ENGINEERED
SOLUTIONS

Engineering Guide

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FORMULAS FOR STEAM LOADS

HEATING AIR

$$\frac{\text{C.F.M.} \times 1.08 \times \text{TEMP. RISE}}{1000 \text{ or LATENT HEAT OF STEAM}} = \text{\#/Hr. of STEAM}$$

HEATING LIQUID

$$\frac{\text{U.S. GAL. per HOUR} \times 8.3 \times \text{SPECIFIC HEAT} \times \text{TEMP. RISE}}{1000 \text{ or LATENT HEAT OF STEAM}} = \text{\#/Hr. of STEAM}$$

HEATING WATER (Short Form)

$$\frac{\text{U.S.G.P.M.} \times \text{TEMP. RISE}}{2} = \text{\#/Hr. of STEAM (approximately)}$$

HEATING OIL (Short Form)

$$\frac{\text{U.S.G.P.M.} \times \text{TEMP. RISE}}{4} = \text{\#/Hr. of STEAM (approximately)}$$

NAPIERS FORMULA (To Determine Steam Flow Through An Orifice)

$$W = \frac{P_1 A}{70}$$

W = #/SECOND OF STEAM (Times 3600 For #/Hr.)

P_1 = P.S.I.A. (Gauge Pressure + 14.7)

A = AREA OF ORIFICE IN SQUARE INCHES (πR^2)

STEAM CAPACITY TABLE – FLOW IN POUNDS PER HOUR

These flow rates provide a simple method for sizing steam pipes with inlet velocities in the range of 7,000 to 10,000 fpm.

PRESSURE psi (gage)	TEMPERATURE °F (sat.)	VALVE OR PIPE SIZE																
		¼	⅜	½	¾	1	1¼	1½	2	2½	3	3½	4	5	6	8	10	12
		Velocity, fpm																
		7062	7094	7125	7187	7250	7312	7375	7500	7625	7750	7875	8000	8250	8500	9000	9500	10000
250	406	176	324	518	916	1498	2615	3591	6018	8731	13700	18620	24360	39470	58730	107700	179200	267700
200	388	143	264	423	748	1223	2135	2932	4913	7128	11190	15200	19880	32230	47950	87910	146300	218500
175	378	127	235	375	664	1086	1895	2603	4361	6328	9931	13490	17650	28610	42560	78040	129800	194000
150	366	111	205	328	580	948	1655	2273	3810	5528	8675	11790	15420	24990	37180	68170	113400	169500
125	353	95	175	280	496	811	1415	1943	3256	4724	7414	10070	13180	21360	31780	58260	96940	144800
100	338	79	145	232	411	672	1173	1612	2701	3919	6150	8356	10930	17720	26360	48330	80410	120100
90	331	72	133	213	377	617	1076	1478	2477	3594	5641	7665	10030	16250	24180	44330	73760	110200
80	324	66	121	194	343	561	979	1345	2254	3270	5132	6973	9122	14780	22000	40330	67100	100300
70	316	59	109	175	309	505	881	1211	2029	2943	4619	6277	8211	13310	19800	36300	60400	90240
60	308	53	97	155	274	449	783	1076	1803	2616	4105	5577	7296	11820	17590	32260	53670	80190
50	298	46	85	136	240	392	684	940	1575	2286	3587	4874	6376	10330	15380	28190	46900	70080
40	287	39	72	116	205	335	585	803	1346	1953	3066	4166	5449	8831	13140	24090	40080	59890
30	274	33	60	96	170	278	485	666	1115	1618	2539	3451	4514	7315	10880	19960	33200	49610
25	267	29	54	86	152	249	434	596	999	1449	2274	3090	4042	6551	9747	17870	29730	44430
20	259	26	47	76	134	219	383	526	881	1279	2006	2726	3566	5780	8600	15770	26230	39200
15	250	22	41	66	116	190	331	455	763	1107	1737	2360	3087	5003	7444	13650	22710	33930
10	240	19	35	55	98	160	279	384	643	933	1464	1990	2603	4218	6276	11510	19150	28610
5	228	15	28	45	79	130	227	311	522	757	1188	1615	2112	3423	5093	9339	15540	23220
0	212	11	21	34	60	97	170	233	391	568	891	1210	1583	2566	3818	7000	11650	17400

VALVE SIZING BY COMPUTATION

FORMULA KEY

D = Degree Superheat (°F) = Total Steam Temperature – Saturated Steam Temperature					
$\bar{v}$ = Specific Volume $F_T^3/\#$	Cv = Valve Coefficient		W = Flow, #/Hr. (Saturated Steam)		
Q = SCFH	S = Specific Gravity		ΔP = Pressure Drop, psi		
T = Absolute T (T + 460)°R	EDR = Equivalent Direct Radiation (Sq. Ft.)		P_1 = Inlet Pressure, psia (psi + 14.7)		
V = Velocity FPM. or FPS			P_2 = Reduced Pressure, psia (psi + 14.7)		
A = Area of Pipe in $(inches)^2$			W_s = Flow, #/Hr. Superheated Steam		

To avoid interpolation or solve problems beyond the scope of the table, valve sizes may be determined by calculation as follows:

STEAM: RET. $P_2 \geq 0.58P_1$ $Cv = \dfrac{W}{2.1\sqrt{\Delta P(P_1 + P_2)}}$

CRIT. $P_2 < 0.58P_1$ $Cv = \dfrac{W}{1.71P_1}$

$W = W_s(1 + .0007D)$

$VFPM = 2.4\dfrac{W\bar{v}}{A}$

LIQUIDS: $Cv = \dfrac{GPM}{\sqrt{\dfrac{\Delta P}{S}}}$

GAS: $Cv = \dfrac{Q}{963}\sqrt{\dfrac{ST}{\Delta P(P_1 + P_2)}}$

LOADS:

WATER	$W = \dfrac{GPM}{2}$	X Temp. Rise (°F)
FUEL OIL	$W = \dfrac{GPM}{4}$	X Temp. Rise (°F)
AIR	$W = \dfrac{CFM}{900}$	X Temp. Rise (°F)
RADIATION	$W = \dfrac{F_T^2 EDR}{4}$	
ABSORPTION	W = 16-20 #/Hr./Ton-Hr.	
STM. ATOM	W = 0.1 #/Hr./#Oil	

EQUIVALENTS & CONVERSION FACTORS

A MULTIPLY	B BY	C TO OBTAIN
Atmospheres	14.697	Pounds per sq. in.
Atmospheres	1.033	Kilograms per sq. cm
Atmospheres	29.92	Inches of mercury
Atmospheres	760	Millimeters of mercury
Atmospheres	407	Inches of water
Atmospheres	33.90	Feet of water
Barrels (petroleum)	42	Gallons
Barrels per day	0.0292	Gallons per minute
Bars-G	14.5	Pounds per sq. in.
Centimeters	0.3937	Inches
Centimeters	0.03281	Feet
Centimeters	0.01	Meters
Centimeters	0.01094	Yards
Cubic centimeters	0.06102	Cubic inches
Cubic feet	7.48055	Gallons
Cubic feet	0.17812	Barrels
Cubic feet per second	448.833	Gallons per minute
Cubic inches	16.39	Cubic centimeters
Cubic inches	0.004329	Gallons
Cubic meters	264.17	Gallons
Cubic meters per hour	4.40	Gallons per minute
Feet	0.3048	Meters
Feet	0.3333	Yards
Feet	30.48	Centimeters
Feet of water	0.882	Inches of mercury
Feet of water	0.433	Pounds per sq. in.
Gallons (U.S.)	3785	Cubic centimeters
Gallons (U.S.)	0.13368	Cubic feet
Gallons (U.S.)	231	Cubic inches
Gallons (Imperial)	277.4	Cubic inches
Gallons (U.S.)	0.833	Gallons (Imperial)
Gallons (U.S.)	3.785	Liters
Gallons of water	8.328	Pounds (at 70°F)
Gallons of liquid per minute	500 x Sp. Gr.	Pounds per hr liquid (at 70°F)
Gallons per minute	0.002228	Cubic feet per second
Horsepower (boiler)	34.5	Pounds water per hr. evaporation
Horsepower (boiler)	33479	Btu per hour
Inches	2.54	Centimeters
Inches	0.0833	Feet
Inches	0.0254	Meters
Inches	0.02778	Yards

A MULTIPLY	B BY	C TO OBTAIN
Inches of mercury	1.133	Feet of water
Inches of mercury	0.4912	Pounds per sq. in.
Inches of mercury	0.0345	Kilograms per sq. cm
Inches of water	0.03613	Pounds per sq. in.
Inches of water	0.07355	Inches of mercury
Kilograms	2.205	Pounds
Kilograms	0.001102	Short tons (2000 lbs.)
Kilograms per minute	132.3	Pounds per hour
Kilograms per sq. cm	14.22	Pounds per sq. in.
Kilograms per sq. cm	0.9678	Atmospheres
Kilograms per sq. cm	28.96	Inches of mercury
Kilopascals	0.145	Pounds per sq. in.
Liters	1000	Cubic centimeters
Liters	0.2642	Gallons
Liters per hour	0.0044	Gallons per minute
Meters	3.281	Feet
Meters	1.0936	Yards
Meters	100	Centimeters
Meters	39.37	Inches
Megapascals	145.0	Pounds per sq. in.
Pounds	0.0005	Short tons (2000 lbs.)
Pounds	0.4536	Kilograms
Pounds	0.000454	Metric Tons
Pounds	16	Ounces
Pounds per hour	6.32/M.W.	Cubic feet per minute
Pounds per hour liquid	0.002/Sp. Gr.	Gallons per minute liquid (at 70°F)
Pounds per sq. in.	27.684	Inches of water
Pounds per sq. in.	2.307	Feet of water
Pounds per sq. in.	2.036	Inches of mercury
Pounds per sq. in.	0.0703	Kilograms per sq. cm
Pounds per sq. in.	51.71	Millimeters of mercury
Pounds per sq. in.	0.7037	Meters of water
Specific Gravity (of gas or vapors)	28.97	Molecular Wt. (of gas or vapors)
Square centimeters	0.1550	Square inches
Square inches	6.452	Square centimeters
Tons (short ton 2000 lbs.)	907.2	Kilograms
Tons (short ton 2000 lbs.)	0.9072	Metric Tons
Tons (metric) per day	91.8	Pounds per hour
Water (cubic feet)	62.3	Pounds (at 70°F)
Yards	0.9144	Meters
Yards	91.44	Centimeters

This table may be used in two ways:

(1) Multiply the unit under column A by the figure under column B; the result is the unit under column C.

(2) Divide the unit under column C by the figure under column B; the result is the unit under column A.

CAPACITY FORMULAS FOR STEAM LOADS

Definition of Terms and Units:

Q_S = Steam Load or Steam Capacity (lbs/hr)
E = Heat Load (Btu/hr)
m = Amount of water to cool per time (lbs/hr)
C_P = Specific Heat of fluid being heated (Btu/(lb-°F))
C_{P1} = Specific heat of solid being heated (Btu/(lb-°F))
ΔT = Temperature rise (°F)
ΔT_1 = Condensate Temp. - Temp. Set Point (°F)
ΔT_2 = Temperature difference (°F)
(Temp. set point - temp. of cooling water)
LH = Latent Heat of Saturated Steam (Btu/lb)
s.g. = Specific gravity of fluid
Q_W = Flow rate of water (GPM)
Q_L = Flow rate of liquid (GPM)
Q_{air} = Flow rate of air (CFM or ft^3/min)
G = Volume of liquid to be heated (gallons)
t = Time to heat product (hours)
W = Weight of material (lbs)
p_{air} = Density of air (lb/ft^3)
500 = 60 min/hr x 8.33 lbs/gal (convert GPM of water to lbs/hr)

APPROXIMATE FORMULAS	EXACT FORMULAS
When Heating Water with Steam	
$Q_S = \frac{Q_W}{2} \times \Delta T$	$Q_S = \frac{Q_W \times \Delta T \times 500}{LH}$
When Heating Fuel Oil with Steam	
$Q_S = \frac{Q_L}{4} \times \Delta T$	$Q_S = \frac{Q_L \times \Delta T \times C_p \times 500 \times s.g.}{LH}$
When Heating Air Coils with Steam	
$Q_S = \frac{Q_{air}}{900} \times \Delta T$	$Q_S = \frac{Q_{air} \times 0.24 \times p_{air} \times 60(min/hr) \times \Delta T}{LH}$
When Heat Load (Btu/hr) is Known	
$Q_S = \frac{E}{1000}$	$Q_S = \frac{E}{LH}$

When Boiler Output (H.P.) is Known

Q_S = Boiler H.P. x 34.5

When Square Feet Equivalent Direct Radiation (EDR) is Known

$Q_S = \frac{EDR}{4}$

Condensate Cooling using Water

Step 1: $E = m\Delta T_1$
Step 2: $Q_S = E/\Delta T_2$
Step 3: Water required: $Q_W(GPM) = Q_S/500$

Heating Water in Open-Top Tank with Direct Steam Injection

$$Q_S = \frac{G \times \Delta T \times 8.33\ (lbs/gal)}{LH \times t}$$

Heating Liquid in Jacketed Kettles

$$Q_S = \frac{G \times s.g. \times C_P \times \Delta T \times 8.33\ (lbs/gal)}{LH \times t}$$

Heating Solids by Direct Steam Injection into Chamber (Platens, Autoclaves, etc.)

$$Q_S = \frac{W \times C_{p1} \times \Delta T}{LH \times t}$$

FORMULAS FOR CONTROL VALVE SIZING FOR LIQUIDS

The following formulas for Control Valve Sizing assume turbulent flow based on liquids similar in viscosity to water, and pipe sizes equal to the size of the valve ports, with no attached fittings.

C_V = Valve Flow Coefficient
Q = Volumetric Flow Rate of Liquid (US GPM)
P_1 = Absolute Inlet Pressure (psia)
P_2 = Absolute Outlet Pressure (psia)
ΔP = Pressure Drop (psi) = $P_1 - P_2$
G = Specific Gravity of the Liquid
P_V = Vapor Pressure of the Liquid

For Normal Flow:

When: $\Delta P < K_C (P_1 - P_V)$:

$Q = C_V\sqrt{\frac{\Delta P}{G}}$ Flow Rate based on C_V and ΔP.

$C_V = Q\sqrt{\frac{G}{\Delta P}}$ C_V required based on Flow Rate and ΔP.

$\Delta P = \left[\frac{Q}{C_V}\right]^2 G$ Pressure drop across valve based on Flow Rate and C_V.

Potential for Cavitation

Cavitation can occur when the pressure inside the control valve drops below the vapor pressure (P_V) of the liquid. Cavitation should be avoided because it restricts flow rate, generates noise and may reduce life expectancy of internal components. When $\Delta P < K_C (P_1 - P_V)$, the Standard Flow Equation will predict performance. When $\Delta P \geq K_C (P_1 - P_V)$, cavitation may occur and the accuracy of the normal flow equation may be reduced.

F_L = The Valve Pressure Recovery Factor. For Globe Style Control Valve. $F_L = 0.9$

$K_C = 0.65\ F_L^2$ Based on when a 2% reduction of normal flow rate occurs. (0.65 proportionality conconstant is used for conservative determination of cavitation)

P_V = Vapor Pressure of the Liquid (psia). (see chart for water at various temperatures.)

Valve Sizing Example:

A control valve is needed that will handle a maximum flow rate of 100 GPM of water @ 180°F. Since the temperature of the water is elevated, cavitation becomes a concern. Determine the maximum pressure drop across the control valve before cavitation will occur. Based on this maximum pressure drop, determine the required minimum C_V value of the control valve.

Conditions of Service:

Q = 100 GPM
T = 180°F Water
P_1 = 50 psig = 64.7 psia

(1) To Determine the ΔP across the valve when cavitation could potentially occur, use the formula $\Delta P_C = K_C (P_1 - P_V)$.

$\Delta P_C = K_C (P_1 - P_V)$
$= 0.53\ (64.7 - 7.51)$
$= 30$ psi

$K_C = 0.65\ F_L^2 = 0.65\ (0.9)^2 = 0.53$ (for globe value)

P_V = 7.51 @ 180°F for water (see chart)

(2) Determine the minimum C_V of the control valve at the maximum ΔP of 30 psi.

$C_V = Q\sqrt{\frac{G}{\Delta P}}$
$= 100\sqrt{\frac{0.972}{30}}$
$= 18$

G = 0.972 @ 180°F for water (see chart)

NOTE: Since a minimum C_V of 18 was calculated, we could choose a 1-1/2" HB globe style control valve which has a $C_V = 22$.

Water Physical Properties

Temp. (°F)	G (Ref. to 60°F)	P_V (psia)
32	1.001	0.09
40	1.001	0.12
50	1.001	0.18
60	1.000	0.26
70	0.999	0.36
80	0.998	0.51
90	0.996	0.70
100	0.994	0.95
120	0.990	1.69
140	0.985	2.89
160	0.979	4.74
180	0.972	7.51
200	0.964	11.5
212	0.959	14.7

FORMULAS FOR VALVE SIZING

Control Valve Sizing for Saturated Steam

The following formulas for Valve Sizing are based on ISA Standard 75.01.01-2007 (60534-2-1 Mod).
The formulas assume pipe sizes equal to the size of the valve ports, with no attached fittings.

- **Cv** = Valve Flow Coefficient
- ΔP = Pressure Drop = $P_1 - P_2$
- P_1 = Absolute Inlet Pressure (psia)
- P_2 = Absolute Outlet Pressure (psia)
- **W** = Saturated Steam Flow (lbs/hr)
- T_1 = Steam Inlet Temperature (°R) (see table)
- Z_1 = Steam Compressibility Factor (see table)
- γ = Heat Capacity Ratio for Steam = 1.3 (0-300 psig)
- F_γ = Heat Capacity Ratio Factor for Steam = $\gamma/1.4 = 1.3/1.4 = 0.93$
- x = Pressure Drop Ratio = $\Delta P/P_1$
- ΔP_{cr} = Critical Pressure Drop
- x_T = Critical Pressure Drop Ratio for Air
- x_{cr} = Critical Pressure Drop Ratio for Steam
  = $\Delta P_{cr} / P_1 = F_\gamma x_T = 0.93 x_T$

For Sub-critical Flow

$$Cv = \frac{W}{82\, P_1 (1 - x/3x_{cr}) \sqrt{x/(T_1 Z_1)}}$$

When $\Delta P/P_1 < x_{cr}$: $x = \Delta P/P_1$

For Critical Flow

$$Cv = \frac{W}{54.6\, P_1 \sqrt{x_{cr}/(T_1 Z_1)}}$$

When $\Delta P/P_1 \geq x_{cr}$

For single-ported globe valve with flow-to-open seating arrangement:

$x_T = 0.72$ $\quad x_{cr} = 0.93 x_T = 0.67$

$$Cv = \frac{W}{82\, P_1 (1 - x/2) \sqrt{x/(T_1 Z_1)}}$$

When $\Delta P/P_1 < 0.67$

$$Cv = \frac{W}{54.6\, P_1 \sqrt{0.67/(T_1 Z_1)}}$$

When $\Delta P/P_1 \geq 0.67$

Example: Determine the Cv Value for a Control Valve with 60 psig Inlet Steam Pressure, and 30 psig Outlet Pressure with a Flow Rate of 4,000 lbs/hr.

- **W** = 4,000 lbs/hr
- P_1 = 60 psig = 74.7 psia
- P_2 = 30 psig = 44.7 psia
- ΔP = 30 psi
- $x = \Delta P/P_1 = 30/74.4 = 0.40$
- $x_{cr} = 0.93 x_T = 0.93 \times 0.72 = 0.67$

Since $x < x_{cr}$ flow is sub-critical

- T_1 = 767 (from table)
- Z_1 = 0.955 (from table)

$$Cv = \frac{W}{82\, P_1 (1 - x/2) \sqrt{x/(T_1 Z_1)}}$$

When $\Delta P/P_1 < 0.67$

$$Cv = \frac{4{,}000}{82\,(74.7)(1 - 0.4/2) \sqrt{0.4/(767 \times 0.955)}}$$

$$= \frac{4{,}000}{114.6} = 35$$

Saturated Steam Table

P_1 psig	P_1 psia	T_1 (°R)	Z_1
0	14.7	672	0.985
10	24.7	699	0.978
20	34.7	718	0.973
30	44.7	734	0.968
40	54.7	746	0.963
50	64.7	757	0.959
60	74.7	767	0.955
70	84.7	776	0.951
80	94.7	784	0.947
90	104.7	791	0.943
100	114.7	798	0.940
110	124.7	804	0.936
120	134.7	810	0.933
130	144.7	815	0.930
140	154.7	821	0.927
150	164.7	826	0.923
160	174.7	830	0.920
170	184.7	835	0.917
180	194.7	839	0.915
190	204.7	843	0.912
200	214.7	848	0.909
210	224.7	851	0.906
220	234.7	855	0.903
230	244.7	859	0.901
240	254.7	862	0.898
250	264.7	866	0.895
260	274.7	869	0.893
270	284.7	872	0.890
280	294.7	875	0.888
290	304.7	879	0.885
300	314.7	882	0.883

Properties of Saturated Steam

Pressure	Temp. (°F)	Heat (BTU/lb)			Volume (ft^3/lb)	
		Sensible	Latent	Total	Condensate	Steam
In Hg vac						
25	133	101	1018	1119	0.01626	143.3
20	161	129	1002	1131	0.01640	75.41
15	179	147	991	1138	0.01650	51.41
10	192	160	983	1143	0.01659	39.22
5	203	171	976	1147	0.01666	31.82
(PSIG)						
0	212	180	970	1151	0.01672	26.80
1	215	184	968	1152	0.01674	25.21
2	219	187	966	1153	0.01676	23.79
3	222	190	964	1154	0.01679	22.53
4	224	193	962	1155	0.01681	21.40
5	227	195	961	1156	0.01683	20.38
6	230	198	959	1157	0.01685	19.46
7	232	201	957	1158	0.01687	18.62
8	235	203	956	1159	0.01689	17.85
9	237	206	954	1160	0.01690	17.14
10	239	208	953	1160	0.01692	16.49
12	244	212	950	1162	0.01696	15.33
14	248	216	947	1163	0.01699	14.33
16	252	220	944	1165	0.01702	13.45
18	255	224	942	1166	0.01705	12.68
20	259	228	940	1167	0.01708	11.99
22	262	231	937	1168	0.01711	11.38
24	265	234	935	1169	0.01713	10.83
25	267	236	934	1170	0.01715	10.57
26	268	237	933	1170	0.01716	10.33
28	271	240	931	1171	0.01719	9.874
30	274	243	929	1172	0.01721	9.459
32	277	246	927	1173	0.01723	9.078
34	279	249	925	1174	0.01726	8.728
35	281	250	924	1174	0.01727	8.563
36	282	251	923	1174	0.01728	8.404
38	284	254	922	1175	0.01730	8.104
40	287	256	920	1176	0.01733	7.826
42	289	258	918	1177	0.01735	7.566
44	291	261	916	1177	0.01737	7.323
45	292	262	916	1178	0.01738	7.208
46	294	263	915	1178	0.01739	7.096
48	296	265	913	1178	0.01741	6.883
50	298	267	912	1179	0.01743	6.683
55	303	272	908	1180	0.01748	6.230
60	307	277	905	1182	0.01753	5.837
65	312	282	901	1183	0.01757	5.491
70	316	286	898	1184	0.01761	5.184
75	320	291	895	1185	0.01766	4.911
80	324	295	892	1186	0.01770	4.665
85	328	298	889	1187	0.01774	4.444
90	331	302	886	1188	0.01778	4.242
95	335	306	883	1189	0.01782	4.059
100	338	309	881	1190	0.01785	3.891
105	341	312	878	1190	0.01789	3.736
110	344	316	876	1191	0.01792	3.594
115	347	319	873	1192	0.01796	3.462
120	350	322	871	1192	0.01799	3.340
125	353	325	868	1193	0.01803	3.226
130	356	328	866	1194	0.01806	3.119
135	358	331	864	1194	0.01809	3.020
140	361	333	861	1195	0.01812	2.927
145	363	336	859	1195	0.01815	2.839

(continued)

Pressure (PSIG)	Temp. (°F)	Heat (BTU/lb)			Volume (ft^3/lb)	
		Sensible	Latent	Total	Condensate	Steam
150	366	339	857	1196	0.01818	2.756
155	368	341	855	1196	0.01821	2.678
160	371	344	853	1196	0.01824	2.605
165	373	346	851	1197	0.01827	2.535
170	375	349	849	1197	0.01830	2.469
175	377	351	847	1198	0.01833	2.407
180	380	353	845	1198	0.01835	2.347
185	382	355	843	1198	0.01839	2.291
190	384	358	841	1199	0.01841	2.237
195	386	360	839	1199	0.01844	2.185
200	388	362	837	1199	0.01847	2.136
205	390	364	836	1200	0.01850	2.089
210	392	366	834	1200	0.01852	2.044
215	394	368	832	1200	0.01855	2.001
220	395	370	830	1200	0.01857	1.960
225	397	372	829	1201	0.01860	1.920
230	399	374	827	1201	0.01863	1.882
235	401	376	825	1201	0.01865	1.845
240	403	378	823	1201	0.01868	1.810
245	404	380	822	1202	0.01870	1.776
250	406	382	820	1202	0.01873	1.744
255	408	384	818	1202	0.01875	1.712
260	409	385	817	1202	0.01878	1.682
265	411	387	815	1202	0.01880	1.652
270	413	389	814	1203	0.01882	1.624
275	414	391	812	1203	0.01885	1.596
280	416	392	811	1203	0.01887	1.570
285	417	394	809	1203	0.01889	1.544
290	419	396	808	1203	0.01891	1.520
295	420	397	806	1203	0.01894	1.497
300	422	399	805	1203	0.01896	1.473
310	425	402	802	1204	0.01901	1.428
320	428	405	799	1204	0.01906	1.386
330	430	408	796	1204	0.01910	1.346
340	433	411	793	1204	0.01915	1.309
350	436	414	790	1204	0.01919	1.273
360	438	417	787	1204	0.01923	1.240
370	441	420	785	1204	0.01927	1.207
380	443	423	782	1205	0.01932	1.177
390	446	426	779	1205	0.01936	1.148
400	448	428	777	1205	0.01940	1.120
450	460	441	764	1205	0.01961	0.9992
500	470	453	752	1205	0.01980	0.9010
550	480	464	740	1204	0.02000	0.8195
600	489	475	729	1203	0.02019	0.7509
650	497	485	718	1203	0.02038	0.6922
700	505	494	707	1202	0.02056	0.6415
750	513	504	697	1200	0.02074	0.5971
800	520	512	687	1199	0.02092	0.5580
900	534	529	667	1196	0.02128	0.4922
1000	546	545	648	1192	0.02164	0.4390
1250	574	581	601	1182	0.02256	0.3410
1500	598	614	556	1169	0.02352	0.2740
1750	618	644	510	1155	0.02456	0.2248
2000	637	674	463	1137	0.02572	0.1864
2250	654	703	413	1116	0.02707	0.1554
2500	669	734	358	1092	0.02871	0.1293
2750	683	766	295	1061	0.03097	0.1062
3000	696	805	211	1016	0.03465	0.0835

DRAINING CONDENSATE FROM STEAM MAINS OR STEAM SUPPLY LINES

Charts Assume All Pipes are Insulated (with 80% efficiency)

Warm Up Loads in Pounds of Condensate per hour per 100 ft. of Steam Main

Warm Up Loads are based on a 1 hour warm up time

Outside Temperature at 70°F. Based on Sch. 40 Pipe up to 250 PSI; Sch. 80 above 250 PSI; Sch. 120, 5" & Larger, above 800 PSI.

Steam Pressure (PSIG)	Pipe Size														0°F Correction Factor †
	2"	2 1/2"	3"	4"	5"	6"	8"	10"	12"	14"	16"	18"	20"	24"	
0	6.2	9.7	12.8	18.2	24.6	31.9	48	68	90	107	140	176	207	308	1.50
5	6.9	11.0	14.4	20.4	27.7	35.9	48	77	101	120	157	198	233	324	1.44
10	7.5	11.8	15.5	22.0	29.9	38.8	58	83	109	130	169	213	251	350	1.41
20	8.4	13.4	17.5	24.9	33.8	44	66	93	124	146	191	241	284	396	1.37
40	9.9	15.8	20.6	90.3	39.7	52	78	110	145	172	225	284	334	465	1.32
60	11.0	17.5	22.9	32.6	44	57	86	122	162	192	250	316	372	518	1.29
80	12.0	19.0	24.9	35.3	48	62	93	132	175	208	271	342	403	561	1.27
100	12.8	20.3	26.6	37.8	51	67	100	142	188	222	290	366	431	600	1.26
125	13.7	21.7	28.4	40	55	71	107	152	200	238	310	391	461	642	1.25
150	14.5	23.0	30.0	43	58	75	113	160	212	251	328	414	487	679	1.24
175	15.3	24.2	31.7	45	61	79	119	169	224	265	347	437	514	716	1.23
200	16.0	25.3	33.1	47	64	83	125	177	234	277	362	456	537	748	1.22
250	17.2	27.3	35.8	51	69	89	134	191	252	299	390	492	579	807	1.21
300	25.0	38.3	51	75	104	143	217	322	443	531	682	854	1045	1182	1.20
400	27.8	43	57	83	116	159	241	358	493	590	759	971	1163	1650	1.18
500	30.2	46	62	91	126	173	262	389	535	642	825	1033	1263	1793	1.17
600	32.7	50	67	98	136	187	284	421	579	694	893	1118	1367	1939	1.16
800	38	58	77	113	203	274	455	670	943	1132	1445	1835	2227	3227	1.16
1000	45	64	86	126	227	305	508	748	1052	1263	1612	2047	2485	3601	1.15
1200	52	72	96	140	253	340	566	833	1172	1407	1796	2280	2767	4010	1.14
1400	62	79	106	155	280	376	626	922	1297	1558	1988	2524	3064	4440	1.13
1600	71	87	117	171	309	415	692	1018	1432	1720	2194	2786	3382	4901	1.13
1750	78	94	126	184	333	448	746	1098	1544	1855	2367	3006	3648	5285	1.13
1800	80	97	129	189	341	459	764	1125	1584	1902	2427	3082	3741	5420	1.13

Running Loads in Pounds of Condensate per hour per 100 ft. of Steam Main

Outside Temperature at 70°F.

Steam Pressure (PSIG)	Pipe Size														0°F Correction Factor †
	2"	2 1/2"	3"	4"	5"	6"	8"	10"	12"	14"	16"	18"	20"	24"	
10	6	7	9	11	13	16	20	24	29	32	36	39	44	53	1.58
30	8	9	11	14	17	20	26	32	38	42	48	51	57	68	1.50
60	10	12	14	18	24	27	33	41	49	54	62	67	74	89	1.45
100	12	15	18	22	28	33	41	51	61	67	77	83	93	111	1.41
125	13	16	20	24	30	36	45	56	66	73	84	90	101	121	1.39
175	16	19	23	26	33	43	53	66	78	86	98	107	119	141	1.38
250	18	22	27	34	42	50	62	77	92	101	116	126	140	168	1.36
300	20	25	30	37	46	54	68	85	101	111	126	138	154	184	1.35
400	23	28	34	43	53	63	80	99	118	130	148	162	180	216	1.33
500	27	33	39	49	61	73	91	114	135	148	170	185	206	246	1.32
600	30	37	44	55	68	82	103	128	152	167	191	208	232	277	1.31
800	36	44	53	69	85	101	131	164	194	214	244	274	305	365	1.30
1000	43	52	63	82	101	120	156	195	231	254	290	326	363	435	1.27
1200	51	62	75	97	119	142	185	230	274	301	343	386	430	515	1.26
1400	60	73	89	114	141	168	219	273	324	356	407	457	509	610	1.25
1600	69	85	103	132	163	195	253	31	375	412	470	528	588	704	1.22
1750	76	93	113	145	179	213	278	347	411	452	516	580	645	773	1.22
1800	79	96	117	150	185	221	288	358	425	467	534	600	667	800	1.21

† For outdoor temperatures of 0°F, multiply load value selected from table by correction factor shown.

STEAM PROPERTIES & FLOW CHARACTERISTICS

STEAM CAPACITY TABLES

This chart provides a simple method for sizing steam pipes with velocities in the range of 7,000 to 10,000 ft/min.
(Example: a 1" pipe with 100 PSIG steam pressure has a flow rate of 672 lbs/hr at a velocity of 7250 ft/min.)

STEAM CAPACITY – Flow in lbs/hr

Pressure (PSIG)	Temp. (°F) (sat.)	FULL-PORT VALVE or PIPE SIZE																
		1/4	3/8	1/2	3/4	1	1 1/4	1 1/2	2	2 1/2	3	3 1/2	4	5	6	8	10	12
		VELOCITY (FPM)																
		7062	7094	7125	7187	7250	7312	7375	7500	7625	7750	7875	8000	8250	8500	9000	9500	10000
250	406	176	324	518	916	1498	2615	3591	6018	8731	13700	18620	24360	39470	58730	107700	179200	267700
200	388	143	264	423	748	1223	2135	2932	4913	7128	11190	15200	19880	32230	47950	87910	146300	218500
175	378	127	235	375	664	1086	1895	2603	4361	6328	9931	13490	17650	28610	42560	78040	129800	194000
150	366	111	205	328	580	948	1655	2273	3810	5528	8675	11790	15420	24990	37180	68170	113400	169500
125	353	95	175	280	496	811	1415	1943	3256	4724	7414	10070	13180	21360	31780	58260	96940	144800
100	338	79	145	232	411	672	1173	1612	2701	3919	6150	8356	10930	17720	26360	48330	80410	120100
90	331	72	133	213	377	617	1076	1478	2477	3594	5641	7665	10030	16250	24180	44330	73760	110200
80	324	66	121	194	343	561	979	1345	2254	3270	5132	6973	9122	14780	22000	40330	67100	100300
70	316	59	109	175	309	505	881	1211	2029	2943	4619	6277	8211	13310	19800	36300	60400	90240
60	308	53	97	155	274	449	783	1076	1803	2616	4105	5577	7296	11820	17590	32260	53670	80190
50	298	46	85	136	240	392	684	940	1575	2286	3587	4874	6376	10330	15380	28190	46900	70080
40	287	39	72	116	205	335	585	803	1346	1953	3066	4166	5449	8831	13140	24090	40080	59890
30	274	33	60	96	170	278	485	666	1115	1618	2539	3451	4514	7315	10880	19960	33200	49610
25	267	29	54	86	152	249	434	596	999	1449	2274	3090	4042	6551	9747	17870	29730	44430
20	259	26	47	76	134	219	383	526	881	1279	2006	2726	3566	5780	8600	15770	26230	39200
15	250	22	41	66	116	190	331	455	763	1107	1737	2360	3087	5003	7444	13650	22710	33930
10	240	19	35	55	98	160	279	384	643	933	1464	1990	2603	4218	6276	11510	19150	28610
5	228	15	28	45	79	130	227	311	522	757	1188	1615	2112	3423	5093	9339	15540	23220
0	212	11	21	34	60	97	170	233	391	568	891	1210	1583	2566	3818	7000	11650	17400

This table represents steam loss thru an orifice on a failed open steam trap, assuming that 25% of the flow consists of condensate.

STEAM FLOW – thru various orifice diameters discharging to atmosphere (0 PSIG) in lbs/hr

Orifice Diameter (Inches)	Inlet Pressure (PSIG)												
	2	5	10	15	25	50	75	100	125	150	200	250	300
1/32	0.31	0.47	0.58	0.70	0.94	1.53	2.12	2.70	3.30	3.90	5.10	6.30	7.40
1/16	1.25	1.86	2.30	2.80	3.80	6.10	8.50	10.80	13.20	15.60	20.30	25.10	29.80
3/32	2.81	4.20	5.30	6.30	8.45	13.80	19.10	24.40	29.70	35.10	45.70	56.40	67.00
1/8	4.50	7.50	7.40	11.20	15.00	24.50	34.00	43.40	52.90	62.40	81.30	100.00	119.00
5/32	7.80	11.70	14.60	17.60	23.50	38.30	53.10	67.90	82.70	97.40	127.00	156.00	186.00
3/16	11.20	16.70	21.00	25.30	33.80	55.10	76.40	97.70	119.00	140.00	183.00	226.00	268.00
7/32	15.30	22.90	28.70	34.40	46.00	75.00	104.00	133.00	162.00	191.00	249.00	307.00	365.00
1/4	20.00	29.80	37.40	45.00	60.10	98.00	136.00	173.00	212.00	250.00	325.00	401.00	477.00
9/32	25.20	37.80	47.40	56.90	76.10	124.00	172.00	220.00	268.00	316.00	412.00	507.00	603.00
5/16	31.20	46.60	58.50	70.30	94.00	153.00	212.00	272.00	331.00	390.00	508.00	627.00	745.00
11/32	37.70	56.40	70.70	85.10	114.00	185.00	257.00	329.00	400.00	472.00	615.00	758.00	901.00
3/8	44.90	67.10	84.20	101.00	135.00	221.00	306.00	391.00	478.00	561.00	732.00	902.00	1073.00
13/32	52.70	78.80	98.80	119.00	159.00	259.00	359.00	459.00	559.00	659.00	859.00	1059.00	1259.00
7/16	61.10	91.40	115.00	138.00	184.00	300.00	416.00	532.00	648.00	764.00	996.00	1228.00	1460.00
15/32	70.20	105.00	131.00	158.00	211.00	344.00	478.00	611.00	744.00	877.00	1144.00	1410.00	1676.00
1/2	79.80	119.00	150.00	180.00	241.00	392.00	544.00	695.00	847.00	998.00	1301.00	1604.00	1907.00

SIZING STEAM PIPES • Steam Velocity Chart (Schedule 40 pipe)

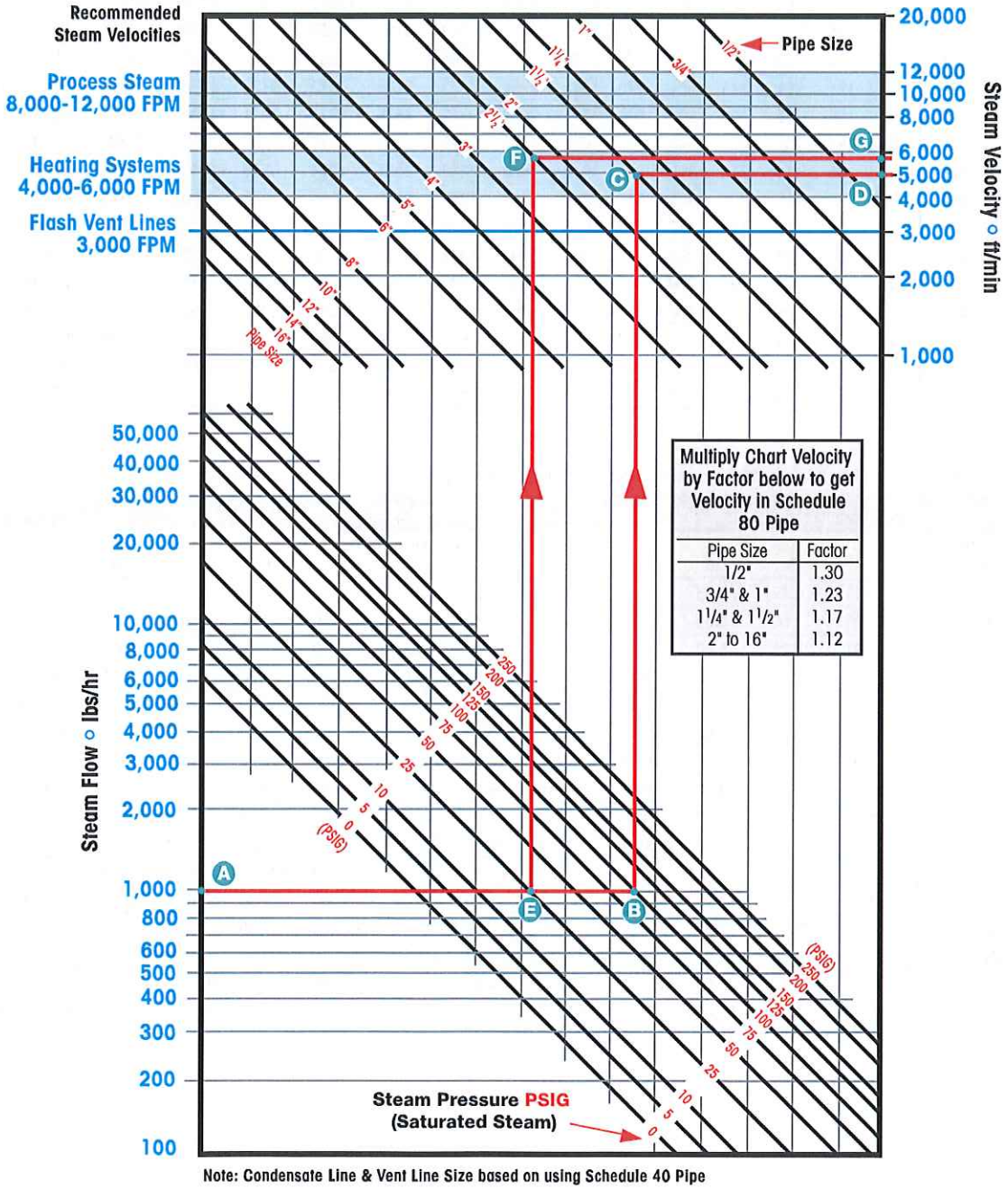
Saturated steam lines should be sized for a steam velocity of 4800 to 7200 ft/min.

Piping on pressure reducing stations should be sized for the same steam velocity on both sides of the regulator. This usually results in having a regulator smaller than the piping and having larger piping on the downstream side of the regulator.

Example using Steam Velocity Chart:
100 PSIG Inlet Pressure to control valve; 25 PSIG Outlet Pressure; 1,000 lbs/hr flow rate; Determine pipe size required.

Upstream Piping:
Enter Velocity Chart at (A) 1000 lbs/hr. Follow line to (B) 100 PSIG Inlet Pressure. Follow line vertically upwards to (C) 1 1/2" Pipe Diameter. Steam Velocity at (D) shows 4800 ft/min.

Downstream Piping:
Enter Velocity Chart at (A) 1000 lbs/hr. Follow line to (E) 25 PSIG Outlet Pressure. Follow line vertically upwards to (F) 2 1/2" Pipe Diameter. Steam Velocity at (G) shows 5500 ft/min.



Note: Condensate Line & Vent Line Size based on using Schedule 40 Pipe

ENGINEERING

SIZING OF CONDENSATE RETURN LINE, FLASH TANK DIAMETER & VENT LINE

- Velocity of Flash Steam in Condensate Return Lines should be between 4000 and 6000 ft/min.
- Velocity in Flash Tank should be less than 600 ft/min.
- Velocity in a Vent Pipe should be less than 4000 ft/min.

Example: **A steam trap with a 150 PSIG steam inlet pressure is being discharged into a flash tank operating at 20 PSIG. The condensate load on the trap is 3200 lbs/hr.**

Problem:

(1) Determine the size of the condensate return line from the trap to the flash tank based on velocities of 4,000 - 6,000 ft/min.

(2) Determine the diameter of the flash tank based on velocities less than 600 ft/min.

(3) Determine the size of the vent line on the flash tank based on velocities less than 4000 ft/min.

Solution:

The accepted practice of determining condensate return pipe sizing is to base the size of the return pipe on the amount of flash steam in the return line. This is due to the fact that the volume of flash steam is over 1,000 times greater than the equivalent volume of liquid condensate. Therefore, the flash steam is the dominant factor affecting flow in the return line. We must first calculate the amount of flash steam produced.

From the **Percent Flash Steam Table** we find that 11.8% of the condensate will flash into steam.
Therefore .118 X 3200 = 377 lbs/hr of flash steam will be produced in the condensate return line and flash tank.

Enter **Condensate Line, Flash Tank & Vent Line Sizing** chart at **A** **377 lbs/hr.**

Move horizontally to point **B** 20 PSIG Flash Tank Pressure.

Move vertically upwards to point **D** to determine a **5" Flash Tank Diameter** is needed to keep velocities less than 600 ft/min.

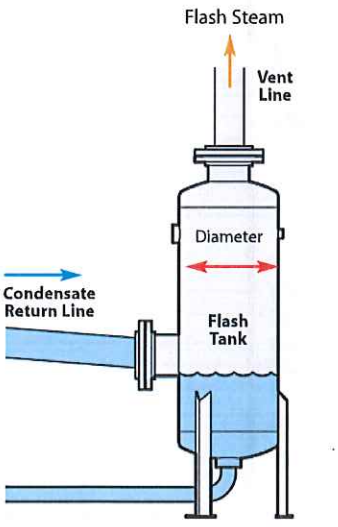
Continue to move vertically to point **E** to determine that the Vent Line on the Flash Tank should be **2" Diameter** in order to keep velocities less than 4,000 ft/min.

Continue to move vertically to point **C** to determine that the **Condensate Line should be 1 1/2" Diameter** in order to maintain condensate return line velocities between 4000 and 6000 ft/min.

PERCENT (%) FLASH STEAM TABLE

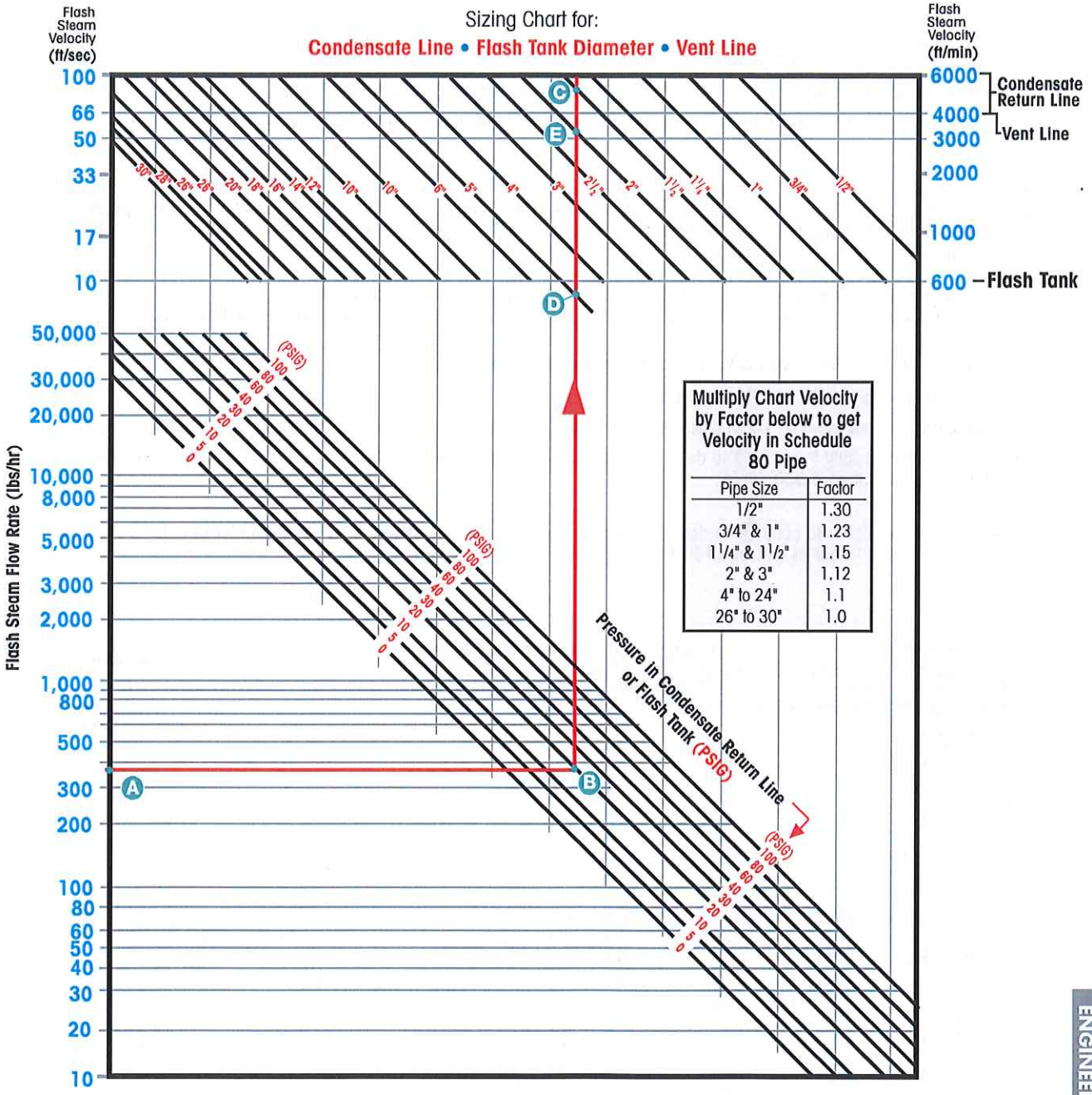
Percent Flash Steam produced when condensate is discharged to atmosphere (0 PSIG) or into a flash tank controlled at various pressures

Condensate Pressure (PSIG)	Flash Tank Pressure (PSIG)								
	0	5	10	20	30	40	60	80	100
5	1.6	0.0							
10	2.9	1.3	0.0						
15	3.9	2.4	1.1						
20	4.9	3.3	2.1	0.0					
30	6.5	5.0	3.7	1.7	0.0				
40	7.8	6.3	5.1	3.0	1.4	0.0			
60	10.0	8.5	7.3	5.3	3.7	2.3	0.0		
80	11.8	10.3	9.1	7.1	5.5	4.2	1.9	0.0	
100	13.3	11.8	10.6	8.7	7.1	5.8	3.5	1.6	0.0
125	14.9	13.5	12.3	10.4	8.8	7.5	5.3	3.4	1.8
150	16.3	14.9	13.7	11.8	10.3	9.0	6.8	4.9	3.3
200	18.7	17.3	16.2	14.3	12.8	11.5	9.4	7.6	6.0
250	20.8	19.4	18.2	16.4	14.9	13.7	11.5	9.8	8.2
300	22.5	21.2	20.0	18.2	16.8	15.5	13.4	11.7	10.2
350	24.1	22.8	21.7	19.9	18.4	17.2	15.1	13.4	11.9
400	25.6	24.2	23.1	21.4	19.9	18.7	16.7	15.0	13.5



SIZING OF CONDENSATE RETURN LINE, FLASH TANK DIAMETER & VENT LINE

- Velocity of Flash Steam in Condensate Return Lines should be between 4000 and 6000 ft/min.
- Velocity in Flash Tank should be less than 600 ft/min.
- Velocity in a Vent Pipe should be less than 4000 ft/min.

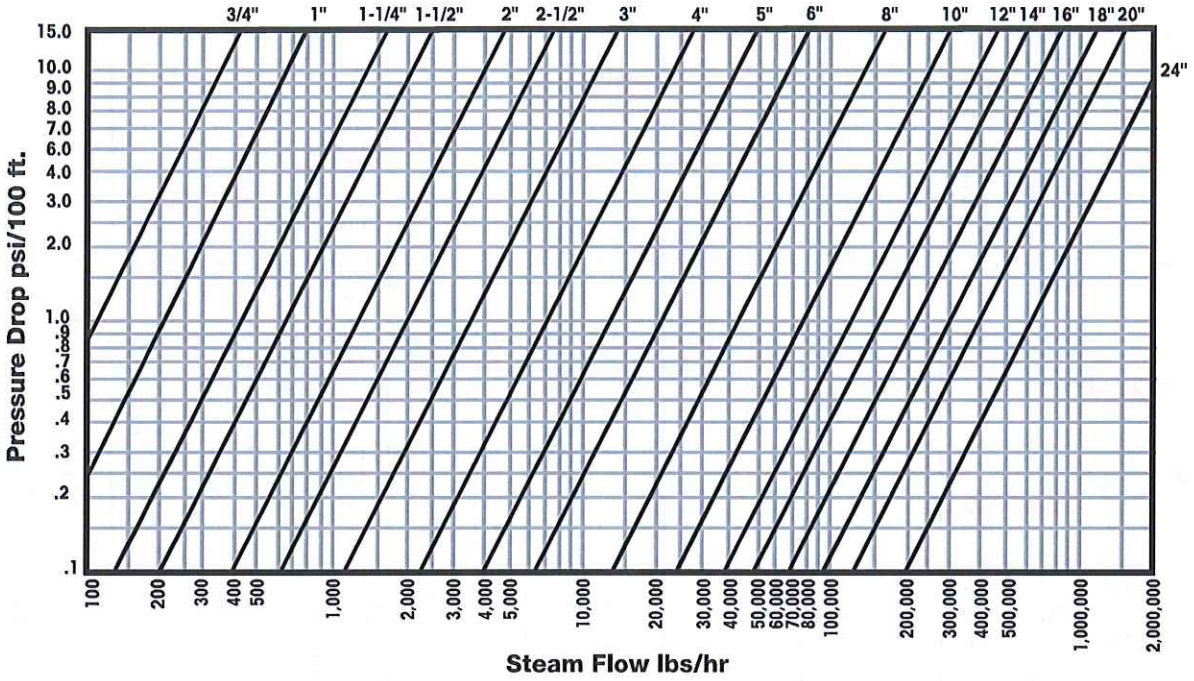


PRESSURE DROP IN SCHEDULE 40 PIPE

100 PSIG Saturated Steam

For other pressures use correction factors

psi	0	0	5	10	15	20	30	40	60	75	90	100	110	125	150	175	200	225	250	300	350	400	500	600
factor	6.9	6.0	5.2	4.3	3.6	3.1	2.4	2.0	1.5	1.3	1.1	1.0	0.92	0.83	0.70	0.62	0.55	0.49	0.45	0.38	0.33	0.29	0.23	0.19



ENGINEERING

Flow of Water thru Schedule 40 Steel Pipe

Pressure Drop per 1,000 Feet of Schedule 40 Steel Pipe

Flow Rate (GPM)	1" Velocity (ft/s)	1" Pressure Drop (PSI)	1¼" Velocity (ft/s)	1¼" Pressure Drop (PSI)	1½" Velocity (ft/s)	1½" Pressure Drop (PSI)	2" Velocity (ft/s)	2" Pressure Drop (PSI)	2½" Velocity (ft/s)	2½" Pressure Drop (PSI)	3" Velocity (ft/s)	3" Pressure Drop (PSI)	3½" Velocity (ft/s)	3½" Pressure Drop (PSI)	4" Velocity (ft/s)	4" Pressure Drop (PSI)	5" Velocity (ft/s)	5" Pressure Drop (PSI)
1	0.37	0.49																
2	0.74	1.70	0.43	0.45														
3	1.12	3.53	0.64	0.94	0.47	0.44												
4	1.49	5.94	0.86	1.55	0.63	0.74												
5	1.86	9.02	1.07	2.36	0.79	1.12												
6	2.24	12.25	1.28	3.30	0.95	1.53	0.57	0.46										
8	2.98	21.1	1.72	5.52	1.26	2.63	0.76	0.75										
10	3.72	30.8	2.14	8.34	1.57	3.86	0.96	1.14	0.67	0.48								
15	5.60	64.6	3.21	17.6	2.36	8.13	1.43	2.33	1.00	0.99								
20	7.44	110.5	4.29	29.1	3.15	13.5	1.91	3.86	1.34	1.64	0.87	0.59						
25			5.36	43.7	3.94	20.2	2.39	5.81	1.68	2.48	1.08	0.67	0.81	0.42				
30			6.43	62.9	4.72	29.1	2.87	8.04	2.01	3.43	1.30	1.21	0.97	0.60				
35			7.51	82.5	5.51	38.2	3.35	10.95	2.35	4.49	1.52	1.58	1.14	0.79	0.88	0.42		
40					6.30	47.8	3.82	13.7	2.68	5.88	1.74	2.06	1.30	1.00	1.01	0.53		
45					7.08	60.6	4.30	17.4	3.00	7.14	1.95	2.51	1.46	1.21	1.13	0.67		
50					7.87	74.7	4.78	20.6	3.35	8.82	2.17	3.10	1.62	1.44	1.26	0.80		
60							5.74	29.6	4.02	12.2	2.60	4.29	1.95	2.07	1.51	1.10		
70							6.69	38.6	4.69	15.3	3.04	5.84	2.27	2.71	1.76	1.50	1.12	0.48
80							7.65	50.3	5.37	21.7	3.48	7.62	2.59	3.53	2.01	1.87	1.28	0.63
90							8.60	63.6	6.04	26.1	3.91	9.22	2.92	4.46	2.26	2.37	1.44	0.80
100	1.11	0.39					9.56	75.1	6.71	32.3	4.34	11.4	3.24	5.27	2.52	2.81	1.60	0.95
125	1.39	0.56							8.38	48.2	5.42	17.1	4.05	7.86	3.15	4.38	2.00	1.48
150	1.67	0.78							10.06	60.4	6.51	23.5	4.86	11.3	3.78	6.02	2.41	2.04
175	1.94	1.06							11.73	90.0	7.59	32.0	5.67	14.7	4.41	8.20	2.81	2.78
200	2.22	1.32									8.68	39.7	6.48	19.2	5.04	10.2	3.21	3.46
225	2.50	1.66	1.44	0.44							9.77	50.2	7.29	23.1	5.67	12.9	3.61	4.37
250	2.78	2.05	1.60	0.55							10.85	61.9	8.10	28.5	6.30	15.9	4.01	5.14
275	3.06	2.36	1.76	0.63							11.94	75.0	8.91	34.4	6.93	18.3	4.41	6.22
300	3.33	2.80	1.92	0.75							13.02	84.7	9.72	40.9	7.56	21.8	4.81	7.41
325	3.61	3.29	2.08	0.88									10.53	45.5	8.18	25.5	5.21	8.25
350	3.89	3.62	2.24	0.97									11.35	52.7	8.82	29.7	5.61	9.57
375	4.16	4.16	2.40	1.11									12.17	60.7	9.45	32.3	6.01	11.0
400	4.44	4.72	2.56	1.27									12.97	68.9	10.08	36.7	6.41	12.5
425	4.72	5.34	2.72	1.43									13.78	77.8	10.70	41.5	6.82	14.1
450	5.00	5.96	2.88	1.60									14.59	87.3	11.33	46.5	7.22	15.0
475	5.27	6.66	3.04	1.69	1.93	0.30									11.96	51.7	7.62	16.7
500	5.55	7.39	3.20	1.87	2.04	0.63									12.59	57.3	8.02	18.5
550	6.11	8.94	3.53	2.26	2.24	0.70									13.84	69.3	8.82	22.4
600	6.66	10.6	3.85	2.70	2.44	0.86									15.10	82.5	9.62	26.7
650	7.21	11.8	4.17	3.16	2.65	1.01											10.42	31.3
700	7.77	13.7	4.49	3.69	2.85	1.18	2.01	0.48									11.22	36.3
750	8.32	15.7	4.81	4.21	3.05	1.35	2.15	0.55									12.02	41.6
800	8.88	17.8	5.13	4.79	3.26	1.54	2.29	0.62									12.82	44.7
850	9.44	20.2	5.45	5.11	3.46	1.74	2.44	0.70	2.02	0.43							13.62	50.5
900	10.00	22.6	5.77	5.73	3.66	1.94	2.58	0.79	2.14	0.48							14.42	56.6
950	10.55	23.7	6.09	6.38	3.87	2.23	2.72	0.88	2.25	0.53							15.22	63.1
1,000	11.10	26.3	6.41	7.08	4.07	2.40	2.87	0.98	2.38	0.59							16.02	70.0
1,100	12.22	31.8	7.05	8.56	4.48	2.74	3.16	1.18	2.61	0.68							17.63	84.6
1,200	13.32	37.8	7.69	10.2	4.88	3.27	3.45	1.40	2.85	0.81	2.18	0.40						
1,300	14.43	44.4	8.33	11.3	5.29	3.86	3.73	1.56	3.09	0.95	2.36	0.47						
1,400	15.54	51.5	8.97	13.0	5.70	4.44	4.02	1.80	3.32	1.10	2.54	0.54						
1,500	16.65	55.5	9.62	15.0	6.10	5.11	4.30	2.07	3.55	1.19	2.73	0.62						
1,600	17.76	63.1	10.26	17.0	6.51	5.46	4.59	2.36	3.80	1.35	2.91	0.71						
1,800	19.98	79.8	11.54	21.6	7.32	6.91	5.16	2.98	4.27	1.71	3.27	0.85	2.58	0.48				
2,000	22.20	98.5	12.83	25.0	8.13	8.54	5.73	3.47	4.74	2.11	3.63	1.05	2.88	0.56				
2,500			16.03	39.0	10.18	12.5	7.17	5.41	5.92	3.09	4.54	1.63	3.59	0.88				
3,000			19.24	52.4	12.21	18.0	8.60	7.31	7.12	4.45	5.45	2.21	4.31	1.27	3.45	0.73		
3,500			22.43	71.4	14.25	22.9	10.03	9.95	8.32	6.18	6.35	3.00	5.03	1.52	4.03	0.94		
4,000			25.65	93.3	16.28	29.9	11.48	13.0	9.49	7.92	7.25	3.92	5.74	2.12	4.61	1.22	3.19	0.51
4,500					18.31	37.8	12.90	15.4	10.67	9.36	8.17	4.97	6.47	2.50	5.19	1.55	3.59	0.60
5,000					20.35	46.7	14.34	18.9	11.84	11.6	9.08	5.72	7.17	3.08	5.76	1.78	3.99	0.74
6,000					24.42	67.2	17.21	27.3	14.32	15.4	10.88	8.24	8.62	4.45	6.92	2.57	4.80	1.00
7,000					28.50	85.1	20.08	37.2	16.60	21.0	12.69	12.2	10.04	6.06	8.06	3.50	5.68	1.36
8,000							22.95	45.1	18.98	27.4	14.52	13.6	11.48	7.34	9.23	4.57	6.38	1.78
9,000							25.80	57.0	21.35	34.7	16.32	17.2	12.92	9.20	10.37	5.36	7.19	2.25
10,000							28.63	70.4	23.75	42.9	18.16	21.2	14.37	11.5	11.53	6.63	7.96	2.78
12,000							34.38	93.6	28.50	61.8	21.80	30.9	17.23	16.5	13.83	9.54	9.57	3.71
14,000									33.20	84.0	25.42	41.6	20.10	20.7	16.14	12.0	11.18	5.05
16,000											29.05	54.4	22.96	27.1	18.43	15.7	12.77	6.60

PIPE, FITTING & FLANGE SPECIFICATIONS

PIPE DATA TABLE

Pipe Size (in.)	Outside Diameter (in.)	Weight Class	Carbon Steel Schedule	Stainless Steel Schedule	Wall Thickness (in.)	Inside Diameter (in.)	Circum. (Ext.) (in.)	Circum. (Int.) (in.)	Flow Area (sq. in.)	Weight of Pipe (lbs/Ft.)	Weight of Water (lbs/Ft.)	Gallons of Water per Ft.	Section Modulus	Pipe Size (in.)
1/8	0.405	–	–	10S	.049	.307	1.27	.96	.074	.19	.032	.004	.00437	1/8
		STD	40	40S	.068	.269		.85	.057	.24	.025	.003	.00523	
		XS	80	80S	.095	.215		.68	.036	.31	.016	.002	.00602	
1/4	0.540	–	–	10S	.065	.410	1.70	1.29	.132	.33	.057	.007	.01032	1/4
		STD	40	40S	.088	.364		1.14	.104	.42	.045	.005	.01227	
		XS	80	80S	.119	.302		.95	.072	.54	.031	.004	.01395	
3/8	0.675	–	–	10S	.065	.545	2.12	1.71	.233	.42	.101	.012	.01736	3/8
		STD	40	40S	.091	.493		1.55	.191	.57	.083	.010	.0216	
		XS	80	80S	.126	.423		1.33	.141	.74	.061	.007	.0255	
1/2	0.840	–	–	5S	.065	.710	2.64	2.23	.396	.54	.172	.021	.0285	1/2
		–	–	10S	.083	.674		2.12	.357	.67	.155	.019	.0341	
		STD	40	40S	.109	.622		1.95	.304	.85	.132	.016	.0407	
		XS	80	80S	.147	.546		1.72	.234	1.09	.102	.012	.0478	
		–	160	–	.187	.466		1.46	.171	1.31	.074	.009	.0527	
		XXS	–	–	.294	.252		.79	.050	1.71	.022	.003	.0577	
3/4	1.050	–	–	5S	.065	.920	3.30	2.89	.665	.69	.288	.035	.0467	3/4
		–	–	10S	.083	.884		2.78	.614	.86	.266	.032	.0566	
		STD	40	40S	.113	.824		2.59	.533	1.13	.231	.028	.0706	
		XS	80	80S	.154	.742		2.33	.433	1.47	.188	.022	.0853	
		–	160	–	.219	.612		1.92	.296	1.94	.128	.015	.1004	
		XXS	–	–	.308	.434		1.36	.148	2.44	.064	.008	.1103	
1	1.315	–	–	5S	.065	1.185	4.13	3.72	1.103	.87	.478	.057	.0760	1
		–	–	10S	.109	1.097		3.45	.945	1.40	.409	.049	.1151	
		STD	40	40S	.133	1.049		3.30	.864	1.68	.375	.045	.1328	
		XS	80	80S	.179	.957		3.01	.719	2.17	.312	.037	.1606	
		–	160	–	.250	.815		2.56	.522	2.84	.230	.027	.1903	
		XXS	–	–	.358	.599		1.88	.282	3.66	.122	.015	.2136	
1 1/4	1.660	–	–	5S	.065	1.530	5.22	4.81	1.839	1.11	.797	.096	.1250	1 1/4
		–	–	10S	.109	1.442		4.53	1.633	1.81	.708	.085	.1934	
		STD	40	40S	.140	1.380		4.34	1.495	2.27	.649	.078	.2346	
		XS	80	80S	.191	1.278		4.02	1.283	3.00	.555	.067	.2913	
		–	160	–	.250	1.160		3.64	1.057	3.76	.458	.055	.3421	
		XXS	–	–	.382	.896		2.81	.630	5.21	.273	.033	.4110	
1 1/2	1.900	–	–	5S	.065	1.770	5.97	5.56	2.461	1.28	1.066	.128	.1662	1 1/2
		–	–	10S	.109	1.682		5.28	2.222	2.09	.963	.115	.2598	
		STD	40	40S	.145	1.610		5.06	2.036	2.72	.882	.106	.3262	
		XS	80	80S	.200	1.500		4.71	1.767	3.63	.765	.092	.4118	
		–	160	–	.281	1.338		4.20	1.406	4.86	.608	.073	.5078	
		XXS	–	–	.400	1.100		3.46	.950	6.41	.420	.049	.5977	
2	2.375	–	–	5S	.065	2.245	7.46	7.05	3.958	1.61	1.72	.206	.2652	2
		–	–	10S	.109	2.157		6.78	3.654	2.64	1.58	.190	.4204	
		STD	40	40S	.154	2.067		6.49	3.355	3.65	1.45	.174	.5606	
		XS	80	80S	.218	1.939		6.09	2.953	5.02	1.28	.153	.7309	
		–	160	–	.344	1.687		5.30	2.241	7.46	.97	.116	.9790	
		XXS	–	–	.436	1.503		4.72	1.774	9.03	.77	.092	1.1040	
2 1/2	2.875	–	–	5S	.083	2.709	9.03	8.51	5.764	2.48	2.50	.299	.4939	2 1/2
		–	–	10S	.120	2.635		8.28	5.453	3.53	2.36	.283	.6868	
		STD	40	40S	.203	2.469		7.76	4.788	5.79	2.07	.249	1.064	
		XS	80	80S	.276	2.323		7.30	4.238	7.66	1.87	.220	1.339	
		–	160	–	.375	2.125		6.68	3.546	10.01	1.54	.184	1.638	
		XXS	–	–	.552	1.771		5.56	2.464	13.69	1.07	.128	1.997	
3	3.500	–	–	5S	.083	3.334	11.00	10.47	8.730	3.03	3.78	.454	.744	3
		–	–	10S	.120	3.260		10.24	8.347	4.33	3.62	.434	1.041	
		STD	40	40S	.216	3.068		9.64	7.393	7.58	3.20	.384	1.724	
		XS	80	80S	.300	2.900		9.11	6.605	10.25	2.86	.343	2.225	
		–	160	–	.438	2.624		8.24	5.408	14.32	2.35	.281	2.876	
		XXS	–	–	.600	2.300		7.23	4.155	18.58	1.80	.216	3.424	
4	4.500	–	–	5S	.083	4.334	14.14	13.62	14.75	3.92	6.39	.766	1.249	4
		–	–	10S	.120	4.260		13.38	14.25	5.61	6.18	.740	1.761	
		STD	40	40S	.237	4.026		12.65	12.73	10.79	5.50	.661	3.214	
		XS	80	80S	.337	3.826		12.02	11.50	14.98	4.98	.597	4.271	
		–	120	–	.438	3.624		11.39	10.31	19.00	4.47	.536	5.178	
		–	160	–	.531	3.438		10.80	9.28	22.51	4.02	.482	5.898	
		XXS	–	–	.674	3.152		9.90	7.80	27.54	3.38	.405	6.791	
5	5.563	–	–	5S	.109	5.345	17.48	16.79	22.44	6.36	9.72	1.17	2.498	5
		–	–	10S	.134	5.295		16.63	22.02	7.77	9.54	1.14	3.029	
		STD	40	40S	.258	5.047		15.86	20.01	14.62	8.67	1.04	5.451	
		XS	80	80S	.375	4.813		15.12	18.19	20.78	7.88	.945	7.431	
		–	120	–	.500	4.563		14.34	16.35	27.04	7.09	.849	9.250	
		–	160	–	.625	4.313		13.55	14.61	32.96	6.33	.759	10.796	
		XXS	–	–	.750	4.063		12.76	12.97	38.55	5.61	.674	12.090	

PIPE DATA TABLE *(continued)*

Pipe Size (in.)	Outside Diameter (in.)	Weight Class	Carbon Steel Schedule	Stainless Steel Schedule	Wall Thickness (in.)	Inside Diameter (in.)	Circum. (Ext.) (in.)	Circum. (Ext.) (in.)	Flow Area (sq. in.)	Weight of Pipe (lbs/Ft.)	Weight of Water (lbs/Ft.)	Gallons of Water per Ft.	Section Modulus	Pipe Size (in.)
		–	–	5S	.109	6.407		20.13	32.24	7.60	13.97	1.68	3.576	
		–	–	10S	.134	6.357		19.97	31.74	9.29	13.75	1.65	4.346	
		STD	40	40S	.280	6.065		19.05	28.89	18.97	12.51	1.50	8.496	
6	6.625	XS	80	80S	.432	5.761	20.81	18.10	26.07	28.57	11.29	1.35	12.22	6
		–	120	–	.562	5.501		17.28	23.77	36.39	10.30	1.24	14.98	
		–	160	–	.719	5.187		16.30	21.15	45.35	9.16	1.10	17.81	
		XXS	–	–	.864	4.897		15.38	18.84	53.16	8.16	.978	20.02	
		–	–	5S	.109	8.407		26.41	55.51	9.93	24.06	2.88	6.131	
		–	–	10S	.148	8.329		26.17	54.48	13.40	23.61	2.83	8.212	
		–	20	–	.250	8.125		25.53	51.85	22.36	22.47	2.69	13.39	
		–	30	–	.277	8.071		25.36	51.16	24.70	22.17	2.66	14.69	
		STD	40	40S	.322	7.981		25.07	50.03	28.55	21.70	2.60	16.81	
8	8.625	–	60	–	.406	7.813	27.10	24.55	47.94	35.64	20.77	2.49	20.58	8
		XS	80	80S	.500	7.625		23.95	45.66	43.39	19.78	2.37	24.51	
		–	100	–	.594	7.437		23.36	43.46	50.95	18.83	2.26	28.14	
		–	120	–	.719	7.187		22.58	40.59	60.71	17.59	2.11	32.58	
		–	140	–	.812	7.001		21.99	38.50	67.76	16.68	2.00	35.65	
		XXS	–	–	.875	6.875		21.60	37.12	72.42	16.10	1.93	37.56	
		–	160	–	.906	6.813		21.40	36.46	74.69	15.80	1.89	38.48	
		–	–	5S	.134	10.482		32.93	86.29	15.19	37.39	4.48	11.71	
		–	–	10S	.165	10.420		32.74	85.28	18.65	36.95	4.43	14.30	
		–	20	–	.250	10.250		32.20	82.52	28.04	35.76	4.29	21.15	
		–	30	–	.307	10.136		31.84	80.69	34.24	34.96	4.19	25.57	
		STD	40	40S	.365	10.020		31.48	78.86	40.48	34.20	4.10	29.90	
10	10.750	XS	60	80S	.500	9.750	33.77	30.63	74.66	54.74	32.35	3.88	39.43	10
		–	80	–	.594	9.562		30.04	71.84	64.43	31.13	3.73	45.54	
		–	100	–	.719	9.312		29.25	68.13	77.03	29.53	3.54	53.22	
		–	120	–	.844	9.062		28.47	64.53	89.29	27.96	3.35	60.32	
		XXS	140	–	1.000	8.750		27.49	60.13	104.13	26.06	3.12	68.43	
		–	160	–	1.125	8.500		26.70	56.75	115.64	24.59	2.95	74.29	
		–	–	5S	.156	12.438		39.08	121.50	20.98	52.65	6.31	19.2	
		–	–	10S	.180	12.390		38.92	120.57	24.17	52.25	6.26	22.0	
		–	20	–	.250	12.250		38.48	117.86	33.38	51.07	6.12	30.2	
		–	30	–	.330	12.090		37.98	114.80	43.77	49.74	5.96	39.0	
		STD	–	40S	.375	12.000		37.70	113.10	49.56	49.00	5.88	43.8	
		–	40	–	.406	11.938		37.50	111.93	53.52	48.50	5.81	47.1	
12	12.750	XS	–	80S	.500	11.750	40.06	36.91	108.43	65.42	46.92	5.63	56.7	12
		–	60	–	.562	11.626		36.52	106.16	73.15	46.00	5.51	62.8	
		–	80	–	.688	11.374		35.73	101.64	88.63	44.04	5.28	74.6	
		–	100	–	.844	11.062		34.75	96.14	107.32	41.66	4.99	88.1	
		XXS	120	–	1.000	10.750		33.77	90.76	125.49	39.33	4.71	100.7	
		–	140	–	1.125	10.500		32.99	86.59	139.67	37.52	4.50	109.9	
		–	160	–	1.312	10.126		31.81	80.53	160.27	34.89	4.18	122.6	
		–	–	5S	.156	13.688		43.00	147.15	23.07	63.77	7.64	23.2	
		–	–	10S	.188	13.624		42.80	145.78	27.73	63.17	7.57	27.8	
		–	10	–	.250	13.500		42.41	143.14	36.71	62.03	7.44	36.6	
		–	20	–	.312	13.376		42.02	140.52	45.61	60.89	7.30	45.0	
		STD	30	–	.375	13.250		41.63	137.88	54.57	59.75	7.16	53.2	
		–	40	–	.438	13.124		41.23	135.28	63.44	58.64	7.03	61.3	
14	14.000	XS	–	–	.500	13.000	43.98	40.84	132.73	72.09	57.46	6.90	69.1	14
		–	60	–	.594	12.812		40.25	128.96	85.05	55.86	6.70	80.3	
		–	80	–	.750	12.500		39.27	122.72	106.13	53.18	6.37	98.2	
		–	100	–	.938	12.124		38.09	115.49	130.85	50.04	6.00	117.8	
		–	120	–	1.094	11.812		37.11	109.62	150.79	47.45	5.69	132.8	
		–	140	–	1.250	11.500		36.13	103.87	170.28	45.01	5.40	146.8	
		–	160	–	1.406	11.188		35.15	98.31	189.11	42.60	5.11	159.6	
		–	–	5S	.165	15.670		49.23	192.85	27.90	83.57	10.02	32.2	
		–	–	10S	.188	15.624		49.08	191.72	31.75	83.08	9.96	36.5	
		–	10	–	.250	15.500		48.69	188.69	42.05	81.74	9.80	48.0	
		–	20	–	.312	15.376		48.31	185.69	52.27	80.50	9.65	59.2	
		STD	30	–	.375	15.250		47.91	182.65	82.58	79.12	9.49	70.3	
16	16.00	XS	40	–	.500	15.000	50.27	47.12	176.72	82.77	76.58	9.18	91.5	16
		–	60	–	.656	14.688		46.14	169.44	107.50	73.42	8.80	116.6	
		–	80	–	.844	14.312		44.96	160.92	136.61	69.73	8.36	144.5	
		–	100	–	1.031	13.938		43.79	152.58	164.82	66.12	7.93	170.5	
		–	120	–	1.219	13.562		42.61	144.50	192.43	62.62	7.50	194.5	
		–	140	–	1.438	13.124		41.23	135.28	233.64	58.64	7.03	220.0	
		–	160	–	1.594	12.812		40.26	128.96	245.25	55.83	6.70	236.7	

PIPE DATA TABLE *(continued)*

Pipe Size (in.)	Outside Diameter (in.)	Weight Class	Carbon Steel Schedule	Stainless Steel Schedule	Wall Thickness (in.)	Inside Diameter (in.)	Circum. (Ext.) (in.)	Circum. (Ext.) (in.)	Flow Area (sq. in.)	Weight of Pipe (lbs/Ft.)	Weight of Water (lbs/Ft.)	Gallons of Water per Ft.	Section Modulus	Pipe Size (in.)
		–	–	5S	.165	17.67		55.51	245.22	31.43	106.26	12.74	40.8	
		–	–	10S	.188	17.62		55.37	243.95	35.76	105.71	12.67	46.4	
		–	10	–	.250	17.50		54.98	240.53	47.39	104.21	12.49	61.1	
		–	20	–	.312	17.38		54.59	237.13	58.94	102.77	12.32	75.5	
		STD	–	–	.375	17.25		54.19	233.71	70.59	101.18	12.14	89.6	
		–	30	–	.438	17.12		53.80	230.30	82.15	99.84	11.96	103.4	
18	18.00	XS	–	–	.500	17.00	56.55	53.41	226.98	93.45	98.27	11.79	117.0	18
		–	40	–	.562	16.88		53.02	223.68	104.87	96.93	11.62	130.1	
		–	60	–	.750	16.50		51.84	213.83	138.17	92.57	11.11	168.3	
		–	80	–	.938	16.12		50.66	204.24	170.92	88.50	10.61	203.8	
		–	100	–	1.156	15.69		49.29	193.30	207.96	83.76	10.04	242.3	
		–	120	–	1.375	15.25		47.91	182.66	244.14	79.07	9.49	277.6	
		–	140	–	1.562	14.88		46.73	173.80	274.22	75.32	9.03	305.5	
		–	160	–	1.781	14.44		45.36	163.72	308.50	70.88	8.50	335.6	
		–	–	5S	.188	19.62		61.65	302.46	39.78	131.06	15.71	57.4	
		–	–	10S	.218	19.56		61.46	300.61	46.06	130.27	15.62	66.3	
		–	10	–	.250	19.50		61.26	298.65	52.73	129.42	15.51	75.6	
		–	20	–	.375	19.25		60.48	290.04	78.60	125.67	15.12	111.3	
		STD	30	–	.500	19.00		59.69	283.53	104.13	122.87	14.73	145.7	
20	20.00	XS	40	–	.594	18.81	62.83	59.10	278.00	123.11	120.46	14.44	170.4	20
		–	60	–	.812	18.38		57.73	265.21	166.40	114.92	13.78	225.7	
		–	80	–	1.031	17.94		56.35	252.72	208.87	109.51	13.13	277.1	
		–	100	–	1.281	17.44		54.78	238.83	256.10	103.39	12.41	331.5	
		–	120	–	1.500	17.00		53.41	226.98	296.37	98.35	11.79	375.5	
		–	140	–	1.750	16.50		51.84	213.82	341.09	92.66	11.11	421.7	
		–	160	–	1.969	16.06		50.46	202.67	379.17	87.74	10.53	458.5	
		–	–	5S	.188	21.62		67.93	367.25	43.80	159.14	19.08	69.7	
		–	–	10S	.218	21.56		67.75	365.21	50.71	158.26	18.97	80.4	
		–	10	–	.250	21.50		67.54	363.05	58.07	157.32	18.86	91.8	
		STD	20	–	.375	21.25		66.76	354.66	86.61	153.68	18.42	135.4	
		XS	30	–	.500	21.00		65.97	346.36	114.81	150.09	17.99	177.5	
22	22.00	–	60	–	.875	20.25	69.12	63.62	322.06	197.41	139.56	16.73	295.0	22
		–	80	–	1.125	19.75		62.05	306.35	250.81	132.76	15.91	366.4	
		–	100	–	1.375	19.25		60.48	291.04	302.88	126.12	15.12	432.6	
		–	120	–	1.625	18.75		58.90	276.12	353.61	119.65	14.34	493.8	
		–	140	–	1.875	18.25		57.33	261.59	403.00	113.36	13.59	550.3	
		–	160	–	2.125	17.75		55.76	247.45	451.06	107.23	12.85	602.4	
		–	–	5S	.218	23.56		74.03	436.10	55	188.98	22.65	96.0	
		–	10	10S	.250	23.50		73.83	433.74	63	187.95	22.53	109.6	
		STD	20	–	.375	23.25		73.04	424.56	95	183.95	22.05	161.9	
		XS	–	–	.500	23.00		72.26	415.48	125	179.87	21.58	212.5	
		–	30	–	.562	22.88		71.86	411.00	141	178.09	21.35	237.0	
24	24.00	–	40	–	.688	22.62	75.40	71.08	402.07	171	174.23	20.88	285.1	24
		–	60	–	.969	22.06		69.31	382.35	238	165.52	19.86	387.7	
		–	80	–	1.219	21.56		67.74	365.22	297	158.26	18.97	472.8	
		–	100	–	1.531	20.94		65.78	344.32	367	149.06	17.89	570.8	
		–	120	–	1.812	20.38		64.01	326.08	430	141.17	16.94	652.1	
		–	140	–	2.062	19.88		62.44	310.28	483	134.45	16.12	718.9	
		–	160	–	2.344	19.31		60.67	292.98	542	126.84	15.22	787.9	
		–	–	5S	.250	29.50		92.68	683.49	79	296.18	35.51	172.3	
		–	10	10S	.312	29.38		92.29	677.71	99	293.70	35.21	213.8	
30	30.00	STD	–	–	.375	29.25	94.25	91.89	671.96	119	291.18	34.91	255.3	30
		XS	20	–	.500	29.00		91.11	660.52	158	286.22	34.31	336.1	
		–	30	–	.625	28.75		90.32	649.18	196	281.31	33.72	414.9	

MAXIMUM ALLOWABLE WORKING PRESSURES (PSIG) FOR SEAMLESS CARBON STEEL PIPE

Nominal Pipe Size (In.)	Maximum allowable working pressure at -20 to 650 °F ▲												
	SCH 10	SCH 20	SCH 30	STD WALL	SCH 40	SCH 60	XH	SCH 80	SCH 100	SCH 120	SCH 140	SCH 160	XXH
1/2	-	-	-	1694	1694	-	3036	3036	-	-	-	4551	9223
3/4	659	-	-	1450	1450	-	2589	2589	-	-	-	4505	7531
1	1065	-	-	1578	1578	-	2601	2601	-	-	-	4290	7150
1 1/4	556	-	-	1069	1069	-	1941	1941	-	-	-	3001	5593
1 1/2	486	-	-	1004	1004	-	1821	1821	-	-	-	3091	5114
2	388	-	-	903	903	-	1659	1659	-	-	-	3225	4475
2 1/2	431	-	-	1214	1214	-	1936	1936	-	-	-	2963	4936
3	346	-	-	1094	1094	-	1773	1773	-	-	-	2933	4405
3 1/2	303	-	-	1023	1023	-	1671	1671	-	-	-	-	-
4	269	-	-	974	974	-	1598	1598	-	2243	-	2868	3858
5	284	-	-	888	888	-	1475	1475	-	2123	-	2791	3485
6	239	-	-	833	833	-	1473	1473	-	2038	-	2738	3414
8	225	543	628	770	1038	1343	1343	1649	2068	2388	2715	2605	-
10	224	434	578	723	723	1070	1070	1311	1641	1975	2406	2754	-
12	219	366	534	630	696	1033	898	1305	1653	2009	2295	2735	-
14	333	451	573	573	693	999	816	1311	1690	2013	2341	2675	-
16	291	395	500	500	711	980	711	1305	1638	1975	2378	2669	-
18	258	350	538	444	725	1013	631	1303	1648	1998	2303	2665	-
20	233	399	568	399	693	995	568	1299	1653	1970	2338	2663	-
22	211	-	-	363	-	-	515	-	-	-	-	-	-
24	194	331	541	331	683	1004	471	1295	1664	2003	2309	2656	-
26	-	-	-	306	-	-	435	-	-	-	-	-	-
30	209	376	488	265	-	-	376	-	-	-	-	-	-
36	-	-	-	220	-	-	314	-	-	-	-	-	-
42	-	-	-	189	-	-	269	-	-	-	-	-	-

▲ For allowable working pressures at higher temperatures, multiply values listed above by the following factors:

Grade A					
Temperature	700 °F	750 °F	800 °F	850 °F	900 °F
Multiply by	0.971	0.892	0.750	0.708	0.417

Grade B					
Temperature	700 °F	750 °F	800 °F	850 °F	900 °F
Multiply by	0.956	0.853	0.720	0.620	0.333

PIPE, FITTING & FLANGE SPECIFICATIONS

FLANGE STANDARDS – Dimensional Data in inches

125 lb. CAST IRON — ANSI STANDARD B16.1

PIPE SIZE	1/2	3/4	1	1 1/4	1 1/2	2	2 1/2	3	3 1/2	4	5	6	8	10	12
Diameter of Flange	–	–	4 1/4	4 5/8	5	6	7	7 1/2	8 1/2	9	10	11	13 1/2	16	19
Thickness of Flange (min)[a]	–	–	7/16	1/2	9/16	5/8	11/16	3/4	13/16	15/16	15/16	1	1 1/8	1 3/16	1 1/4
Diameter of Bolt Circle	–	–	3 1/8	3 1/2	3 7/8	4 3/4	5 1/2	6	7	7 1/2	8 1/2	9 1/2	11 3/4	14 1/4	17
Number of Bolts	–	–	4	4	4	4	4	4	8	8	8	8	8	12	12
Diameter of Bolts	–	–	1/2	1/2	1/2	5/8	5/8	5/8	5/8	5/8	3/4	3/4	3/4	7/8	7/8

[a] 125 lb. Cast Iron Flanges have plain faces (i.e. not raised faces).

250 lb. CAST IRON — ANSI STANDARD B16.1

PIPE SIZE	1/2	3/4	1	1 1/4	1 1/2	2	2 1/2	3	3 1/2	4	5	6	8	10	12
Diameter of Flange	–	–	4 7/8	5 1/4	6 1/8	6 1/2	7 1/2	8 1/4	9	10	11	12 1/2	15	17 1/2	20 1/2
Thickness of Flange (min)[b]	–	–	11/16	3/4	13/16	7/8	1	1 1/8	1 3/16	1 1/4	1 3/8	1 7/16	1 5/8	1 7/8	2
Diameter of Raised Face	–	–	2 11/16	3 1/16	3 9/16	4 3/16	4 15/16	5 11/16	6 5/16	6 15/16	8 5/16	9 11/16	11 15/16	14 1/16	16 7/16
Diameter of Bolt Circle	–	–	3 1/2	3 7/8	4 1/2	5	5 7/8	6 5/8	7 1/4	7 7/8	9 1/4	10 5/8	13	15 1/4	17 3/4
Number of Bolts	–	–	4	4	4	8	8	8	8	8	8	12	12	16	16
Diameter of Bolts	–	–	5/8	5/8	3/4	5/8	3/4	3/4	3/4	3/4	3/4	3/4	7/8	1	1 1/8

[b] 250 lb. Cast Iron Flanges have a 1/16" raised face which is included in the flange thickness dimensions.

150 lb. BRONZE — ANSI STANDARD B16.24

PIPE SIZE	1/2	3/4	1	1 1/4	1 1/2	2	2 1/2	3	3 1/2	4	5	6	8	10	12
Diameter of Flange	3 1/2	3 7/8	4 1/4	4 5/8	5	6	7	7 1/2	8 1/2	9	10	11	13 1/2	16	19
Thickness of Flange (min)[c]	5/16	11/32	3/8	13/32	7/16	1/2	9/16	5/8	11/16	11/16	3/4	13/16	15/16	1	1 1/16
Diameter of Bolt Circle	2 3/8	2 3/4	3 1/8	3 1/2	3 7/8	4 3/4	5 1/2	6	7	7 1/2	8 1/2	9 1/2	11 3/4	14 1/4	17
Number of Bolts	4	4	4	4	4	4	4	4	8	8	8	8	8	12	12
Diameter of Bolts	1/2	1/2	1/2	1/2	1/2	5/8	5/8	5/8	5/8	5/8	3/4	3/4	3/4	7/8	7/8

[c] 150 lb. Bronze Flanges have plain faces (i.e. not raised faces) with two concentric gasket-retaining grooves between the port and the bolt holes.

300 lb. BRONZE — ANSI STANDARD B16.24

PIPE SIZE	1/2	3/4	1	1 1/4	1 1/2	2	2 1/2	3	3 1/2	4	5	6	8	10	12
Diameter of Flange	3 3/4	4 5/8	4 7/8	5 1/4	6 1/2	6 1/2	7 1/2	8 1/4	9	10	11	12 1/2	15	–	–
Thickness of Flange (min)[d]	1/2	17/32	19/32	5/8	11/16	3/4	13/16	29/32	31/32	1 1/16	1 1/8	1 3/16	1 3/8	–	–
Diameter of Bolt Circle	2 5/8	3 1/4	3 1/2	3 7/8	4 1/2	5	5 7/8	6 5/8	7 1/4	7 7/8	9 1/4	10 5/8	13	–	–
Number of Bolts	4	4	4	4	4	8	8	8	8	8	8	12	12	–	–
Diameter of Bolts	1/2	5/8	5/8	5/8	3/4	5/8	3/4	3/4	3/4	3/4	3/4	3/4	7/8	–	–

[d] 300 lb. Bronze Flanges have plain faces (i.e. not raised faces) with two concentric gasket-retaining grooves between the port and the bolt holes.

FLANGE STANDARDS – Dimensional Data in inches (continued)

150 lb. STEEL — ANSI STANDARD B16.5

PIPE SIZE	1/2	3/4	1	1 1/4	1 1/2	2	2 1/2	3	3 1/2	4	5	6	8	10	12
Diameter of Flange	–	–	4	4 5/8	5	6	7	7 1/2	8 1/2	9	10	11	13 1/2	16	19
Thickness of Flange (min)[e]	–	–	7/16	1/2	9/16	5/8	11/16	3/4	13/16	15/16	15/16	1	1 1/8	1 3/16	1 1/4
Diameter of Raised Face	–	–	2	2 1/2	2 7/8	3 5/8	4 1/8	5	5 1/2	6 3/16	7 5/16	8 1/2	10 5/8	12 3/4	15
Diameter of Bolt Circle	–	–	3 1/8	3 1/2	3 7/8	4 3/4	5 1/2	6	7	7 1/2	8 1/2	9 1/2	11 3/4	14 1/4	17
Number of Bolts	–	–	4	4	4	4	4	4	8	8	8	8	8	12	12
Diameter of Bolts	–	–	1/2	1/2	1/2	5/8	5/8	5/8	5/8	5/8	3/4	3/4	3/4	7/8	7/8

[e] 150 lb. Steel Flanges have a 1/16" raised face which is included in the flange thickness dimensions.

300 lb. STEEL — ANSI STANDARD B16.5

PIPE SIZE	1/2	3/4	1	1 1/4	1 1/2	2	2 1/2	3	3 1/2	4	5	6	8	10	12
Diameter of Flange	–	–	4 7/8	5 1/4	6 1/8	6 1/2	7 1/2	8 1/4	9	10	11	12 1/2	15	17 1/2	20 1/2
Thickness of Flange (min)[f]	–	–	11/16	3/4	13/16	7/8	1	1 1/8	1 3/16	1 1/4	1 3/8	1 7/16	1 5/8	1 7/8	2
Diameter of Raised Face	–	–	2	2 1/2	2 7/8	3 5/8	4 1/8	5	5 1/2	6 3/16	7 5/16	8 1/2	10 5/8	12 3/4	15
Diameter of Bolt Circle	–	–	3 1/2	3 7/8	4 1/2	5	5 7/8	6 5/8	7 1/4	7 7/8	9 1/4	10 5/8	13	15 1/4	17 3/4
Number of Bolts	–	–	4	4	4	8	8	8	8	8	8	12	12	16	16
Diameter of Bolts	–	–	5/8	3/4	5/8	3/4	3/4	3/4	3/4	3/4	3/4	3/4	7/8	1	1 1/8

[f] 300 lb. Steel Flanges have a 1/16" raised face which is included in the flange thickness dimensions.

400 lb. STEEL — ANSI STANDARD B16.5

PIPE SIZE	1/2	3/4	1	1 1/4	1 1/2	2	2 1/2	3	3 1/2	4	5	6	8	10	12
Diameter of Flange	3 3/4	4 5/8	4 7/8	5 1/4	6 1/8	6 1/2	7 1/2	8 1/4	9	10	11	12 1/2	15	17 1/2	20 1/2
Thickness of Flange (min)[g]	9/16	5/8	11/16	13/16	7/8	1	1 1/8	1 1/4	1 3/8	1 3/8	1 1/2	1 5/8	1 7/8	2 1/8	2 1/4
Diameter of Raised Face	1 3/8	1 11/16	2	2 1/2	2 7/8	3 5/8	4 1/8	5	5 1/2	6 3/16	7 5/16	8 1/2	10 5/8	12 3/4	15
Diameter of Bolt Circle	2 5/8	3 1/4	3 1/2	3 7/8	4 1/2	5	5 7/8	6 5/8	7 1/4	7 7/8	9 1/4	10 5/8	13	15 1/4	17 3/4
Number of Bolts	4	4	4	4	4	8	8	8	8	8	8	12	12	16	16
Diameter of Bolts	1/2	5/8	5/8	5/8	3/4	5/8	3/4	3/4	7/8	7/8	7/8	7/8	1	1 1/8	1 1/4

[g] 400 lb. Steel Flanges have a 1/4" raised face which is included in the flange thickness dimensions.

600 lb. STEEL — ANSI STANDARD B16.5

PIPE SIZE	1/2	3/4	1	1 1/4	1 1/2	2	2 1/2	3	3 1/2	4	5	6	8	10	12
Diameter of Flange	3 3/4	4 5/8	4 7/8	5 1/4	6 1/8	6 1/2	7 1/2	8 1/4	9	10 3/4	13	14	16 1/2	20	22
Thickness of Flange (min)[h]	9/16	5/8	11/16	13/16	7/8	1	1 1/8	1 1/4	1 3/8	1 1/2	1 3/4	1 7/8	2 3/16	2 1/2	2 5/8
Diameter of Raised Face	1 3/8	1 11/16	2	2 1/2	2 7/8	3 5/8	4 1/8	5	5 1/2	6 3/16	7 5/16	8 1/2	10 5/8	12 3/4	15
Diameter of Bolt Circle	2 5/8	3 1/4	3 1/2	3 7/8	4 1/2	5	5 7/8	6 5/8	7 1/4	8 1/2	10 1/2	11 1/2	13 3/4	17	19 1/4
Number of Bolts	4	4	4	4	4	8	8	8	8	8	8	12	12	16	20
Diameter of Bolts	1/2	5/8	5/8	5/8	3/4	5/8	3/4	3/4	7/8	7/8	1	1	1 1/8	1 1/4	1 1/4

[h] 600 lb. Steel Flanges have a 1/4" raised face which is included in the flange thickness dimensions.

PIPE FITTING & FLANGE SPECIFICATIONS

FITTING STANDARDS & SPECIFICATIONS

Class or Material	Dimensions	Material Spec.	Galvanizing	Thread	Pressure Rating	Federal/Other
Malleable Iron Fittings						
Class 150/PN 20	ASME B16.3•	ASTM A-197	ASTM A-153	ASME B120.1+	ASME B16.3•	ASME B16.3**
Class 300/PN 50	ASME B16.3•	ASTM A-197	ASTM A-153	ASME B120.1+	ASME B16.3•	
Malleable Iron Unions						
Class 150/PN 20	ASME B16.39•	ASTM A-197	ASTM A-153	ASME B120.1+	ASME B16.39•	ASME B16.39***
Class 250	ASME B16.39•	ASTM A-197	ASTM A-153	ASME B120.1+	ASME B16.39•	
Class 300/PN 50	ASME B16.39•	ASTM A-197	ASTM A-153	ASME B120.1+	ASME B16.39•	
Cast Iron Threaded Fittings						
Class 125	ASME B16.4•	ASTM A-126 (A)	ASTM A-153	ASME B120.1+	ASME B16.4•	ASME B16.4u
Class 250	ASME B16.4•	ASTM A-126 (A)	ASTM A-153	ASME B120.1+	ASME B16.4•	ASME B16.4u
Cast Iron Plugs & Bushings						
	ASME B16.14•	ASTM A-126 (A)	ASTM A-153	ASME B120.1+	ASME B16.14•	WW-P-471
Cast Iron Drainage Threaded Fittings						
	ASME B16.12•	ASTM A-126 (A)	ASTM A-153	ASME B120.1+	ASME B16.12•	
Cast Iron Flanges & Flanged Fittings						
Class 125 (1"-12")	ASME B16.1•	ASTM A-126 (A) or (B)	ASTM A-153	ASME B120.1+	ASME B16.1•	ASME B16.1•
Class 125 (14" & up)	ASME B16.1•	ASTM A-126 (B)	ASTM A-153	ASME B120.1+	ASME B16.1•	ASME B16.1•
Class 250 (1"-12")	ASME B16.1•	ASTM A-126 (A) or (B)	ASTM A-153	ASME B120.1+	ASME B16.1•	ASME B16.1•
Class 250 (14" & up)	ASME B16.1•	ASTM A-126 (B)	ASTM A-153	ASME B120.1+	ASME B16.1•	ASME B16.1•
Forged Steel Threaded Fittings						
Class 2000, 3000, 6000	ASME B16.11•	ASTM A105, ASTM A182, ASTM A350		ASME B120.1+	ASME B16.11•	
Pipe Nipples						
Steel Pipe - welded	ASTM A733	ASTM A53 Type F or Type E		ASME B120.1+		WWN 351
Steel Pipe - seamless (High Temperature)	ASTM A733	ASTM A106 Gr.B		ASME B120.1+		WWN 351
Brass		ASTM B43		ASME B120.1+		WWN 351

• an American National standard (ANSI)
+ ASME B120.1 was ANSI B2.1
u Formerly WW-P-501
** Formerly WW-P-521
*** Formerly WW-U-531

STANDARD CLASS PRESSURE-TEMPERATURE RATINGS ANSI/ASME B16.34

Working Pressure by Classes	Temperature (°F)	A 216 WCB (a)	A 352 LCB (d)	A 216 WCC (a) A 352 LC2 (d) A 352 LC3 (d) A 352 LCC (e)	A 217 WC1 (b) A 352 LC1 (d)	A 217 WC4 (h) A 217 WC5 (i)	A 217 WC6 (j)	A 217 WC9 (j)	A 217 C5	A 217 C12	A 351 CF3 (f) A 351 CF8	A 351 CF3M (g) A 351 CF8M	A 351 CF8C	A 351 CN7M (l)
		Working Pressure in PSI												
150 LB.	-20 to 100	285	265	290	265	290	290	290	290	290	275	275	275	230
	200	260	250	260	260	260	260	260	260	260	235	240	245	215
	300	230	230	230	230	230	230	230	230	230	205	215	225	200
	400	200	200	200	200	200	200	200	200	200	180	195	200	185
	500	170	170	170	170	170	170	170	170	170	170	170	170	170
	600	140	140	140	140	140	140	140	140	140	140	140	140	140
	650	125	125	125	125	125	125	125	125	125	125	125	125	125
	700	110	110	110	110	110	110	110	110	110	110	110	110	110
	750	95	95	95	95	95	95	95	95	95	95	95	95	95
	800	80	80	80	80	80	80	80	80	80	80	80	80	80
	850	65	65	65	65	65	65	65	65	65	65	65	65	–
	900	50	50	50	50	50	50	50	50	50	50	50	50	–
	950	35	35	35	35	35	35	35	35	35	35	35	35	–
	1000	20	20	20	20	20	20	20	20	20	20	20	20	–
	1050	–	–	–	–	20(1)	20(1)	20(1)	20(1)	20(1)	20(1)	20(1)	20(1)	–
	1100	–	–	–	–	–	20(1)	20(1)	20(1)	20(1)	20(1)	20(1)	20(1)	–
	1150	–	–	–	–	–	20(1)	20(1)	20(1)	20(1)	20(1)	20(1)	20(1)	–
	1200	–	–	–	–	–	15(1)	20(1)	20(1)	20(1)	20(1)	20(1)	20(1)	–
	1250	–	–	–	–	–	–	–	–	–	20(1)	20(1)	20(1)	–
	1300	–	–	–	–	–	–	–	–	–	20(1)	20(1)	20(1)	–
	1350	–	–	–	–	–	–	–	–	–	20(1)	20(1)	20(1)	–
	1400	–	–	–	–	–	–	–	–	–	20(1)	20(1)	20(1)	–
	1450	–	–	–	–	–	–	–	–	–	15(1)	20(1)	20(1)	–
	1500	–	–	–	–	–	–	–	–	–	10(1)	15(1)	15(1)	–
300 LB.	-20 to 100	740	695	750	695	750	750	750	750	750	720	720	720	600
	200	675	655	750	680	750	710	715	750	750	600	620	635	555
	300	655	640	730	655	730	675	675	730	730	530	560	590	525
	400	635	620	705	640	705	660	650	705	705	470	515	555	480
	500	600	585	665	620	665	640	640	665	665	435	480	520	470
	600	550	535	605	605	605	605	605	605	605	415	450	490	455
	650	535	525	590	590	590	590	590	590	590	410	445	480	450
	700	535	520	570	570	570	570	570	570	570	405	430	470	445
	750	505	475	505	530	530	530	530	530	530	400	425	460	440
	800	410	390	410	510	510	510	510	510	510	395	415	455	430
	850	270	270	270	485	485	485	485	440	485	390	405	445	–
	900	170	170	170	450	450	450	450	355	450	385	395	430	–
	950	105	105	105	280	345	380	380	260	370	375	385	385	–
	1000	50	50	50	165	215	225	270	190	290	325	365	365	–
	1050	–	–	–	–	190	140	200	140	190	310	360	360	–
	1100	–	–	–	–	–	95	115	105	115	260	325	325	–
	1150	–	–	–	–	–	50	105	70	75	195	275	275	–
	1200	–	–	–	–	–	35	55	45	50	155	205	170	–
	1250	–	–	–	–	–	–	–	–	–	110	180	125	–
	1300	–	–	–	–	–	–	–	–	–	85	140	95	–
	1350	–	–	–	–	–	–	–	–	–	60	105	70	–
	1400	–	–	–	–	–	–	–	–	–	50	75	50	–
	1450	–	–	–	–	–	–	–	–	–	35	60	40	–
	1500	–	–	–	–	–	–	–	–	–	25	40	35	–

STANDARD CLASS PRESSURE-TEMPERATURE RATINGS ANSI/ASME B16.34 (continued)

Working Pressure by Classes	Temperature (°F)	A 216 WCB (a)	A 352 LCB (d)	A 216 WCC (a) A 352 LC2 (d) A 352 LC3 (d) A 352 LCC (e)	A 217 WC1 (b) A 352 LC1 (d)	A 217 WC4 (h) A 217 WC5 (l)	A 217 WC6 (j)	A 217 WC9 (j)	A 217 C5	A 217 C12	A 351 CF3 (f) A 351 CF8	A 351 CF3M (g) A 351 CF8M	A 351 CF8C	A 351 CN7M (l)
		Working Pressure in PSI												
400 LB.	-20 to 100	990	925	1000	925	1000	1000	1000	1000	1000	960	960	960	800
	200	900	875	1000	905	1000	950	955	1000	1000	800	825	850	740
	300	875	850	970	870	970	895	905	970	970	705	745	785	700
	400	845	825	940	855	940	880	865	940	940	630	685	740	640
	500	800	775	885	830	885	855	855	885	885	585	635	690	625
	600	730	710	805	805	805	805	805	805	805	555	600	655	605
	650	715	695	785	785	785	785	785	785	785	545	590	640	600
	700	710	690	755	755	755	755	755	755	755	540	575	625	595
	750	670	630	670	710	710	710	710	710	710	530	565	615	585
	800	550	520	550	675	675	675	675	675	675	525	555	610	575
	850	355	355	355	650	650	650	650	585	650	520	540	590	–
	900	230	230	230	600	600	600	600	470	600	510	525	575	–
	950	140	140	140	375	460	505	505	350	495	500	515	515	–
	1000	70	70	70	220	285	300	355	255	390	430	485	485	–
	1050	–	–	–	–	250	185	265	190	250	410	480	480	–
	1100	–	–	–	–	–	130	150	140	150	345	430	430	–
	1150	–	–	–	–	–	70	140	90	100	260	365	365	–
	1200	–	–	–	–	–	45	75	60	70	205	275	230	–
	1250	–	–	–	–	–	–	–	–	–	145	245	165	–
	1300	–	–	–	–	–	–	–	–	–	110	185	125	–
	1350	–	–	–	–	–	–	–	–	–	85	140	90	–
	1400	–	–	–	–	–	–	–	–	–	65	100	70	–
	1450	–	–	–	–	–	–	–	–	–	45	80	55	–
	1500	–	–	–	–	–	–	–	–	–	30	55	45	–
600 LB.	-20 to 100	1480	1390	1500	1390	1500	1500	1500	1500	1500	1440	1440	1440	1200
	200	1350	1315	1500	1360	1500	1425	1430	1500	1500	1200	1240	1270	1115
	300	1315	1275	1455	1305	1455	1345	1355	1455	1455	1055	1120	1175	1045
	400	1270	1235	1410	1280	1410	1315	1295	1410	1410	940	1030	1110	960
	500	1200	1165	1330	1245	1330	1285	1280	1330	1330	875	955	1035	935
	600	1095	1065	1210	1210	1210	1210	1210	1210	1210	830	905	985	910
	650	1075	1045	1175	1175	1175	1175	1175	1175	1175	815	890	960	900
	700	1065	1035	1135	1135	1135	1135	1135	1135	1135	805	865	935	890
	750	1010	945	1010	1065	1065	1065	1065	1065	1065	795	845	920	880
	800	825	780	825	1015	1015	1015	1015	1015	1015	790	830	910	865
	850	535	535	535	975	975	975	975	880	975	780	810	890	–
	900	345	345	345	900	900	900	900	705	900	770	790	865	–
	950	205	205	205	560	685	755	755	520	740	750	775	775	–
	1000	105	105	105	330	425	445	535	385	585	645	725	725	–
	1050	–	–	–	–	380	275	400	280	380	620	720	720	–
	1100	–	–	–	–	–	190	225	205	225	515	645	645	–
	1150	–	–	–	–	–	105	205	140	150	390	550	550	–
	1200	–	–	–	–	–	70	110	90	105	310	410	345	–
	1250	–	–	–	–	–	–	–	–	–	220	365	245	–
	1300	–	–	–	–	–	–	–	–	–	165	275	185	–
	1350	–	–	–	–	–	–	–	–	–	125	205	135	–
	1400	–	–	–	–	–	–	–	–	–	95	150	105	–
	1450	–	–	–	–	–	–	–	–	–	70	115	80	–
	1500	–	–	–	–	–	–	–	–	–	50	85	70	–

STANDARD CLASS PRESSURE-TEMPERATURE RATINGS ANSI/ASME B16.34 (continued)

Working Pressure by Classes	Temperature (°F)	A 216 WCB (a)	A 352 LCB (d)	A 216 WCC (a) A 352 LC2 (d) A 352 LC3 (d) A 352 LCC (e)	A 217 WC1 (b) A 352 LC1 (d)	A 217 WC4 (h) A 217 WC5 (i)	A 217 WC6 (j)	A 217 WC9 (j)	A 217 C5	A 217 C12	A 351 CF3 (f) A 351 CF8	A 351 CF3M (g) A 351 CF8M	A 351 CF8C	A 351 CN7M (l)
		Working Pressure in PSI												
900 LB.	-20 to 100	2220	2085	2250	2085	2250	2250	2250	2250	2250	2160	2160	2160	1800
	200	2025	1970	2250	2035	2250	2135	2150	2250	2250	1800	1860	1910	1670
	300	1970	1915	2185	1955	2185	2020	2030	2185	2185	1585	1680	1765	1570
	400	1900	1850	2115	1920	2115	1975	1945	2115	2115	1410	1540	1665	1445
	500	1795	1745	1995	1865	1995	1925	1920	1995	1995	1310	1435	1555	1405
	600	1640	1600	1815	1815	1815	1815	1815	1815	1815	1245	1355	1475	1365
	650	1610	1570	1765	1765	1765	1765	1765	1765	1765	1225	1330	1440	1350
	700	1600	1555	1705	1705	1705	1705	1705	1705	1705	1210	1295	1405	1335
	750	1510	1420	1510	1595	1595	1595	1595	1595	1595	1195	1270	1385	1320
	800	1235	1175	1235	1525	1525	1525	1525	1490	1525	1180	1245	1370	1295
	850	805	805	805	1460	1460	1460	1460	1315	1460	1165	1215	1330	–
	900	515	515	515	1350	1350	1350	1350	1060	1350	1150	1180	1295	–
	950	310	310	310	845	1030	1130	1130	780	1110	1125	1160	1160	–
	1000	155	155	155	495	640	670	805	575	875	965	1090	1090	–
	1050	–	–	–	–	565	410	595	420	565	925	1080	1080	–
	1100	–	–	–	–	–	290	340	310	340	770	965	965	–
	1150	–	–	–	–	–	155	310	205	225	585	825	825	–
	1200	–	–	–	–	–	105	165	135	155	465	620	515	–
	1250	–	–	–	–	–	–	–	–	–	330	545	370	–
	1300	–	–	–	–	–	–	–	–	–	245	410	280	–
	1350	–	–	–	–	–	–	–	–	–	185	310	205	–
	1400	–	–	–	–	–	–	–	–	–	145	225	155	–
	1450	–	–	–	–	–	–	–	–	–	105	175	125	–
	1500	–	–	–	–	–	–	–	–	–	70	125	105	–
1500 LB.	-20 to 100	3705	3470	3750	3470	3750	3750	3750	3750	3750	3600	3600	3600	3000
	200	3375	3280	3750	3395	3750	3560	3580	3750	3750	3000	3095	3180	2785
	300	3280	3190	3640	3260	3640	3365	3385	3640	3640	2640	2795	2940	2615
	400	3170	3085	3530	3200	3530	3290	3240	3530	3530	2350	2570	2770	2405
	500	2995	2910	3325	3105	3325	3210	3200	3325	3325	2185	2390	2590	2340
	600	2735	2665	3025	3025	3025	3025	3025	3025	3025	2075	2255	2460	2275
	650	2685	2615	2940	2940	2940	2940	2940	2940	2940	2040	2220	2400	2250
	700	2665	2590	2840	2840	2840	2840	2840	2840	2840	2015	2160	2340	2225
	750	2520	2365	2520	2660	2660	2660	2660	2660	2660	1990	2110	2305	2200
	800	2060	1955	2060	2540	2540	2540	2540	2485	2540	1970	2075	2280	2160
	850	1340	1340	1340	2435	2435	2435	2435	2195	2435	1945	2030	2220	–
	900	860	860	860	2245	2245	2245	2245	1765	2245	1920	1970	2160	–
	950	515	515	515	1405	1715	1885	1885	1305	1850	1870	1930	1930	–
	1000	260	260	260	825	1065	1115	1340	960	1460	1610	1820	1820	–
	1050	–	–	–	–	945	684	995	705	945	1545	1800	1800	–
	1100	–	–	–	–	–	480	565	515	565	1285	1610	1610	–
	1150	–	–	–	–	–	260	515	345	380	980	1370	1370	–
	1200	–	–	–	–	–	170	275	225	260	770	1030	855	–
	1250	–	–	–	–	–	–	–	–	–	550	910	615	–
	1300	–	–	–	–	–	–	–	–	–	410	685	465	–
	1350	–	–	–	–	–	–	–	–	–	310	515	345	–
	1400	–	–	–	–	–	–	–	–	–	240	380	255	–
	1450	–	–	–	–	–	–	–	–	–	170	290	205	–
	1500	–	–	–	–	–	–	–	–	–	120	205	170	–

Note: For welding end valves only.
(1) Flanged end ratings terminate at 1000°F.

Footnotes:
a) Permissible, but not recommended for prolonged usage above about 800°F.
b) Permissible, but not recommended for prolonged usage above about 850°F.
d) Not to be used over 650°F.
e) Not to be used over 700°F.
f) Not to be used over 800°F.
g) Not to be used over 850°F.
h) Not to be used over 1000°F.
i) Not to be used over 1050°F.
j) Not to be used over 1100°F.

SPECIFIC GRAVITY OF VARIOUS LIQUIDS

Liquid	Temp. (°F)	Specific Gravity (Relative to Water at 60°F)
Acetaldehyde	68	.784
Acetic Acid	80	1.05
Acetone	68	.790
Alcohol, Allyl	68	.856
Alcohol, Butyl	68	.811
Alcohol, Ethyl	68	.790
Alcohol, Methyl	68	.791
Alcohol, Propyl	68	.805
Ammonia (Anhydrous)	39	.63
Aniline	59	1.028
Automotive Oil, SAE 10	115	.94
Automotive Oil, SAE 20	115	.94
Automotive Oil, SAE 30	115	.94
Automotive Oil, SAE 40	155	.94
Automotive Oil, SAE 50	155	.94
Automotive Oil, SAE 60	155	.94
Automotive Oil, SAE 70	155	.94
Automotive Oil, SAE 80	0	.94
Automotive Oil, SAE 90	170	.94
Automotive Oil, SAE 250	130	.94
Benzene	68	.880
Brine, CaCl 25%	32	1.239
Brine, NaCl 25%	32	1.197
Butyric Acid - n	68	.960
Carbolic Acid (Phenol)	80	1.07
Carbon Disulphide	68	1.264
Carbon Tetrachloride	77	1.586
Castor Oil	115	.962
Chlorine	32	1.455
Chloroform	77	1.481
Diethyl Ether	68	.715
Ethyl Acetate	68	.903
Ethyl Bromide	68	1.460
Ethylene Bromide	68	2.183
Ethylene Chloride	68	1.257
Ethylene Glycol	80	1.12
Freon, 11	80	1.47
Freon, 12	80	1.30
Freon, 21	80	1.36
Fuel Oil, #1	85	.95
Fuel Oil, #2	85	.95
Fuel Oil #4	115	.95
Fuel Oil, #5	115	.95
Fuel Oil, #6	141	.95
Gasoline	60	.713
Glycerine, 100%	70	1.260
Heptane - n	68	.684
Hexane - n	68	.660
Kerosene	85	.82
Linseed Oil (Raw)	115	.940
Methyl Acetate	68	.931
Methyl Iodide	68	2.283
Milk	68	1.05
Naphthelene	68	1.146
Nitric Acid, 60%	68	1.378
Nitrobenzene	82	1.206
Nonane - n	68	.718
Octane - n	68	.703
Olive Oil	68	.911
Propionic Acid	68	.993
Soybean Oil	115	.98
Trichloroethylene	80	1.46
Turbine Oil	115	.91
Turpentine	60	.869
Water, Fresh	32	1.001
Water, Sea	60	1.03
Xylene - o	80	.87

SPECIFIC GRAVITY OF GASES

Gas	Formula	Molecular Weight M	Specific Gravity (Relative to Air) Sg
Acetylene	C_2H_2	26.02	.899
Air	—	28.97	1.0
Allylene	C_3H_4	40.0	1.38
Ammonia	NH_3	17.03	.59
Argon	A	39.94	1.38
Benzene	C_6H_6	78.05	2.69
Boron Fluoride	BF_3	67.82	2.34
Butane	C_4H_{10}	58.08	2.00
Butylene	C_4H_8	56.06	1.94
Carbon Dioxide	CO_2	44.01	1.53
Carbon Disulphide	CS_2	76.12	2.63
Carbon Monoxide	CO	28.00	.97
Carbon Tetrachloride	CCl_4	153.83	5.31
Chlorine	Cl_2	70.91	2.45
Chloroform	$CHCl_3$	119.39	4.12
Cyclohexane	C_6H_{12}	84.16	2.91
Dimethylamine	$(CH_3)_2NH$	45.08	1.56
Ethane	C_2H_6	30.05	1.05
Ethyl Alcohol	C_2H_5OH	46.07	1.59
Ethyl Chloride	C_2H_5Cl	64.50	2.23
Ethylene	C_2H_4	28.03	.97
Fluorine	F_2	38	1.31
Freon - 11	CCl_3F	137.37	4.74
12	CCl_2F_2	120.94	4.17
22	$CHClF_2$	86.48	2.99
Hellum	He	4.00	.138
Heptane	C_7H_{16}	100.13	3.47
Hexane	C_6H_{14}	86.12	2.98
Hydrogen	H_2	2.02	.069
Hydrogen Chloride	HCl	36.46	1.27

Gas	Formula	Molecular Weight M	Specific Gravity (Relative to Air) Sg
Hydrogen Sulphide	H_2S	34.08	1.19
Isobutane	C_4H_{10}	58.12	2.00
Isopentane	C_5H_{12}	72.19	2.50
Krypton	Kr	83.70	2.89
Methane	CH_4	16.03	.55
Methyl Alcohol	CH_3OH	32.04	1.11
Methyl Amine	CH_3NH_2	31.06	1.08
Methyl Chloride	CH_3Cl	50.48	1.74
Napthalene	$C_{10}H_8$	128.06	4.42
Neon	Ne	20.18	.70
Nitric Oxide	NO	30.04	1.04
Nitrogen	N_2	28.02	.97
Nitrous Oxide	N_2O	44.02	1.53
Octane	C_8H_{18}	114.22	3.94
Oxygen	O_2	32	1.11
Ozone	O_3	48	1.66
Pentane	C_5H_{12}	72.10	2.50
Propane	C_3H_8	44.07	1.53
Propyl Alcohol	C_2H_7OH	60.09	2.07
Propylene	C_3H_6	42.05	1.45
Sulphur Dioxide	SO_2	64.06	2.21
Sulphur Trioxide	SO_3	80.06	2.76
Xenon	Xe	131.30	4.53
Xylene	C_8H_{10}	106.16	3.66

SPECIFIC HEATS

TABLE I

VARIOUS SOLIDS

Material	B.t.u. per Lb. per°F.
Aluminum	.22
Andalusite	.17
Antimony	.05
Apatite	.20
Asbestos	.20
Augite	.19
Bakelite, wood filler	.33
Bakelite, asbestos filler	.38
Barite	.11
Barium	.07
Basalt rock	.20
Beryl	.20
Bismuth	.03
Borax	.24
Boron	.31
Cadmium	.06
Calcite, 32-100F	.19
Calcite, 32-212F	.20
Calcium	.15
Carbon	.17
Carborundum	.16
Cassiterite	.09
Cement, dry	.37
Cement, powder	.20
Charcoal	.24
Chalcopyrite	.13
Chromium	.12
Clay	.22
Coal	.26-.37
Cobalt	.11
Concrete, stone	.19
Concrete, cinder	.18
Copper	.09
Corundum	.10
Diamond	.15
Dolomite rock	.22
Fluorite	.22
Fluorspar	.21
Galena	.05
Garnet	.18
Glass, common	.20
Glass, crystal	.12
Glass, plate	.12
Glass, wool	.16
Gold	.03
Granite	.19
Hermatite	.16
Hornblende	.20
Hypersthene	.19
Ice, —112F	.35
Ice, —40F	.43
Ice, —4F	.47
Ice, 32F	.49
Iridium	.03
Iron, cast	.12
Iron, wrought	.12
Labradorite	.19
Lava	.20
Lead	.03
Limestone	.22
Magnetite	.16
Magnesium	.25
Malachite	.18
Manganese	.11
Marble	.21
Mercury	.03
Mica	.21
Molybdenum	.06
Nickel	.11
Oligloclose	.21
Orthoclose	.19
Plaster paris	1.14
Platinum	.03
Porcelain	.26
Potassium	.13
Pyrexglass	.20
Pyrolusite	.16
Pyroxylin plastics	.34-.38
Quartz, 55-212F	.19
Quartz, 32F	.17
Rock salt	.22
Rubber	.48
Sandstone	.22
Serpentine	.26
Silk	.33
Silver	.06
Sodium	.30
Steel	.12
Stone	.20
Stoneware	.19
Talc	.21
Tar	.35
Tellurium	.05
Tin	.05
Tile, hollow	.15
Titanium	.14
Topaz	.21
Tungsten	.04
Vanadium	.12
Vulcanite	.33
Wood	.32-.48
Wool	.33
Zinc blend	.11
Zinc	.09

TYPICAL STEAM CONSUMPTION RATES

	Operating pressure PSIG	Lbs per hr	
		In use	Maximum
PLASTIC MOLDING			
Each 12 to 15 sq ft platen surface	125	29	
PAPER MANUFACTURE			
Corrugators per 1,000 sq ft	175	29	
Wood pulp paper, per 100 lb paper	50	372	
RESTAURANT EQUIPMENT	5-20		
Standard steam tables, per ft length		36	
Standard steam tables, per 20 sq ft tank		29	
Bain Marie, per ft length, 30" wide		13	
Bain Marie, per 10 sq ft tank		29	
Coffee urns, per 10 gal, cold make-up		13	
3-compartment egg boiler		13	
Oyster steamers		13	
Clam or lobster steamer		29	
Steam Jacketed Kettles	5-20		
10 gal capacity		13	
25 gal stock kettle		29	
40 gal stock kettle		44	
60 gal stock kettle		58	
Plate And Dish Warmers	5-20		
Per 100 sq ft shelf		58	
Per 20 cu ft shelf		29	
Warming ovens, per 20 cu ft		29	
Direct vegetable steamer, per compartment		29	
Potato steamer		29	
Morandi Proctor, 30 comp., no return		87	
Pot sink, steam jets, average use		29	
Silver burnishers, Tahara		58	
SILVER MIRRORING			
Average steam tables	5	102	
TIRE SHOPS	100		
Truck molds, large		87	
Truck molds, medium		58	
Passenger molds		29	
Sections, per section		7	
Puff Irons, each		7	

TYPICAL STEAM CONSUMPTION RATES

HOSPITAL EQUIPMENT (Continued)	Operating pressure PSIG	Lbs per hr	
		In use	Maximum
Sterilizers, Non-Pressure Type			
For bottles or pasteurization Start with water at 70 F, maintained for 20 minutes at boiling at a depth of 3″	40	51	69
Instruments and Utensils:	40		
Start with water at 70F, boil vigorously for 20 min:			
Depth 3½″: Size 8 × 9 × 18″		27	27
Depth 3½″: Size 9 × 20 × 10″		30	30
Depth 4″: Size 10 × 12 × 22″		39	39
Depth 4″: Size 12 × 16 × 24″		60	60
Depth 4″: Size 10 × 12 × 36″		66	66
Depth 10″: Size 16 × 15 × 20″		92	92
Depth 10″: Size 20 × 20 × 24″		144	144
LAUNDRY EQUIPMENT	100		
Vacuum stills, per 10 gal		16	
Spotting board, trouser stretcher		29	
Dress finisher, overcoat shaper, each		58	
Jacket finisher, Susie Q, each		44	
Air vacuum finishing board, 18″ Mushroom Topper, ea.		20	
Steam irons, each		4	
Flat Iron Workers:	100		
48″ × 120″, 1 cylinder		248	
48″ × 120″, 2 cylinder		310	
4-Roll, 100 to 120″		217	
6-Roll, 100 to 120″		341	
8-Roll, 100 to 120″		465	
Shirt Equipment	100		
Single cuff, neckband, yoke No. 3, each		7	
Double sleeve		13	
Body		29	
Bosom		44	
Dry Rooms	100		
Blanket		20	
Conveyor, per loop, approx.		7	
Truck, per door, approx.		58	
Curtain, 50 × 114		29	
Curtain, 64 × 130		58	
Starch cooker, per 10 gal cap		7	
Starcher, per 10-in. length, approx.		5	
Laundry presses, per 10-in. length, approx.		7	
Handy irons, per 10-in. length, approx.		5	
Collar equipment: Collar and Cuff Ironer		21	
Deodorizer		87	
Wind Whip, Single		58	
Wind Whip, Double		87	
Tumblers, General Usage Other Source	100		
36″, per 10″ length, approx.		29	
40″, per 10″ length, approx.		38	
42″, per 10″ length, approx.		52	
Vorcone, 46″ × 120″		310	
Presses, central vacuum, 42″		20	
Presses, steam, 42″		29	

TYPICAL STEAM CONSUMPTION RATES

	Operating pressure PSIG	Lbs per hr	
BAKERIES		In use	Maximum
Dough room trough, 8 ft long	10	4	
Proof boxes, 500 cu ft capacity		7	
Ovens: Peel Or Dutch Type	10		
White bread, 120 sq ft surface		29	
Rye bread, 10 sq ft surface		58	
Master Baker Ovens		29	
Century Reel, w/pb per 100 lb bread		29	
Rotary ovens, per deck		29	
Bennett 400, single deck		44	
Hubbard (any size)		58	
Middleby-Marshall, w/pb		58	
Baker-Perkins travel ovens, long tray (per 100 lbs)		13	
Baker-Perkins travel ovens, short tray (per 100 lbs)		29	
General Electric		20	
Fish Duothermic Rotary, per deck		58	
Revolving ovens: 8-10 bun pan		29	
12-18 bun pan		58	
18-28 bun pan		87	
BOTTLE WASHING	5		
Soft drinks, beer, etc.: per 100 bottles/min		310	
Milk quarts, per 100 cases per hr		58	
CANDY and CHOCOLATE	70		
Candy cooking, 30-gal cooker, 1 hour, 325 deg		46	
Chocolate melting, jacketed, 24″ dia		29	
Chocolate dip kettles, per 10 sq ft tank surface		29	
Chocolate tempering, tops mixing, each 20 sq ft active surface		29	
Candy kettle per sq ft of jacket	30		60
Candy kettle per sq ft of jacket	75		100
CREAMERIES and DAIRIES	15-75		
Creamery cans 3 per min			310
Pasteurizer, per 100 gal heated 20 min			232
DISH WASHERS	10-30		
2-Compartment tub type			58
Large conveyor or roller type			58
Autosan, colt, depending on size		29	117
Champion, depending on size		58	310
Hobart Crescent, depending on size		29	186
Fan Spray, depending on size		58	248
Crescent manual steam control	30		
Hobart model AM-5	10		
Dishwashing machine	15-20	60-70	
HOSPITAL EQUIPMENT	40-50		
Stills, per 100 gal distilled water		102	
Sterilizers, bed pan		3	
Sterilizers, dressing, per 10″ length, approx.		7	
Sterilizers, instrument, per 100 cu in approx.		3	
Sterilizers, water, per 10 gal, approx.		6	
Disinfecting Ovens, Double Door:	40-50		
Up to 50 cu ft, per 10 cu ft approx.		29	
50 to 100 cu ft, per 10 cu ft approx.		21	
100 and up, per 10 cu ft, approx.		16	

TABLE II
VARIOUS LIQUIDS

Liquid	B.t.u. per Lb. per°F.
Alcohol, ethyl 32F	.55
Alcohol, ethyl, 104F	.65
Alcohol, methyl, 40-50F	.59
Alcohol, methyl, 60-70F	.60
Ammonia, 32F	1.10
Ammonia, 104F	1.16
Ammonia, 176F	1.29
Ammonia, 212F	1.48
Ammonia, 238F	1.61
Anilin	.52
Benzol	.42
Calcium Chloride, sp. gr. 1.20	.73
Castor Oil	.43
Citron Oil	.44
Diphenylamine	.46
Ethyl ether	.53
Fuel oil, sp. gr. .96	.40
Fuel oil, sp. gr. .91	.44
Fuel oil, sp. gr. .86	.45
Fuel oil, sp. gr. .81	.50
Gasoline	.53
Glycerine	.58
Kerosene	.98
Naphthalene	.41
Nitrobenzole	.36
Olive oil	.47
Petroleum	.51
Potassium hydrate	.88
Sea water, sp. gr. 1.0235	.94
Sesame oil	.39
Sodium hydrate	.94
Sodium chloride	.79
Toluol	.36
Turpentine	.41
Water, 20F	1.021
Water, 30F	1.010
Water, 40F	1.005
Water, 50F	1.002
Water, 60F	.995
Water, 70F	.998
Water, 80F	.998
Water, 90F	.997
Water, 100F	.997
Water, 110F	.997
Water, 120F	.997
Water, 130F	.998
Water, 140F	.998
Water, 150F	.999
Water, 160F	1.000
Water, 170F	1.007
Water, 180F	1.002
Water, 190F	1.003
Water, 200F	1.004
Water, 210F	1.005

TABLE III
GASES AND VAPORS

Gas or Vapor	Specific Heat, Btu per Lb. per°F at Constant Pressure	Specific Heat, Btu per Lb. per°F at Constant Volume
Acetone	.35	—
Air, dry, 50F	.24	.172
Air, dry, 32-392F	.24	.172
Air, dry, 68-824F	.24	.103
Air, dry, 68-1166F	.24	.131
Air, dry, 68-1472F	.24	.172
Air, saturated, 70F	.85	—
Alcohol, C_2H_5OH	.45	.398
Alcohol, CH_3OH	.46	.366
Ammonia	.54	.422
Argon	.12	.072
Benzene, C_6H_6	.33	.236
Bromine	.06	.047
Carbon dioxide	.20	—
Carbon monoxide	.24	.172
Carbon disulphide	.16	.132
Chlorine	.11	.082
Chloroform	.15	.131
Ether	.48	.466
Hydrochloric acid	.19	.136
Hydrogen	3.41	—
Hydrogen sulphide	.25	.189
Methane	.59	.446
Nitrogen	.24	.170
Nitric oxide	.23	.166
Nitrogen tetroxide	1.12	—
Nitrous oxide	.21	.166
Oxygen	.22	—
Steam, 32F	.47	.370
Steam, 212F	.42	.316
Steam, 356F	.51	.389
Sulphur dioxide	.15	.119
Water vapor, 32F	.47	.370
Water vapor, 212F	.42	.316
Water vapor, 356F	.51	.389

TABLE IV

FOODSTUFFS

Food	Specific Heat, Btu per Lb. per°F, Above Freezing	Specific Heat, Btu per Lb. per°F, Below Freezing
Apples	.87	.42
Apricots, fresh	.88	.43
Artichokes	.87	.42
Asparagus	.94	.45
Asparagus beans	.88	.43
Avocados	.72	.37
Bananas	.80	.40
Barracuda	.80	.40
Bass	.82	.41
Beef, carcass	.68	.48
Beef, flank	.56	.32
Beef, loin	66	.35
Beef, rib	.67	.36
Beef, round	.74	.38
Beef, rump	.62	.34
Beef, shanks	.76	.39
Beef, corned	.63	.34
Beets	.90	.43
Blackberries	.87	.42
Blueberries	.87	.42
Brains	.84	.41
Broccoli	.92	.44
Brussels sprouts	.88	.43
Butter	.20	.24
Butterfish	.77	.39
Cabbage	.94	.45
Candy	.93	.—
Carp	.82	.41
Carrots	.91	.44
Cauliflower	.93	.44
Celery	.94	.45
Chard	.93	.44
Cherries, sour	.88	.43
Cherries, sweet	.84	.41
Chicken, squab	.80	.40
Chicken, broilers	.77	.39
Chicken, fryers	.74	.38
Chicken, hens	.65	.35
Chicken, capons	.88	.44
Clams, meat only	.84	.41
Coconut, meat and milk	.68	.36
Coconut, milk only	.95	.45
Codfish	.86	.42
Cod Roe	.76	.39
Cowpeas, fresh	.73	.39
Cowpeas, dry	.28	.22
Crabs	.84	.41
Crab apples	.85	.41
Cranberries	.90	.43
Cream	.90	.38
Cucumber	.97	.45
Currants	.97	.45
Dandelion greens	.88	.43
Dates	.20	.007
Eels	.77	.39
Eggs	.76	.40
Eggplant	.94	.45
Endive	.95	.45
Figs, fresh	.82	.41
Figs, dried	.39	.26
Figs, candied	.37	.26
Flounders	.86	.42
Flour	.38	.28
Frogs legs	.88	.44
Garlic	.79	.40
Gizzards	.78	.39
Goose	.61	.34
Gooseberry	.86	.42
Granadilla	.84	.41
Grapefruit	.91	.44
Grapes	.86	.42
Grape juice	.82	.41
Guavas	.86	.42
Guinea hen	.75	.38
Haddock	.85	.42
Halibut	.80	.40
Herring, smoked	.71	.37
Horseradish, fresh	.79	.40
Horseradish, prepared	.88	.43
Ice Cream	.74	.40
Kale	.89	.43
Kidneys	.81	.40
Kidney beans, dried	.28	.23
Kohlrabi	.92	.44
Kumquats	.85	.41
Lamb, carcass	.73	.38
Lamb, leg	.71	.37
Lamb, rib cut	.61	.34
Lamb, shoulder	.67	.35
Lard	.54	.31
Leeks	.91	.44
Lemons	.91	.44
Lemon juice	.92	.44
Lettuce	.96	.45
Lima beans	.73	.38
Limes	.89	.43
Lime juice	.93	.44
Litchi fruits, dried	.39	.26
Lobsters	.82	.41
Loganberries	.86	.42
Loganberry juice	.91	.44
Milk, cow	.90	.47
Mushrooms, fresh	.93	.44
Mushrooms, dried	.30	.23
Muskmelons	.94	.45
Nectarines	.86	.42
Nuts	.28	.24
Olives, green	.80	.40
Onions	.90	.43
Onions, Welsh	.91	.44

TABLE IV

FOODSTUFFS (Continued)

Food	Specific Heat, Btu per Lb. per°F, Above Freezing	Specific Heat, Btu per Lb. per°F, Below Freezing
Oranges, fresh	.90	.43
Orange juice	.89	.43
Oysters	.84	.41
Peaches, Georgia	.87	.42
Peaches, N. Carolina	.89	.43
Peaches, Maryland	.90	.43
Peaches, New Jersey	.91	.44
Peach juice, fresh	.89	.43
Pears, Bartlett	.89	.43
Pears, Beurre Bosc	.85	.41
Pears, dried	.39	.26
Peas, young	.85	.41
Peas, medium	.81	.40
Peas, old	.88	.43
Peas, split	.28	.23
Peppers, ripe	.91	.44
Perch	.82	.41
Persimmons	.72	.37
Pheasant	.75	.36
Pickerel	.84	.41
Pickles, sweet	.82	.41
Pickles, sour and dill	.96	.45
Pickles, sweet mixed	.78	.29
Pickles, sour mixed	.95	.45
Pig's feet, pickled	.50	.31
Pike	.84	.41
Pineapple, fresh	.88	.43
Pineapple, sliced or crushed	.82	.41
Pineapple juice	.90	.43
Plums	.89	.43
Pomegranate	.85	.41
Pompano	.77	.39
Porgy	.81	.40
Pork, bacon	.36	.25
Pork, ham	.62	.34
Pork, loin	.66	.35
Pork, shoulder	.59	.33
Pork, spareribs	.62	.34
Pork, smoked ham	.65	.35
Pork, salted	.31	.24
Potatoes	.82	.41
Prickly pears	.91	.43
Prunes	.81	.40
Pumpkin	.92	.44
Quinces	.88	.43
Rabbit	.76	.39
Radishes	.95	.45
Raisins	.39	.26
Raspberries, black	.85	.41
Raspberries, red	.89	.43
Raspberry juice, black	.91	.44
Raspberry juice, red	.93	.44
Reindeer	.73	.37
Rhubarb	.96	.45
Rose Apple	.89	.43
Rutabagas	.91	.44
Salmon	.71	.37
Sand dab, California	.86	.42
Sapodilla	.91	.44
Sapote	.73	.37
Sauerkraut	.93	.44
Sausage, beef and pork	.56	.32
Sausage, bockwurst	.71	.37
Sausage, bologna	.71	.37
Sausage, frankfurt	.69	.36
Sausage, salami	.45	.28
Sardines	.77	.39
Shad	.76	.39
Shrimp	.83	.41
Spanish mackerel	.73	.39
Strawberries	.95	.45
Strawberry juice	.79	.39
String beans	.91	.44
Sturgeon, raw	.83	.41
Sturgeon, smoked	.71	.37
Sugar apple, fresh	.79	.39
Sweet potatoes	.75	.38
Swordfish	.80	.40
Terrapin	.80	.40
Tomatoes, red	.95	.45
Tomatoes, green	.96	.45
Tomato juice	.95	.45
Tongue, beef	.74	.38
Tongue, calf	.79	.40
Tongue, lamb	.76	.38
Tongue, pork	.74	.39
Tongue, sheep	.69	.36
Tripe, beef	.83	.41
Tripe, pickled	.89	.43
Trout	.82	.41
Tuna	.76	.39
Turkey	.67	.35
Turnips	.93	.44
Turtle	.84	.41
Veal, carcass	.74	.38
Veal, flank	.65	.35
Veal, loin	.75	.38
Veal, rib	.73	.37
Veal, shank	.77	.39
Veal, quarter	.74	.38
Venison	.78	.39
Watercress	.95	.45
Watermelons	.94	.45
Whitefish	.76	.39
Yams	.78	.39

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Product Cross Reference

Steam Traps

THERMODYNAMIC TRAPS

Manufacturer		Watson McDaniel		Armstrong		Spence Nicholson		Hoffman		Spirax Sarco		Yarway		TLV	
Desc.	Size	Product	F/F Dim	Product	F/F Dim	Product	F/F Dim	Product	F/F Dim	Product	F/F Dim	Product	F/F Dim	Product	F/F Dim
Standard 600 PSI															
Disc Trap	3/8"	TD600	2"	CD-33	3.31"	NTD600	2"	TD6523	2"	TD-52	2"	29	2"		
	1/2"		2.7"				2.68"	TD6524	2.75"		2.7"		2.25"		
	3/4"		2.8"		3.31"		2.81"	TD6526	2.75"		2.8"		2.87"		
	1"		3.3"		3.31"		3.31"	TD6528	3.25"		3.3"		3.37"		
Low Capacity Disc Trap	1/2"	TD600L	2.7"	CD-33L	3.31"	S610L	3.25"			TD-52L	2.7"				
	3/4"		2.8"		3.31"		3.25"				2.8"				
Low Capacity Disc Trap w/ Strainer	1/2"	TD600LS	3.1"	CD-33SL	3.31"					TD-42L	3.1"				
	3/4"		3.5"		3.31"						3.5"				
	1"		3.7"		3.31"						3.7"				
Disc Trap with Strainer	1/2"	TD600S	3.1"	CD-33S	3.5"	NTD600S	2"	TD6424	3.06"	TD-42H	3.1"	129Y	2.76"	A3N	3.87"
								TD6426	3.06"					P46SS	2.75"
	3/4"		3.5"		3.5"		2.68"	TD6428	3.25"		3.5"		2.95"	A3N	4.06"
														P46SS	2.75"
Disc Trap with Strainer & Blowdown	1/2"	TD600SB	3.5"	CD-33SB	3.5"	NTD600SB	2"			TD-42HB	3.1"	129YB	2.76"	A3N	3.87"
														P46SS	2.75"
	3/4"		3.7"		3.5"		2.68"				3.7"		2.95"	A3N	4.06"
														P46SS	2.75"
Low Cap. Disc Trap w/ Strainer & Blowdown	1/2"	TD600LSB	3.1"	CD-33SBL	3.5"					TD-42LB	3.1"				
	3/4"		3.5"								3.5"				
	1"		3.7"								3.7"				
Repairable In-line															
Disc Trap with Strainer	1/2"	TD700S	3.16"			S610	3.25"					721	3.15"	A46S A50S P46SRN	3.12"
	3/4"		3.55"										3.54"	A46S A50S P46SRN	3.12"
	1"		6.31"										3.93"	A46S A50S P46SRN	3.43"
Disc Trap with Strainer & Blowdown	1/2"	TD700SB	3.16"									721	3.15"	A46S A50S P46SRN	3.12"
	3/4"		3.55"										3.54"	A46S A50S P46SRN	3.12"
	1"		6.31"										3.93"	A46S A50S P46SRN	3.43"
High-Pressure Repairable In-line															
Disc Trap with Strainer	1/2"	TD700HS	3.15"									721HP	3.15"		
	3/4"		3.54"										3.54"		
	1"		6.31"										3.93"		
Disc Trap w/ Strainer & Blowdown	1/2"	TD700HSB	3.15"										3.15"		
	3/4"		3.54"										3.54"		
	1"		6.31"										3.93"		
High-Pressure Repairable In-line – 900 PSI															
Disc Trap with Strainer	1/2"	TD900S	3.6"							TD62	3.6"	460D3	4.81"	A65SS	3.12"
	3/4"		3.6"								3.6"		4.81"		3.12"
Ultra High-Pressure Repairable In-line – 3600 PSI															
Disc Trap	1"	TD3600	6.5"							TD120	3.9"		4.81"		3.43"
	1/2"		6.2"								6.2"				
	3/4"		6.2"								6.2"				
	1"		6.2"								6.2"				

Steam Traps (continued)

THERMOSTATIC TRAPS

Manufacturer		Watson McDaniel		Armstrong		Spence Nicholson		Spirax Sarco		Hoffman		TLV	
Desc.	Size	Product	F/F Dim	Product	F/F Dim	Product	F/F Dim	Product	F/F Dim	Product	F/F Dim	Product	F/F Dim
Non-Repairable													
Thermostatic 300 PSI	1/2"	WT1000	2.5"					TSS300	2.5"			LV21	2.18"
	3/4"		2.5"						2.5"				2.18"
Thermostatic 650 PSI	1/2"	WT2000C	3.75"	WT-1	4.5"	TA	3.75"	DTS300	2.5"				
	3/4"		3.75"	TTF-1	4.69"		3.93"		2.5"				
Repairable													
Thermostatic 250 PSI	1/2"	WT2500	3"			N450	3"						
	3/4"		3"				3"						
Thermostatic 650 PSI	1/2"	WT3000	4.5"			N650	5"						
	3/4"		4.5"				5"						
Thermostatic 650 PSI with Strainer	1/2"	WT3000S	4.5"			N650Y	5"	TM600N	5.25"			L21S L32S	3.12"
	3/4"		4.5"				5"		5.25"			L21S L32S	3.12"
Thermostatic 650 PSI with Strainer & Blowdown	1/2"	WT3000SB	4.5"			N650Y	5"						
	3/4"		4.5"				5"						
Thermostatic 300 PSI	3/4"	WT4000	4.5"			N450	3"						
	1"		4.5"				3"						
Thermostatic 300 PSI with Strainer	3/4"	WT4000S	4.5"			N450Y	3"						
	1"		4.5"				3"						
Thermostatic 300 PSI w/ Strainer & Blowdown	3/4"	WT4000SB	4.5"			N450Y	3"						
	1"		4.5"				3"						
Thermostatic 125 PSI, Angle*	1/2"	TA125	2.81"	TS-3	3.12"	N125	2.75"	RTA-125	2.8"	17C	3.24"	RT3A	3.12"
	3/4"		3.06"		3.5"		3.18"		3"	8C	3.12"		3.06"
Adjustable Bi-Metallic													
1/2"		WT5000	2.75"									LEX3N-TZ LEXW3N-TZ LEXF3N-TZ	2.75"
3/4"			3.12"									LEX3N-TZ LEXW3N-TZ LEXF3N-TZ	3.12"
1"			3.12"									LEX3N-TZ LEXW3N-TZ LEXF3N-TZ	3.12"

* Right Angle (90˚) Ports

Steam Traps (continued)

FLOAT & THERMOSTATIC TRAPS

Manufacturer		Watson McDaniel		Armstrong		Hoffman		Spence Nicholson		Spirax Sarco		TLV	
Desc.	Size	Product	F/F Dim	Product	F/F Dim	Product	F/F Dim	Product	F/F Dim	Product	F/F Dim	Product	F/F Dim
Ductile Iron – Repairable In-Line													
In-Line	1/2"	FTT	4.8"	BI2	2.75"	FTI	5.5"	FTE10	5.06"	FT14	4.8"	J3X	4.75"
	3/4"		4.8"	BI3	2.75"		5.5"		5.06"		4.8"		4.75"
	1"		4.8"	BI4	3"		5.5"		5.06"		4.7"		4.75"
	1.5"		10.6"	BI6	4.18"				11.12"		10.6"	JS7X	11"
	2"		11.9"	BI8	6"				12.12"		11.9"	J87	21.31"
High Capacity	1.5"	FTE	3"					HC	3"	FTB	3"		
	2"		4.5"	J&L	6.62"	FT-X-8	6.3"		6.62"		4.5"		
	2.5"		7.25"	K&M	11.31"	FT-C-10	9.5"		9.5"		7.25"		
Cast Iron – Repairable In-Line													
15 PSI	3/4"	WFT-015	3.3"	15-B3	2.75"	FT015H-3	3.93"	FTN	3.31"	FT-15	3.3"	SJ3-1	3.31"
	1"		3.3"	15-B4	3"	FT015H-4	3.93"		3.31"		3.3"	SJ3-1	5.12"
	1.25"		3"	15-B5	3"	FT015H-5	3"		3"		3"	SJ5-1	3"
	1.5"		3"	15-B6	4.18"	FT015H-6	3"		3"		4.25"	SJ6-1	4.93"
	2"		4.9"	15-B8	6"	FT015H-8	4.94"		4.94"		4.9"	SJ6-1	4.93"
30 PSI	3/4"	WFT-030	3.3"	30-B3	2.75"	FT030H-3	3.31"	FTN	3.31"	FT-30	3.3"	SJ3-2	5.12"
	1"		3.3"	30-B4	3"	FT030H-4	3.31"		3.31"		3.3"	SJ3-2	5.12"
	1.25"		3"	30-B5	3"	FT030H-5	3"		3"		3"	SJ5-2	3"
	1.5"		3"	30-B6	4.18"	FT030C-6	3"		3"		4.25"	SJ6-2 SJ7-2	4.06"
	2"		4.9"	30-B8	6"	FT030C-8	4.94"		4.94"		4.9"	SJ6-2 SJ7-2	4.93"
75 PSI	3/4"	WFT-075	3.3"	75-A3	2.75"	FT075H-3	3.31"	FTN	3.31"	FT-75	3.3"	SJ3-5	5.12"
	1"		3.3"	75-A4	3"	FT075H-4	3.31"		3.31"		3.3"	SJ3-5	5.12"
	1.25"		3"	75-A5	3"	FT075C-5	3"		3"		4.25"	SJ5-5	3"
	1.5"		3"	75-A6	4.18"	FT075C-6	3"		3"		4.25"	SJ6-10 SJ7-10	4.93"
	2"		4.9"	75-A8	6"	FT075C-8	4.94"		4.94"		4.9"	SJ6-10 SJ7-10	4.93"
125 PSI	3/4"	WFT-125	3.3"	125-A3	2.75"	FT125H-3	3.31"	FTN	3.31"	FT-125	3.3"	SJ3-10	5.12"
	1"		3.3"	125-A4	3"	FT125H-4	3.31"		3.31"		3.3"	SJ3-10	5.12"
	1.25"		3"	125-A5	3"	FT125C-5	3"		3"		4.25"	SJ5-10	3"
	1.5"		3"	125-A6	4.18"	FT125C-6	3"		3"		4.25"	SJ6-10 SJ7-10	4.93"
	2"		4.9"	125-A8	6"	FT125C-8	4.94"		4.94"		4.9"	SJ6-10 SJ7-10	4.93"
175 PSI	3/4"	WFT-175	3"	175-A3	2.75"	FT175H-3	3.31"			FT-200	3.3"	SJ3-14	5.12"
	1"		3"	175-A4	3"	FT175H-4	3.31"				3.3"	SJ3-14	5.12"
	1.25"		3"	175-A5	3"	FT175C-5	3"				4.25"	SJ5-14	3"
	1.5"		3"	175-A6	4.18"	FT175C-6	3"				4.25"	SJ6-14 SJ7-14	4.93"
	2"		4.5"	175-A8	6"	FT175C-8	4.94"				4.9"	SJ6-14 SJ7-14	4.93"
250 PSI	3/4"	WFT-250	3"							FT-200	3.3"	SJ3-14	5.12"
	1"		3"								3.3"	SJ3-14	5.12"
	1.25"		3"								4.25"	SJ5-14	3"
	1.5"		3"								4.25"	SJ6-14 SJ7-14	4.93"
	2"		4.5"								4.9"	SJ6-14 SJ7-14	4.93"
H Pattern 15 PSI	3/4"	FT3	4.12"			FT015H-3	3.31"						
	1"	FT4	4.12"			FT015H-4	3.31"						
	1.25"	FT6	5"			FT015H-5	3"						
	1.5"	FT7	6.37"			FT015H-6	5.25"						
	2"	FT8	6.5"			FT015H-8	7.46"						
H Pattern 30 PSI	3/4"	FT33	4.12"			FT030H-3	3.31"						
	1"	FT34	4.12"			FT030H-4	3.31"						
	1"	FT35	5"										
	1.25"	FT36	5"			FT030H-5	3"						
	1.5"	FT37L	6.37"			FT030H-6	5.25"						
	2"	FT38	6.5"										
H Pattern 75 PSI	3/4"	FT73	4.12"			FT075H-3	3.31"						
	1"	FT74	4.12"			FT075H-4	3.31"						
	1"	FT75	5"										
	1.25"	FT76	5"										
	1.5"	FT77L	6.37"										
	2"	FT78	6.5"										

Steam Traps (continued)

FLOAT & THERMOSTATIC TRAPS (continued)

Manufacturer		Watson McDaniel		Armstrong		Hoffman		Spence Nicholson		Spirax Sarco		TLV	
Desc.	Size	Product	F/F Dim	Product	F/F Dim	Product	F/F Dim	Product	F/F Dim	Product	F/F Dim	Product	F/F Dim
Carbon Steel													
In-Line	3/4"	FT600	6.1"	CS	6.75"			FTE44 NFT650	5.12" 5.5"	FT450	6.1"	JH3X	5.12"
	1"		6.5"	CS	8.37"			FTE44 NFT650	5.12" 11"	FT450	6.5"	JH3X	5.25"
	1.5"		9.8"	CS	11"			FTE44 NFT650	11.12" 13.75"	FT450	9.8"	JH7.2X	16"
	2"		11.8"	CS	11"			FTE44 NFT650	12.12" 13.75"	FT450	11.8"	JH8RX	23.25"
	3"		27.55" 39"							FT450	27.55" 39"	JL10 JL16	10.32"
	4"		39"							FT450	39"	J10	23.43" 24.06"
Offset	2.5"	FTES	8.4"	LS	11.31"					FTB	9.25"		
Stainless Steel													
In-Line	3/4"	FT601	6.1"							FT46	5.8"		
	1"		6.5"								6.2"		
	1.5"		9.8"								9"		
	2"		11.8"								9"		
	3"		27.55" 39"										
	4"		39"										

INVERTED BUCKET (IB) TRAPS

Manufacturer		Watson McDaniel		Armstrong		Hoffman		Spence Nicholson		Spirax Sarco	
Desc.	Size	Product	F/F Dim	Product	F/F Dim	Product	F/F Dim	Product	F/F Dim	Product	F/F Dim
Cast Iron											
IB Trap	1/2"	IB1031	5"	800	5"					B1H	5"
	3/4"		5"		5"						5"
	1/2"	IB1032	5"	811	5"	B1-2	6.93"				
	3/4"		5"		5"	B1-3	6.93"			B2	6.6"
	1"		5"		5"						
	1/2"	IB1033	6.5"	812	6.5"	B2-2	6.93"				
	3/4"		6.5"		6.5"	B2-3	6.93"			B2	6.6"
	3/4"	IB1034	7.75"	813	7.75"	B3-3	9.44"			B2	6.6"
	1"		7.75"		7.75"	B3-4	9.44"			B3	7.9"
IB Trap with Strainer	1/2"	IB1041	5"	880	5"			80S	5.06"		5"
	3/4"		5"		5"				5.06"		5"
	1/2"	IB1042	5"	881	5"	B1S-2	6.93"	81S	5.06"		
	3/4"		5"		5"	B1S-3	6.93"		5.06"	B2S	6.6"
	3/4"	IB1044	7.12"	883	7.87"	B3-3	9.44"	82S	7.00"	B2S	6.6"
	1"		7.12"		7.87"	B3-4	9.44"	83S	8.12"	B3S	7.9"
	1.25"	IB1038S	7.12"							B4S	9.3"
	1.5"		7.12"								

STAINLESS STEEL INVERTED BUCKET (SS IB) TRAPS

Manufacturer		Watson McDaniel		Armstrong		Spence Nicholson		Spirax Sarco	
Desc.	Size	Product	F/F Dim	Product	F/F Dim	Product	F/F Dim	Product	F/F Dim
SS IB Trap	1/2"	SIB	4.55"	1810	4.31"	TSBT-LS/MS	4.31"	SIB30	4.3"
	3/4"		4.55"		4.31"		4.31"		4.3"
SS IB Trap Hi Cap.	1/2"	SIBH	4.55"	1811	4.31"		4.31"	SIB30H	4.3"
	3/4"		4.55"		4.31"		4.31"		4.3"

Steam Traps (continued)

UNIVERSAL CONNECTORS

Manufacturer		Watson McDaniel		Armstrong		Spence Nicholson		Spirax Sarco		TLV	
Desc.	Size	Product	F/F Dim	Product	F/F Dim	Product	F/F Dim	Product	F/F Dim	Product	F/F Dim
Universal Connector	1/2"	UC450	2.92"	IS-2	3.5"	UMTC	3.5"	UPC	2.4"		
	3/4"		2.92"		3.5"		3.5"		2.9"		
	1"		5.66"		3.5"		3.5"		3.6"		
Universal Connector w/ Str	1/2"	UC450S	3.31"			UMTCY	3.5"			FS	3.12"
	3/4"		3.31"				3.5"				3.12"
	1"		6.06"				3.5"				3.75"
Universal Connector w/ Str/BD	1/2"	UC450SB	3.31"							FS	3.12"
	3/4"		3.31"								3.12"
	1"		6.06"								3.75"
Universal Connector w/ Str	1/2"	UC450S-LR UC450S-RL	3.31"	IS-2	3.5"			USC	3.2"		
	3/4"		3.31"		3.5"				3.5"		
	1"		3.62"		3.5"				3.9"		
Universal Connector w/ Str/BD	1/2"	UC450SB-LR UC450SB-RL	3.31"					USCB	3.2"		
	3/4"		3.31"						3.5"		
	1"		3.62"						3.9"		

Str = Strainer; BD = Blowdown Valve

UNIVERSAL STEAM TRAP MODULES

Description	Watson McDaniel	Armstrong	Spence Nicholson	Spirax Sarco	TLV
Standard Thermodynamic	TD450		UMT-TD10		
Standard Thermodynamic LC	TD450L		UMT-TD10L		
SM Thermodynamic	TD450SM	CD-3300		UTD52H	FP32
SM Thermodynamic LC	TD450LSM			UTD52L	
SM Thermodynamic LC/HP	TD600LSM-HP			UTD52L-HP	
Thermostatic	UT450	WT-2000 TT-2000	UMT450T	UBP32	FL21 FL32
Float & Thermostatic	UFT450	FT-4000		UFT14	FS3 FS5
Inverted Bucket	USIB450	2010	USBT	UIB30	
Inverted Bucket HP	USIB450H	2011	USBT	UIB30H	
Bi-Metallic	UB450	AB-2000		USM21	FX-1

SM = Side Mount; LC = Low Capacity; HP = High Pressure

SANITARY / CLEAN STEAM TRAPS

Description	Watson McDaniel	Armstrong	Spence Nicholson	Spirax Sarco	TLV
Thermostatic Repairable, Angle*	FDA400		CDH		
Thermostatic Repairable	FDA500	TC-C	CDS	BT6	SS5P
Thermostatic	FDA600	TC-R	DS100	BTM7	
Thermodynamic	FDA800		NTD230L	BTD52L	P10

* Right Angle (90°) Ports

Pressure Motive Pumps

PRESSURE MOTIVE PUMPS

Description	Watson McDaniel	Armstrong	Spence Nicholson	Spirax Sarco	Hoffman	TLV
Ductile Iron	PMPNT	PT104		PPEC		GP10L
Upright Ductile Iron	PMPC	PT3500	P3	PPC	PCC	GP10
				PTC		GP14
Upright Carbon Steel	PMPF	PT400	P3 Classic Vertical	PPF	PCS	GP10F
				PTF		GP14F
Low Profile Carbon Steel	PMPLS	PT200	P3 Little Boy	PPEC		GP10L
Hi-Cap 4"x4" Carbon Steel	PMPBP	PT516	Big Boy	PTF4		
Pump-Trap Combination						
1"x1" PMPM & FTE-200	WPT1	Double Duty 4		APT-10		GT10L-1
1 1/4"x1 1/4" PMPM & FTE-200	WPT2					
1 1/2"x1 1/2" PMPLS & FTE-200	WPT3	Double Duty 6		APT-14		GT10L-1-1/2
2"x2" PMPC & FTE-200	WPT4			APT-14HC		
3"x2" PMPC & FTE-200	WPT5					
1", 1 1/2" PMP w/ Internal Trap	PMPT	Double Duty 4		APT-14		GL10L-1

SKID MOUNTED PUMP SYSTEMS

Watson McDaniel	Armstrong	Spirax Sarco Pivitrol	Spence Nicholson Condensate Commander
PMPM Simplex, 6" x 36" Receiver	SPT-104LBRP-6 (4 Gallon)	PPEC Simplex	
PMPM Simplex, 8" x 36" Receiver	SPT-104LBRP-8 (7 Gallon)		
PMPM Simplex, 10" x 36" Receiver	SPT-104LBRP-10 (10 Gallon)	PPEC Simplex, 12 Gallon	
PMPM Duplex, 21-Gallon Receiver	DPT-104LBRP-12 (22 Gallon)	PPEC Duplex	
PMPC Simplex, 6" x 36" Receiver	SPT-200LBRP-6	PTC Simplex	
PMPC Simplex, 8" x 36" Receiver	SPT-200LBRP-8		
PMPC Simplex, 10" x 36" Receiver	SPT-200LBRP-10		
PMPC Simplex, 21-Gallon Receiver	SPT-200LBRP-16 (30 Gallon)	PTC Simplex, 31 Gallon	
PMPC Duplex, 21-Gallon Receiver	DPT-200LBRP-12	PTC Duplex, 31 Gallon	
PMPC Duplex, 75-Gallon Receiver	DPT-200LBRP-24 (85 Gallon)	PTC Duplex, 65 Gallon	
PMPF Simplex, 10" x 36" Receiver	SPT-400LBRP-10	PTF Simplex, 12 Gallon	
PMPF Simplex, 21-Gallon Receiver	SPT-400LBRP-16	PTF Simplex, 31 Gallon	Classic Vertical Simplex, 25 Gallon
PMPF Duplex, 21-Gallon Receiver	DPT-400LBRP-12	PTF Duplex, 31 Gallon	Classic Vertical Duplex, 25 Gallon
PMPF Duplex, 75-Gallon Receiver	DPT-400LBRP-24	PTF Duplex, 65 Gallon	Classic Vertical Duplex, 65 Gallon
PMPF Triplex, 116-Gallon Receiver	TPT-400LBRP (24" x 72")	PTF Triplex, 135 Gallon	Classic Vertical Triplex, 115 Gallon
PMPF Quadraplex, 116-Gallon Receiver	QPT-400LBRP (24" x 72")	PTF Quadraplex, 185 Gallon	Classic Vertical Quadraplex, 250 Gallon
PMPC Simplex, 10" x 36" Receiver	SPT-3500LBRP-10	PTC Simplex	
PMPC Simplex, 21-Gallon Receiver	SPT-3500LBRP-16	PTC Simplex, 31 Gallon	
PMPC Duplex, 21-Gallon Receiver	DPT-3500LBRP-12	PTC Duplex, 31 Gallon	
PMPC Duplex, 75-Gallon Receiver	DPT-3500LBRP-24	PTC Duplex, 65 Gallon	
PMPC Triplex	TPT-3500LBRP	PTC Triplex	
PMPC Quadraplex	QPT-3500LBRP	PTC Quadraplex	
PMPF Simplex, 10" x 36" Receiver	SPT-300LBRP-10	PTF Simplex	
PMPF Simplex, 21-Gallon Receiver	SPT-300LBRP-16	PTF Simplex, 31 Gallon	Classic Vertical Simplex, 25 Gallon
PMPF Duplex, 21-Gallon Receiver	DPT-300LBRP-12	PTF Duplex, 31 Gallon	Classic Vertical Duplex, 25 Gallon
PMPF Duplex, 75-Gallon Receiver	DPT-300LBRP-24	PTF Duplex, 65 Gallon	Classic Vertical Duplex, 65 Gallon
PMPF Triplex	TPT-300LBRP	PTF Triplex	Classic Vertical Triplex
PMPF Quadraplex	QPT-300LBRP	PTF Quadraplex	Classic Vertical Quadraplex
PMPBP Simplex, 116-Gallon Receiver	SPT-516RP (24" x 72")	PTF4 Simplex	Big Boy Simplex
PMPBP Duplex, 280-Gallon Receiver	DPT-516RP (30" x 84")	PTF4 Duplex	Big Boy Duplex

Pressure & Temperature Regulators

PILOT-OPERATED REGULATING VALVES

Description	Watson McDaniel	Armstrong	Spence Nicholson	Spirax Sarco	Hoffman	Fisher Controls
External Pilot-Operated Main Valve, Ductile Iron	HD	GP	E	25	2100	92
Pressure Pilot	PP	GP-2000	D	P	SPS	92B
Temperature Pilot	PT/PTU	OB-2000	T124 T14	T	STPA	
Temperature Pilot w/ Dial	PTRP		T14			
Air Pilot	PA	GP-2000K	A	A	AP	
Back Pressure Pilot	BP	GP-2000R	Q	BP		
Solenoid Pilot	SP	GP-2000	M	E		
Pneumatic Temperature Controller	PTL/PTR	OBK-2000	T61/62/63/64			
Differential Pressure Pilot	PDP		Type N			

SELF-CONTAINED PRESSURE REDUCING VALVES

Description	Watson McDaniel	Armstrong	Spence Nicholson	Spirax Sarco	Hoffman	Watts	TLV
Cast Iron, Steam, Water & Air Service	O-Series	GD30 GD6(N)	D-50	BRV	754	152	
Ductile Iron, Piston Actuated High-Capacity Steam & Air Service	402/403	GP-1000 GP-18/28 GP-1					COSR ACOSR
Bronze & Cast Iron Water, Air & Oil Service	B-Series	GD-200	D-34		740	223	

TEMPERATURE REGULATING VALVES

Description	Watson McDaniel	Trerice	Powers	Spence Nicholson	Hoffman
Direct Acting, Heating w/ Dial	H175* H175T**	91000 91400	11	2000	1140
Reverse Acting, Cooling w/ Dial	C153* C153T**	91000 91400	11	2000	1140R
Heating or Cooling, w/o Dial	W91	91000	11	2000	1140 1140R
Heating or Cooling, w/ Dial	W94	91400	11	2000	1140 1140R

* Watson McDaniel Models 175 & 153 were upgraded to Model W91.

** Watson McDaniel Models 175T & 153T were upgraded to Model W94.

BACK PRESSURE / RELIEF VALVES

Description	Watson McDaniel	Fisher Controls
Bronze & Cast Iron Water, Air & Oil Service	3040	98H
Bronze Water Service	R-Series & 10691	

Liquid Drainers

LIQUID DRAINERS					
Description	**Size**	**Watson McDaniel**	**Armstrong**	**Spirax Sarco**	**Hoffman**
High Capacity Float Type					
Ductile Iron	1.5"	WLDE		FAB	
	2"		JD & L		
	2.5"		KD & L		
Float Type					
Ductile Iron	1/2" - 2"	WLD1400		CA14	
				FAI	
				CA10S	
Cast Iron	3/4" - 2"	WLD1900	21	FA	793
Carbon Steel	2.5"	WLDES-300	LS	FAB	
	3/4" - 4"	WLD600	LS	FA450	
			MS		
Stainless Steel	3/4" - 4"	WLD601		CA46S	
				CAS14	
	1/2", 3/4"	WLD1800	11-LD		
		WLD1800R	32-LD		
Thermodynamic Type					
Stainless Steel	1/2"	WLD1703S		TDA52	656A
Inverted Bucket Type					
Cast Iron	3/4", 1"	WLD1500	1-LD		

Air Eliminators, Air Vents & Vacuum Breakers

AIR ELIMINATORS & AIR VENTS					
Description	**Watson McDaniel**	**Armstrong**	**Spirax Sarco**	**Hoffman**	**Spence Nicholson**
Float-Type Air Eliminators					
Cast Iron	AV813W	21AR	13WS	792	
Stainless Steel	AE1800	11AV			
		22AV			
	AE1800R	32AV			
Thermostatic Air Vents					
Stainless Steel	AV2000C	TTF-1	VS204		TAV
			VS206 (Cast Iron)		
Brass	AVT125	TS-2	T202	17C	
		SV-12A		8C	

VACUUM BREAKERS			
Description	**Watson McDaniel**	**Spirax Sarco**	**Hoffman**
Stainless Steel	WVBSS	VB21	62
Brass		VB14	