1/4	13/16	3/4	.....	.....	.....	.....
3/8	15/16	13/16	.....	.....	.....	.....
1/2	1 1/8	7/8	2 1/2	1 7/8	.....	.....
3/4	1 5/16	1	3	2 1/4	.....	.....
1	1 7/16	1 1/8	3 1/2	2 3/4	.....	.....
1 1/4	1 3/4	1 5/16	4 1/4	3 1/4	2 1/8	.....
1 1/2	1 15/16	1 7/16	4 7/8	3 13/16	2 1/4	.....
2	2 1/4	1 11/16	5 3/4	4 1/2	2 7/16	.....
2 1/2	2 11/16	1 15/16	6 3/4	5 3/16	2 11/16	.....
3	3 1/8	2 3/16	7 7/8	6 1/8	2 15/16	.....
3 1/2	3 7/16	2 3/8	8 7/8	6 7/8	3 1/8	.....
4	3 3/4	2 5/8	9 3/4	7 5/8	3 3/8	2 1/16
4 1/2	4 1/16	2 13/16	10 5/8	8 1/2	3 5/8	2 3/16
5	4 7/16	3 1/16	11 5/8	9 1/4	3 7/8	2 3/8
6	5 1/8	3 7/16	13 7/16	10 3/4	4 3/8	2 5/8
7	5 13/16	3 7/8	15 1/4	12 1/4	4 13/16	2 7/8
8	6 1/2	4 1/4	16 15/16	13 5/8	5 1/4	3 1/8
9	7 3/16	4 11/16	20 11/16	16 3/4	5 11/16	3 3/8
10	7 7/8	5 3/16	20 11/16	16 3/4	6 3/16	3 5/8
12	9 1/4	6	24 1/8	19 5/8	7 1/8	4 1/4

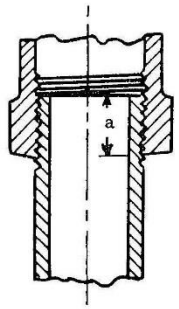
NOTE: The above dimensions are subject to slight alterations by manufacturer.



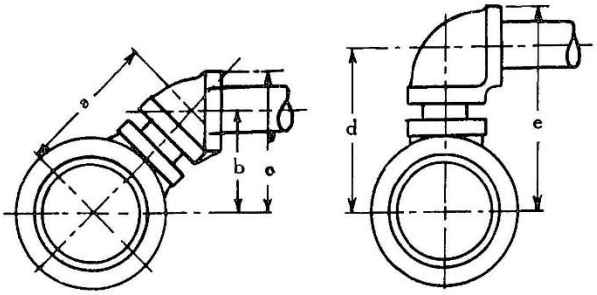
LENGTH OF THREAD ON PIPE THAT IS A SCREWED INTO FITTING TO A MAKE A TIGHT JOINT

Pipe Size (Inches)	Dimension "A" (Inches)	Pipe Size (Inches)	Dimension "A" (Inches)
1/8	1/4	3 1/2	1 1/16
1/4	3/8	4	1 1/16
3/8	3/8	4 1/2	1 1/8
1/2	1/2	5	1 3/16
3/4	1/2	6	1 1/4
1	9/16	7	1 1/4
1 1/4	5/8	8	1 5/16
1 1/2	5/8	9	1 3/8
2	11/16	10	1 1/2
2 1/2	15/16	12	1 5/8
3	1		

NOTE: Dimensions given do not allow for alteration in tapping or threading by manufacturer.



BRANCH CONNECTIONS



Dimension "A" (Inches)

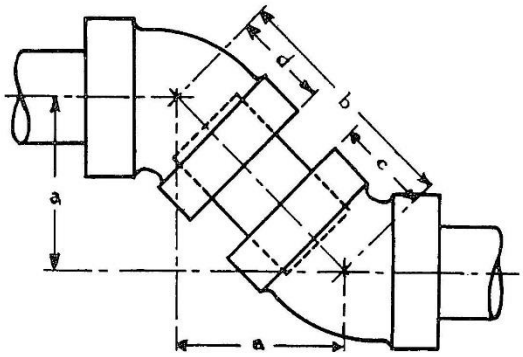
Minimum Height of Connections Off Pipe Mains

Mains (inches)	Branches (inches)	A In.	B In.	C In.	D In.	E In.	Branches (inches)	Mains (inches)
2	1	3 3/8	2 3/8	3 13/32	3 31/32	5	1	2
2	1 1/4	3 11/16	2 5/8	3 7/8	4 7/16	5 11/16	1 1/4	2
2	1 1/2	4	2 27/32	4 7/32	4 13/16	6 3/16	1 1/2	2
2 1/2	1	3 3/4	2 21/32	3 11/16	4 11/32	5 3/8	1	2 1/2
2 1/2	1 1/4	4 1/16	2 7/8	4 1/8	4 13/16	6 1/16	1 1/4	2 1/2
2 1/2	1 1/2	4 3/8	3 3/32	4 15/16	5 3/16	6 9/16	1 1/2	2 1/2
2 1/2	2	4 7/8	3 7/16	5 1/8	5 7/8	7 9/16	2	2 1/2
3	1	4 1/16	2 7/8	3 29/32	4 21/32	5 11/16	1	3
3	1 1/4	4 3/8	3 3/32	4 11/32	5 1/8	6 3/8	1 1/4	3
3	1 1/2	4 11/16	3 5/16	4 11/16	5 1/2	6 7/8	1 1/2	3
3	2	5 5/16	3 11/16	5 3/8	6 3/16	7 7/8	2	3
3	2 1/2	5 9/16	3 15/16	6	6 13/16	8 7/8	2 1/2	3
3 1/2	1	4 11/32	3 1/16	4 3/32	4 15/16	5 31/32	1	3 1/2
3 1/2	1 1/4	4 21/32	3 5/16	4 9/16	5 13/32	6 21/32	1 1/4	3 1/2
3 1/2	1 1/2	4 31/32	3 17/32	4 9/32	5 25/32	7 5/32	1 1/2	3 1/2
3 1/2	2	5 15/32	3 7/8	5 9/16	6 15/32	8 5/32	2	3 1/2
3 1/2	2 1/2	5 27/32	4 1/8	6 3/16	7 3/32	9 5/32	2 1/2	3 1/2
4	1	4 11/16	3 5/16	4 11/32	5 9/32	6 5/16	1	4
4	1 1/4	5	3 17/32	4 25/32	5 3/4	7	1 1/4	4
4	1 1/2	5 5/16	3 3/4	5 1/8	6 1/8	7 1/2	1 1/2	4
4	2	5 13/16	4 1/8	5 13/16	6 13/16	8 1/2	2	4
4	2 1/2	6 3/16	4 3/8	6 7/16	7 7/16	9 1/2	2 1/2	4
5	1 1/4	5 17/32	3 29/32	5 5/32	6 9/32	7 17/32	1 1/4	5
5	1 1/2	5 27/32	4 1/8	5 1/2	6 21/32	8 1/32	1 1/2	5
5	2	6 11/32	4 1/2	6 3/16	7 11/32	9 1/32	2	5
5	2 1/2	6 23/32	4 3/4	6 13/16	7 31/32	10 1/32	2 1/2	5
6	1 1/4	6 3/16	4 3/8	5 1/8	6 15/16	8 3/16	1 1/4	6
6	1 1/2	6 1/2	4 5/8	6	7 5/16	8 11/16	1 1/2	6
6	2	7	4 31/32	6 21/32	8	9 11/16	2	6
6	2 1/2	7 3/8	5 7/32	7 9/32	8 5/8	10 11/16	2 1/2	6
8	2	8 1/4	5 27/32	7 17/32	9 1/4	10 15/16	2	8
8	2 1/2	8 5/8	6 1/8	8 3/16	9 7/8	11 15/16	2 1/2	8
8	3	9	6 3/8	8 3/4	10 7/16	12 13/16	3	8

NOTE: The above table prepared by F. Du Bois Ingalls, M.E., indicates dimensions of branch connections when made up as close as possible with close nipple between tee on main and branch nipple.

PIPE FITTINGS AND DIMENSIONS

OFFSET CONNECTIONS

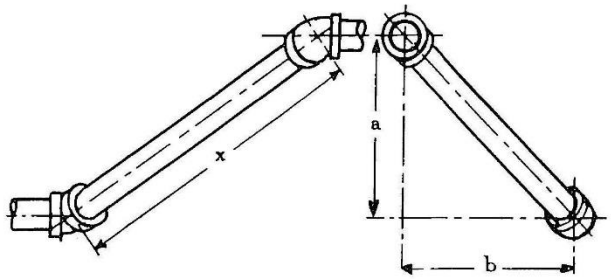


Pipe Size (inches)	DIMENSIONS IN INCHES — Close Nipple: Length of Nipple	Offset "A"	Center to Center "B"	Center to Face "C"	Short Nipple: Length of Nipple	Offset "A"	Center to Center "B"	Center to Face "C"
½	1 1/8	1 5/16	1 7/8	7/8	1 1/2	1 9/16	2 1/4	7/8
¾	1 3/8	1 11/16	2 3/8	1	2	2 3/16	3	1
1	1 1/2	1 7/8	2 5/8	1 1/8	2	2 1/4	3 1/8	1 1/8
1 ¼	1 5/8	2 1/8	3	1 5/16	2 1/2	2 3/4	3 7/8	1 5/16
1 ½	1 3/4	2 3/8	3 3/8	1 7/16	2 1/2	2 15/16	4 1/8	1 7/16
2	2	2 13/16	4	1 11/16	2 1/2	3 3/16	4 1/2	1 11/16
2 ½	2 1/2	3 3/16	4 1/2	1 15/16	3	3 9/16	5	1 15/16
3	2 5/8	3 9/16	5	2 3/16	3	3 13/16	5 3/8	2 3/16
3 ½	2 3/4	3 13/16	5 3/8	2 3/8	4	4 11/16	6 5/8	2 3/8
4	3	4 5/16	6 1/8	2 5/8	4	5 1/16	7 1/8	2 5/8
4 ½	3	4 1/2	6 3/8	2 13/16	4	5 3/16	7 3/8	2 13/16
5	3 1/4	4 15/16	7	3 1/16	4 1/2	5 13/16	8 1/4	3 1/16
6	3 1/4	5 3/8	7 5/8	3 7/16	4 1/2	6 1/4	8 7/8	3 7/16
7	3 1/2	6 3/16	8 3/4	3 7/8	5	7 1/4	10 1/4	3 7/8
8	3 1/2	6 5/8	9 3/8	4 1/4	5	7 11/16	10 7/8	4 1/4

NOTE: Offset "A" is equal to the distance "B" divided by 1.414.

ROLLING OFFSETS

It is often necessary to calculate the length of a piece of pipe between two 45-degree fittings where there is both a drop and a spread. In the sketch below, "A" represents the drop. "B" the spread, "X" the center to center distance. The formula used is: $X = 1.414\ \sqrt{A^2+B^2}$, which means that the center to center distance equals 1.414 times the square root of the sum of the drop squared plus the spread squared.



Example

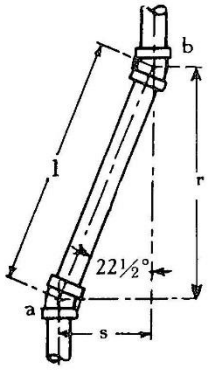
Drop A = 12″
Spread B = 8″
$X = 1.414\ \sqrt{(12)^2+(8)^2}$
$= 1.414\ \sqrt{\quad 208}$
$= 1.414 \times 14.42''$
$= 20.38''$

For rolling offsets using other than 45° elbows, the numbers given in the "Table for Offset Calculations," page 383, may be substituted for 1.414 as follows:

For rolling offsets using 5⅝° elbows . . $X = 10.207\ \sqrt{A^2+B^2}$
For rolling offsets using 11¼° elbows . . $X = 5.126\ \sqrt{A^2+B^2}$
For rolling offsets using 22½° elbows . . $X = 2.613\ \sqrt{A^2+B^2}$
For rolling offsets using 30° elbows . . . . $X = 2\ \sqrt{A^2+B^2}$
For rolling offsets using 60° elbows . . . . $X = 1.155\ \sqrt{A^2+B^2}$

3695 44th Street SE - Grand Rapids, MI 49512 - (P) 616-971-3420 - www.mepcollc.com

OFFEST CALCULATIONS



Example

Set S = 10″, 22½° angle
Length L = S × Factor
(from table below)
L = 10″ × 2.6131
= 26.131″ approx. 26⅛″

Note that the three sides of the triangle are lettered and that each side may be referred to as part of the offset. "S" stands for the short side or "SET" of the offset, "L" for the long side or "LENGTH" of center to center distance of the fittings, and "R" for the "RUN" side.

In calculating the usual offset, side "S" is known and side "L" is required, thus the figures in the top line of the following table are most frequently used.

The Right Triangle is the basis of the solution of all offsets. The angle from which a fitting derives its name is the angle shown as 22½° ("A" and "B").

To Find Side	When You Know Side	Multiply Side	For 5⅜° Elbows By	For 11¼° Elbows By	For 22½° Elbows By	For 30° Elbows By	For 45° Elbows By	For 60° Elbows By
L	S	S	10.207	5.1258	2.6131	2.00	1.41421	1.1547
S	L	L	.0980	.1951	.3827	.50	.707	.866
R	S	S	10.153	5.0273	2.4142	1.732	1.	.5773
S	R	R	.0985	.1989	.4142	.5773	1.	1.732
L	R	R	1.0048	1.0196	1.0824	1.1547	1.41421	2.00
R	L	L	.9952	.9809	.9239	.866	.7071	.500

WEIGHTS AND MEASURES

METRIC AND ENGLISH MEASURES

	METERIC			ENGLISH
Length	1	meter	= 39.37	in.
			= 3.28	ft.
	.3048	meter	= 1	ft.
	1	centimeter	= .3937	in.
	2.54	centimeters	= 1	in.
	1	millimeter	= .03937	in. (1/25 in., approx.)
	25.4	millimeters	= 1	in.
	1	kilometer	= 1093.61	yards
Surface	1	square meter	= 10.764	sq. ft.
	.0929	square meter	= 1	sq. ft.
	1	square centimeter	= .155	sq. in.
	6.452	square centimeters	= 1.	sq. in.
	1	square mill	= .00155	sq. in.
	645.2	square mills	= 1	sq. in.
Volume	1	cubic meter	= 35.314	cubic ft.
	.02832	cubic meter	= 1	cubic ft.
	1	cubic decimeter	= 61.023	cubic in.
			= .0353	cubic ft.
	28.32	cubic decimeters	= 1	cubic ft.
	16.387	cubic centimeters	= 1	cubic in.
	1	cubic centimeter	= 1	millimeter
			= .061	cubic in.
Capacity		liter = 1 cubic decimeter	= 61.023	cubic in.
			= .0353	cubic ft.
			= .2642	gallon (U.S.)
			= 2.202	lbs. of water at 62° F.
	28.317	liters	= 1	cubic ft. (7.481 U.S. gallons)
	4.543	liters	= 1	gallon (Imperial)
	3.785	liters	= 1	gallon (U.S.)
Weight	28.35	grams	= 1	ounce avoirdupois
	1	kilogram	= 2.2046	lbs.
	.4536	kilogram	= 1	lb.
	1	metric ton		
	1000	kilograms	= .9842	ton of 2240 lbs.
	1.012	metric ton		
	1016	kilograms	= 1	ton of 2240 lbs.
Pressure and Weight	1 pound per square inch		= 144	lbs. per sq. ft.
			= 2.0355	ins. of mercury at 32° F.
			= 2.0416	ins. of mercury at 62° F.
			= 2.309	ft. of water at 62° F.
			= 27.71	ins. of water at 62° F.
	1 Atmosphere (14.7 pound per square inch)		= 2116.3	lbs. per sq. ft.
			= 1.0335	kilograms per square centimeter
			= 33.947	ft. of water at 62° F.
			= 30	ins. of mercury at 62° F.
			= 29.922	ins. of mercury at 32° F.
			= 760	millimeters of mercury at 32° F.
	1 Foot of Water at 62° F.		= .433	lb. per sq. in.
			= 62.355	lbs. per sq. ft.
	1 Inch of Mercury at 62° F.		= .491	lb. or 7.86 oz. per sq. in.
			= 1.132	ft. of water at 62° F.
			= 13.58	ins. of water at 62° F.

3695 44th Street SE - Grand Rapids, MI 49512 - (P) 616-971-3420 - www.mepcollc.com

MISCELLANEOUS

1	gram per square millimeter	=	1.422	lb. per sq. in.
1	kilogram per square millimeter	=	1422.32	lb. per sq. in.
1	kilogram per square centimeter	=	14.223	lb. per sq. in.
0.070308	kilogram per square centimeter	=	1	lb. per sq. in.

GENERAL DATA

1 Calorie (KG MEAN)	=	3.968	Btu
1 Btu	=	0.252	KG calorie
1 lb. per sq. in.	=	703.08	kilograms per sq. meter
1 Kilogram per sq. meter	=	.00142	lb. per sq. in.
1 Calorie per sq. meter	=	.3687	Btu per sq. ft.
1 Btu per sq. ft.	=	2.712	calories per sq. meter
1 Calorie per sq. meter per degree difference C.	=	.2048	Btu per sq. ft. per degree difference F.
1 Btu per sq. ft. per degree difference F.	=	4.882	calories per sq. meter per degree difference C.
1 Btu per lb.	=	.556	calories per kilogram
1 Calorie per kilogram	=	1.8	Btu per lb.
1 Liter of Coke at 26.3 lb. per cubic foot	=	.93	lb.
1 lb. of Coke at 26.3 lb. per cu. ft.	=	1.076	liters
Water expands in bulk from 40 degrees to 212 degrees	=	One twenty-third.	

A cubic inch of water evaporated under ordinary atmospheric pressure is converted into 1 cubic foot of steam (approximately).

MISCELLANEOUS DATA

TEMPERATURE CONVERSION FORMULA

To find Fahrenheit temperature when Centigrade temperature is known—(Centigrade Reading $\times$ 1.8) + 32 = Fahrenheit.

To find Centigrade temperature when Fahrenheit temperature is known, $\left(\frac{\text{Fahrenheit Reading} - 32}{1.8}\right)$ = Centigrade temperature.

DECIMAL EQUIVALENTS OF FRACTIONS

Fraction	Dec. Equiv.	Fraction	Dec. Equiv.	Fraction	Dec. Equiv.	Fraction	Dec. Equiv.
1-64	.0156	17-64	.2656	33-64	.5156	49-64	.7656
1-32	.0312	9-32	.2812	17-32	.5312	25-32	.7812
3-64	.0468	19-64	.2968	35-64	.5468	51-64	.7968
1-16	.0625	5-16	.3125	9-16	.5625	13-16	.8125
5-64	.0781	21-64	.3281	37-64	.5781	53-64	.8281
3-32	.0937	11-32	.3437	19-32	.5937	27-32	.8437
7-64	.1093	23-64	.3593	39-64	.6093	55-64	.8593
1-8	.125	3-8	.375	5-8	.625	7-8	.875
9-64	.1406	25-64	.3906	41-64	.6406	57-64	.8906
5-32	.1562	13-32	.4062	21-32	.6562	29-32	.9062
11-64	.1718	27-64	.4218	43-64	.6718	59-64	.9218
3-16	.1875	7-16	.4375	11-16	.6875	15-16	.9375
13-64	.2031	29-64	.4531	45-64	.7031	61-64	.9531
7-32	.2187	15-32	.4687	23-32	.7187	31-32	.9687
15-64	.2343	31-64	.4843	47-64	.7343	63-64	.9843
1-4	.25	1-2	.5	3-4	.75	1	1.0

EQUIVALENTS OF ELECTRICAL UNITS

1 Watt = 44.236 foot-pounds minute
1 Watt = 2654.16 foot-pounds hour
1 Kilowatt = 44235 foot-pounds minute
1 Kilowatt = 1.34 H.P.
1 Kilowatt = 0.955 B.T.U. per second
1 Kilowatt = 57.3 B.T.U. per minute
1 Kilowatt = 3438 B.T.U. per hour
1 Horse Power = 33000 foot-pounds minute
1 Horse Power = 746 Watts
1 Horse Power = 42.746 B.T.U. per minute
1 Horse Power = 2564.76 B.T.U. per hour
1 B.T.U. (British Thermal Unit) = 772 ft. lbs.
1 B.T.U. = 17.452 watt minutes
1 B.T.U. = 0.2909 watt hour

3695 44th Street SE - Grand Rapids, MI 49512 - (P) 616-971-3420 - www.mepcollc.com

NUMBER OF U.S. GALLONS IN ROUND TANKS

Diameter (inches)

Depth or Length	18-inch	24-inch	30-inch	36-inch	42-inch	48-inch	54-inch	60-inch	66-inch	72-inch
1 Inch	1.10	1.96	3.06	4.41	5.99	7.83	9.91	12.24	14.81	17.62
1 ft.	13.	23.	37.	53.	72.	94.	119.	147.	178.	211.
1½ ft.	20.	35.	55.	79.	108.	141.	179.	220.	267.	317.
2 ft.	26.	47.	73.	106.	144.	188.	238.	294.	355.	423.
2½ ft.	33.	59.	92.	132.	180.	235.	298.	367.	444.	529.
3 ft.	40.	71.	110.	159.	216.	282.	357.	441.	533.	634.
3½ ft.	46.	82.	129.	185.	252.	329.	417.	514.	622.	740.
4 ft.	53.	94.	147.	211.	288.	376.	476.	587.	711.	846.
4½ ft.	59.	106.	165.	238.	324.	423.	536.	661.	800.	952.
5 ft.	66.	118.	183.	264.	360.	470.	597.	734.	889.	1157.
5½ ft.	73.	129.	202.	291.	396.	517.	657.	808.	977.	1263.
6 ft.	79.	141.	220.	317.	432.	564.	714.	881.	1066.	1369.
7 ft.	92.	164.	257.	370.	504.	658.	833.	1028.	1244.	1580.
8 ft.	106.	188.	294.	423.	576.	752.	952.	1175.	1422.	1792.
9 ft.	119.	212.	330.	476.	648.	846.	1071.	1322.	1599.	2003.
10 ft.	132.	235.	367.	529.	720.	940.	1190.	1469.	1777.	2115.
12 ft.	157.	282.	440.	634.	864.	1128.	1428.	1762.	2133.	2537.
14 ft.	185.	329.	514.	740.	1008.	1316.	1666.	2056.	2488.	2960.
16 ft.	211.	376.	587.	846.	1152.	1504.	1904.	2350.	2844.	3383.
18 ft.	238.	423.	661.	952.	1296.	1692.	2142.	2644.	3199.	3806.
20 ft.	264.	470.	734.	1057.	1440.	1880.	2380.	2937.	3554.	4229.

NOTE: One-inch depth is given to facilitate figuring intermediate depths.
For tanks having a diameter other than those given in the table, multiply the square of the diameter in inches by the length in feet and multiply this product by 0.0408 to obtain tank capacity in U. S. gallons. When both diameter and length are given in inches, the capacity in U. S. gallons equals $0.0034 \times d^2 L$.

NUMBER OF U.S. GALLONS IN RECTANGULAR TANKS

(For one foot in depth)

Width of Tank	Length of Tank																				
	2 ft.	2 ft. 6 in.	3 ft.	3 ft. 6 in.	4 ft.	4 ft. 6 in.	5 ft.	5 ft. 6 in.	6 ft.	6 ft. 6 in.	7 ft.	7 ft. 6 in.	8 ft.	8 ft. 6 in.	9 ft.	9 ft. 6 in.	10 ft.	10 ft. 6 in.	11 ft.	11 ft. 6 in.	12 ft.
2 ft.	30	37	45	52	60	67	75	82	90	97	105	112	120	127	135	142	150	157	165	172	180
2 ft. 6 in.	...	47	56	65	75	84	94	103	112	122	131	140	150	159	168	178	187	196	206	215	224
3 ft.	...	...	67	79	90	101	112	123	135	146	157	168	180	191	203	213	224	236	247	258	269
3 ft. 6 in.	...	...	...	92	105	118	131	144	157	170	183	196	209	223	236	249	262	275	288	301	314
4 ft.	...	...	...	...	120	135	150	165	180	194	209	224	239	254	269	284	299	314	329	344	359
4 ft. 6 in.	...	...	...	...	...	151	168	185	202	219	236	252	269	286	303	320	337	353	370	387	404
5 ft.	...	...	...	...	...	...	187	206	224	243	262	281	299	318	337	355	374	393	411	430	449
5 ft. 6 in.	...	...	...	...	...	...	...	226	247	267	288	309	329	350	370	391	411	432	453	473	494
6 ft.	...	...	...	...	...	...	...	...	269	292	314	337	359	381	404	426	449	471	494	516	539
6 ft. 6 in.	...	...	...	...	...	...	...	...	...	316	340	365	389	413	438	462	486	511	535	559	583
7 ft.	...	...	...	...	...	...	...	...	...	...	367	393	419	445	471	497	524	550	576	602	628
7 ft. 6 in.	...	...	...	...	...	...	...	...	...	...	...	421	449	477	505	533	561	589	617	645	673
8 ft.	...	...	...	...	...	...	...	...	...	...	...	...	479	509	540	569	598	628	658	688	718
8 ft. 6 in.	...	...	...	...	...	...	...	...	...	...	...	...	...	540	572	604	636	668	699	731	763
9 ft.	...	...	...	...	...	...	...	...	...	...	...	...	...	...	606	640	673	707	741	774	808
9 ft. 6 in.	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	675	711	746	782	817	853
10 ft.	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	748	785	823	860	898
10 ft. 6 in.	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	825	864	903	943
11 ft.	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	905	946	987
11 ft. 6 in.	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	989	1032
12 ft.	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1077

WEIGHTS OF SHEET STEEL

No. of Gauge	Approximate thickness in fractions of an inch U. S. Standard	Approximate Thickness in decimal parts of an inch U. S. Standard	Weight per square foot in pounds Avoirdupois Steel
0000000	1-2	.5	20.4
000000	15-32	.46875	19.125
00000	7-16	.4375	17.85
0000	13-32	.40625	16.575
000	3-8	.375	15.30
00	11-32	.34375	14.025
0	5-16	.3125	12.75
1	9-32	.28125	11.475
2	17-64	.265625	10.8375
3	1-4	.25	10.2
4	15-64	.234375	9.5625
5	7-32	.21875	8.925
6	13-64	.203125	8.2875
7	3-16	.1875	7.65
8	11-64	.171875	7.0125
9	5-32	.15625	6.375
10	9-64	.140625	5.7375
11	1-8	.125	5.1
12	7-64	.109375	4.4625
13	3-32	.09375	3.825
14	5-64	.078125	3.1875
15	9-128	.0703125	2.86875
16	1-16	.0625	2.55
17	9-160	.05625	2.295
18	1-20	.05	2.04
19	7-160	.04375	1.785
20	3-80	.0375	1.53
21	11-320	.034375	1.4025
22	1-32	.03125	1.275
23	9-320	.028125	1.1475
24	1-40	.025	1.02
25	7-320	.021875	.8925
26	3-160	.01875	.765
27	11-640	.0171875	.70125
28	1-64	.015625	.6375
29	9-640	.0140625	.57375
30	1-80	.0125	.51
31	7-640	.0109375	.44625
32	13-1280	.01015625	.414375
33	3-320	.009375	.3825
34	11-1280	.00859375	.350625
35	5-640	.0078125	.31875
36	9-1280	.00703125	.286875
37	17-2560	.006640625	.2709375
38	1-160	.00625	.255

3695 44th Street SE - Grand Rapids, MI 49512 - (P) 616-971-3420 - www.mepcollc.com

TERMINOLOGY

ABSOLUTE ZERO: The zero from which absolute temperature is reckoned. Approximately -273.2°C or -459.8°F.

AIR CONDITIONING: The simultaneous control of all or at least the first three of those factors affecting both the physical and chemical conditions of the atmosphere within any structure. These factors include temperature, humidity, motion, distribution, dust, bacteria, odors and toxic gases, most of which affect in greater or lesser degree human health or comfort.

AIR, STANDARD: Air with a density of 0.075 lb. per cubic ft. This is substantially equivalent to dry air at 70° F and 29.92 in. (Hg) barometer.

ANEOMETER: An instrument for measuring the velocity of a fluid.

ATMOSPHERIC PRESSURE: The pressure due to the weight of the atmosphere. It is the pressure indicated by a barometer. Standard Atmospheric Pressure or Standard Atmosphere is equivalent to 14.696 lb. or 29.921 in. of mercury at 32° F.

BLAST HEATER: A set of heat transfer coils or sections used to heat air which is drawn or forced through it by a fan.

BLOW (THROW): In air distribution, the distance an air stream travels from an outlet to a position at which air motion along the axis reduces to a velocity of 50fpm. For unit heaters, the distance an air stream travels from a heater without a perceptible rise due to temperature difference and loss of velocity.

BOILER HEATING SURFACE: That portion of the surface of the heat-transfer apparatus in contact with the fluid being heated on one side and the gas or refractory being cooled on the other, in which the fluid being heated forms part of the circulating system; this surface shall be measured on the side receiving heat. This includes the boiler, water walls, water screens and water floor. (A.S.M.E. Power Test Codes Series 1929).

BOILER HORSEPOWER: The equivalent evaporations of 34.5 lbs. of water per hour from and at 212° F. This is equal to a heat output of 970.3 x 34.5 or 33,475 Btu per hour.

BRITISH THERMAL UNIT: Classically the Btu is defined as the quantity of heat required to raise the temperature of 1 lb. if water 1° Fahrenheit. By this definition the exact value depends upon the initial temperature of the water. Several valves of the Btu are in more or less common use, each differing from the others by a slight amount. One of the more common of these is the mean Btu which is defined as $1/180^{th}$ of the heat required to raise the temperature of 1 lb. of water from 32° F to 212° F at a constant atmospheric pressure or 14.696 lbs. per sq. in. absolute.

CENTRAL FAN SYSTEM: A mechanical indirect system of heating, ventilating, or air conditioning in which the air is treated or handled by equipment located outside the rooms served, usually at a central location and is conveyed to and from the rooms by means of a fan and a system of distributing ducts.

CHIMNEY EFFECT: The tendency of air or gas in a duct or other vertical passage to rise when heated due to its lower density compared with that of the surrounding air or gas. In buildings the tendency toward displacement (caused by the difference in temperature) of internal heated air by unheated outside air due to the difference in density of outside and inside air.

COMFORT AIR-CONDITIONING: The process by which simultaneously the temperature, moisture content, movement and quality of the enclosed spaces intended for human occupancy may be maintained within required limits. (See Air Conditioning).

COMFORT LINE: A line on the comfort chart showing relation between the effective temperature and percentage of adults feeling comfortable.

COMFORT ZONE (Average): The range of effective temperatures over which the majority (50 percent or more) of adults feel comfortable.

CONDENSATE: The liquid formed by condensation of a vapor. In steam heating, water condensed from steam.

CONDENSATION: The process of changing a vapor into liquid by the extraction of heat.

CONDUCTANCE, THERMAL: The time rate of heat flow through unit area of a body, of given size and shape, per unit temperature difference. Common unit is: Btu per (hour) (square foot) (Fahrenheit degree). Symbol C.

CONDUCTIVITY, THERMAL: The time rate of heat flow through unit area of a homogeneous substance under the influence of a unit temperature gradient. Common units are: Btu per (hour) (square foot) (Fahrenheit degree per inch). Symbol k.

CONVECTION: The motion resulting in a fluid from the difference in density and the action of gravity. In heat transmission this meaning has been extended to include both forced and natural motion or circulation.

CONVECTOR: An agency of convection. In heat transfer, a surface designed to transfer its heat to a surrounding fluid largely or wholly by convection. The heated fluid may be removed mechanically or by gravity (Gravity Convector). Such a surface may or may not be enclosed or concealed. When concealed and enclosed the resulting device is sometimes referred to as a concealed radiator. (See also definition of Radiator.)

DEGREE-DAY: A unit, based upon temperature difference and time, used in estimating fuel consumption and specifying nominal heating load of a building in winter. For any one day, when the mean temperature is less than 65° F, there exists as many degree-days as there are Fahrenheit degrees difference in temperature between the mean temperature for the day and 65° F.

DIRECT-RETURN SYSTEM (Hot Water): A hot water system in which the water, after it has passed through a heating unit is returned to the boiler along a direct path so that the total distance traveled by the water is the shortest feasible, and so that there are considerable differences in the lengths of the several circuits composing the system.

DOWN-FEED SYSTEM (Steam): A steam heating system in which the supply mains are above the level of the heating units which they serve.

DRAFT HEAD (Side Outlet Enclosure): The height of a gravity convector between the bottom of the heating unit and the bottom of the air outlet opening (Top Outlet Enclosure): The height of a gravity convector between the bottom of the heating unit and the top of the enclosure.

DRAW OFF: A valved connection from the return header of a boiler; it is usually piped to the sewer. Scale and sediment are blown from the boiler through the draw off.

DRIP: A pipe (or a steam trap and a pipe considered as a unit) which conducts condensation from the steam side to the return side of a steam heating system.

DRY HEATING SYSTEMS: Heating systems which utilize air as a medium for conveying heat.

EDR (EQUIVALENT DIRECT RADIATION): The term "EDR" is the result of originally rating heat output of direct radiation (free-standing cast iron radiators and pipe coils) on the basis of the actual square feet of heating surface. However, radiators were found to vary in heat output per square foot of surface depending upon height, depth and width of sections. Consequently, a standard was set up; namely 240 Btu/hr. output per square foot of heating surface. This standard has been adopted for rating present day radiation used with steam. The term now in use is therefore Equivalent Direct Radiation or EDR. One square foot EDR equals 240 Btu/hr.

EQUIVALENT EVAP ORATION: The amount of water a boiler would evaporate, in pounds per hour, if it received feed water at 212° F and vaporized it at the same temperature and corresponding atmospheric pressure.

FURNACE VOLUME (Total): The total furnace volume for horizontal-return tubular boilers and water-tube boilers is the cubical contents of the furnace between the grate and the first plane of entry in to or between tubes. It therefore includes the volume behind the bridge wall as in ordinary horizontal-return tubular boiler settings, unless manifestly ineffective (i.e., no gas flow taking place through it), as in the case of waste-heat boilers with auxiliary coal furnaces, where one part of the furnace is out of action when the other is being used. For Scotch or other internally fired boilers it is the cubical contents of the furnace, flues and combustion chamber, up to the plane of first entry into the tubes. (A.S.M.E. Power Test Codes, Series 1929).

GRATE AREA: The area of the grate surface, measured in square feet, to be used in estimating the rate of burning fuel. This area is construed to mean the a rea measured in the plane of the top surface of the grate, except that with special furnaces, such as those having magazine feed, or special shapes, the grate area shall be the mean area of the active part of the fuel bed taken perpendicular to the path of the gases through it. For furnaces having a secondary grate, such as those in double-grate down draft boilers, the effective area shall be taken as the area of the upper grate plus one-eighth of the area of the lower grate, both areas being estimated as previously defined.

HARTFORD CONNECTION: A manner of connecting pipe and pipe fittings in the bleeder or equalizer between the steam and return headers of a boiler. The connection into the bleeder or equalizer is made at a height which would prevent the boiler water level from lowering dangerously below normal level (because of backward flow in to the return mains or pump discharge lines).

HEAT, LATENT: A term used to express the energy involved in a change of state.

HEAT, SENSIBLE: A term used in heating and cooling to indicate any portion of heat which changes only the temperature of the substances involved.

HEAT TRANSMISSION, COEFFICIENT: Any one of a number of coefficients used in the calculation of heat transmission by conduction, convection and radiation, through various materials and structures. (See thermal conductance, thermal conductivity, thermal resistance, thermal resistivity, thermal transmittance, etc.)

HUMIDITY, ABSOLUTE: The weight of water vapor per unit volume, pounds per cubic foot or grams per cubic centimeter.

HUMIDITY, RELATIVE: The ratio of the weight of water vapor actually present in a unit volume of air to the weight that would be present if the air were saturated with vapor at its actual temperature.

LIFT FITTING OR LIFT CONNECTION: A casting or an assembly of pipe fittings which provides a seal between a horizontal return main and a vertical connection to another return main at a higher level. Used in piping between the outlet tapping of an accumulator tank and the suction connection of a vacuum pump if this distance exceeds 5 ' in height.

LOAD, ESTIMATED DESIGN: In a heating or cooling system, the sum of the useful heat transfer plus heat transfer from or to the connected piping plus heat transfer occurring in any auxiliary apparatus connected to the system. The units are Btu per hour or, in heating, equivalent direct radiation (EDR).

PANEL HEATING: A heating system in which heat is transmitted by both radiation and convection from panel surfaces to both air and surrounding surfaces.

PANEL RADIATOR: A heating unit placed on or flush with a flat wall surface and intended to f unction essentially as a radiator.

PLENUM CHAMBER: An air compartment maintained under pressure and connected to one or more distributing ducts.

PRESSURE, ABSOLUTE: The sum of the gage pressure and the barometric pressure.

PRESSURE, GAGE: Pressure measured from atmospheric pressure as a base. Gage pressure may be indicated by a manometer which has one leg connected to the pressure source and the other exposed to atmospheric pressure.

PROCESS EQUIPMENT: Equipment used for processing, such as kitchen equipment, tannery equipment, clothing manufacturing equipment, cleaning and pressing equipment, laundry equipment, hospital equipment, etc., which usually requires high pressure steam.

RADIANT HEATING: A heating system in which only the heat radiated from panels is effective in providing the heating requirements. The term Radiant Heating is frequently used to include both Panel & Radiant Heating.

RADIATION: A method of heat transfer, by means of rays traveling in direct lines from the source to another body. Also, a term meaning heat transfer units (convectors, radiators, etc.).

RADIATION, EQUIVALENT DIRECT (EDR): A unit of heat delivery of 2 40 Btu per hour. It does not imply 1 4 4 sq. in. of surface.

REFRIGERATION, TON OF: The removal of heat at a rate of 200 Btu per min., 12,000 Btu per hr., or 288,000 Btu per 24 hrs.

RESISTANCE, THERMAL: The reciprocal of thermal conductance. Symbol R.

RESISTIVITY THERMAL: The reciprocal of thermal conductivity. Symbol r.

RETURN, DRY: A return pipe in a steam heating system which carries both water of condensation and air. The dry return is above the level of the water line in the boiler in a gravity system. (See Return, etc.).

RETURN HEADER (of a boiler): The horizontal piping connected to the return tapping or tapping's of the boiler. The bleeder or equalizer of the steam header is connected to the return header. Condensate from the steam header and also from the heating system piping returns to the boiler through the return header.

RETURN MAIN: The horizontal piping through which the heating medium is conveyed from the various return pipes from the radiation to the boiler, return trap, or pump.

RETURN, WET: That part of a return main of a steam heating system which is filled with water of condensation. The wet return usually is below the level of the water line in the boiler, although not necessarily so. (See Return, Dry).

REVERSED-RETURN SYSTEM: A system in which the heating or cooling medium from several heat transfer units is returned along paths arranged so that all circuits composing the system or composing a major sub-division of it are of practically equal length.

RISER: A vertical pipe carrying either steam or condensate from floor to floor in a building.

RUNOUT: The horizontal connection from a convector or radiator to the riser.

SPLIT SYSTEM: A system in which the heating is accomplished by means of radiators or convectors and mechanical circulation of air from a central point supplies the ventilation. (The mechanically circulated air does not supply the heat to balance the heat loss.)

SPRINGPIECE: The horizontal connection from a main to a riser or radiator.

3695 44th Street SE - Grand Rapids, MI 49512 - (P) 616-971-3420 - www.mepcollc.com

SQUARE FOOT OF HEATING SURFACE (Equivalent): This term is synonymous with Equivalent Direct Radiation (EDR).

STACK HEIGHT (CONVECTOR): The height of a gravity convector between the bottom of the heating unit and the top of the outlet opening.

STEAM HEADER (of a boiler): The horizontal piping connected to the boiler steam outlet or outlets. This header serves as a steam reservoir and the steam main or mains are connected to it. A bleeder or equalizer connection between the steam and ret urn headers of the boiler allows condensate to be drained from the header-also equalizes the boiler pressure to keep the boiler water line steady.

STEAM TRAP: A device for allowing the passage of condensate, or air and condensate, and preventing the passage of steam.

STRATIFICATION: Arrangement in strata or layers. In heating, stratification of air may occur in a room with a high ceiling resulting in a marked temperature difference between floor and ceiling.

STUB: The vertical piping connection to a radiator valve or trap from the steam and return riser runouts or spring pieces.

SUPPLY MAIN: The horizontal pipe through which the heating medium flows from the boiler or source of supply to the spring pieces, risers and runouts leading to the heat transfer units.

SURFACE, HEATING: The exterior surface of a heating u nit. Extended heating surface (or extended surface): Heating surface consisting of fins, pins or ribs which receive heat by conduction from the prime surface. Prime Surface: Heating surface having the heating medium on one side and air (or medium to which heat is transfer red) on the other (See also Boiler Heating Surface).

TEMPERATURE, ABSOLUTE: Temperature expressed in degrees above absolute zero.

TEMPERATURE, DEW-POINT: The temperature at which the condensation of water vapor in a space begins for a given state of humidity and pressure as the temperature of the vapor is reduced. The temperature corresponding to saturation (100 per cent relative humidity) for a given absolute humidity at constant pressure.

TEMPERATURE, DRY-BULB: The temperature of a gas or mixture of gases indicated by an accurate thermometer after correction f or radiation.

TEMPERATURE, EFFECTIVE: An arbitrary index which combines into a single value the effect of temperature, humidity, and air movement on the sensation of warmth or cold felt by the human body. The numerical value is that of the temperature of still, saturated air which would induce an identical sensation.

TEMPERATURE, WET-BULB: Thermodynamic wet-bulb temperature is the temperature at which liquid or solid water, by evaporating into air, can bring the air to saturation adiabatically a t the same temperature. Wet-bulb temperature (without qualification) is the temperature indicated by a wet-bulb psychrometer constructed and used according to specifications. (A.S.M.E. Power Test Codes. Series 1932, Instruments and Apparatus, Part 18.)

TRANSMITTANCE, THERMAL: The time rate of heat flow, from the fluid on the warm side to the fluid on the cold side, per (square foot) (degree temperature difference between the two fluids). Sometimes called Over-all Coefficient of Heat Transfer. Common unit is Btu per (hour) (square foot) (Fahrenheit degree). Symbol U.

"U" FACTOR: The time rate of heat Row (expressed in Btu/hr.) for one square foot of surface for a temperature difference of one degree between the fluids (air) on the two sides of this surface.

WATER HAMMER: The noise resulting from steam coming in contact with condensate in pocketed or back-graded piping.

3695 44th Street SE - Grand Rapids, MI 49512 - (P) 616-971-3420 - www.mepcollc.com

PRINTED IN U.S.A.

3 M 1/67 RY PRINTED IN U.S.A.