

Friction of Water (Continued)
(Based on Darcy's Formula)
Copper Tubing—"S.P.S. Copper and Brass Pipe"
10 Inch

Flow — cu ft per sec	Type K tubing		Type L tubing		Type M tubing		"Pipe"		Flow — cu ft per sec
	11.312" inside dia		10.621" inside dia		9.752" inside dia		10.020" inside dia		
	Velocity ft/sec	Head loss ft/100 ft	Velocity ft/sec	Head loss ft/100 ft	Velocity ft/sec	Head loss ft/100 ft	Velocity ft/sec	Head loss ft/100 ft	
1000	1.29	0.19	1.21	0.19	1.11	0.16	1.10	0.16	1000
1500	1.93	0.27	1.83	0.27	1.66	0.24	1.66	0.24	1500
2000	2.57	0.35	2.43	0.35	2.22	0.31	2.22	0.31	2000
2500	3.21	0.43	3.05	0.43	2.80	0.37	2.80	0.37	2500
3000	3.85	0.51	3.67	0.51	3.36	0.44	3.36	0.44	3000
3500	4.49	0.59	4.27	0.59	3.92	0.51	3.92	0.51	3500
4000	5.13	0.67	4.91	0.67	4.48	0.58	4.48	0.58	4000
4500	5.77	0.75	5.55	0.75	5.04	0.65	5.04	0.65	4500
5000	6.41	0.83	6.19	0.83	5.60	0.72	5.60	0.72	5000
5500	7.05	0.91	6.83	0.91	6.16	0.79	6.16	0.79	5500
6000	7.69	0.99	7.47	0.99	6.72	0.86	6.72	0.86	6000
6500	8.33	1.07	8.11	1.07	7.28	0.93	7.28	0.93	6500
7000	8.97	1.15	8.75	1.15	7.84	1.00	7.84	1.00	7000
7500	9.61	1.23	9.39	1.23	8.40	1.07	8.40	1.07	7500
8000	10.25	1.31	10.03	1.31	8.96	1.14	8.96	1.14	8000
8500	10.89	1.39	10.67	1.39	9.52	1.21	9.52	1.21	8500
9000	11.53	1.47	11.31	1.47	10.08	1.28	10.08	1.28	9000
9500	12.17	1.55	11.95	1.55	10.64	1.35	10.64	1.35	9500
10000	12.81	1.63	12.59	1.63	11.20	1.42	11.20	1.42	10000
10500	13.45	1.71	13.23	1.71	11.76	1.49	11.76	1.49	10500
11000	14.09	1.79	13.87	1.79	12.32	1.56	12.32	1.56	11000
11500	14.73	1.87	14.51	1.87	12.88	1.63	12.88	1.63	11500
12000	15.37	1.95	15.15	1.95	13.44	1.70	13.44	1.70	12000
12500	16.01	2.03	15.79	2.03	14.00	1.77	14.00	1.77	12500
13000	16.65	2.11	16.43	2.11	14.56	1.84	14.56	1.84	13000
13500	17.29	2.19	17.07	2.19	15.12	1.91	15.12	1.91	13500
14000	17.93	2.27	17.71	2.27	15.68	1.98	15.68	1.98	14000
14500	18.57	2.35	18.35	2.35	16.24	2.05	16.24	2.05	14500
15000	19.21	2.43	18.99	2.43	16.80	2.12	16.80	2.12	15000
15500	19.85	2.51	19.63	2.51	17.36	2.19	17.36	2.19	15500
16000	20.49	2.59	20.27	2.59	17.92	2.26	17.92	2.26	16000
16500	21.13	2.67	20.91	2.67	18.48	2.33	18.48	2.33	16500
17000	21.77	2.75	21.55	2.75	19.04	2.40	19.04	2.40	17000
17500	22.41	2.83	22.19	2.83	19.60	2.47	19.60	2.47	17500
18000	23.05	2.91	22.83	2.91	20.16	2.54	20.16	2.54	18000
18500	23.69	2.99	23.47	2.99	20.72	2.61	20.72	2.61	18500
19000	24.33	3.07	24.11	3.07	21.28	2.68	21.28	2.68	19000
19500	24.97	3.15	24.75	3.15	21.84	2.75	21.84	2.75	19500
20000	25.61	3.23	25.39	3.23	22.40	2.82	22.40	2.82	20000
20500	26.25	3.31	26.03	3.31	22.96	2.89	22.96	2.89	20500
21000	26.89	3.39	26.67	3.39	23.52	2.96	23.52	2.96	21000
21500	27.53	3.47	27.31	3.47	24.08	3.03	24.08	3.03	21500
22000	28.17	3.55	27.95	3.55	24.64	3.10	24.64	3.10	22000
22500	28.81	3.63	28.59	3.63	25.20	3.17	25.20	3.17	22500
23000	29.45	3.71	29.23	3.71	25.76	3.24	25.76	3.24	23000
23500	30.09	3.79	29.87	3.79	26.32	3.31	26.32	3.31	23500
24000	30.73	3.87	30.51	3.87	26.88	3.38	26.88	3.38	24000
24500	31.37	3.95	31.15	3.95	27.44	3.45	27.44	3.45	24500
25000	32.01	4.03	31.79	4.03	28.00	3.52	28.00	3.52	25000
25500	32.65	4.11	32.43	4.11	28.56	3.59	28.56	3.59	25500
26000	33.29	4.19	33.07	4.19	29.12	3.66	29.12	3.66	26000
26500	33.93	4.27	33.71	4.27	29.68	3.73	29.68	3.73	26500
27000	34.57	4.35	34.35	4.35	30.24	3.80	30.24	3.80	27000
27500	35.21	4.43	34.99	4.43	30.80	3.87	30.80	3.87	27500
28000	35.85	4.51	35.63	4.51	31.36	3.94	31.36	3.94	28000
28500	36.49	4.59	36.27	4.59	31.92	4.01	31.92	4.01	28500
29000	37.13	4.67	36.91	4.67	32.48	4.08	32.48	4.08	29000
29500	37.77	4.75	37.55	4.75	33.04	4.15	33.04	4.15	29500
30000	38.41	4.83	38.19	4.83	33.60	4.22	33.60	4.22	30000
30500	39.05	4.91	38.83	4.91	34.16	4.29	34.16	4.29	30500
31000	39.69	4.99	39.47	4.99	34.72	4.36	34.72	4.36	31000
31500	40.33	5.07	40.11	5.07	35.28	4.43	35.28	4.43	31500
32000	40.97	5.15	40.75	5.15	35.84	4.50	35.84	4.50	32000
32500	41.61	5.23	41.39	5.23	36.40	4.57	36.40	4.57	32500
33000	42.25	5.31	42.03	5.31	36.96	4.64	36.96	4.64	33000
33500	42.89	5.39	42.67	5.39	37.52	4.71	37.52	4.71	33500
34000	43.53	5.47	43.31	5.47	38.08	4.78	38.08	4.78	34000
34500	44.17	5.55	43.95	5.55	38.64	4.85	38.64	4.85	34500
35000	44.81	5.63	44.59	5.63	39.20	4.92	39.20	4.92	35000
35500	45.45	5.71	45.23	5.71	39.76	4.99	39.76	4.99	35500
36000	46.09	5.79	45.87	5.79	40.32	5.06	40.32	5.06	36000
36500	46.73	5.87	46.51	5.87	40.88	5.13	40.88	5.13	36500
37000	47.37	5.95	47.15	5.95	41.44	5.20	41.44	5.20	37000
37500	48.01	6.03	47.79	6.03	42.00	5.27	42.00	5.27	37500
38000	48.65	6.11	48.43	6.11	42.56	5.34	42.56	5.34	38000
38500	49.29	6.19	49.07	6.19	43.12	5.41	43.12	5.41	38500
39000	49.93	6.27	49.71	6.27	43.68	5.48	43.68	5.48	39000
39500	50.57	6.35	50.35	6.35	44.24	5.55	44.24	5.55	39500
40000	51.21	6.43	50.99	6.43	44.80	5.62	44.80	5.62	40000
40500	51.85	6.51	51.63	6.51	45.36	5.69	45.36	5.69	40500
41000	52.49	6.59	52.27	6.59	45.92	5.76	45.92	5.76	41000
41500	53.13	6.67	52.91	6.67	46.48	5.83	46.48	5.83	41500
42000	53.77	6.75	53.55	6.75	47.04	5.90	47.04	5.90	42000
42500	54.41	6.83	54.19	6.83	47.60	5.97	47.60	5.97	42500
43000	55.05	6.91	54.83	6.91	48.16	6.04	48.16	6.04	43000
43500	55.69	6.99	55.47	6.99	48.72	6.11	48.72	6.11	43500
44000	56.33	7.07	56.11	7.07	49.28	6.18	49.28	6.18	44000
44500	56.97	7.15	56.75	7.15	49.84	6.25	49.84	6.25	44500
45000	57.61	7.23	57.39	7.23	50.40	6.32	50.40	6.32	45000
45500	58.25	7.31	58.03	7.31	50.96	6.39	50.96	6.39	45500
46000	58.89	7.39	58.67	7.39	51.52	6.46	51.52	6.46	46000
46500	59.53	7.47	59.31	7.47	52.08	6.53	52.08	6.53	46500
47000	60.17	7.55	59.95	7.55	52.64	6.60	52.64	6.60	47000
47500	60.81	7.63	60.59	7.63	53.20	6.67	53.20	6.67	47500
48000	61.45	7.71	61.23	7.71	53.76	6.74	53.76	6.74	48000
48500	62.09	7.79	61.87	7.79	54.32	6.81	54.32	6.81	48500
49000	62.73	7.87	62.51	7.87	54.88	6.88	54.88	6.88	49000
49500	63.37	7.95	63.15	7.95	55.44	6.95	55.44	6.95	49500
50000	64.01	8.03	63.79	8.03	56.00	7.02	56.00	7.02	50000

Note: The allowance has been made for age, difference in diameter, or any abnormal condition of interior surface. Any factor of safety must be estimated from the local conditions and the requirements of each particular installation. It is recommended that for most commercial design purposes a safety factor of 1.5 to 2.0% be added to the values in the tables—see page 2-5.

Friction of Water (Continued)
(Based on Darcy's Formula)
Copper Tubing—"S.P.S. Copper and Brass Pipe"
12 Inch

Flow — cu ft per sec	Type K tubing		Type L tubing		Type M tubing		"Pipe"		Flow — cu ft per sec
	11.312" inside dia		10.621" inside dia		9.752" inside dia		10.020" inside dia		
	velocity ft/sec	Head loss ft/100 ft	velocity ft/sec	Head loss ft/100 ft	velocity ft/sec	Head loss ft/100 ft	velocity ft/sec	Head loss ft/100 ft	
1000	1.29	0.17	1.21	0.16	1.11	0.15	1.10	0.15	1000
1500	1.93	0.25	1.83	0.24	1.66	0.22	1.66	0.22	1500
2000	2.57	0.33	2.43	0.32	2.22	0.29	2.22	0.29	2000
2500	3.21	0.41	3.05	0.40	2.80	0.36	2.80	0.36	2500
3000	3.85	0.49	3.67	0.48	3.36	0.43	3.36	0.43	3000
3500	4.49	0.57	4.27	0.56	3.92	0.50	3.92	0.50	3500
4000	5.13	0.65	4.91	0.64	4.48	0.57	4.48	0.57	4000
4500	5.77	0.73	5.55	0.72	5.04	0.64	5.04	0.64	4500
5000	6.41	0.81	6.19	0.80	5.60	0.71	5.60	0.71	5000
5500	7.05	0.89	6.83	0.88	6.16	0.78	6.16	0.78	5500
6000	7.69	0.97	7.47	0.96	6.72	0.85	6.72	0.85	6000
6500	8.33	1.05	8.11	1.04	7.28	0.92	7.28	0.92	6500
7000	8.97	1.1	8.75	1.09	7.84	0.99	7.84	0.99	7000
7500	9.61	1.18	9.39	1.17	8.40	1.06	8.40	1.06	7500
8000	10.25	1.26	10.03	1.25	8.96	1.13	8.96	1.13	8000
8500	10.89	1.34	10.67	1.33	9.52	1.2	9.52	1.2	8500
9000	11.53	1.42	11.31	1.41	10.08	1.27	10.08	1.27	9000
9500	12.17	1.5	11.95	1.49	10.64	1.34	10.64	1.34	9500
10000	12.81	1.58	12.59	1.57	11.20	1.41	11.20	1.41	10000
10500	13.45	1.66	13.23	1.65	11.76	1.48	11.76	1.48	10500
11000	14.09	1.74	13.87	1.73	12.32	1.55	12.32	1.55	11000
11500	14.73	1.82	14.51	1.81	12.88	1.62	12.88	1.62	11500
12000	15.37	1.9	15.15	1.89	13.44	1.69	13.44	1.69	12000
12500	16.01	1.98	15.79	1.97	14.00	1.76	14.00	1.76	12500
13000	16.65	2.06	16.43	2.05	14.56	1.83	14.56	1.83	13000
13500	17.29	2.14	17.07	2.13	15.12	1.9	15.12	1.9	13500
14000	17.93	2.22	17.71	2.21	15.68	1.97	15.68	1.97	14000
14500	18.57	2.3	18.35	2.29	16.24	2.04	16.24	2.04	14500
15000	19.21	2.38	18.99	2.37	16.80	2.11	16.80	2.11	15000
15500	19.85	2.46	19.63	2.45	17.36	2.18	17.36	2.18	15500
16000	20.49	2.54	20.27	2.53	17.92	2.25	17.92	2.25	16000
16500	21.13	2.62	20.91	2.61	18.48	2.32	18.48	2.32	16500
17000	21.77	2.7	21.55	2.69	19.04	2.39	19.04	2.39	17000
17500	22.41	2.78	22.19	2.77	19.60	2.46	19.60	2.46	17500
18000	23.05	2.86	22.83	2.85	20.16	2.53	20.16	2.53	18000
18500	23.69	2.94	23.47	2.93	20.72	2.6	20.72	2.6	18500
19000	24.33	3.02	24.11	3.01	21.28	2.67	21.28	2.67	19000
19500	24.97	3.1	24.75	3.09	21.84	2.74	21.84	2.74	19500
20000	25.61	3.18	25.39	3.17	22.40	2.81	22.40	2.81	20000
20500	26.25	3.26	26.03	3.25	22.96	2.88	22.96	2.88	20500
21000	26.89	3.34	26.67	3.33	23.52	2.95	23.52	2.95	21000
21500	27.53	3.42	27.31	3.41	24.08	3.02	24.08	3.02	21500
22000	28.17	3.5	27.95	3.49	24.64	3.09	24.64	3.09	22000
22500	28.81	3.58	28.59	3.57	25.20	3.16	25.20	3.16	22500
23000	29.45	3.66	29.23	3.65	25.76	3.23	25.76	3.23	23000
23500	30.09	3.74	29.87	3.73	26.32	3.3	26.32	3.3	23500
24000	30.73	3.82	30.51	3.81	26.88	3.37	26.88	3.37	24000
24500	31.37	3.9	31.15	3.89	27.44	3.44	27.44	3.44	24500
25000	32.01	3.98	31.79	3.97	28.00	3.51	28.00	3.51	25000
25500	32.65	4.06	32.43	4.05	28.56	3.58	28.56	3.58	25500
26000	33.29	4.14	33.07	4.13	29.12	3.65	29.12	3.65	26000
26500	33.93	4.22	33.71	4.21	29.68	3.72	29.68	3.72	26500
27000	34.57	4.3	34.35	4.29	30.24	3.79	30.24	3.79	27000
27500	35.21	4.38	34.99	4.37	30.80	3.86	30.80	3.86	27500
28000	35.85	4.46	35.63	4.45	31.36	3.93	31.36	3.93	28000
28500	36.49	4.54	36.27	4.53	31.92	4.0	31.92	4.0	28500
29000	37.13	4.62	36.91	4.61	32.48	4.07	32.48	4.07	29000
29500	37.77	4.7	37.55	4.69	33.04	4.14	33.04	4.14	29500
30000	38.41	4.78	38.19	4.77	33.60	4.21	33.60	4.21	30000
30500	39.05	4.86	38.83	4.85	34.16	4.28	34.16	4.28	30500
31000	39.69	4.94	39.47	4.93	34.72	4.35	34.72	4.35	31000
31500	40.33	5.02	40.11	5.01	35.28	4.42	35.28	4.42	31500
32000	40.97	5.1	40.75	5.09	35.84	4.49	35.84	4.49	32000
32500	41.61	5.18	41.39	5.17	36.40	4.56	36.40	4.56	32500
33000	42.25	5.26	42.03	5.25	36.96	4.63	36.96	4.63	33000
33500	42.89	5.34	42.67	5.33	37.52	4.7	37.52	4.7	33500
34000	43.53	5.42	43.31	5.41	38.08	4.77	38.08	4.77	34000
34500	44.17	5.5	43.95	5.49	38.64	4.84	38.64	4.84	34500
35000	44.81	5.58	44.59	5.57	39.20	4.91	39.20	4.91	35000
35500	45.45	5.66	45.23	5.65	39.76	4.98	39.76	4.98	35500
36000	46.09	5.74	45.87	5.73	40.32	5.05	40.32	5.05	36000
36500	46.73	5.82	46.51	5.81	40.88	5.12	40.88	5.12	36500
37000	47.37	5.9	47.15	5.89	41.44	5.19	41.44	5.19	37000
37500	48.01	5.98	47.79	5.97	42.00	5.26	42.00	5.26	37500
38000	48.65	6.06	48.43	6.05	42.56	5.33	42.56	5.33	38000
38500	49.29	6.14	49.07	6.13	43.12	5.4	43.12	5.4	38500
39000	49.93	6.22	49.71	6.21	43.68	5.47	43.68	5.47	39000
39500	50.57	6.3	50.35	6.29	44.24	5.54	44.24	5.54	39500
40000	51.21	6.38	50.99	6.37	44.80	5.61	44.80	5.61	40000
40500	51.85	6.46	51.63	6.45	45.36	5.68	45.36	5.68	40500
41000	52.49	6.54	52.27	6.53	45.92	5.75	45.92	5.75	41000
41500	53.13	6.62	52.91	6.61	46.48	5.82	46.48	5.82	41500
42000	53.77	6.7	53.55	6.69	47.04	5.89	47.04	5.89	42000
42500	54.41	6.78	54.19	6.77	47.60	5.96	47.60	5.96	42500
43000	55.05	6.86	54.83	6.85	48.16	6.03	48.16	6.03	43000
43500	55.69	6.94	55.47	6.93	48.72	6.1	48.72	6.1	43500
44000	56.33	7.02	56.11	7.01	49.28	6.17	49.28	6.17	44000
44500	56.97	7.1	56.75	7.09	49.84	6.24	49.84	6.24	44500
45000	57.61	7.18	57.39	7.17	50.40	6.31	50.40	6.31	45000
45500	58.25	7.26	58.03	7.25	50.96	6.38	50.96	6.38	45500
46000	58.89	7.34	58.67	7.33	51.52	6.45	51.52	6.45	46000
46500	59.53	7.42	59.31	7.41	52.08	6.52	52.08	6.52	46500
47000	60.17	7.5	59.95	7.49	52.64	6.59	52.64	6.59	47000
47500	60.81	7.58	60.59	7.57	53.20	6.66	53.20	6.66	47500
48000	61.45	7.66	61.23	7.65	53.76	6.73	53.76	6.73	48000
48500	62.09	7.74	61.87	7.73	54.32	6.8	54.32	6.8	48500
49000	62.73	7.82	62.51	7.81	54.88	6.87	54.88	6.87	49000
49500	63.37	7.9	63.15	7.89	55.44	6.94	55.44	6.94	49500
50000	64.01	7.98	63.79	7.97	56.00	7.01	56.00	7.01	50000
50500	64.65	8.06	64.43	8.05	56.56	7.08	56.56	7.08	50500
51000	65.29	8.14	65.07	8.13	57.12	7.15	57.12	7.15	51000
51500	65.93	8.22	65.71	8.21	57.68	7.22	57.68	7.22	51500
52000	66.57	8.3	66.35	8.29	58.24	7.29	58.24	7.29	52000
52500	67.21	8.38	66.99	8.37	58.80	7.36	58.80	7.36	52500
53000	67.85	8.46	67.63	8.45	59.36	7.43	59.36	7.43	53000
53500	68.49	8.54	68.27	8.53	59.92	7.5	59.92	7.5	53500
54000	69.13	8.62	68.91	8.61	60.48	7.57	60.48	7.57	54000
54500	69.77	8.7	69.55	8.69	61.04	7.64	61.04	7.64	54500
55000	70.41	8.78	70.19	8.77	61.60	7.71	61.60	7.71	55000
55500	71.05	8.86	70.83	8.85	62.16	7.78	62.16	7.78	55500
56000	71.69	8.94	71.47	8.93	62.72	7.85	62.72	7.85	56000
56500	72.33	9.02	72.11	9.01	63.28	7.92	63.28	7.92	56500
57000	72.97	9.1	72.75	9.09	63.84	7.99	63.84	7.99	57000
57500	73.61	9.18	73.39	9.17	64.40	8.06	64.40	8.06	57500
58000	74.25	9.26	74.03	9.25	64.96	8.13	64.96	8.13	58000
58500	74.89	9.34	74.67	9.33	65.52	8.2	65.52	8.2	58500
59000	75.53	9.42	75.31	9.41	66.08	8.27	66.08	8.27	59000
59500	76.17	9.5	75.95	9.49	66.64	8.34	66.64	8.34	59500
60000	76.81	9.58	76.59	9.57	67.20	8.41	67.20	8.41	60000
60500	77.45	9.66	77.23	9.65	67.76	8.48	67.76	8.48	60500
61000	78.09	9.74	77.87	9.73	68.32	8.55	68.32	8.55	61000
61500	78.73	9.82	78.51	9.81	68.88	8.62	68.88	8.62	61500
62000	79.37	9.9	79.15	9.89					

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