PENTAIR

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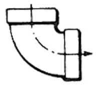
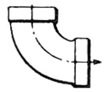
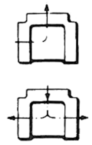
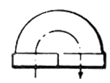
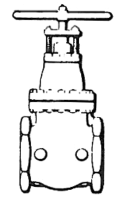
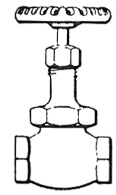
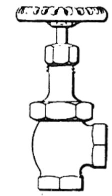
ENGINEERING MANUAL

FRICTION LOSSES THROUGH PIPE FITTINGS

FRICTION LOSSES THROUGH PIPE FITTINGS IN TERMS OF EQUIVALENT LENGTHS OF STANDARD PIPE

									
SIZE OF PIPE (SMALL DIA.)	**STANDARD ELBOW**	**MEDIUM RADIUS ELBOW**	**LONG RADIUS ELBOW**	**45° ELBOW**	**TEE**	**RETURN BEND**	**GATE VALVE OPEN**	**GLOBE VALVE OPEN**	**ANGLE VALVE OPEN**
LENGTH OF STRAIGHT PIPE GIVING EQUIVALENT RESISTANCE FLOW									
1/2"	1.5	I.4	1.1	.77	3.4	3.8	.35	16	8.4
3/4"	2.2	I.8	1.4	1.0	4.5	5.0	.47	22	12.
I"	2.7	2.3	1.7	1.3	5.8	6.I	.6	27	15.
1-1/4"	3.7	3.0	2.4	1.6	7.8	8.5	.8	37	18.
1-1/2"	4.3	3.6	2.8	2.0	9.0	10.	.95	44	22.
2"	5.5	4.6	3.5	2.5	II.	13.	1.2	57	28.
2-1/2"	6.5	5.4	4.2	3.0	14.	15.	I.4	66	33.
3"	8.I	6.8	5.I	3.8	17.	18.	I.7	85	42.
3-1/2"	9.5	8.0	6.0	4.4	19.	21.	2.	99	50.
4"	II.	9.I	7.0	5.0	22.	24.	2.3	110	58.
4-1/2"	12.	10.	7.9	5.6	24.	27.	2.6	130	61.
5"	14.	12.	8.9	6.I	27.	31.	2.9	140	70.
6"	16.	14.	II.	7.7	33.	37.	3.5	160	83.
8"	21.	18.	14.	10.	43.	49.	4.5	220	110.
10"	26.	22.	17.	13.	56.	61.	5.7	290	140.
12"	32.	26.	20.	15.	66.	73.	6.7	340	170.
14"	36.	31.	23.	17.	76.	85.	8.	390	190.
16"	42.	35.	27.	19.	87.	100.	9.	430	220.
18"	46.	40.	30.	21.	100.	110.	10.2	500	250.
20"	52.	43.	34.	23.	110.	120.	12.	560	280.
22"	58.	50.	37.	25.	130.	140.	13.	610	310.
24"	63.	53.	40.	28.	140.	150.	14.	680	340.
30"	79.	68.	50.	35.	165.	190.	17.	860	420.
36"	94.	79.	60.	43.	200	220.	20.	1000	500.
42"	120.	95.	72.	50.	240	260.	23.	1200	600.
48"	135.	110.	82.	58.	275	300.	26.	1400	680.

From "Engineering Data on Flow of Fluids In Pipes." - Crane Co.

PIPE FRICTION FOR OFFSET JET PUMPS
Friction Loss in Feet Per 100 Feet offset

Jet size H. P.	SUCTION AND PRESSURE PIPE SIZES (In Inches)										
	¾ x 1	1 x 1	1 x 1¼	1¼ x 1¼	1¼ x 1½	1½ x 1½	1½ x 2	2 x 2	2 x 2½	2½ x 2½	2½ x 3	3 x 3
¼	27	18	7	5	3	2	--	--	--	--	--	--
⅓			12	8	6	4	--	--	--	--	--	--
½			18	12	8	6	3	2	--	--	--	--
¾				22	16	11	6	4	--	--	--	--
1					25	16	9	6	--	--	--	--
1½							13	8	5	3	--	--
2		**Operations Below Line**					20	13	7	5	--	--
3		**Not Recommended**							13	9	6	4

NOTE: Friction loss is to be added to vertical lift.

FRICTION OF WATER IN PIPES

½" Pipe (.622" I. D.)

Gallons Per Minute	Velocity Ft. Per Sec.	Velocity Head Feet	Head Loss Ft. Per 100 Feet
0.5	.52	.00	.6
1.0	1.06	.02	2.1
1.5	1.58	.04	4.4
2.0	2.11	.07	7.6
2.5	2.64	.11	11.4
3.0	3.17	.16	16.0
3.5	3.70	.21	21.3
4.0	4.23	.28	27.3
4.5	4.75	.35	33.9
5.0	5.28	.43	41.2
5.5	5.81	.52	49.2
6.0	6.34	.62	57.8
6.5	6.87	.73	67.0
7.0	7.39	.85	76.8
7.5	7.92	.97	87.3
8.0	8.45	1.11	98.3
8.5	8.98	1.25	110.
9.0	9.51	1.4	122.
9.5	10.0	1.6	135.
10	10.6	1.7	149.

¾" Pipe (.824" I. D.)

Gallons Per Minute	Velocity Ft. Per Sec.	Velocity Head Feet	Head Loss Ft. Per 100 Feet
1.5	.90	.01	1.1
2.0	1.20	.02	1.9
2.5	1.51	.04	2.9
3.0	1.81	.05	4.1
3.5	2.11	.07	5.4
4.0	2.41	.09	6.9
4.5	2.71	.11	8.6
5	3.01	.14	10.5
6	3.61	.20	14.7
7	4.21	.28	19.6
8	4.84	.36	25.0
9	5.42	.46	31.1
10	6.02	.56	37.8
11	6.62	.68	45.1
12	7.22	.81	53.0
13	7.82	.95	61.5
14	8.43	1.10	70.5
16	9.63	1.44	90.2
18	10.8	1.8	112.
20	12.0	2.2	136

1" Pipe (1.049" I. D.)

Gallons Per Minute	Velocity Ft. Per Sec.	Velocity Head Feet	Head Loss Ft. Per 100 Feet
2	.74	.01	.6
3	1.11	.02	1.3
4	1.49	.03	2.1
5	1.86	.05	3.2
6	2.23	.08	4.5
8	2.97	.14	7.7
10	3.71	.21	11.7
12	4.46	.31	16.4
14	5.20	.42	21.8
16	5.94	.55	27.9
18	6.68	.69	34.7
20	7.43	.86	42.1
22	8.17	1.04	50.2
24	8.91	1.23	59.0
26	9.66	1.45	68.4
28	10.4	1.7	78.5
30	11.1	1.9	89.2
35	13.0	2.6	119.
40	14.9	3.5	152.
45	16.7	4.3	189.

1¼" Pipe (1.380" I. D.)

Gallons Per Minute	Velocity Ft. Per Sec.	Velocity Head Feet	Head Loss Ft. Per 100 Feet
4	.86	.01	.6
5	1.07	.02	.9
6	1.29	.03	1.2
7	1.50	.04	1.6
8	1.72	.05	2.0
10	2.15	.07	3.1
12	2.57	.10	4.3
14	3.00	.14	5.7
16	3.43	.18	7.3
18	3.86	.23	9.1
20	4.29	.29	11.1
25	5.36	.45	16.8
30	6.43	.64	23.5
35	7.51	.88	31.2
40	8.58	1.14	40.0
50	10.7	1.8	60.4
60	12.9	2.6	84.7
70	15.0	3.5	114.
80	17.2	4.6	144.
90	19.3	5.8	179.

1½" Pipe (1.610" I. D.)

Gallons Per Minute	Velocity Ft. Per Sec.	Velocity Head Feet	Head Loss Ft. Per 100 Feet
6	.95	.01	.6
8	1.26	.02	1.0
10	1.58	.04	1.5
12	1.89	.06	2.0
14	2.21	.08	2.7
16	2.52	.10	3.5
18	2.84	.13	4.3
20	3.15	.15	5.2
22	3.47	.19	6.3
24	3.78	.22	7.3
26	4.10	.26	8.5
28	4.41	.30	9.8
30	4.73	.35	11.1
32	5.04	.39	12.5
34	5.36	.45	14.0
36	5.67	.50	15.5
38	5.99	.56	17.2
40	6.30	.62	18.9
42	6.62	.68	20.7
44	6.93	.75	22.5
46	7.25	.82	24.5
48	7.57	.89	27.1
50	7.88	.97	28.5
55	8.67	1.17	34.0
60	9.46	1.39	40.0
65	10.2	1.6	46.4
70	11.0	1.9	53.2
75	11.8	2.2	60.4
80	12.6	2.5	68.1
85	13.4	2.8	76.2
90	14.2	3.1	84.7

2" Pipe (2.067" I. D.)

Gallons Per Minute	Velocity Ft. Per Sec.	Velocity Head Feet	Head Loss Ft. Per 100 Feet
10	.96	.01	.4
12	1.15	.02	.6
14	1.34	.03	.8
16	1.53	.04	1.0
18	1.72	.05	1.3
20	1.91	.06	1.6
22	2.10	.07	1.9
24	2.29	.08	2.2
26	2.49	.10	2.5
28	2.68	.11	2.9
30	2.87	.13	3.3
35	3.35	.17	4.4
40	3.82	.23	5.6
45	4.30	.29	7.0
50	4.78	.36	8.5
55	5.26	.43	10.1
60	5.74	.51	11.9
65	6.21	.60	13.7
70	6.69	.70	15.8
75	7.17	.80	17.9
80	7.65	.91	20.2
85	8.13	1.03	22.6
90	8.61	1.15	25.1
95	9.08	1.28	27.7
100	9.56	1.42	30.5
110	10.5	1.7	36.4
120	11.5	2.1	42.7
130	12.4	2.4	49.6
140	13.4	2.8	56.9
150	14.3	3.2	64.7

Friction head loss in pipes from William and Hazen for co-efficient of 100 corresponding to 10 year old steel or 18 year old C. I. pipe.

FRICTION OF WATER IN PIPES (CONTINUED)

Gallons Per Minute	Velocity Ft. Per Sec.	Velocity Head In Feet	Head Loss Ft. Per 100 Feet	Gallons Per Minute	Velocity Ft. Per Sec.	Velocity Head In Feet	Head Loss Ft. Per 100 Feet	Gallons Per Minute	Velocity Ft. Per Sec.	Velocity Head In Feet	Head Loss Ft. Per 100 Feet
2½" Pipe (2.469" I. D.)				**3"** Pipe (3.068" I. D.)				**4"** Pipe (4 .026" I. D.)			
20	1.34	.03	0.7	30	1.30	.03	.48	60	1.51	.04	.5
25	1.67	.05	1.1	35	1.52	.04	.64	80	2.02	.06	.8
30	2.02	.06	1.4	40	1.74	.05	.82	100	2.52	.10	1.2
35	2.35	.09	1.8	45	1.95	.06	1.0	120	3.02	.14	1.7
40	2.68	.11	2.4	50	2.17	.07	1.2	140	3.53	.19	2.2
45	3.02	.14	2.9	60	2.60	.11	1.7	160	4.03	.25	2.8
50	3.35	.17	3.6	70	3.04	.14	2.3	180	4.54	.32	3.5
55	3.69	.21	4.2	80	3.47	.19	3.0	200	5.05	.40	4.3
60	4.02	.25	5.0	90	3.99	.24	3.7	220	5.55	.48	5.1
65	4.36	.30	5.8	100	4.34	.29	4.5	240	6.05	.57	6.0
70	4.69	.34	6.6	120	5.21	.42	6.3	260	6.55	.67	7.0
75	5.03	.39	7.6	140	6.08	.57	8.3	280	7.06	.77	8.0
80	5.36	.45	8.5	160	6.94	.75	10.7	300	7.57	.89	9.1
85	5.70	.50	9.5	180	7.81	.95	13.2	320	8.07	1.01	10.2
90	6.03	.57	10.6	200	8.68	1.17	16.1	340	8.58	1.14	11.5
95	6.37	.63	11.7	220	9.55	1.42	19.2	360	9.08	1.28	12.7
100	6.70	.70	12.8	240	10.4	1.7	22.6	380	9.59	1.43	14.1
110	7.37	.84	15.3	260	11.3	2.0	26.2	400	10.1	1.6	15.5
120	8.04	1.00	18.0	280	12.2	2.3	30.0	420	10.6	1.7	16.9
130	8.71	1.18	20.9	300	13.0	2.6	34.1	460	11.6	2.1	20.0
140	9.38	1.37	23.9	320	13.9	3.0	38.4	500	12.6	2.5	23.4
160	10.7	1.8	30.7	340	14.8	3.4	43.0	550	13.9	3.0	27.9
180	12.1	2.3	38.1	360	15.6	3.8	47.8	600	15.1	3.5	32.8
200	13.4	2.8	46.3	380	16.5	4.2	52.8	650	16.4	4.2	38.0
220	14.7	3.4	55.3	400	17.4	4.7	58.0	700	17.6	4.8	43.6
240	16.1	4.0	66.4	420	18.2	5.1	63.5	750	18.9	5.6	49.5
4" 0. D. Pipe (3.826" I. D.)				**5"** Pipe (5.047" I. D.)				**5"** 0. D. Pipe (4.813" I. D.)			
60	1.67	.04	.6	100	1.60	.04	.4	100	1.76	.05	.5
80	2.23	.08	1.0	120	1.92	.06	.6	120	2.11	.07	.7
100	2.79	.12	1.5	160	2.56	.10	1.0	160	2.82	.12	1.2
120	3.35	.17	2.1	200	3.20	.16	1.4	200	3.52	.19	1.8
140	3.91	.24	2.8	250	4.02	.25	2.2	250	4.41	.30	2.7
160	4.47	.31	3.6	300	4.81	.36	3.0	300	5.29	.43	3.8
180	5.02	.39	4.5	350	5.61	.49	4.0	350	6.18	.60	5.1
200	5.58	.48	5.5	400	6.41	.64	5.2	400	7.05	.77	6.5
220	6.14	.59	6.5	450	7.22	.81	6.4	450	8.43	.98	8.0
240	6.70	.70	7.7	500	8.02	1.00	7.8	500	8.82	1.21	9.8
260	7.27	.82	8.9	550	8.82	1.21	9.3	550	9.70	1.46	11.7
280	7.82	.95	10.2	600	9.62	1.49	10.9	600	10.6	1.7	13.7
300	8.38	1.09	11.6	650	10.4	1.7	12.6	650	11.5	2.1	15.9
320	8.94	1.24	13.1	700	11.2	1.9	14.5	700	12.3	2.4	18.3
340	9.50	1.40	14.7	750	12.0	2.2	16.5	750	13.2	2.7	20.8
360	10.0	1.6	16.3	800	12.8	2.5	18.6	800	14.1	3.1	23.4
380	10.6	1.7	18.0	850	13.6	2.9	20.8	850	15.0	3.5	36.5
400	11.2	1.9	19.8	900	14.4	3.2	23.1	900	15.9	3.9	29.1
420	11.7	2.1	21.7	950	15.2	3.6	25.5	950	16.7	4.3	32.2
460	12.8	2.5	25.7	1000	16.0	4.0	28.1	1000	17.6	4.8	35.4
500	14.0	3.0	30.0	1100	17.6	4.8	33.5	1100	19.4	5.8	42.2
550	15.3	3.6	35.7	1200	19.2	5.7	39.3	1200	21.1	6.9	49.5
600	16.7	4.3	42.0	1300	20.8	6.7	45.6	1300	22.9	8.2	57.4
650	18.1	5.1	48.7	1400	22.4	7.8	52.3	1400	24.7	9.5	65.9
700	19.5	5.9	55.8	1500	24.0	9.0	59.4	1500	26.4	10.8	74.8
750	20.9	6.8	63.4	1600	25.6	10.2	66.9	1600	28.2	12.4	84.3

Gallons Per Minute	Velocity Ft. Per Sec.	Velocity Head In Feet	Head Loss Ft. Per 100 Feet	Gallons Per Minute	Velocity Ft. Per Sec.	Velocity Head In Feet	Head Loss Ft. Per 100 Feet	Gallons Per Minute	Velocity Ft. Per Sec.	Velocity Head In Feet	Head Loss Ft. Per 100 Feet
6" Pipe (6.065" I. D.)				**6"** O. D. Pipe (5.761" I. D.)				**8"** Pipe (7.981" I. D.)			
200	2.22	.08	.6	200	2.46	.09	.7	400	2.57	.10	.55
250	2.78	.12	.9	250	3.08	.15	1.1	450	2.88	.13	.69
300	3.33	.17	1.2	300	3.69	.21	1.6	500	3.20	.16	.84
350	3.89	.23	1.6	350	4.31	.29	2.1	550	3.52	.19	1.00
400	4.44	.31	2.11	400	4.93	.38	2.7	600	3.85	.23	1.17
450	5.00	.39	2.62	450	5.54	.48	3.4	650	4.17	.27	1.36
500	5.56	.48	3.19	500	6.16	.59	4.1	700	4.49	.31	1.56
550	6.11	.58	3.80	550	6.77	.71	4.9	750	4.81	.36	1.77
600	6.66	.69	4.46	600	7.39	.85	5.7	800	5.13	.41	1.99
650	7.22	.81	5.17	650	8.00	.99	6.6	900	5.77	.52	2.48
700	7.78	.94	5.93	700	8.63	1.16	7.6	1000	6.41	.64	3.0
750	8.34	1.08	6.74	750	9.24	1.33	8.7	1100	7.05	.77	3.6
800	8.90	1.23	7.60	800	9.85	1.51	9.8	1200	7.69	.92	4.2
850	9.45	1.39	8.50	850	10.5	1.7	10.9	1300	8.33	1.08	4.9
900	10.0	1.6	9.44	900	11.1	1.9	12.1	1400	8.97	1.25	5.6
950	10.5	1.7	10.2	950	11.7	2.1	13.4	1500	9.61	1.44	6.4
1000	11.1	1.9	11.5	1000	12.3	2.4	14.7	1600	10.3	1.7	7.20
1100	12.2	2.3	13.7	1100	13.5	2.8	17.6	1800	11.5	2.1	9.0
1200	13.3	2.7	16.1	1200	14.8	3.4	20.7	2000	12.8	2.5	10.9
1300	14.4	3.2	18.6	1300	16.0	4.0	23.9	2200	14.1	3.1	13.0
1400	15.6	3.8	21.4	1400	17.2	4.6	27.5	2400	15.4	3.7	15.2
1600	17.8	4.9	27.4	1600	19.7	6.0	35.2	2600	16.7	4.3	17.7
1800	20.0	6.2	34.0	1800	22.2	7.7	43.7	2800	18.0	5.0	20.3
2000	22.2	7.7	41.4	2000	24.6	9.4	53.1	3000	19.2	5.7	23.0
2200	24.4	9.3	49.4	2200	27.1	11.4	63.4	3500	22.4	7.8	30.6
2400	26.7	11.1	58.0	2400	29.6	13.6	74.5	4000	25.6	10.2	39.2
8" O. D. Pipe (7.625" I. D.)				**10"** Pipe (10.02" I. D.)				**10"** O. D. Pipe (9.750" I. D.)			
400	2.81	.12	.69	700	2.85	.13	.56	700	3.01	.14	.59
450	3.16	.15	.86	800	3.25	.16	.66	800	3.46	.19	.75
500	3.51	.19	1.05	900	3.66	.21	.82	900	3.87	.23	.94
550	3.86	.23	1.25	1000	4.07	.26	1.00	1000	4.30	.29	1.14
600	4.22	.28	1.46	1100	4.48	.31	1.19	1100	4.73	.35	1.36
650	4.57	.32	1.70	1200	4.89	.37	1.40	1200	5.16	.41	1.60
700	4.92	.38	1.95	1300	5.30	.44	1.62	1300	5.59	.49	1.85
750	5.27	.43	2.21	1400	5.70	.50	1.86	1400	6.01	.56	2.12
800	5.62	.49	2.49	1500	6.10	.58	2.11	1500	6.44	.64	2.41
900	6.32	.62	3.10	1600	6.51	.66	2.4	1600	6.88	.74	2.72
1000	7.03	.77	3.77	1800	7.32	.83	2.96	1800	7.74	.93	3.38
1100	7.83	.95	4.49	2000	8.14	1.03	3.60	2000	8.60	1.15	4.11
1200	8.43	1.10	5.28	2200	8.95	1.24	4.29	2200	9.45	1.39	4.90
1300	9.13	1.30	6.12	2400	9.76	1.48	5.04	2400	10.3	1.6	5.76
1400	9.83	1.50	7.02	2600	10.6	1.7	5.84	2600	11.2	1.9	6.67
1500	10.5	1.7	7.98	2800	11.4	2.0	6.70	2800	12.0	2.2	7.65
1600	11.2	2.0	8.99	3000	12.2	2.3	7.61	3000	12.9	2.6	8.70
1800	12.6	2.5	11.2	3200	13.0	2.7	8.58	3200	13.8	3.0	9.80
2000	14.1	3.1	13.6	3400	13.8	3.0	9.60	3400	14.6	3.3	11.0
2200	15.5	3.7	16.6	3600	14.6	3.3	10.7	3600	15.5	3.7	12.2
2400	16.9	4.4	19.0	3800	15.5	3.7	11.8	3800	16.3	4.1	13.5
2600	18.3	5.2	22.1	4000	16.3	4.1	13.0	4000	17.2	4.6	14.8
2800	19.7	6.0	25.3	4500	18.3	5.2	16.1	4500	19.3	5.8	18.4
3000	21.1	6.9	28.8	5000	20.3	6.4	19.6	5000	21.5	7.2	22.4
3500	24.6	9.4	38.3	5500	22.4	7.8	23.4	5500	23.6	8.7	26.7
4000	28.1	12.3	49.0	6000	24.4	9.3	27.5	6000	25.8	10.3	31.4

FRICTION OF WATER IN PIPES (CONTINUED)

Gallons Per Minute	Velocity Ft. Per Sec.	Velocity Head In Feet	Head Loss Ft. Per 100 Feet	Gallons Per Minute	Velocity Ft. Per Sec.	Velocity Head In Feet	Head Loss Ft. Per 100 Feet	Gallons Per Minute	Velocity Ft. Per Sec.	Velocity Head In Feet	Head Loss Ft. Per 100 Feet
12" Pipe (12.000" I. D.)				**12"** O. D. Pipe (11.750" I. D.)				**14"** O. D. Pipe (13.25" I. D.)			
1000	2.84	.13	.42	1000	2.96	.14	.46	700	1.63	.04	.13
1100	3.12	.15	.50	1100	3.25	.16	.55	800	1.86	.05	.17
1200	3.41	.18	.58	1200	3.55	.20	.64	900	2.09	.07	.21
1300	3.69	.21	.67	1300	3.84	.23	.74	1000	2.33	.08	.26
1400	3.98	.25	.77	1400	4.14	.27	.85	1100	2.56	.10	.31
1500	4.26	.28	.88	1500	4.44	.31	.97	1200	2.79	.12	.36
1600	4.55	.32	.99	1600	4.73	.35	1.10	1300	3.02	.14	.42
1800	5.11	.41	1.23	1800	5.33	.44	1.36	1400	3.26	.17	.48
2000	5.68	.50	1.50	2000	5.92	.54	1.66	1500	3.49	.19	.54
2200	6.25	.61	1.78	2200	6.51	.66	1.98	1600	3.72	.22	.61
2400	6.81	.72	2.10	2400	7.10	.78	2.32	1700	3.95	.24	.68
2600	7.38	.85	2.43	2600	7.69	.92	2.69	1800	4.19	.27	.76
2800	7.95	.98	2.78	2800	8.28	1.07	3.09	1900	4.42	.30	.84
3000	8.52	1.13	3.17	3000	8.88	1.23	3.51	2000	4.65	.34	.92
3500	9.95	1.54	4.21	3500	10.3	1.6	4.67	2500	5.81	.52	1.40
4000	11.4	2.0	5.39	4000	11.8	2.2	5.97	3000	6.98	.76	1.96
4500	12.8	2.5	6.70	4500	13.3	2.7	7.43	3500	8.15	1.03	2.60
5000	14.2	3.1	8.15	5000	14.8	3.4	9.03	4000	9.31	1.35	3.32
5500	15.6	3.8	9.72	5500	16.3	4.1	10.8	4500	10.5	1.7	4.13
6000	17.0	4.5	11.4	6000	17.7	4.9	12.6	5000	11.6	2.1	5.03
6500	18.4	5.3	13.2	6500	19.2	5.7	14.7	6000	14.0	3.0	7.05
7000	19.9	6.2	15.2	7000	20.7	6.7	16.8	7000	16.3	4.1	9.38
7500	21.3	7.1	17.3	7500	22.2	7.7	19.1	8000	18.6	5.4	12.0
8000	22.7	8.0	19.4	8000	23.7	8.7	21.5	9000	20.9	6.8	14.9
8500	24.2	9.1	21.7	8500	25.1	8.8	24.1	10000	23.3	8.4	18.1
9000	25.6	10.2	24.2	9000	26.6	11.0	26.8	11000	25.6	10.2	21.6
16" O. D. Pipe (15.25" I. D.)				**18"** O. D. Pipe (17.18" I. D.)				**20"** O. D. Pipe (19.18" I. D.)			
700	1.23	.02	.07	700	.97	.01	.04	1200	1.33	.03	.06
800	1.41	.03	.09	800	1.11	.02	.05	1400	1.55	.04	.08
900	1.58	.04	.11	900	1.25	.02	.06	1600	1.78	.05	.10
1000	1.76	.05	.13	1000	1.38	.03	.07	1800	2.00	.06	.13
1200	2.11	.07	.18	1200	1.66	.04	.10	2000	2.22	.08	.15
1400	2.46	.09	.24	1400	1.94	.06	.13	2500	2.78	.12	.23
1600	2.81	.12	.31	1600	2.21	.08	.17	3000	3.33	.17	.32
1800	3.16	.16	.38	1800	2.49	.10	.22	3500	3.89	.24	.43
2000	3.51	.19	.47	2000	2.77	.12	.26	4000	4.45	.31	.55
2500	4.39	.30	.70	2500	3.46	.19	.39	5000	5.55	.48	.83
3000	5.27	.43	.99	3000	4.15	.27	.55	6000	6.67	.69	1.17
3500	6.15	.59	1.31	3500	4.85	.37	.74	7000	7.78	.94	1.55
4000	7.03	.77	1.68	4000	5.54	.48	.94	8000	8.89	1.2	1.98
4500	7.91	.97	2.09	4500	6.23	.60	1.17	10000	11.1	1.9	3.00
5000	8.79	1.2	2.54	5000	6.92	.74	1.42	12000	13.3	2.7	4.20
6000	10.5	1.7	3.56	6000	8.31	1.1	1.99	14000	15.5	3.7	5.59
7000	12.3	2.4	4.73	7000	9.70	1.5	2.65	15000	16.7	4.3	6.35
8000	14.1	3.1	6.06	8000	11.1	1.9	3.39	16000	17.8	4.9	7.15
9000	15.8	3.9	7.53	9000	12.5	2.4	4.22	18000	20.0	6.2	8.90
10000	17.6	4.8	9.15	10000	13.8	3.0	5.12	20000	22.2	7.7	10.80
11000	19.3	5.8	10.9	12000	16.6	4.3	7.18	22000	24.4	9.3	12.90
12000	21.1	6.9	12.8	14000	19.4	5.8	9.55	24000	26.7	11.1	15.10
13000	22.8	8.1	14.9	16000	22.1	7.6	12.2	25000	27.8	12.0	16.30
14000	24.6	9.4	17.1	18000	24.9	9.6	15.2	26000	28.9	13.0	17.60
15000	26.3	10.7	19.2	20000	27.7	11.9	18.5	28000	31.1	15.0	20.10
16000	28.1	12.3	21.8	22000	30.3	14.3	22.0	30000	33.3	17.2	22.90

24" O. D. Pipe (23.5" I. D.)

Gallons Per Minute	Velocity Ft. Per Sec.	Velocity Head In Feet	Head Loss Ft. Per 100 Feet
1600	1.18	.01	.02
1800	1.33	.02	.03
2000	1.48	.02	.03
2500	1.70	.03	.05
3000	2.22	.05	.07
3500	2.59	.07	.09
4000	2.96	.09	.120
4500	3.33	.11	.150
5000	3.70	.14	.183
6000	4.44	.20	.259
7000	5.18	.27	.348
8000	5.92	.35	.448
9000	6.66	.44	.560
10000	7.40	.55	.685
11000	8.14	.66	.821
12000	8.88	.79	.968
13000	9.62	.93	1.127
14000	10.4	1.68	1.297
15000	11.1	1.92	1.479
20000	14.8	3.41	2.545
25000	17.0	4.50	3.890

30" O. D. Pipe (29.5" I. D.)

Gallons Per Minute	Velocity Ft. Per Sec.	Velocity Head In Feet	Head Loss Ft. Per 100 Feet
2500	1.27	.03	.02
3000	1.52	.04	.02
3500	1.77	.05	.03
4000	2.02	.06	.04
4500	2.28	.08	.05
5000	2.53	.10	.06
6000	3.18	.15	.09
7000	3.54	.19	.11
8000	4.05	.26	.15
9000	4.55	.32	.18
10000	5.06	.40	.22
11000	5.57	.48	.27
12000	6.08	.58	.32
13000	6.59	.68	.37
14000	7.09	.79	.43
15000	7.60	.90	.49
20000	10.12	1.59	.84
25000	12.66	2.48	1.28
30000	15.19	3.59	1.81
35000	17.72	4.89	2.43

36" O. D. Pipe (35.5" I. D.)

Gallons Per Minute	Velocity Ft. Per Sec.	Velocity Head In Feet	Head Loss Ft. Per 100 Feet
3500	1.14	.02	.01
4000	1.30	.03	.02
4500	1.46	.03	.02
5000	1.63	.04	.02
6000	1.95	.06	.03
7000	2.28	.08	.05
8000	2.60	.10	.06
9000	2.82	.12	.07
10000	3.25	.16	.09
11000	3.58	.20	.11
12000	3.91	.24	.13
13000	4.23	.28	.15
14000	4.56	.32	.17
15000	4.88	.37	.20
20000	6.51	.66	.34
25000	8.14	1.0	.52
30000	9.76	1.5	.73
35000	11.40	2.0	.98
40000	13.00	2.6	1.26
45000	14.60	3.3	1.58
50000	16.30	4.1	1.93

42" O. D. Pipe (41.5" I. D.)

Gallons Per Minute	Velocity Ft. Per Sec.	Velocity Head In Feet	Head Loss Ft. Per 100 Feet
4500	1.07	.02	.01
5000	1.19	.02	.01
6000	1.43	.03	.02
7000	1.67	.04	.02
8000	1.90	.06	.03
9000	2.14	.07	.03
10000	2.38	.09	.04
11000	2.62	.11	.05
12000	2.86	.13	.06
13000	3.09	.15	.07
14000	3.33	.17	.08
15000	3.56	.20	.09
20000	4.76	.35	.15
25000	5.95	.55	.24
30000	7.14	.79	.34
35000	8.33	1.0	.47
40000	9.51	1.4	.59
45000	10.70	1.8	.74
50000	11.89	2.2	.90
55000	13.08	2.7	1.12
60000	14.27	3.2	1.27
70000	16.62	4.3	1.48

48" O. D. Pipe (47.5" I. D.)

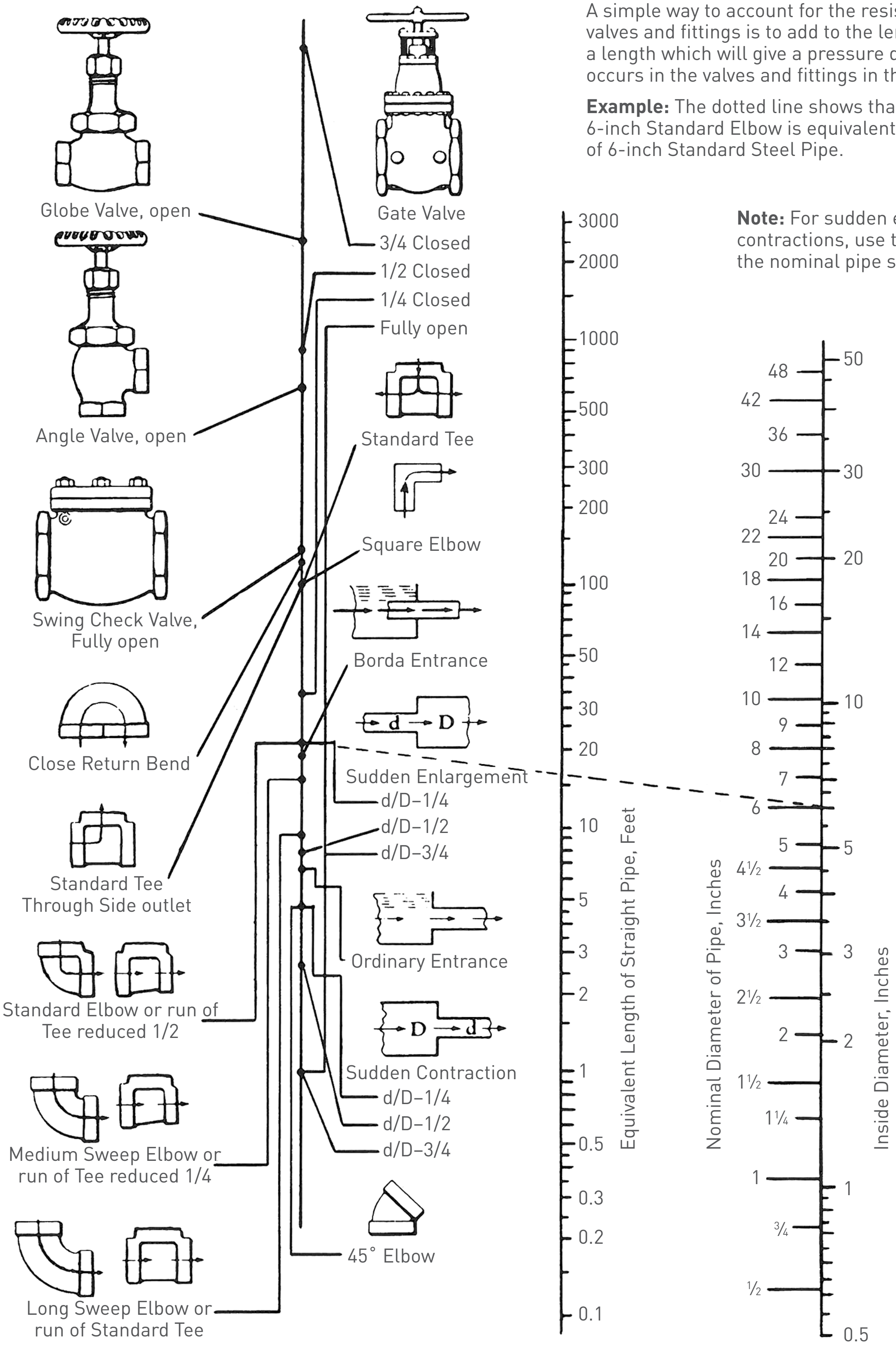
Gallons Per Minute	Velocity Ft. Per Sec.	Velocity Head In Feet	Head Loss Ft. Per 100 Feet
6000	1.09	.02	.01
7000	1.27	.03	.01
8000	1.45	.03	.01
9000	1.63	.04	.02
10000	1.82	.05	.02
11000	1.99	.06	.03
12000	2.18	.07	.03
13000	2.36	.09	.04
14000	2.54	.10	.04
15000	2.72	.11	.05
20000	3.63	.20	.08
25000	4.54	.32	.12
30000	5.44	.46	.18
35000	6.36	.63	.24
40000	7.26	.82	.30
45000	8.17	1.0	.38
50000	9.06	1.3	.46
55000	9.98	1.5	.56
60000	10.87	1.8	.66
70000	12.68	2.5	.88
80000	14.49	3.3	1.13
90000	16.30	4.1	1.42

RESISTANCE OF VALVES AND FITTINGS TO FLOW OF FLUIDS

A simple way to account for the resistance offered to flow by valves and fittings is to add to the length of pipe in the line a length which will give a pressure drop equal to that which occurs in the valves and fittings in the line.

Example: The dotted line shows that the resistance of a 6-inch Standard Elbow is equivalent to approximately 16 feet of 6-inch Standard Steel Pipe.

Note: For sudden enlargements or sudden contractions, use the smaller diameter on the nominal pipe size scale.



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FRICTION LOSS IN PLASTIC PIPE - SCHEDULE 40

Velocity measured in ft./sec., Loss in feet of water head per 100 ft. of pipe.

GALS. PER MIN.	1/2"		3/4"		1"		1 1/4"		1 1/2"		2"		2 1/2"		3"		3 1/2"		4"	
	Vel	Loss	Vel	Loss	Vel	Loss	Vel	Loss	Vel	Loss	Vel	Loss	Vel	Loss	Vel	Loss	Vel	Loss	Vel	Loss
2	2.10	3.47	1.20	0.89																
4	4.23	12.7	2.41	3.29	1.49	1.01	.86	.27	.63	.12										
6	6.34	26.8	3.61	6.91	2.23	2.14	1.29	.57	.94	.26	.57	.09								
8	8.45	46.1	4.82	11.8	2.98	3.68	1.72	.95	1.26	.45	.77	.16	.52	.05						
10	10.6	69.1	6.02	17.9	3.72	5.50	2.14	1.44	1.57	.67	.96	.24	.65	.08	.43	.03				
12			7.22	24.9	4.46	7.71	2.57	2.02	1.89	.94	1.15	.37	.78	.11	.52	.05				
15			9.02	37.6	5.60	11.8	3.21	3.05	2.36	1.41	1.50	.51	.98	.17	.65	.07	.49	.03		
18			10.8	50.9	6.69	16.5	3.86	4.28	2.83	1.99	1.72	.70	1.18	.24	.78	.10	.58	.04		
20	5" PIPE		12.0	63.9	7.44	19.7	4.29	5.21	3.15	2.44	1.01	.86	1.31	.29	.87	.12	.65	.05	.51	.03
25					9.30	30.1	5.36	7.80	3.80	3.43	2.50	1.28	1.63	.43	1.09	.18	.81	.08	.64	.04
30	.49	.02			11.15	41.8	6.43	10.8	4.72	5.17	2.89	1.80	1.96	.61	1.30	.25	.97	.11	.77	.06
35	.57	.03			13.02	55.9	7.51	14.7	5.51	6.91	3.35	2.40	2.35	.81	1.52	.33	1.14	.15	.89	.08
40	.65	.04	6"PIPE		14.88	71.4	8.58	18.8	6.30	8.83	3.82	3.10	2.68	1.03	1.74	.43	1.30	.19	1.02	.10
45	.73	.04			16.70		9.65	23.5	7.08	10.9	4.30	3.85	3.02	1.32	1.95	.54	1.46	.24	1.15	.13
50	.82	.05	.57	.02			10.72	28.2	7.87	13.3	4.78	4.65	3.35	1.56	2.17	.65	1.62	.29	1.28	.16
55	.90	.06	.62	.02			11.78	33.8	8.66	16.0	5.26	5.55	3.69	1.88	2.39	.74	1.70	.34	1.41	.19
60	.98	.07	.68	.03			12.87	40.0	9.44	18.6	5.74	6.53	4.02	2.19	2.60	.90	1.95	.40	1.53	.22
65	1.06	.09	.74	.04			13.92	46.7	10.23	21.6	6.21	7.56	4.36	2.53	2.82	1.02	2.00	.47	1.66	.25
70	1.14	.10	.79	.04			15.01	53.1	11.02	24.9	6.69	8.64	4.69	2.91	3.04	1.21	2.27	.54	1.79	.30
75	1.22	.11	.85	.05			16.06	60.6	11.80	28.2	7.17	9.82	5.03	3.33	3.25	1.41	2.32	.60	1.91	.34
80	1.31	.13	.91	.05			17.16	68.2	12.69	32.0	7.65	11.1	5.36	3.71	3.49	1.54	2.60	.69	2.04	.38
85	1.39	.15	.96	.06			18.21	77.0	13.38	35.3	8.13	12.5	5.70	3.81	3.69	1.66	2.62	.76	2.17	.42
90	1.47	.16	1.02	.07			19.30	84.6	14.71	39.5	8.61	13.8	6.03	4.61	3.91	1.92	2.92	.85	2.30	.47
95	1.55	.18	1.08	.07					14.95	43.7	9.08	15.3	6.37	5.07	4.12	2.04	2.93	.96	2.42	.53
100	1.63	.19	1.13	.08					15.74	47.9	9.56	16.8	6.70	5.64	4.34	2.33	3.25	1.03	2.55	.57
110	1.79	.23	1.25	.10					17.31	57.3	10.5	20.2	7.37	6.81	4.77	2.82	3.57	1.25	2.81	.69
120	1.96	.27	1.36	.11	8" PIPE				18.89	67.2	11.5	23.5	8.04	7.89	5.21	3.29	3.99	1.45	3.06	.80
130	2.12	.31	1.47	.13					20.46	78.0	12.4	27.3	8.71	8.79	5.64	3.81	4.22	1.68	3.31	.93
140	2.29	.36	1.59	.15	.90	.04			22.04	89.3	13.4	31.5	9.38	10.5	6.08	4.32	4.54	1.93	3.57	1.07
150	2.45	.41	1.70	.17	.96	.04			23.6		14.3	35.7	10.00	12.0	6.51	4.93	4.87	2.19	3.82	1.23
160	2.61	.46	1.80	.19	1.02	.05					15.3	40.4	10.7	13.6	6.94	5.54	5.19	2.47	4.08	1.37
170	2.77	.51	1.92	.21	1.08	.05					16.3	45.1	11.4	16.0	7.36	6.25	5.52	2.75	4.33	1.53
180	2.94	.57	2.04	.24	1.15	.06					17.2	50.3	12.1	16.8	7.81	6.58	5.85	3.07	4.60	1.70
190	3.10	.63	2.16	.26	1.21	.07	10" PIPE				18.2	55.5	12.7	18.6	8.24	7.28	6.17	3.39	4.84	1.88
200	3.27	.70	2.27	.29	1.28	.07					19.1	60.6	13.4	20.3	8.68	8.36	6.50	3.73	5.11	2.06
220	3.59	.83	2.44	.34	1.40	.08	.90	.03			21.0	72.4	14.7	24.9	9.55	10.0	7.14	4.45	5.62	2.44
240	3.92	.98	2.67	.41	1.53	.10	.98	.03			22.9	85.5	16.1	28.7	10.4	11.8	7.79	5.22	6.13	2.91
260	4.25	1.13	2.89	.47	1.66	.12	1.06	.04			24.9	99.2	17.4	33.0	11.3	13.7	8.44	6.07	6.64	3.28
280	4.50	1.30	3.11	.54	1.79	.13	1.15	.04					18.8	38.1	12.2	15.7	9.09	6.95	7.15	3.85
300	4.90	1.48	3.33	.62	1.91	.15	1.22	.05					20.1	43.2	13.0	17.9	9.74	7.90	7.66	4.37
320	5.13	1.66	3.56	.69	2.05	.17	1.31	.06					21.6	48.4	13.9	20.1	10.40	8.88	8.17	4.93
340	5.44	1.87	3.78	.76	2.18	.19	1.39	.07	12" PIPE				22.9	54.5	14.8	22.5	11.00	9.96	8.58	5.50
360	5.77	2.07	4.00	.86	2.30	.21	1.47	.07					24.2	60.2	15.6	24.9	11.70	11.0	9.10	6.15
380	6.19	2.28	4.22	.94	2.43	.24	1.55	.08	1.08	.03			25.6	66.7	16.5	27.7	12.3	12.2	9.59	6.58
400	6.44	2.5	4.43	1.03	2.60	.25	1.63	.09	1.14	.04			26.8	73.3	17.4	30.6	13.0	13.4	10.10	7.52
450	7.20	3.1	5.00	1.29	2.92	.32	1.84	.11	1.28	.05					19.5	36.7	13.9	16.7	11.49	9.31
500	8.02	3.8	5.56	1.36	3.19	.39	2.04	.13	1.42	.05					21.7	46.1	16.2	20.3	12.6	11.3
550	8.82	4.5	6.11	1.86	3.52	.46	2.24	.16	1.56	.06					23.9	55.0	17.9	24.3	13.0	13.5
600	9.62	5.3	6.65	2.19	3.85	.54	2.45	.18	1.70	.07					26.0	64.4	19.5	28.5	15.10	15.8
650	10.40	6.2	7.22	2.53	4.16	.63	2.65	.21	1.84	.09					28.2		21.1	33.0	16.40	18.3
700	11.2	7.1	7.78	2.92	4.46	.72	2.86	.24	1.99	.10							22.7	37.9	17.60	21.1
750	12.0	8.1	8.34	3.35	4.80	.82	3.06	.28	2.13	.11							24.4	43.0	18.90	24.0
800	12.8	9.1	8.90	3.74	5.10	.89	3.26	.31	2.27	.13							26.0	48.4	20.20	26.8
850	13.6	10.2	9.45	4.21	5.48	1.03	3.47	.35	2.41	.15							27.6	54.1	21.4	30.1
900	14.4	11.3	10.0	4.75	5.75	1.16	3.67	.39	2.56	.16									22.7	33.4
950	15.2	12.5	10.5	5.26	6.06	1.35	3.88	.43	2.70	.18										
1000	16.0	13.7	11.1	5.66	6.38	1.40	4.08	.48	2.84	.19										
1100	17.6	16.4	12.2	6.84	7.03	1.65	4.49	.56	3.13	.23										
1200	19.61	19.2	13.3	8.04	7.66	1.96	4.90	.66	3.41	.27										
1300	20.8		14.4	8.6	8.30	2.28	5.31	.76	3.69	.31										
1400	22.4		15.6	10.6	8.95	2.59	5.71	.88	3.98	.37										
1500	24.0		16.7	12.0	9.58	2.93	6.12	1.00	4.26	.42										
1600	25.6		17.8	12.6	10.21	3.29	6.53	1.12	4.55	.46										
1800			20.0		11.50	4.13	7.35	1.39	5.11	.57										
2000			22.2		12.78	5.03	8.16	1.69	5.68	.70										
2200			24.4		14.05	6.00	8.98	1.99	6.25	.85										
2400			26.7		15.32	6.7	9.80	2.37	6.81	.98										
2600							10.61	2.73	7.38	1.14										
2800							11.41	3.15	7.95	1.29										
3000							12.24	3.58	8.52	1.48										
3200							13.05	3.7	9.10	1.65										
3500							14.30	4.74	9.95	1.96										
3800							15.51	6.3	10.80	2.30										
4200									11.92	2.76										
4500									12.78	3.24										
5000									14.20	3.95										
5500																				
6000																				

*Data shown is calculated from Williams and Hazen formula $H = \frac{3.023}{C^{1.852}} \frac{V^{1.852}}{D^{1.167}}$ using C-150. For water at 60°F.

Where H = head loss, V = fluid velocity ft./sec., D = diameter of pipe, ft., C = coefficient representing roughness of pipe interior surface.

FRICTION LOSS IN PLASTIC PIPE - SCHEDULE 80

Velocity measured in ft./sec., Loss in feet of water head per 100 ft. of pipe.

GALS. PER MIN.	1/2"		3/4"		1"		1 1/4"		1 1/2"		2"		2 1/2"		3"		3 1/2"		4"	
	Vel	Loss	Vel	Loss	Vel	Loss	Vel	Loss	Vel	Loss	Vel	Loss	Vel	Loss	Vel	Loss	Vel	Loss	Vel	Loss
2	2.74	6.72	1.48	1.51																
4	5.48	24.2	2.97	5.45	1.79	1.54	1.00	.39	.73	.177										
6	8.23	51.2	4.45	11.5	2.68	3.34	1.50	.82	1.09	.375	.65	.107								
8	11.0	86.9	5.94	19.6	3.57	5.69	2.00	1.39	1.45	.64	.87	.183	.61	.077						
10	13.7	132.0	7.42	29.6	4.46	8.60	2.50	2.10	1.82	.96	1.09	.276	.76	.115	.485	.039				
12			8.91	41.5	5.36	12.0	3.00	2.94	2.18	1.35	1.30	.387	.91	.161	.572	.055				
15			11.1	62.7	6.7	22.9	3.76	4.45	2.72	2.04	1.63	.585	1.14	.243	.727	.083	.54	.035		
18			13.4	87.9	8.03	25.5	4.50	6.25	3.27	2.86	1.96	.818	1.36	.340	.873	.116	.65	.056		
20	5" PIPE		14.8	107	8.92	30.9	5.00	7.57	3.63	3.47	2.17	.996	1.51	.414	.97	.140	.72	.068	.56	.037
25					11.2	58.8	6.25	11.4	4.55	5.25	2.71	1.51	1.9	.625	1.21	.212	.90	.103	.695	.055
30	.53	.025			13.4	65.3	7.50	16.0	5.45	7.38	3.26	2.11	2.27	.874	1.44	.297	1.08	.145	.84	.077
35	.62	.034			15.6	86.9	8.75	21.3	6.38	9.78	3.80	2.81	2.65	1.16	1.70	.396	1.26	.192	.973	.103
40	.71	.043			17.9	111	10.0	27.3	7.26	12.5	4.35	3.59	3.03	1.49	1.94	.507	1.44	.246	1.12	.132
45	.795	.054	6" PIPE				11.2	33.9	8.26	15.6	4.89	4.46	3.41	1.86	2.18	.629	1.63	.306	1.25	.164
50	.88	.065	.62	.027			12.5	41.3	9.08	18.9	5.43	5.41	3.79	2.25	2.42	.766	1.80	.372	1.40	.199
55	.973	.078	.676	.032			13.7	49.2	10.00	32.0	5.98	6.44	4.16	2.68	2.67	.912	1.99	.443	1.53	.237
60	1.06	.091	.74	.039			15.0	57.8	10.9	26.5	6.52	7.61	4.54	3.16	2.92	1.07	2.17	.522	1.67	.279
65	1.15	.106	.80	.044			16.1	67.0	11.8	30.7	7.06	8.84	4.92	3.66	3.14	1.25	2.35	.604	1.81	.323
70	1.23	.121	.86	.051			17.5	77.1	12.7	35.3	7.61	10.1	5.30	4.20	3.39	1.43	2.53	.691	1.95	.371
75	1.33	.138	.923	.057			18.8	87.4	13.6	40.1	8.15	11.5	5.68	4.79	3.64	1.62	2.70	.787	2.08	.421
80	1.41	.155	.98	.065			20.0	98.2	14.5	45.2	8.69	12.9	6.05	5.36	3.88	1.83	2.89	.888	2.23	.475
85	1.50	.174	1.04	.072			21.2	110	15.4	50.3	9.03	14.5	6.43	6.02	4.10	2.04	3.05	.992	2.34	.531
90	1.59	.193	1.11	.080			22.5	122	16.3	55.9	9.78	16.1	6.81	6.53	4.33	2.27	3.25	1.10	2.51	.592
95	1.67	.213	1.20	.089					17.2	62.0	10.3	17.8	7.19	7.38	4.57	2.51	3.42	1.21	2.64	.652
100	1.76	.234	1.23	.098					18.2	68.2	10.9	19.6	7.57	8.13	4.85	2.76	3.67	1.34	2.79	.719
110	1.95	.279	1.36	.117					20.0	81.3	12.0	23.4	8.33	9.68	5.33	3.29	3.97	1.60	3.07	.855
120	2.11	.329	1.48	.137	8" PIPE				21.8	95.4	13.0	27.4	9.08	11.4	5.80	3.87	4.33	1.88	3.35	1.00
130	2.3	.381	1.60	159					23.6	111	14.1	31.8	9.84	13.2	6.30	4.48	4.69	2.18	3.63	1.16
140	2.47	.437	1.72	.182	.98	.047			25.4	127	15.2	36.5	10.6	15.1	6.80	5.12	5.05	2.50	3.91	1.33
150	2.65	.496	1.85	.207	1.05	054					16.3	41.5	11.3	17.2	7.27	5.87	5.41	2.84	4.19	1.52
160	2.82	.559	1.97	.234	1.12	.059					17.4	46.7	12.1	19.4	7.75	6.58	5.78	3.20	4.47	1.71
170	3.0	.626	2.08	.261	1.19	.067					18.5	52.2	12.9	21.7	8.20	7.37	6.14	3.58	4.75	1.91
180	3.16	.696	2.22	.290	1.26	.074					19.6	58.3	13.6	24.1	8.60	8.18	6.50	3.97	5.02	2.12
190	3.36	.769	2.34	.321	1.33	.082					20.6	64.4	14.4	26.6	9.20	9.05	6.85	4.39	5.30	2.35
200	3.52	.846	2.46	.353	1.41	.090					21.7	70.5	15.1	29.3	9.70	9.96	7.22	4.84	5.58	2.58
220	3.88	1.01	2.71	.421	1.55	.108					23.9	84.1	16.7	34.9	10.6	11.9	7.94	5.78	6.14	3.08
240	4.23	1.18	2.96	.484	1.69	.126					26.1	98.7	18.2	41.0	11.6	13.9	8.66	6.77	6.70	3.62
260	4.58	1.37	3.20	.573	1.83	.147					28.3	115	19.7	47.5	12.6	16.2	9.38	7.85	7.26	4.19
280	4.94	1.57	3.45	.658	1.97	.168							21.2	54.5	13.5	18.6	10.1	9.02	7.82	4.79
300	5.29	1.79	3.69	.747	2.11	.191							22.7	62.0	14.4	21.1	10.8	10.2	8.38	5.45
320	5.64	2.01	3.94	.841	2.24	.215							24.2	69.9	15.5	23.7	11.5	11.5	8.94	6.16
340	5.99	2.26	4.19	.940	2.39	.240							25.8	78.2	16.3	26.6	12.3	12.9	9.50	6.91
360	6.35	2.51	4.43	1.05	2.64	.261							27.2	86.9	17.4	29.5	13.0	14.3	10.0	7.66
380	6.70	2.77	4.68	1.16	2.68	.295							28.8	96.1	18.6	32.6	13.7	15.8	10.6	8.46
400	7.05	3.05	4.93	1.27	2.81	.325							30.3	106	19.4	35.9	14.4	17.4	11.2	9.31
450	7.95	3.79	5.54	1.58	3.16	.404									21.8	44.6	16.2	21.6	12.5	11.6
500	8.82	4.61	6.16	1.92	3.51	.493									23.2	54.1	18.1	26.3	14.0	14.1
550	9.70	5.50	6.77	2.29	3.86	.587									26.5	64.9	19.9	31.4	15.3	16.8
600	10.6	6.44	7.39	2.69	4.22	.686									29.1	76.1	21.7	36.9	16.7	19.7
650	11.5	7.47	8.00	3.12	4.57	.799											23.5	42.8	18.1	22.9
700	12.3	8.60	8.63	3.58	4.92	.916											25.3	48.9	19.5	26.2
750	13.2	9.77	9.24	4.07	5.27	1.04											27.1	55.9	20.9	29.8
800	14.1	11.0	9.85	4.58	5.62	1.17											28.9	61.6	22.3	33.6
850	15.0	12.3	10.5	5.12	5.97	1.31											30.7	70.5	23.7	37.6
900	15.9	13.7	11.1	5.69	6.32	1.46													25.1	41.8
950	16.7	15.1	11.7	6.29	6.67	1.61														
1000	17.6	16.6	12.3	6.91	7.03	1.77														
1100	19.4	19.8	13.5	8.27	7.83	2.11														
1200	21.1	23.3	14.8	9.73	8.43	2.48														
1300					9.13	2.87														
1400					9.83	3.30														
1500					10.5	3.75														
1600					11.2	4.23														
1800					12.6	5.26														
2000					14.1	6.39														
2200					15.5	7.80														
2400					16.9	8.93														
2600																				
2800																				
3000																				
3200																				
3500																				
3800																				
4200																				
4500																				
5000																				
5500																				
6000																				

*Data shown is calculated from Williams and Hazen formula $H = \frac{3.023}{C^{1.852}} \frac{V^{1.852}}{D^{1.167}}$ using C-150. For water at 60°F.

Where H = head loss, V = fluid velocity ft./sec., D = diameter of pipe, ft., C = coefficient representing roughness of pipe interior surface.

WATER FRICTION IN 100 FEET OF SMOOTH BORE HOSE

For various flows and hose sizes, table gives velocity of water and feet of head lost in friction in 100 feet of smooth bore hose.

SIZE OF HOSE SHOWN ARE ACTUAL INSIDE DIAMETERS

Flow In U.S. Gals. Per Min.	Velocity In Feet Per Sec.	Friction Head In Feet	Velocity In Feet Per Sec.	Friction Head In Feet	Velocity In Feet Per Sec.	Friction Head In Feet	Velocity In Feet Per Sec.	Friction Head In Feet	Velocity In Feet Per Sec.	Friction Head In Feet	Velocity In Feet Per Sec.	Friction Head In Feet
	5/8"		**3/4"**		**1"**		**1-1/4"**		**1-1/2"**		**2"**	
1.5	1.6	2.3	1.1	.97								
2.5	2.6	6.0	1.8	2.5								
5	5.2	21.4	3.6	8.9	2.0	2.2	1.3	.74	.9	.3		
10	10.5	76.8	7.3	31.8	4.1	7.8	2.6	2.64	1.8	1.0	1.0	.2
15	**2-1/2"**		10.9	68.5	6.1	16.8	3.9	5.7	2.7	2.3	1.5	.5
20	1.3	.32			8.2	28.7	5.2	9.6	3.6	3.9	2.0	.9
25	1.6	.51	**3"**		10.2	43.2	6.5	14.7	4.5	6.0	2.5	1.4
30	2.0	.70	1.4	.3	12.2	61.2	7.8	20.7	5.4	8.5	3.1	2.0
35	2.3	.93	1.6	.4	14.3	80.5	9.1	27.6	6.4	11.2	3.6	2.7
40	2.6	1.2	1.8	.5			10.4	35.0	7.3	14.3	4.1	3.5
45	2.9	1.5	2.0	.6			11.7	43.0	8.2	17.7	4.6	4.3
50	3.3	1.8	2.3	.7			13.1	52.7	9.1	21.8	5.1	5.2
60	3.9	2.5	2.7	1.0			15.7	73.5	10.9	30.2	6.1	7.3
70	4.6	3.3	3.2	1.3					12.7	40.4	7.1	9.8
80	5.2	4.3	3.6	1.7	**4"**				14.5	52.0	8.2	12.6
90	5.9	5.3	4.1	2.1	2.3	.5			16.3	64.2	9.2	15.7
100	6.5	6.5	4.5	2.6	2.5	.6			18.1	77.4	10.2	18.9
125	8.2	9.8	5.7	4.0	3.2	.9					12.8	28.6
150	9.8	13.8	6.8	5.6	3.8	1.33					15.3	40.7
175	11.4	18.1	7.9	7.4	4.5	1.8	**5"**		**6"**		17.9	53.4
200	13.1	23.4	9.1	9.6	5.1	2.3	3.3	.8	2.3	.32	20.4	68.5
225	14.7	29.0	10.2	11.9	5.7	2.9	3.7	1.0	2.6	.40		
250	16.3	35.0	11.3	14.8	6.4	3.5	4.1	1.2	2.8	.49		
275	18.0	42.0	12.5	17.2	7.0	4.2	4.5	1.4	3.1	.58		
300	19.6	40.0	13.6	20.3	7.7	4.9	4.9	1.7	3.3	.69		
325			14.7	23.5	8.3	5.7	5.3	2.0	3.7	.80		
350			15.9	27.0	8.9	6.6	5.7	2.3	4.0	.90		
375			17.0	30.7	9.6	7.4	6.1	2.6	4.3	1.0	**8"**	
400					10.2	8.4	6.5	2.9	4.5	1.1	2.6	.28
450					11.5	10.5	7.4	3.6	5.1	1.4	2.9	.35
500					12.8	12.7	8.2	4.3	5.7	1.7	3.2	.43
600					15.3	17.8	9.8	6.1	6.8	2.4	3.8	.60
700					17.9	237	11.4	8.1	7.9	3.3	4.5	.80
800							13.1	10.3	9.1	4.2	5.1	1.1
900							14.7	12.8	10.2	5.2	5.8	1.3
1000							16.3	15.6	11.4	6.4	6.4	1.6
1100							17.9	18.5	12.5	7.6	7.0	1.9
1200									13.6	9.2	7.7	2.3
1300									14.7	10.0	8.3	2.6
1400									15.9	11.9	8.9	3.0
1500									17.0	13.6	9.6	3.3
1600											10.2	3.7
1800											11.5	4.7
2000											12.8	5.7
2500											16.0	8.6
3000											19.1	12.2

THEORETICAL DISCHARGE OF NOZZLES IN U.S. GPM

Head		Velocity of Discharge Feet Per Second	DIAMETER OF NOZZLE IN INCHES								
Pounds	**Feet**		**1/16**	**1/8**	**3/16**	**1/4**	**3/8**	**1/2**	**5/8**	**3/4**	**7/8**
10	23.1	38.6	0.37	1.48	3.32	5.91	13.3	23.6	36.9	53.1	72.4
15	34.6	47.25	0.45	1.84	4.06	7.24	16.3	28.9	45.2	65.0	88.5
20	46.2	54.55	0.52	2.09	4.69	8.35	18.8	33.4	52.2	75.1	102
25	57.7	61.0	0.58	2.34	5.25	9.34	21.0	37.3	58.3	84.0	114
30	69.3	66.85	0.64	2.56	5.75	10.2	23.0	40.9	63.9	92.0	125
35	80.8	72.2	0.69	2.77	6.21	11.1	24.8	44.2	69.0	99.5	135
40	92.4	77.2	0.74	2.96	6.64	11.8	26.6	47.3	73.8	106	145
45	103.9	81.8	0.78	3.13	7.03	12.5	28.2	50.1	78.2	113	153
50	115.5	86.25	0.83	3.30	7.41	13.2	29.7	52.8	82.5	119	162
S5	127.0	90.4	0.87	3.46	7.77	13.8	31.1	55.3	86.4	125	169
60	138.6	94.5	0.90	3.62	8.12	14.5	32.5	57.8	90.4	130	177
65	150.1	98.3	0.94	3.77	8.45	15.1	33.8	60.2	94.0	136	184
70	161.7	102.1	0.98	3.91	8.78	15.7	35.2	62.5	97.7	141	191
75	173.2	105.7	1.01	4.05	9.08	16.2	36.4	64.7	101	146	198
80	184.8	109.1	1.05	4.18	9.39	16.7	37.6	66.8	104	150	205
85	196.3	112.5	1.08	4.31	9.67	17.3	38.8	68.9	108	155	211
90	207.9	115.8	1.11	4.43	9.95	17.7	39.9	70.8	111	160	217
95	219.4	119.0	1.14	4.56	10.2	18.2	41.0	72.8	114	164	223
100	230.9	122.0	1.17	4.67	10.0	18.7	42.1	74.7	117	168	229
105	242.4	125.0	1.20	4.79	10.8	19.2	43.1	76.5	120	172	234
110	254.0	128.0	1.23	4.90	11.0	19.6	44.1	78.4	122	176	240
115	265.5	130.9	1.25	5.01	11.2	20.0	45.1	80.1	125	180	245
120	277.1	133.7	1.28	5.12	11.5	20.5	46.0	81.8	128	184	251
125	288.6	136.4	1.31	5.22	11.7	20.9	47.0	83.5	130	188	256
130	300.2	139.1	1.33	5.33	12.0	21.3	48.0	85.2	133	192	261
135	311.7	141.8	1.36	5.43	12.2	21.7	48.9	86.7	136	195	266
140	323.3	144.3	1.38	5.53	12.4	22.1	49.8	88.4	138	199	271
145	334.8	146.9	1.41	5.62	12.6	22.5	50.6	89.9	140	202	275
150	346.4	149.5	1.43	5.72	12.9	22.9	51.5	91.5	143	206	280
175	404.1	161.4	1.55	6.18	13.9	24.7	55.6	98.8	154	222	302
200	461.9	172.6	1.65	6.61	14.8	26.4	59.5	106	165	238	323

Head		Velocity of Discharge Feet Per Second	DIAMETER OF NOZZLE IN INCHES								
Pounds	**Feet**		**1**	**1 1/8**	**1 1/4**	**1 3/8**	**1 1/2**	**1 3/4**	**2**	**2 1/4**	**2 1/2**
10	23.1	38.6	94.5	120	148	179	213	289	378	479	591
15	34.6	47.25	116	147	181	219	260	354	463	585	723
20	46.2	54.55	134	169	209	253	301	409	535	676	835
25	57.7	61.0	149	189	234	283	336	458	598	756	934
30	69.3	66.85	164	207	256	309	368	501	655	828	1023
35	80.8	72.2	177	224	277	334	398	541	708	895	1106
40	92.4	77.2	188	239	296	357	425	578	756	957	1182
45	103.9	81.8	200	253	313	379	451	613	801	1015	1252
50	115.5	86.25	211	267	330	399	475	647	845	1070	1320
55	127.0	90.0	221	280	346	418	498	678	886	1121	1385
60	138.6	94.5	231	293	362	438	521	708	926	1172	1447
65	150.1	98.3	241	305	376	455	542	737	964	1220	1506
70	161.7	102.1	250	317	391	473	563	765	1001	1267	1565
75	173.2	105.7	259	327	404	489	582	792	1037	1310	1619
80	184.8	109.1	267	338	418	505	602	818	1010	1354	1672
85	196.3	112.5	276	349	431	521	620	844	1103	1395	1723
90	207.9	115.8	284	359	443	536	638	868	1136	1436	1773
95	219.4	119.0	292	369	456	551	656	892	1168	1476	1824
100	230.9	122.0	299	378	467	565	672	915	1196	1512	1870
105	242.2	125.0	306	388	479	579	689	937	1226	1550	1916
110	254.0	128.0	314	397	490	593	705	960	1255	1588	1961
115	265.5	130.9	320	406	501	606	720	980	1282	1621	2005
120	277.1	133.7	327	414	512	619	736	1002	1310	1659	2050
125	288.6	136.4	334	423	522	632	751	1022	1338	1690	2090
130	300.2	139.1	341	432	533	645	767	1043	1365	1726	2132
135	311.7	141.8	347	439	543	656	780	1063	1390	1759	2173
140	323.3	144.3	354	448	553	668	795	1082	1415	1790	2212
145	334.8	146.9	360	455	562	680	809	1100	1440	1820	2250
150	346.4	149.5	366	463	572	692	824	1120	1466	1853	2290
175	404.1	161.4	395	500	618	747	890	1210	1582	2000	2473
200	461.9	172.6	423	535	660	799	950	1294	1691	2140	2645

NOTE - The actual quantities will vary from these figures, the amount of variation depending upon the shape of nozzle and size of pipe at the point where the pressure is determined. With smooth toper nozzles the actual discharge is about 94 per cent of the figures given in the tables.

"YARDSTICK" WATER MEASURING METHOD

THE GPM FLOW FROM PIPES MAY BE APPROXIMATED BY MEASURING THE DISTANCE "X" IN INCHES WHEN THE VERTICAL DISTANCE IS 12" (OR 6", SEE NOTE BELOW TABLE) AND FIND VALUE IN TABLE 1.

FOR PIPES FLOWING FULL

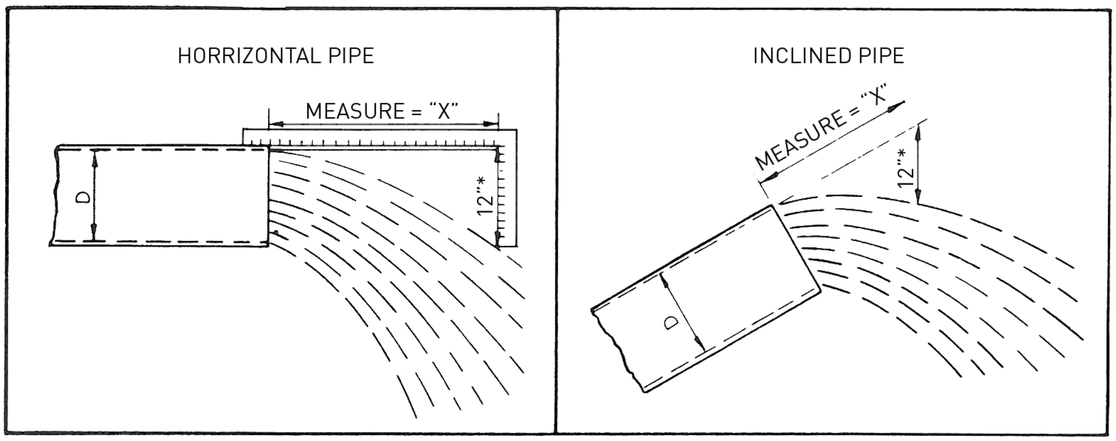
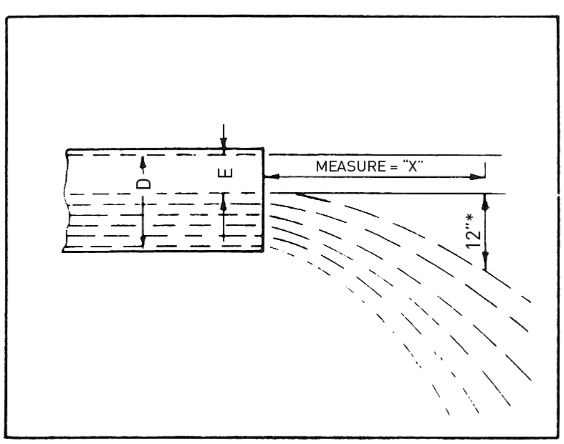


TABLE I
GALLONS PER MINUTE

Dia. Pipe = D	Horizontal Distance = "X"									
	12"	**14"**	**16"**	**18"**	**20"**	**22"**	**24"**	**26"**	**28"**	**30"**
2"	41	48	55	61	68	75	82	89	96	102
3"	90	105	120	135	150	165	180	195	210	225
4"	150	181	207	232	258	284	310	336	361	387
6"	352	410	470	528	587	645	705	762	821	880
8"	610	712	813	915	1017	1119	1221	1322	1425	1527
10"	960	1120	1280	1440	1600	1760	1920	2080	2240	2400
12"	1378	1607	1835	2032	2300	2521	2760	2980	3210	3430

APPROXIMATE FLOWS FROM PIPE RUNNING FULL
*IF 6" VERTICAL DISTANCE IS USED MULTIPLY GPM BY 1.4

FOR PIPES FLOWING PARTIALLY FULL

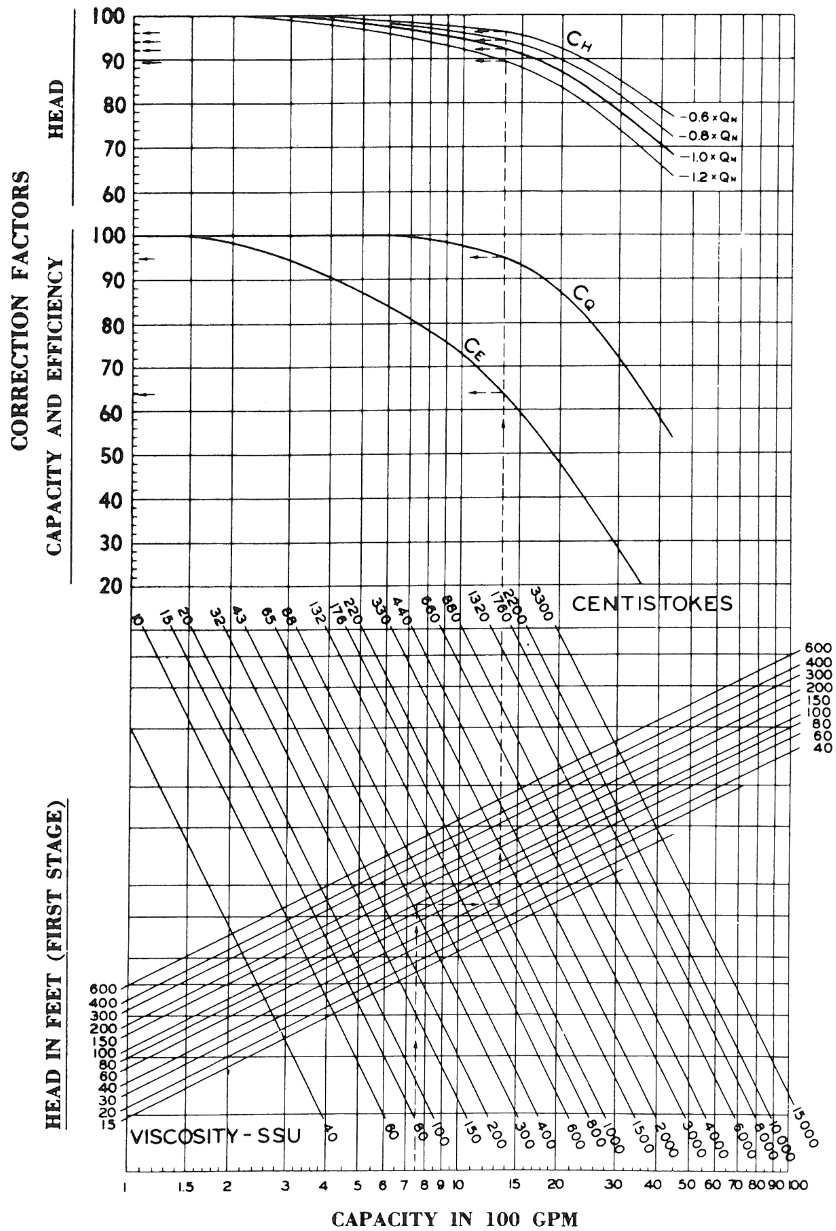


FLOW FROM PARTIALLY FILLED PIPES
Divide "E" by "D" for percent factor. Multiply flow for full pipe of "D" diameter (Table I) by factor obtained from Table 2.
E - Measure of empty portion of pipe.
D - Measure of inside diameter of full pipe.

TABLE 2

E/D	Factor	E/D	Factor
10	0.95	50	0.50
20	0.86	60	0.38
25	0.81	65	0.31
30	0.75	70	0.25
35	0.69	80	0.14
40	0.63	90	0.05
45	0.56	100	0.00

PERFORMANCE CORRECTION CHART



EXAMPLE. Select a pump to deliver 750 gpm at 100 feet total head of a liquid having a viscosity of 1000 SSU and a specific gravity of 0.90 at the pumping temperature. Enter the chart (Fig. BF-19) with 750 gpm, go up to 100 feet head, over to 1000 SSU, and then up to the correction factors:

$C_Q = 0.95$
$C_H = 0.92$ (for 1.0 Q_{NW})
$C_E = 0.635$

$$Q_W = \frac{750}{0.95} = 790 \text{ gpm}$$

$$H_W = \frac{100}{0.92} = 108.8 = 109 \text{ feet head}$$

Select a pump for a water capacity of 790 gpm at 109 feet head. The selection should be at or close to the maximum efficiency point for water performance. If the pump selected has an efficiency on water of 81 percent at 790 gpm, then the efficiency for the viscous liquid will be as follows:

$E_{VIS} = 0.635 \times 81\% = 51.5$ percent

The brake horsepower for pumping the viscous liquid will be:

$$bhp_{VIS} = \frac{750 \times 100 \times 0.90}{3960 \times 0.515} = 33.1 \text{ hp}$$

ENGINEERING DATA & CONVERSION FACTORS

VOLUME

1 U.S. Gallon	231.	cu. in.
	0.137	cu. ft.
	3.785	litres
	.00379	cu. meters
	0.833	Imp. gal.
	.0238	42-gal. barrel
1 Imperial Gallon	1.2	U.S. gal.
1 Cubic Foot	7.48	U.S. gal.
	0.0283	cu. meter
1 Barrel (Oil)	42	U.S. gal.
1 Litre	.2642	U.S. gal.
1 Cubic Meter	35.314	cu. ft.
	264.2	U.S. gal.
1 Acre Foot	43,560	cu. ft.
	325,829	U.S. gal.
1 Acre Inch	3,630	cu. ft.
	27,100	U.S. gal.

CAPACITY

1 Cubic Foot per Second (2nd foot) (c.f.s.)	449	g.p.m.
1 Acre Foot Per Day	227	g.p.m.
1 Acre Inch Per Hour	454	g.p.m.
1 Litre Per Second	15.85	g.p.m.
1 Cubic Meter Per Minute	264.2	g.p.m.
1 Miner's Inch (Idaho, Kans., Neb., N.M., N.D., S.D., Utah, Wash.)	9.0	g.p.m.
1 Miner's Inch (Ariz., Calif., Mont., Nev., and Ore.)	11.22	g.p.m.
1, 000,000 gal. per day	695	g.p.m.

HEAD

1 Pound Per Square Inch (p.s.i.)	2.31 ft. head of water
	2.04 in. mercury
	0.07 kg. per sq. cm.
1 Foot of Water	0.433 lb. per sq. in.
	.885 in. mercury
1 Inch of Mercury (or vacuum)	1.132 ft. of water
1 Kilogram Per Square Cm.	14.22 lb. per sq. in.
1 Atmosphere (at sea level)	14.7 lb. per sq. in.
	34.0 ft. of water
	10.35 meters of water
1 Meter of Water	3.28 feet of water

WEIGHT

1 U.S. Gallon of Water	8.33 lb.= 8-1/3 lbs.
1 Cubic Foot of Water	62.35 lb.
1 Kilogram or Litre	2.2 lb.
1 Imperial Gallon	10.0 lb.

LENGTH

1 Inch	2.54 centimeters
1 Meter	3.28 feet
	39.37 inches
1 Rod	16.5 feet
1 Mile	5280 ft. (1.61 kilometers)

HORSEPOWER

1 H.P. =	.746 kilowatts or 746 watts
	33,000 ft. lbs. per minute
	550ft. lbs. per second
H.P. Input =	Horsepower input to motor
	1.34 x kilowatts input to motor
Water H.P. =	H.P. required to lift water at a definite rate to a given distance assuming 100% efficiency
	$\frac{\text{G.P.M. x total head (in. ft.)}}{3960}$
Brake H.P. =	H.P. delivered by motor
	H.P. required by pump
	H.P. input x motor efficiency
	1.34 x KW input x motor efficiency
	$\frac{\text{Water H.P.}}{\text{Pump efficiency}}$
	$\frac{\text{G.P.M. times total head (ft.)}}{\text{3960 x pump efficiency}}$
	$\frac{\text{G.P.H. x total head (lbs. per sq. in.)}}{\text{103,000 x pump efficiency}}$

EFFICIENCY

Efficiency =	$\frac{\text{Power output}}{\text{Power input}}$
Motor Efficiency =	$\frac{\text{H.P. output}}{\text{K.W. input x 1.34}}$
Pump Efficiency =	$\frac{\text{G.P.M. x total head (ft.)}}{\text{3960 X B.H.P.}}$
Plant Efficiency =	$\frac{\text{G.P.M. x total head (ft.)}}{\text{5300 x KW input}}$

ELECTRICAL DATA

SIZE OF FUSES FOR CROSS LINE STARTING FOR BRANCH CIRCUITS
AND APPROXIMATE FULL LOAD AMPERES OF MOTORS

HP Rating of Motors	Alternating Current Motors								Direct Current Compound Wound Motors					
	Single Phase 60 Cycle				Three Phase 60 Cycle									
	Ampere Rating of Motor and Max. Fuse Size								Ampere Rating of Motor and Max. Fuse Size					
	115V	**Fuse**	**230V**	**Fuse**	**220V**	**Fuse**	**440V**	**Fuse**	**32V**	**Fuse**	**115V**	**Fuse**	**230V**	**Fuse**
1/4	5.8	20	2.9	15					9.7	15	2.9	15	1.5	15
1/3	7.2	25	3.6	15					14.4	25	3.6	15	1.8	15
1/2	9.8	30	4.9	15	2.0	15	1.0	15	17.8	30	5.2	15	2.6	15
3/4	13.8	45	6.9	25	2.8	15	1.4	15	24.5	40	7.4	15	3.7	15
1	16	50	8	25	3.5	15	1.8	15	30.0	45	9.4	15	4.7	15
1 1/2	20	60	10	30	5.0	15	2.5	15			13.2	20	6.6	15
2	24	80	12	40	6.5	25	3.3	15			17	30	8.5	15
3	34	110	17	60	9.0	30	4.5	15			25	40	12.2	20
5	56	175	28	90	15	45	7.5	25						
7 1/2	80	250	40	125	22	70	11.0	35						
10	100	300	50	150	27	80	14	45						
15					40	125	20	60						
20					52	175	26	80						
25					64	200	32	100						
30					78	250	39	125						
40					104	350	52	175						
50					125	400	63	200						
60					150	450	75	225						
75					185	600	93	300						
100					246	800	123	400						
125							155	500						
150							180	600						
200							240	800						

Fuses are recommended only to protect the wiring in case of accidental ground or short circuit.
Thermal overload heaters in a starter provide protection for the motor and should be selected on the basis of motor current obtained from the motor nameplate and the type of starter enclosure.
For three phase power 3 heater elements are recommended for maximum protection.
If fusetrons are used instead of the instantaneous type fuse the size should be selected based on motor current similarly to thermal overload elements.

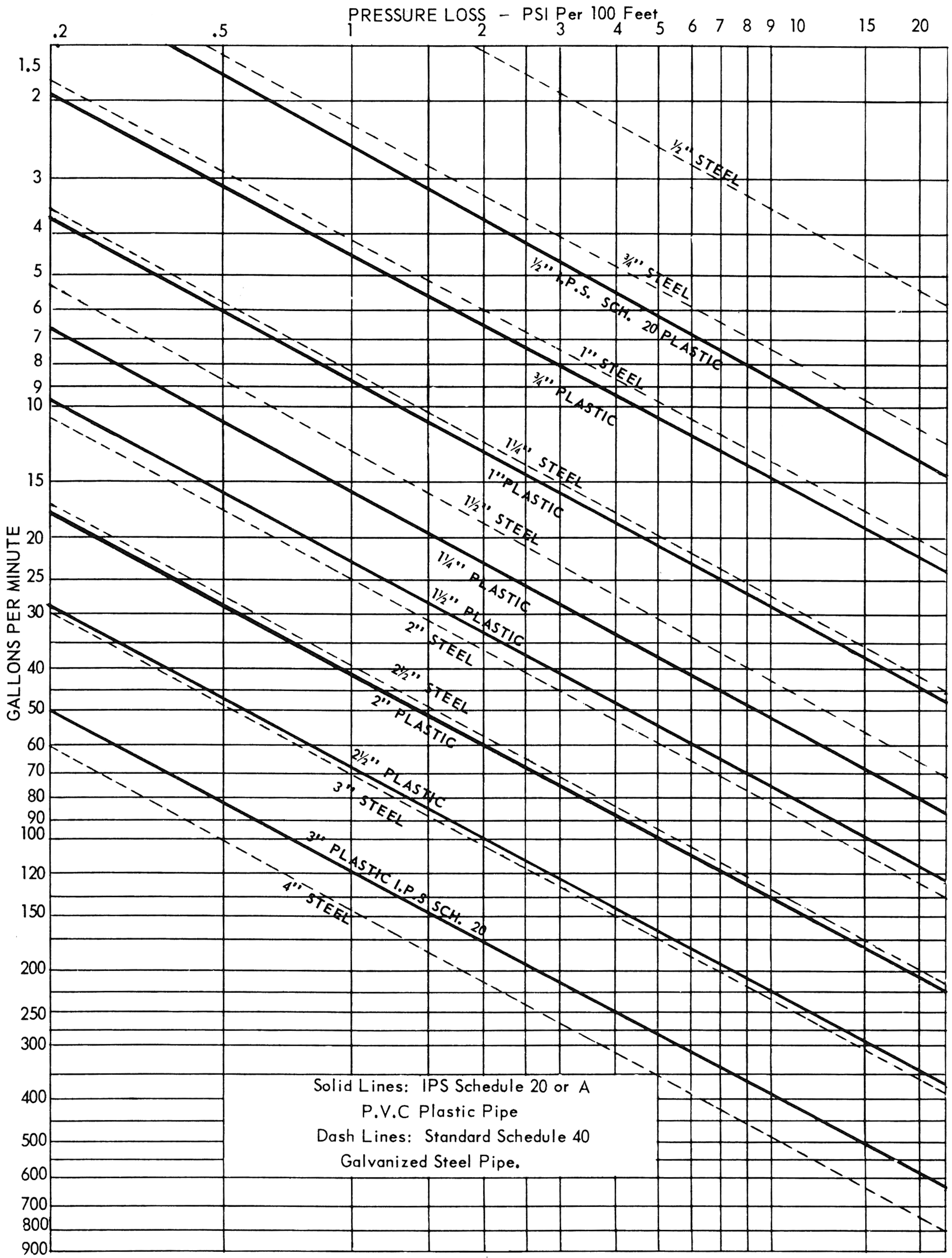
Above figures from NEC 1962 (NBFU Bul. No.70)

ALLOWABLE CURRENT-CARRYING CAPACITIES OF INSULATED COPPER CONDUCTORS IN AMPERES

RUBBER Type R - Type RW - Type RU- Type RUW (14-2) Type RH-RW - Thermoplastic - Type T - Type TW	
Size AWG,MCM	Amperes
14	15
12	20
10	30
8	40
6	55
4	70
3	80
2	95
1	110
0	125
00	145
000	165
0000	195
250	215
300	240
350	260
400	280
500	320

TYPICAL MOTOR EFFICIENCY (%) 60 CYCLE

MOTOR HP	Single phase		3 phase	
	1750 RPM	3450 RPM	1750 RPM	3450 RPM
1/3	60	59		
1/2	64	61		
3/4	68	65		69
1	70	66	79.5	76
1 1/2	72	72	82.0	79.5
2	76	73	84.5	83.0
3	76	75	84.5	85.0
5	76	78	86	84.5
7 1/2			87	86.5
10			87.5	85.5
15			88.5	87.5
20			89.5	87.5
25			89.5	89.0
30			90.5	89.5
40			90.5	90.0
50			91.0	90.5
60			91.5	90.5
75			92.0	91.0
100			92.0	92.0
125			92.5	91.5
150			92.5	92.5


PRESSURE LOSS – PSI Per 100 Feet
.2
.5
1
2
3
4
5
6
7
8
9
10
15
20
GALLONS PER MINUTE
1.5
2
3
4
5
6
7
8
9
10
15
20
25
30
40
50
60
70
80
90
100
120
150
200
250
300
400
500
600
700
800
900
½" STEEL
¾" STEEL
½" I.P.S. SCH. 20 PLASTIC
1" STEEL
¾" PLASTIC
1¼" STEEL
1" PLASTIC
1½" STEEL
1¼" PLASTIC
1½" PLASTIC
2" STEEL
2½" STEEL
2" PLASTIC
2½" PLASTIC
3" STEEL
3" PLASTIC I.P.S SCH. 20
4" STEEL
Solid Lines: IPS Schedule 20 or A
P.V.C Plastic Pipe
Dash Lines: Standard Schedule 40
Galvanized Steel Pipe.

USEFUL PUMP DATA

EFFECT OF SMALL CHANGES OF PUMP SPEED
1. The capacity varies directly as the speed.
2. The head varies as the square of the speed.
3. The brake horsepower varies as the cube of the speed.

EFFECT OF SMALL CHANGES OF IMPELLER DIAMETER
1. The capacity varies directly as the diameter.
2. The head varies as the square of the diameter.
3. The brake horsepower varies as the cube of the diameter.

EFFECT OF SPECIFIC GRAVITY
Brake horsepower varies directly with specific gravity. If the liquid has a specific gravity other than water (1.0) multiply the brake horsepower for water by the specific gravity of the liquid to be handled. A centrifugal pump will always develop the same head in feet no matter what the specific gravity of the liquid pumped. However, the pressure (in pounds per square inch) will be increased or decreased in direct proportion to the specific gravity.

EFFECT OF VISCOSITY
Viscous liquids tend to reduce pump capacity, head and efficiency and to increase pump brake horsepower and increase pipe line friction. See page 11 for correction factors.

EFFECT OF ALTITUDE
Suction lift data are based on values at sea level. Therefore, above sea level the total suction lift must be reduced.

EFFECT OF HOT LIQUIDS
Hot liquids vaporize at higher absolute pressures than cold liquids, therefore the suction lift must be reduced when handling hot liquids. When handling liquids with a high vapor pressure or at high temperatures the liquid must flow to the pump suction under pressure.

PNEUMATIC TANK SELECTION TABLE
The following table indicates the minimum size pressure tank recommended for an automatic water system based on the capacity of the pump and the operating pressures.

	PRESSURE (Lbs. per Sq. In.)									
Cut in	20	20	30	40	50	50	60	60	70	Cut in
Cut out	35	40	50	60	80	70	90	80	100	Cut out
Average	27.5	30	40	50	65	60	75	70	85	Average
Tank Size	Capacity in Gals. per Hr. at Average Pressure									Tank Size
18	185	230	145	100	90	80	80	60	65	18
32	325	400	260	185	155	140	150	110	120	32
42	430	530	340	240	200	180	190	140	155	42
82	840	1020	660	475	400	355	365	270	295	82
120	1230	1500	970	695	585	520	550	400	445	120
144	1470	1800	1160	830	700	620	650	480	525	144
180	1830	2250	1460	1040	860	770	820	600	660	180
220	2250	2760	1760	1265	1060	940	990	730	800	220
315	3240	3930	2550	1810	1520	1350	1410	1040	1150	315
525	5360	6545	4260	3030	2540	2250	2360	1740	1900	525
1000	10,400	12,500	8100	5760	4850	4300	4500	3310	3650	1000
1500	15,300	18,800	12,180	8650	9700	6420	6750	4980	5450	1500
2000	20,400	25,000	16,200	11,500	13,000	8520	9000	6600	7250	2000
3000	30,600	37,500	24,300	17,300	19,500	12,800	13,500	9950	10,900	3000
5000	51,000	62,500	40,500	28,800	32,400	21,700	22,500	16,550	18,300	5000
7500	76,000	94,000	61,000	45,000	48,500	32,400	33,700	25,000	27,400	7500
10,000	102,000	130,000	81,000	57,600	64,800	43,400	45,000	33,100	36,600	10,000

NOTE 1. Capacity is based on atmospheric initial charge at sea level.
NOTE 2. If no air charger is employed, increase tonk size by approximately 50%.
NOTE 3. Tank capacity should be increased 25% for elevations above 5000 feet.

WATER REQUIRED PER MINUTE TO FEED BOILERS
One Boiler Horse-Power equals 34.5 lbs. of water evaporated per hour from and at 212 degrees Fahrenheit.
One Gallon of Water weighs 8.34 lbs. at 60 degrees Fahrenheit.
Boiler H.P. times .069 Gallons per minute Feed Water required.

H.P.	G.P.M.	H.P.	G.P.M.	H.P.	G.P.M.	H.P.	G.P.M.	H.P.	G.P.M.
20	1.38	60	4.14	110	7.59	190	13.1	400	27.6
25	1.73	65	4.49	120	8.29	200	13.8	450	31.1
30	2.07	70	4.83	130	8.97	225	15.5	500	34.5
35	2.42	75	5.18	140	9.66	250	17.3	600	41.4
40	2.76	80	5.52	150	10.40	275	19.0	700	48.3
45	3.11	85	5.87	160	11.10	300	20.7	800	55.2
50	3.45	90	6.21	170	11.70	325	22.5	900	62.1
55	3.80	100	6.90	180	12.40	350	24.2	1000	69.0

In selecting Boiler Feed pumps, the fact that boilers are often run 200 and 300 percent of rating should be taken into consideration. The above figures are of the actual Boiler Horse-Power developed.

APPROXIMATE BOILER FEED PUMP PRESSURES

Boiler Pressure	Boiler Feed Pump Discharge Pressure
200	250
400	475
800	925
1200	1350

MATERIAL SELECTION DATA REQUIREMENTS

1. SOLUTION TO BE PUMPED (Give common name, where possible, such as "spinning bath," "black liquor," "spent pickle," etc.) ____________________

2. PRINCIPAL CORROSIVES (H_2S0_4 , HC1, etc.) ____________________% by weight
(In the case of mixtures, state definite percentages by weight. For example: mixture contains 2% acid, in terms of 96.5% H_2S0_4.)

3. pH (if aqueous solution) __________ at __________ F

4. IMPURITIES OR OTHER CONSTITUENTS NOT GIVEN IN "2" (List amounts of any metallic salts. such as chlorides, sulphates, sulphides, chromates, and any organic materials which may be present. even though in percentages as low as .01%. Indicate, where practical, whether they act as accelerators or inhibitors on the pump material.) ____________________

5. SPECIFIC GRAVITY (solution pumped) __________ at __________ F

6. TEMPERATURE OF SOLUTION: Maximum __________ F, Minimum __________ F, Normal __________ F

7. VAPOR PRESSURES AT ABOVE TEMPERATURES: Maximum __________ Minimum __________ Normal __________
(Indicate units used, such as pounds gauge, inches water, millimeters mercury.)

8. VISCOSITY __________ SSU; or __________ centistokes; at __________ F

9. AERATION: Air-Free __________ Partial __________ Saturated __________
Does liquid have tendency to foam? __________

10. OTHER GASES IN SOLUTION __________ ppm, or __________ cc per liter

11. SOLIDS IN SUSPENSION: (state types) ____________________
Specific gravity of solids __________
Quantity of solids: __________ % by weight
Particle size: __________ mesh __________ % by weight
__________ mesh __________ % by weight
__________ mesh __________ % by weight
Character of solids: Pulpy __________ Gritty __________ Hard __________ Soft __________

12. CONTINUOUS OR INTERMITTENT SERVICE __________
Will pump be used for circulation in closed system or for transfer? __________
Will pump be operated at times against closed discharge? __________
If intermittent, how often is pump started? __________ times per__________
Will pump be flushed and drained when not in service? __________

13. TYPE OF MATERIAL IN PIPE LINES TO BE CONNECTED TO PUMP __________
If desirable, are insulated joints practical? __________
If so, what percentage of element (Fe, Ni, Cu, etc) is objectionable? __________

14. IS METAL CONTAMINATION UNDESIRABLE? __________

15. PREVIOUS EXPERIENCE Have you pumped this solution previously? __________
If so, of what material or materials was pump made? __________
Service life in months? __________
In case of trouble, what parts were affected? __________
Was trouble primarily due to corrosion? __________ erosion? __________
galvanic action? __________ stray current? __________
Was attack uniform?__________ If localized , what parts were involved? __________
If galvanic action, name materials involved __________
If pitted, describe size, shape and location (A sketch will be helpful in an analysis of problem) __________

16. WHAT IS CONSIDERED AN ECONOMIC LIFE? __________
(If replacement does not become too frequent, the use of inexpensive pump materials may be the most economical)

MATERIALS OF CONSTRUCTION FOR PUMPING VARIOUS LIQUIDS

Column 1	Column 2	Column 3	Column 4	Column 5
Liquid	**Condition of Liquid**	**Chemical Symbol**	**Specific Gravity**	**Material Selection**
Acetaldehyde		C_2H_4O	0.78	C
Acetate Solvents				A, B, C, 8, 9, 10, 11
Acetone		C_3H_6O	0.79	B,C
Acetic Anhydride		$C_4H_6O_3$	1.08	8, 9, 10, 11, 12
Acid, Acetic	Conc. Cold	$C_2H_4O_2$	1.05	8, 9, 10, 11, 12
Acid, Acetic	Dil. Cold			A, 8, 9, 10, 11, 12
Acid, Acetic	Conc. Boiling			9, 10, 11, 12
Acid, Acetic	Dil. Boiling			9, 10, 11, 12
Acid, Arsenic, Ortho-		$H_3AsO_4 . \frac{1}{2}H_2O$	2.0-2.5	8, 9, 10, 11, 12
Acid, Benzoic		$C_7H_6O_2$	1.27	8, 9, 10, 11
Acid, Boric	Aqueous Sol.	H_3BO_3		A, 8, 9, 10, 11, 12
Acid, Butyric	Conc.	$C_4H_8O_2$	0.96	8, 9, 10, 11
Acid, Carbolic	Conc. (M.P. 106 F)	C_6H_6O	1.07	C, 8, 9, 10, 11
Acid, Carbolic	(See Phenol)			B, 8, 9, 10, 11
Acid, Carbonic	Aqueous Sol.	$CO_2 + H_2O$		A
Acid, Chromic	Aqueous Sol.	$Cr_2O_3 + H_2O$		8, 9, 10, 11, 12
Acid, Citric	Aqueous Sol.	$C_6H_8O_7 + H_2O$		A, 8, 9, 10, 11, 12
Acids, Fatty (Oleic, Palmitic, Stearic, etc.)				A, 8, 9, 10, 11
Acid, Formic		CH_2O_2	1.22	9, 10, 11
Acid, Fruit				A, 8, 9, 10, 11, 14
Acid, Hydrochloric	Coml. Conc.	HCl	1.19 (38%)	11, 12
Acid, Hydrochloric	Dil. Cold			10, 11, 12, 14, 15
Acid, Hydrochloric	Dil. Hot			11, 12
Acid, Hydrocyanic		HCN	0.70	C, 8, 9, 10, 11
Acid, Hydrofluoric	Anhydrous, with Hydro Carbon	$HF + H_xC_x$		3, 14
Acid, Hydrofluoric	Aqueous Sol.	HF		A, 14
Acid, Hydrofluosilicic		H_2SiF_6	1.30	A, 14
Acid, Lactic		$C_3H_6O_3$	1.25	A, 8, 9, 10, 11, 12
Acid, Mine Water				A, 8, 9, 10, 11
Acid, Mixed	Sulfuric + Nitric			C, 3, 8, 9, 10, 11, 12
Acid, Muriatic	(See Acid, Hydrochloric)			
Acid, Naphthenic				C, 5, 8, 9, 10, 11
Acid, Nitric	Conc. Boiling	HNO_3	1.50	6, 7, 10, 12
Acid, Nitric	Dilute			5, 6, 7, 8, 9, 10, 12
Acid, Oxalic	Cold	$C_2H_2O_4 . 2H_2O$	1.65	8, 9, 10, 11, 12
Acid, Oxalic	Hot	$C_2H_2O_4 . 2H_2O$		10, 11, 12
Acid, Ortho-Phosphoric		H_3PO_4	1.87	9, 10, 11
Acid, Picric		$C_6H_3N_3O_7$	1.76	8, 9, 10, 11, 12
Acid, Pyrogallic		$C_6H_6O_3$	1.45	8, 9, 10, 11
Acid, Pyroligneous				A, 8, 9, 10, 11
Acid, Sulfuric	> 77% Cold	H_2SO_4	1.69-1.84	C, 10, 11, 12
Acid, Sulfuric	65 / 93% > 175 F			11, 12
Acid, Sulfuric	65 / 93% < 175 F			10, 11, 12
Acid, Sulfuric	10-65%			10, 11, 12
Acid, Sulfuric	< 10%			A, 10, 11 , 12, 14
Acid, Sulfuric (Oleum)	Fuming	$H_2SO_4 + SO_3$	1.92-1.94	3, 10, 11
Acid, Sulfurous		H_2SO_3		A, 8, 9, 10, 11
Acid, Tannic		$C_{14}H_{10}O_9$		A, 8, 9, 10, 11, 14

MATERIALS OF CONSTRUCTION (CONTINUED)

Column 1	Column 2	Column 3	Column 4	Column 5
Liquid	**Condition of Liquid**	**Chemical Symbol**	**Specific Gravity**	**Material Selection**
Acid, Tartaric	Aqueous Sol.	$C_4H_6O_6.\ H_2O$		A, 8, 9, 10, 11, 14
Alcohols				A, B
Alum	(See Aluminum Sulphate and Potash Alum)			
Aluminum Sulphate	Aqueous Sol.	$Al_2(SO_4)_3$		10, 11, 12, 14
Ammonia, Aqua		NH_4OH		C
Ammonium Bicarbonate	Aqueous Sol.	NH_4HCO_3		C
Ammonium Chloride	Aqueous Sol.	NH_4Cl		9, 10, 11, 12, 14
Ammonium Nitrate	Aqueous Sol.	NH_4NO_3		C, 8, 9, 10, 11, 14
Ammonium Phosphate, Dibasic	Aqueous Sol.	$(NH_4)_2HPO_4$		C, 8, 9, 10, 11, 14
Ammonium Sulfate	Aqueous Sol.	$(NH_4)_2SO_4$		C, 8, 9, 10, 11
Ammonium Sulfate	With sulfuric acid			A, 9, 10, 11, 12
Aniline		C_6H_7N	1.02	B, C
Aniline Hydrochloride	Aqueous Sol.	$C_6H_5NH_2HC_1$		11, 12
Asphalt	Hot		0.98-1.4	C, 5
Barium Chloride	Aqueous Sol.	$BaCl_2$		C, 8, 9, 10, 11
Barium Nitrate	Aqueous Sol.	$Ba(NO_3)_2$		C, 8, 9, 10, 11
Beer				A, 8
Beer Wort				A, 8
Beet Juice				A, 8
Beet Pulp				A, B, 8, 9, 10, 11
Benzene		C_6H_6	0.88	
Benzine	(See Petroleum ether)			
Benzol	(See Benzene)			B, C
Bichloride of Mercury	(See Mercuric Chloride)			
Black Liquor	(See Liquor, Pulp Mill)			
Bleach Solutions	(See type)			
Blood				A, B
Boiled Feedwater	(See Water, Boiler Feed)			
Brine, Calcium Chloride	pH > 8	$CaCl_2$		C
Brine, Calcium Chloride	pH < 8			A, 10, 11, 13, 14
Brine, Calcium & Magnesium Chlorides	Aqueous Sol.			A, 10, 11, 13, 14
Brine, Calcium & Sodium Chloride	Aqueous Sol.			A, 10, 11, 13, 14
Brine, Sodium Chloride	Under 3% Salt, Cold	NaCl		A, C, 13
Brine, Sodium Chloride	Over 3% Salt, Cold		1.02-1.20	A, 8, 9, 10, 11, 13, 14
Brine, Sodium Chloride	Over 3% Salt, Hot			9, 10, 11, 12, 14
Brine, Sea Water			1.03	A, B, C
Butane		C_4H_{10}	0.60 @ 32 F	B, C, 3
Calcium Bisulfite	Paper Mill	$Ca(HSO_3)_2$	1.06	9, 10, 11
Calcium Chlorate	Aqueous Sol.	$Ca(ClO_3)_2 2H_2O$		10, 11, 12
Calcium Hypochlorite		$Ca(OCl)_2$		C, 10, 11, 12
Calcium Magnesium Chloride	(See Brines)			
Cane Juice				A, B, 13
Carbon Bisulfide		CS_2	1.26	C
Carbonate of Soda	(See Soda Ash)			
Carbon Tetrachloride	Anhydrous	CCl_4	1.50	B, C
Carbon Tetrachloride	Plus Water			A, 8
Catsup				A, 8, 9, 10, 11
Caustic Potash	(See Potassium Hydroxide)			

MATERIALS OF CONSTRUCTION (CONTINUED)

Column 1	Column 2	Column 3	Column 4	Column 5
Liquid	Condition of Liquid	Chemical Symbol	Specific Gravity	Material Selection
Caustic Soda	(See Sodium Hydroxide)			
Cellulose Acetate				9, 10, 11
Chlorate of Lime	(See Calcium Chlorate)			
Chloride of Lime	(See Calcium Hypochlorite)			
Chlorine Water	(Depending on conc.)			9, 10, 11, 12
Chlorobenzene		C_6H_5Cl	1.1	A, B, 8
Chloroform		$CHCl_3$	1.5	A, 8, 9, 10, 11, 14
Chrome Alum	Aqueous Sol.	$CrK(SO_4)_2 . 12H_2O$		10, 11, 12
Condensate	(See Water, Distilled)			
Copperas, Green	(See Ferrous Sulfate)			
Copper Ammonium Acetate	Aqueous Sol.			C, 8, 9, 10, 11
Copper Chloride (Cupric)	Aqueous Sol.	$CuCl_2$		11, 12
Copper Nitrate		$Cu(NO_3)_2$		8, 9, 10, 11
Copper Sulfate, Blue Vitriol	Aqueous Sol.	$CuSO_4$		8, 9, 10, 11, 12
Creosote	(Sec Oil, Creosote)			
Cresol, Meta		C_7H_8O	1.03	C, 5
Cyanide	(See Sodium Cyanide and Potassium Cyanide)			
Cyanogen	In Water	$(CN)_2$Gas		C
Diphenyl		$C_6H_5 . C_6H_5$	.99	C, 3
Enamel				C
Ethanol	(See Alcohols)			
Ethylene Chloride (di-chloride)	Cold	$C_2H_4Cl_2$	1.28	A, 8, 9, 10, 11, 14
Ferric Chloride	Aqueous Sol.	$FeCl_3$		11, 12
Ferric Sulphate	Aqueous Sol.	$Fe_2(SO_4)_3$		8, 9, 10, 11, 12
Ferrous Chloride	Cold, Aqueous	$FeCl_2$		11, 12
Ferrous Sulphate (Green Copperas)	Aqueous Sol.	$FeSO_4$		9, 10, 11, 12, 14
Formaldehyde		CH_2O	1.08	A, 8, 9, 10, 11
Fruit Juices				A, 8, 9, 10, 11, 14
Furfural		$C_5H_4O_2$	1.16	A, C, 8, 9, 10, 11
Gasoline			0.68-0.75	B, C
Glaubers Salt	(See Sodium Sulfate)			
Glucose				A, B
Glue	Hot			B, C
Glue Sizing				A
Glycerol (Glycerin)		$C_3H_8O_3$	1.26	A, B, C
Green Liquor	(See Liquor, Pulp Mill)			
Heptane		C_7H_{16}	0.69	B, C
Hydrogen Peroxide	Aqueous Sol.	H_2O_2		8, 9, 10, 11
Hydrogen Sulfide	Aqueous Sol.	H_2S		8, 9, 10, 11
Hydrosulfite of Soda	(See Sodium Hydrosulfite)			
Hyposulfite of Soda	(See Sodium Thiosulfate)			
Kaolin Slip	Suspension in Water			C, 3
Kaolin Slip	Suspension in Acid			10, 11, 12
Kerosene	(See Oil, Kerosene)			
Lard	Hot			B, C
Lead Acetate (Sugar of Lead)	Aqueous Sol.	$Pb(C_2H_3O_2)_2 . 3H_2O$		9, 10, 11, 14
Lead	Molten			C, 3
Lime Water (Milk of Lime)		$Ca(OH)_2$		C
Liquor–Pulp Mill: Black				C, 3, 9, 10, 11, 12, 14

MATERIALS OF CONSTRUCTION (CONTINUED)

Column 1	Column 2	Column 3	Column 4	Column 5
Liquid	**Condition of Liquid**	**Chemical Symbol**	**Specific Gravity**	**Material Selection**
Liquor–Pulp Mill: Green				C, 3, 9, 10, 11, 12, 14
Liquor–Pulp Mill: White				C, 3, 9, 10, 11, 12, 14
Liquor–Pulp Mill: Pink				C, 3, 9, 10, 11, 12, 14
Liquor–Pulp Mill: Sulfite				9, 10, 11
Lithium Chloride	Aqueous Sol.	$LiCl$		C
Lye, Caustic	(See Potassium & Sodium Hydroxide)			
Magnesium Chloride	Aqueous Sol.	$MgCl_2$		10, 11, 12
Magnesium Sulfate (Epsom Salts)	Aqueous Sol.	$MgSO_4$		C, 8, 9, 10, 11
Manganese Chloride	Aqueous Sol.	$MnCl_2 \cdot {}_4H_2O$		A, 8, 9, 10, 11, 12
Manganous Sulfate	Aqueous Sol.	$MnSO_4 \cdot 4H_2O$		A, C, 8, 9, 10, 11
Mash				A, B, 8
Mercuric Chloride	Very Dilute Aqueous Sol.	$HgCl_2$		9, 10, 11, 12
Mercuric Chloride	Coml. Conc. Aqueous Sol.	$HgCl_2$		11, 12
Mercuric Sulfate	In Sulfuric Acid	$HgSO_4 + H_2SO_4$		10, 11, 12
Mercurous Sulfate	In Sulfuric Acid	$Hg_2SO_4 + H_2SO_4$		10, 11, 12
Methyl Chloride		CH_3Cl	0.52	C
Methylene Chloride		CH_2Cl_2	1.34	C, 8
Milk			1.03-1.04	8
Milk of Lime	(See Lime Water)			
Mine Water	(See Acid, Mine Water)			
Miscella	(20% Soybean Oil & Solvent)		0.75	C
Molasses				A, B
Mustard				A, 8, 9, 10, 11, 12
Naphtha			0.78-0.88	B, C
Naphtha, Crude			0.92-0.95	B, C
Nicotine Sulfate		$(C_{10}H_{14}N_2)_2H_2SO_4$		10, 11, 12, 14
Nitre	(See Potassium Nitrate)			
Nitre Cake	(See Sodium Bisulphate)			
Nitro Ethane		$C_2H_5NO_2$	1.04	B, C
Nitro Methane		CH_3NO_2	1.14	B, C
Oil, Coal Tar				B, C, 8, 9, 10, 11
Oil, Coconut			0.91	A, B, C, 8, 9, 10, 11, 14
Oil, Creosote			1.04-1.10	B, C
Oil, Crude	Cold			B, C
Oil, Crude	Hot			3
Oil, Essential				A, B, C
Oil, Fuel				B, C
Oil, Kerosene				B, C
Oil, Linseed			0.94	A, B, C, 8, 9, 10, 11, 14
Oil, Lubricating				B, C
Oil, Mineral				B, C
Oil, Olive			0.90	B, C
Oil, Palm			0.90	A, B, C, 8, 9, 10, 11, 14
Oil, Quenching			0.91	B, C
Oil, Rapeseed			0.92	A, 8, 9, 10, 11, 14
Oil, Soya Bean				A, B, C, 8, 9, 10, 11, 14
Oil, Turpentine			0.87	B, C
Paraffin	Hot			B, C
Perhydrol	(See Hydrogen Peroxide)			

MATERIALS OF CONSTRUCTION (CONTINUED)

Column 1	Column 2	Column 3	Column 4	Column 5
Liquid	**Condition of Liquid**	**Chemical Symbol**	**Specific Gravity**	**Material Selection**
Peroxide of Hydrogen	(See Hydrogen Peroxide)			
Petroleum Ether				B, C
Phenol		C_6H_6O	1.07	
Pink Liquor	(See Liquor, Pulp Mill)			
Photographic Developers				8, 9, 10, 11
Plating Solutions	(Varied and complicated, consult pump mfgrs.)			
Potash	Plant Liquor			A, 8, 9, 10, 11, 13, 14
Potash Alum	Aqueous Sol.	$Al_2(SO_4)_3K_2SO_4.24H_2O$		A, 9, 10, 11, 12, 13, 14
Potassium Bichromate	Aqueous Sol.	$K_2Cr_2O_7$		C
Potassium Carbonate	Aqueous Sol.	K_2CO_3		C
Potassium Chlorate	Aqueous Sol.	$KClO_3$		8, 9, 10, 11, 12
Potassium Chloride	Aqueous Sol.	KCl		A, 8, 9, 10, 11, 14
Potassium Cyanide	Aqueous Sol.	KCN		C
Potassium Hydroxide	Aqueous Sol.	KOH		C, 5, 8, 9, 10, 11, 13, 14, 15
Potassium Nitrate	Aqueous Sol.	KNO_3		C, 5, 8, 9, 10, 11
Potassium Sulfate	Aqueous Sol.	K_2SO_4		A, 8, 9, 10, 11
Propane		C_3H_8	0.59 @ 48 F	B, C, 3
Pyridine		C_5H_5N	0.98	C
Pyridine Sulphate				10, 12
Rhidolene				B
Rosin (Colophony)	Paper Mill			C
Sal Ammoniac	(See Ammonium Chloride)			
Salt Lake	Aqueous Sol.	Na_2SO_4 + impurities		A, 8, 9, 10, 11, 12
Salt Water	(See Brines)			
Sea Water	(See Brines)			
Sewage				A, B, C
Shellac				A
Silver Nitrate	Aqueous Sol.	$AgNO_3$		8, 9, 10, 11, 12
Slop, Brewery				A, B, C
Slop, Distillers				A, 8, 9, 10, 11
Soap Liquor				C
Soda Ash	Cold	Na_2CO_3		C
Soda Ash	Hot			8, 9, 10, 11, 13, 14
Sodium Bicarbonate	Aqueous Sol.	$NaHCO_3$		C, 8, 9, 10, 11, 13
Sodium Bisulfate	Aqueous Sol.	$NaHSO_4$		10, 11, 12
Sodium Carbonate	(See Soda Ash)			
Sodium Chlorate	Aqueous Sol.	$NaClO_3$		8, 9, 10, 11, 12
Sodium Chloride	(See Brines)			
Sodium Cyanide	Aqueous Sol.	NaCN		C
Sodium Hydroxide	Aqueous Sol.	NaOH		C, 5, 8, 9, 10, 11, 13, 14, 15
Sodium Hydrosulfite	Aqueous Sol.	$Na_2S_2O_4.\ 2H_2O$		8, 9, 10, 11
Sodium Hypochlorite		NaOCl		10, 11, 12
Sodium Hyposulfite	(See Sodium Thiosulfate)			
Sodium Meta Silicate				C
Sodium Nitrate	Aqueous Sol.	$NaNO_3$		C, 5, 8, 9, 10, 11
Sodium Phosphate: Monobasic	Aqueous Sol.	$NaH_2PO_4.\ H_2O$		A, 8, 9, 10, 11
Sodium Phosphate: Dibasic	Aqueous Sol.	$Na_2HPO_4.\ _7H_2O$		A, C, 8, 9, 10, 11
Sodium Phosphate: Tribasic	Aqueous Sol.	$Na_3PO_4.\ _{12}H_2O$		C
Sodium Phosphate: Meta	Aqueous Sol.	$Na_4P_4O_{12}$		A, 8, 9, 10, 11
Sodium Phosphate: Hexameta	Aqueous Sol.	$(NaPO_3)_6$		8, 9, 10, 11

MATERIALS OF CONSTRUCTION (CONTINUED)

Column 1	Column 2	Column 3	Column 4	Column 5
Liquid	**Condition of Liquid**	**Chemical Symbol**	**Specific Gravity**	**Material Selection**
Sodium Plumbite	Aqueous Sol.			C
Sodium Sulfate	Aqueous Sol.	Na_2SO_4		A, 8, 9, 10, 11
Sodium Sulfide	Aqueous Sol.	Na_2S		C, 8, 9, 10, 11
Sodium Sulfite	Aqueous Sol.	Na_2SO_3		A, 8, 9, 10, 11
Sodium Thiosulfate	Aqueous Sol.	$Na_2S_2O_3$. $5H_2O$		8, 9, 10, 11
Stannic Chloride	Aqueous Sol.	$SnCl_4$		11, 12
Stannous Chloride	Aqueous Sol.	$SnCl_2$		11, 12
Starch		$(C_6H_{10}O_5)x$		A, B
Strontium Nitrate	Aqueous Sol.	$Sr(NO_3)_2$		C, 8
Sugar	Aqueous Sol.			A, 8, 9, 10, 11, 13
Sulfite Liquor	(See Liquor, Pulp Mill)			
Sulfur	In Water	S		A, C, 8, 9, 10, 11
Sulfur	Molten	S		C
Sulfur Chloride	Cold	S_2Cl_2		C
Syrup	(See Sugar)			
Tallow	Hot		0.90	C
Tanning Liquors				A, 8, 9, 10, 11, 12, 14
Tar	Hot			C, 3
Tar & Ammonia	In Water			C
Tetrachloride of Tin	(See Stannic Chloride)			
Tetraethyl Lead		$Pb(C_2H_5)_4$	1.66	B, C
Toluene (Toluol)		C_7H_8	0.87	B, C
Trichloroethylene		C_2HCl_3	1.47	A, B, C, 8
Urine				A, 8, 9, 10, 11
Varnish				A, B, C, 8, 14
Vegetable Juices				A, 8, 9, 10, 11, 14
Vinegar				A, 8, 9, 10, 11, 12
Vitriol, Blue	(See Copper Sulfate)			
Vitriol, Green	(See Ferrous Sulfate)			
Vitriol, Oil of	(See Acid, Sulfuric)			
Vitriol, White	(See Zinc Sulfate)			
Water, Boiler Feed	Not evaporated pH > 8.5		1.00	C
High Makeup	pH < 8.5			B
Low Makeup	Evaporated, any pH		1.66	4, 5, 8, 14
Water, Distilled	High Purity		0.87	A, 8
Water, Distilled	Condensate			A, B
Water, Fresh			1.00	B
Water, Mine	(See Acid, Mine Water)			
Water, Salt & Sea	(See Brines)			
Whiskey				A, 8
White Liquor	(See Liquor, Pulp Mill)			
White Water	Paper Mill			A, B, C
Wine				A, 8
Wood Pulp (Stock)				A, B, C
Wood Vinegar	(See Acid Pyroligneous)			
Wort	(See Beer Wort)			
Xylol (Xylene)		C_8H_{10}	0.87	B, C, 8, 9, 10, 11
Yeast				A, B
Zinc Chloride	Aqueous Sol.	$ZnCl_2$		9, 10, 11, 12
Zinc Sulfate	Aqueous Sol.	$ZnSO_4$		A, 9, 10, 11

MATERIALS TABULATION SUMMARY

A- designates an All Bronze pump
B- designates a Bronze Fitted pump
C- designates an All Iron pump
The following tabulation summarizes the selections and associated Society* designations covered by the previous paragraph:

SUMMARY OF MATERIAL SELECTIONS AND NATIONAL SOCIETY STANDARDS DESIGNATIONS

Materials Selection #	Corresponding National Society* Standards Designation			Remarks
	ASTM	ACI	AISI	
1	A48, Classes 20, 25, 30, 35, 40 & 50			Gray Iron-six grades
2	B143, 1B & 2A; B144, 3A; B145, 4A			Tin Bronze-six grades (includes two grades not covered by ASTM Specifications as explained above under Selection #2)
3	A216, WCB		1030	Carbon Steel
4	A217, C5		501	5% Chromium Steel
5	A296, CA15	CA15	410	13% Chromium Steel
6	A296, CB30	CB30		20% Chromium Steel
7	A296, CC50	CC50	446	28% Chromium Steel
8	A296, CF-8	CF-8	304	18-8 Austenitic Steel
9	A296, CF-8M	CF-8M	316	18-8 Molybdenum Austenitic Steel
10		CN-7M		A series of highly-alloyed steels normally used where the corrosive conditions are severe
11				A series of nickle-base alloys
12				High-silicon cast iron
13				Austenitic cast iron
14				Monel metal
15				Nickel

* ASTM–denotes American Society for Testing Materials
ACI–denotes Alloy Casting Institute
AISI–denotes American Iron and Steel Institute

BELT DRIVE
SELECTION OF "V" BELT SECTION AND SHEAVE

HP	Section	Pitch Dia. Sm. Sheave	Normal Sm. Sheave
1/4 to 5	A	3.0 to 6"	4.2
2 - 25	B	5.4 to 11	6.4
15 - 75	C	9.6 to 16	9.6
50 - 100	D	13 to 22	14.2
Over 100	E	21.6 & Over	23.2

BELT SPEED

For satisfactory operation and belt life, the pulleys should be as large as possible without exceeding a belt speed of 5000 feet per minute. Belt Speed = S = .26D x RPM = Feet per minute

as may be determined from the following table
The pulley should not be greater than 5½'' for 3500 RPM.

Example: If the pulley diameter (D) is 6", and its speed is 1750 rpm, then the belt speed = S = .26 x 6 x 1750 = 2740 feet per minute.

The following table shows speed RPM which a pulley of diameter (D) may be run for a belt speed of 5000 feet per minute.

Pulley dia. D (in.)	RPM	Pulley dia. D (in.)	RPM
4	4800	10	1920
5	3850	11	1750
5½	3500	12	1610
6	3220	13	1480
7	2750	14	1370
8	2400	15	1280
9	2140	16	1200

MINIMUM WIRE SIZE TABLE OF RUBBER INSULATED COPPER WIRE ON 32, 115, 230 VOLT LINE

Max. Line Load (Amps.)	DISTANCE FROM MOTOR TO METER IN FEET																				
	0' - 50'			50' - 100'			100' - 150'			150' - 200'			200' - 300'			300' - 400'			400' - 500'		
	32V	115V	230V	32V	115V	230V	32V	115V	230V	32V	115V	230V	32V	115V	230V	32V	115V	230V	32V	115V	230V
2	14	14	14	14	14	14	14	14	14	12	14	14	12	14	14	10	14	14	8	14	14
3	14	14	14	14	14	14	12	14	14	10	14	14	8	14	14	8	12	14	6	12	14
4	14	14	14	12	14	14	10	14	14	10	14	14	8	12	14	6	12	14	6	10	14
5	14	14	14	12	14	14	10	14	14	8	14	14	6	12	14	6	10	14	5	10	12
6	14	14	14	10	14	14	8	14	14	8	12	14	6	12	14	5	10	12	4	8	12
7	12	14	14	10	14	14	8	14	14	6	12	14	5	10	14	4	10	12	3	8	12
8	12	14	14	10	14	14	8	12	14	6	12	14	5	10	12	4	8	12	3	8	10
9	12	14	14	8	14	14	6	12	14	6	12	14	4	10	12	3	8	12	2	8	10
10	12	14	14	8	14	14	6	12	14	6	10	14	4	8	12	3	8	10	2	6	10
12	10	14	14	8	12	14	6	12	14	5	10	12	3	8	12	2	6	10	1	6	8
15	10	14	14	6	12	14	5	10	14	4	8	12	2	8	10	1	6	8	0	4	8
20	8	12	12	6	10	12	4	8	12	3	8	10	1	6	8	0	5	8	00	4	6
25	8	10	10	5	10	10	3	8	10	2	6	10	0	5	8	00	4	6	000	3	6
30	6	8	8	4	8	8	2	8	8	1	6	8	00	5	8	000	3	6	0000	2	5
35	6	8	8	3	8	8	1	6	8	0	6	8	000	4	6	0000	3	6		2	5
40	6	6	6	2	6	6	1	6	6	0	5	6	000	3	6	0000	2	5		1	4
45	5	6	6	2	6	6	0	6	6	00	5	6	0000	3	6		2	5		1	4
50	5	6	6	2	6	6	0	5	6	00	4	6	0000	2	5		1	4		0	3
55	4	5	5	1	5	5	00	5	5	000	4	5		2	5		1	4		0	3
60	4	4	4	1	4	4	00	4	4	000	3	4		2	4		0	3		00	2
70	3	4	4	0	4	4	000	4	4	0000	3	4		1	4		0	3		00	2
80	3	3	3	0	3	3	000	3	3	0000	2	3		0	3		00	2		000	1
90	2	2	2	00	2	2	0000	2	2		1	2		0	2		00	2		000	1
100	1	1	1	00	1	1	0000	1	1		1	1		00	1		000	1		0000	0

NOTE: Above table is based on maximum line drop of 5% or the maximum allowable current capacity of rubber insulated wire.
For 440 volts, use 230V column and 1/2 the actual distance from motor to meter.

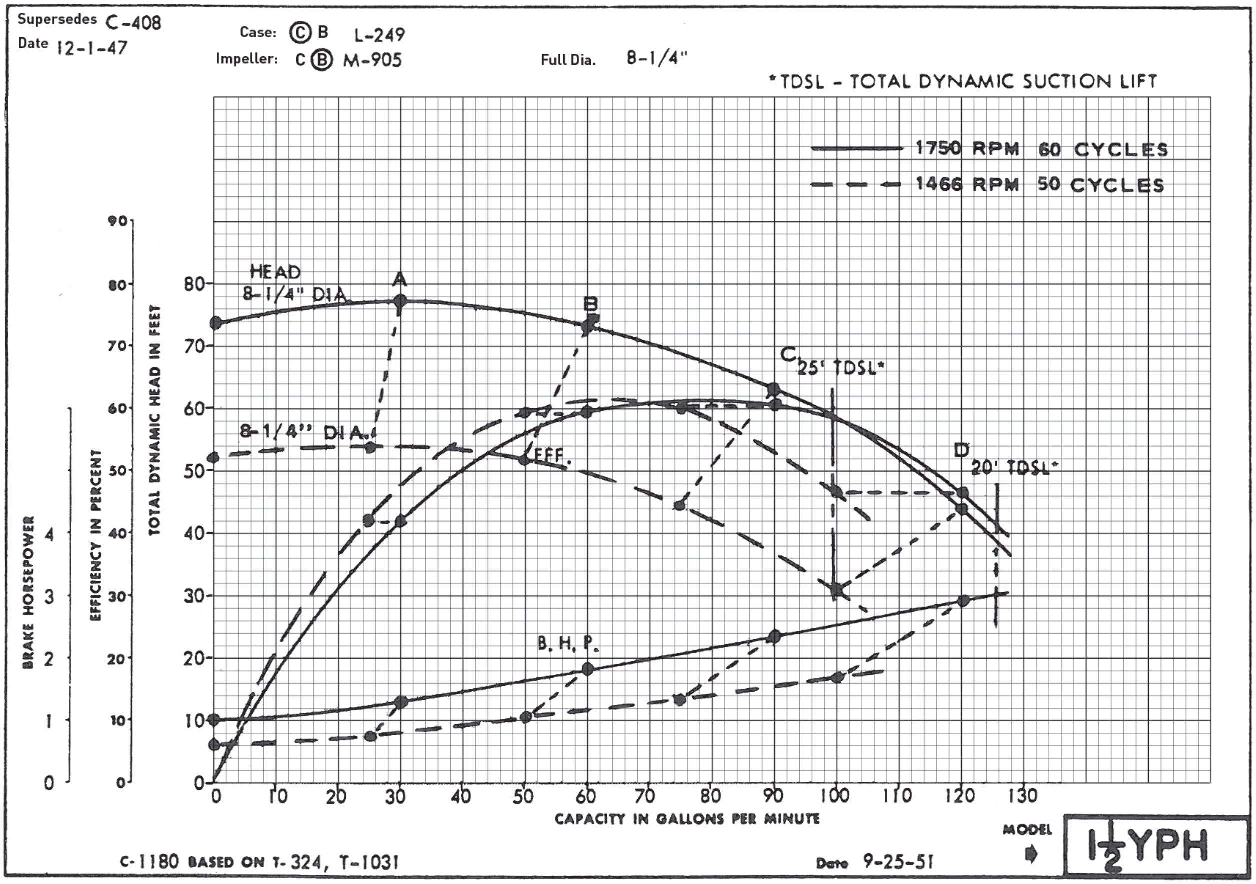


FIG. 1

ESTIMATION OF 50 CYCLE PERFORMANCE

Point	CAPACITY		HEAD		HORSEPOWER		EFFICIENCY
	FROM 60 CURVE	60 CAP X .833 = 50 CAP	FROM 60 CURVE	60 HD X .694 = 50 HD	FROM 60 CURVE	60 HP X .579 = 50 HP	$\frac{50 \text{ CAP X } 50 \text{ HD}}{3960 \text{ X } 50 \text{ HP}}$
Shut Off	0	0	74	52	1.0	.58	0
A	30	25	77	54	1.3	.76	42
B	60	50	73	51	1.8	1.04	59
C	90	75	63	44	2.3	1.35	61
D	120	100	44	31	2.9	1.68	46

FIG. 2

The above example is based on the published curves for BERKELEY Model 1½YPH which indicate a speed of 1760 RPM for 60 cycles. To estimate the performance of this pump using 50 cycle current, proceed as follows:

Step 1. Select points on the Head/Capacity curve (Fig. I) in the approximate area in which you expect to work. Label them as indicated. Pick corresponding points on the BHP and Efficiency curves directly below the above points.

Step 2. Construct a table (Fig. 2.) as shown above and insert the 60 cycle values for Capacity, Head and Horsepower.

Step 3. Calculate the new values for 50 cycles.

Step 4. Plot the new Head/Capacity and Horsepower points and draw the performance curves.

Step 5. Determine the new efficiency curve by moving the points on the 60 cycle curve horizontally to the left to the new capacity values OR calculate the corresponding efficiencies by means of the formula and plot the new Efficiency Curve.

If the area of concern is known quite closely it is frequently only necessary to select one set of points and to make the necessary calculations. Plot the new points and then draw small segments of the new performance curves parallel to the 60 cycle ones.

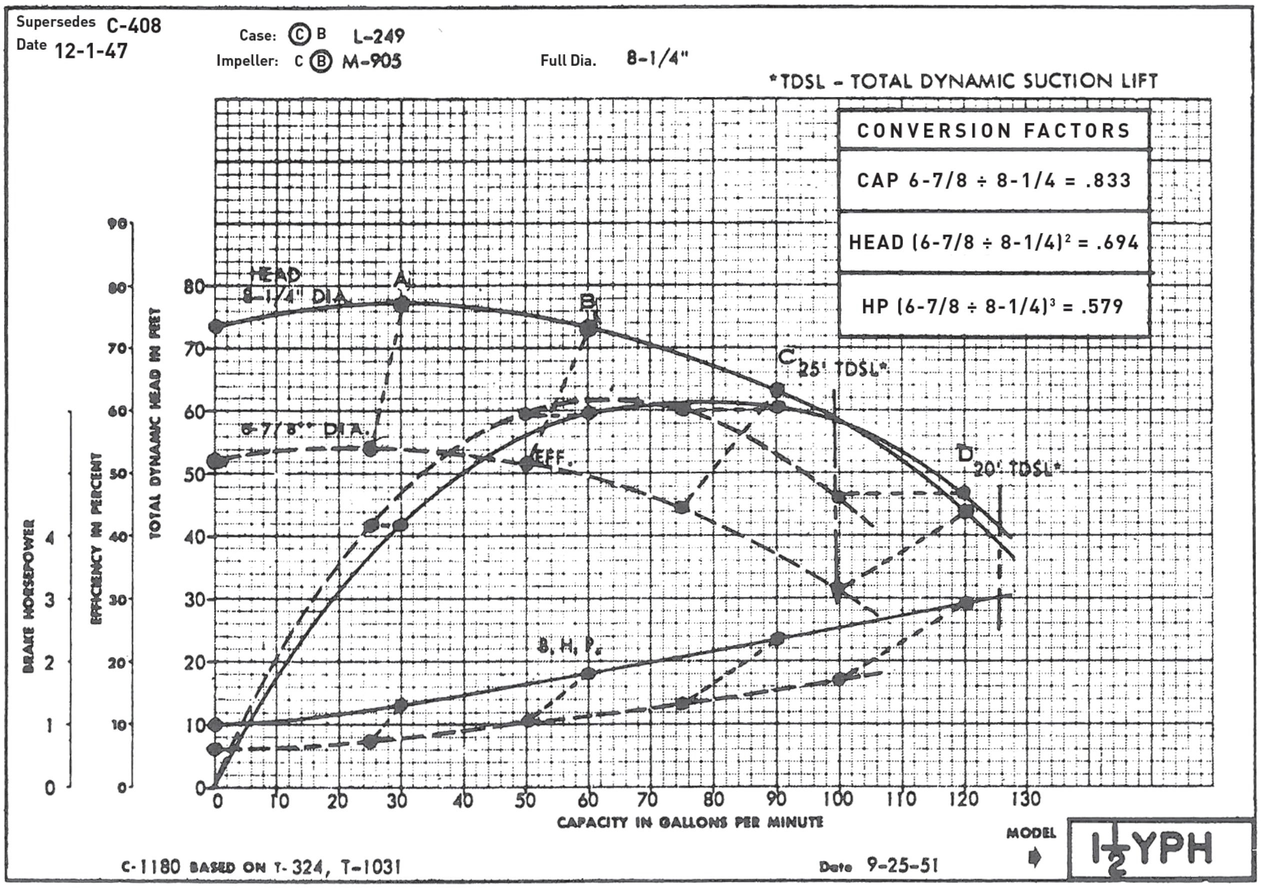


FIG. 3

ESTIMATION OF PERFORMANCE
With Trimmed Impeller

Point	CAPACITY		HEAD		HORSEPOWER		EFFICIENCY
	FROM 8¼" DIA. CURVE	8¼" CAP X .833 = 6-7/8" CAP	FROM 8¼" DIA. CURVE	8¼" HD X .694 = 6-7/8" HD	FROM 8¼" DIA. CURVE	8¼" HP X .579 = 6-7/8" HP	6-7/8" CAP X 6-7/8" HD / 3960 X 6-7/8" HP
Shut Off	0	0	74	52	1.0	.58	0
A	30	25	77	54	1.3	.76	42
B	60	50	73	51	1.8	1.04	59
C	90	75	63	44	2.3	1.35	61
D	120	100	44	31	2.9	1.68	46

FIG. 4

The above example is based on the published curves for BERKELEY Model 1½ YPH (1760 RPM) which indicates an impeller diameter of 8¼". To estimate the performance of this pump using an impeller of 6 7/8" diameter proceed as follows:

Step 1. Select points on the Head/Capacity curve (Fig. 3) in the approximate area in which you expect to work. Label them as indicated. Pick corresponding points on the Horsepower and Efficiency curves directly below the above points.

Step 2. Construct a table (Fig. 4) as shown above and insert the 8¼" diameter values for Capacity, Head and Horsepower.

Step 3. Calculate the new values for 6 7/8" diameter.

Step 4. Plot the new Head/Capacity and Horsepower points and draw the performance curves.

Step 5. Determine the new efficiency curve by moving the points on the 8¼" diameter curve horizontally to the left to the new capacity values OR calculate the corresponding efficiencies by means of the formula and plot the new Efficiency curve.

If the area of concern is known quite closely it is frequently only necessary to select one set of points and to make the necessary calculations. Plot the new points and then draw small segments of the new performance curves parallel to the 8¼" diameter ones.

SUCTION LIMITS - TDSL

Suction limit correction for altitude and temperature.

Several factors must be controlled for satisfactory performance of a centrifugal pump. One of these is arrival of the water at the inlet to the pump in a condition that is within the suction ability of the pump. Operation with on excessive Total Dynamic Suction Lift DEMAND (TDSL Demand) for the supply piping system will usually reduce the capacity and efficiency of the pump, and may lead to serious trouble through vibration and cavitation. To ovoid this, the TDSL DEMAND for the suction piping system may be calculated, and compared against the TDSL ABILITY of the pump, which is shown as "TDSL" on the pump performance curve.

TO CALCULATE TDSL DEMAND FOR SUCTION PIPING SYSTEM

1. Measure the vertical lift (H_E in feet) from the surface of the water source to the center line of the impeller eye.
2. Calculate the EQUIVALENT LENGTH of the suction piping system. Include pipe, fittings, strainer, etc . Refer to Table of Equivalent Lengths for Fittings (see Engineering 9020).
3. Calculate the Friction Loss (H_L in feet) at the required GPM flow rate through the equivalent length of the size and type of pipe used (see Engineering 9020).
4. Determine the Velocity Head (H_V in feet) shown in the Pipe Friction Table, at the required GPM, for the pipe size for which the pump inlet is machined. (Note: ALWAYS use the Velocity Head for the pump inlet size, even though larger pipe is used for the main run and reduced to pump inlet size at the pump.)
5. Add the three values found above:
   $H_E + H_L + H_V$ = TDSL DEMAND for the suction piping system.

TO MEASURE TDSL DEMAND FOR THE SUCTION PIPING SYSTEM FOR AN EXISTING PUMP

1. Install a vacuum gauge in the suction pipe about one pipe diameter upstream from the pump inlet opening, preferably into a piece of pipe the same size as the pump inlet.
2. Operate the pump at the required flow rate. Read the vacuum gauge.
3. Multiply the vacuum gauge reading, in inches of mercury, times 1.13, to convert to feet of water. This is the TDSL DEMAND for the suction piping system at the observed flow rate. (Note: If the vacuum gauge must be installed in a pipe that is larger than the pump inlet opening, compute the difference between the velocity heads for the different pipe sizes, and ADD the difference to the vacuum gauge reading to obtain the TDSL DEMAND.)

COMPARISON OF TDSL DEMAND AGAINST TDSL ABILITY OF PUMP

1. Obtain the TDSL at the required GPM from the pump performance curve. This is the TDSL ABILITY of the pump when pumping WATER, at 70˚F . or less, at Sea Level. For higher water temperatures, or higher altitude, find the correction in the Table below, and SUBTRACT it from the pump TDSL ABILITY.
2. Compare the TDSL DEMAND (either calculated or measured) against the corrected TDSL ABILITY.
3. If the TDSL DEMAND is LESS than the TDSL ABILITY, the suction condition is acceptable.
4. If the TDSL DEMAND is EQUAL TO or GREATER THAN the TDSL ABILITY, cavitation can be expected.

SYSTEM CORRECTIONS. If the TDSL DEMAND exceeds the adjusted TDSL ABILITY of the pump, it may be possible to reduce the TDSL DEMAND by lowering the pump to reduce the vertical lift, or by using a larger size pipe to reduce the Friction Loss . If these adjustments ore still not adequate, select a different pump with a greater TDSL ABILITY.

TOTAL DYNAMIC SUCTION LIFT (TDSL) CORRECTION FOR ALTITUDE AND TEMPERATURE EXPRESSED IN FEET OF WATER

Altitude In Feet	Temperature of Water in °F.											
	40-70	100	120	130	140	150	160	170	180	190	200	210
Sea Level	0	1.3	3.0	4.4	6.0	8.0	10.5	13.5	17.2	21.5	26.7	33.5
2000	2.4	3.7	5.4	6.8	8.4	10.4	12.9	15.9	19.6	23.9	29.1	35.9
4000	4.7	6.0	7.7	9.1	10.7	12.7	15.2	18.2	21.9	26.2	31.4	38.2
6000	6.8	8.1	9.8	11.2	12.8	14.8	17.3	20.3	24.0	28.3	33.5	40.3
8000	8.8	10.1	11.8	13.2	14.8	16.8	19.3	22.3	26.0	30.3	35.5	42.3
10000	10.5	11.8	13.5	14.9	16.5	18.5	21.0	24.0	27.7	32.0	37.2	44.0

METER TYPES

Table for determining horsepower demand from RPM of watthour meter disc.

MAKE		Single Element (2 and 3 W 1 Ph.)				Two Element (3 and 4 W△, 3 Ph.)				Three Element (4 W-Y 3 Ph.)		
General Electric			1-16,20 30,50,55 A-S		1-60 (A-S)	D-6 D-7		D-14 V-2, 3 A-S V-6 A-S	V-62-63 V-66 Series		D-15 V-4A, 7A 10A	V-65 A-S
Westinghouse		All Except DA-DS	DA-DS				OA, OB, OC CA, C5 Series	DA-DS Series		CA-3, 9 CS-3, 9		
Sangamo		HC HFA-S HFC	JA-JS	J-2 (A-S)			L-2	LC-2 Series	P-2 Series CL-100 CL-200		L-3 LC-3	PS
Duncan		MF (A-S)	MK (A-S)	MK CL-100 CL-200			MF-MG Series	MH Series			MH Series	
Basic-K_h		I/3	.6	1.0	1.2	.6	2/3	1.2	2.4	1.0	1.8	3.6
Volts	**Amps. or Class**		**MULTIPLY VALUES BELOW BY RPM OF METER TO GET HP DEMAND**									
100 to 120	2.5	.0134	.0241	.0402	.483	.0241	.0268	.0483	.0965	.0402	.0724	.1447
	5	.0268	.0483	.0804	.0965	.0483	.0536	.0965	.1930	.0804	.1447	.2894
	12.5-15	.0670	.1206									
	15	.0804	.1448	.2413	.2895	.1448	.1609	.2895	.5791	.2413	.4341	.8683
	25	.1340	.2413									
	50	.2681	.4826				.5362	.9651	1.9303	.8040	1.4472	2.8944
	CL-100			.2413	.2895			.2895	.5791	.2413	.4341	.8683
	CL-200			.4826	.5791			.5791	1.1583	.4826	.8682	1.7364
200 to 240	2.5	.0268	.0483	.0804	.0965	.0483	.0536	.0965	.1930	.0804	.1447	.2894
	5	.0536	.0965	.1609	.1930	.0965	.1072	.1930	.3861	.1609	.2894	.5788
	12.5-15	.1340	.2413									
	15	.1609	.2895	.4826	.5791	.2895	.3217	.5791	1.1583			
	25	.2681	.4826			.4826	.5362	.9651				
	50	.5362	.9651	1.6086		.9651	1.0724	1.9303	3.8610			
	CL-100		.2895		.5791			.5791	1.1583			
	CL-200		.5791		1.1583			1.1583	2.3164			
to 480	2.5					.0965	.1072	.1930	.3861			
	5					.1930	.2145	.3861	.7721			
	15					.5791	.6434	1.1583	2.3164			
	25					.9651	1.0724	1.9300	3.8610			
	50					1.9303	2.1448	3.8610	7.7210			
	CL-100											
500 to 600	2.5					.1206	.1340	.2413				
	5					.2413	.2681	.4826				
	15					.7239	.8043	1.4477				
	25					1.2064	1.3405	2.4129				
	50					2.4129	2.6810	4.8257				

Above values represent horsepower constant of the meter. They are determined by multiplying Kh value (stamped on nameplate of meter) by 0.0804. For meters not listed above, horsepower constants can be calculated from Kh value.

EXAMPLE: G.E. Meter (two element) Type V2-A 240V
50 Amp.
Meter Disk RPM = 15
H.P. Demand = 1.9303 x 15 = 28.95 HP

COMPUTING HP FROM RPM OF WATTHOUR METER DISC

An accurate method of measuring power consumption is of general interest to the owner or operator of electrically driven equipment including pumps. The watthour meter is used to measure the power consumed. The meter is usually mounted on the power pole or wall of pump housing adjacent to the motor control equipment.

Current and/or potential transformers are required for larger units to reduce line current and voltage to the capacity of the watthour meter. When computing the horsepower consumption by this method, it is important that the horsepower consumption obtained from the watthour meter be multiplied by the ratio of both current and potential transformers to obtain the correct power consumption of the motor.

CURRENT TRANSFORMERS (C.T.s) Basic rating of all standard C.T.s used in metering is 5 amps secondary and, in general, no smaller than 200 amps primary (there are still in use C.T.s of the following ratios: 100:5 and 150:5 - these ratios are very seldom supplied on new installations). C.T.s most commonly used and in current issue are called 200, 400, 600 and 800 amp C.T.s with the 5 being understood.

POTENTIAL TRANSFORMERS (P.T.s - for metering purposes.)

100-120 volt and 200-240 volt systems do not require P.T.s.

Most 400 to 480 volt systems now metered without P.T.s. There are, however, some 400 to 480 volt systems using 4:1 P.T.'s with 120 volt meters.

Most 2300 volt systems use 20:1 P.T.s with 120 volt meters, 4000 volt WYE (or Star) - 2300 volt Delta.

7200 volt Delta or 12,000 volt WYE (or Star) use a 60:1 P.T.s.

HORSEPOWER CONSTANTS OF THE METER. All meters now installed have the K_h value stamped on the nameplate. This K_h value represents the number of watt hours passed through the meter while the disc makes one revolution . The K_h value multiplied by 60/746, or 0.0804, gives the horsepower constant of the meter. The horsepower constant of the meter multiplied by the RPM of the disc gives the horsepower input to motor.

Where K_h is not available, use the chart on Page 29 to obtain the proper horsepower constant. For example: Westinghouse 2 element meter, type DA, 480 volt, 50 ampere

Horsepower constant = 3.861

Horsepower input = 3.861 x meter disc RPM.

USE OF CURRENT AND POTENTIAL TRANSFORMERS. Where current and potential transformers are used, the horsepower constant of the meter must be multiplied by a factor M to obtain the true horsepower constant.

$$M = \frac{\text{Primary current rating of C.T.}}{\text{Secondary current rating of C.T.}} \times \frac{\text{Primary voltage rating of P.T.}}{\text{Secondary voltage rating of P.T.}}$$

Example: Assume a G.E. Meter type V-62 series, 2 element, 120 volt, 5 amp, K_h amp, =

Meter disc makes 5 revolutions in 2 min. 38 seconds (158 seconds)

$$RPM = \frac{5 \times 60}{158} = 1.9$$

Current transformer rated 200:5

Potential transformer rated 480:120

Basic horsepower constant:

(1) (from chart) 0.1930

(2) (by computation) using

$$K_h \times \frac{60}{746} = 2.4 \times .0804 = 0.1930$$

$$M = \frac{200}{5} \times \frac{480}{120} = 160$$

True horsepower constant 0.1930 X 160 = 30.88

RPM of disc = 1.9

Horsepower 30.88 X 1.9 = 58.7

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B-9020 (REV 03/21/13)