4715.3700 DETERMINATION OF PEAK DEMAND.

Subpart 1. **Estimating water supply demand.** In determining the size of water supply distribution piping, the maximum momentary volume rate of flow of water shall first be determined. This is the supply demand which is based on the numbers and kinds of fixtures installed, on the rates of flow required by the different kinds of fixtures, and on the probable simultaneous operation of the various fixtures. The total daily requirements do not enter into this determination. In computing supply demand, use shall be made of subpart 2.

Subp. 2. **Supply fixture unit values for various plumbing fixtures.**

Fixture of group[1]	Type of supply control	Supply fixture unit values		
		Hot	Cold	Total[2]
Bathroom group	Flush valve	3	6	8
Bathroom group	Flush tank	3	4.5	6
Bathtub	Faucet	1.5	1.5	2
Combination fixture	Faucet	2	2	3
Kitchen sink	Faucet	1.5	1.5	2
Laundry tray	Faucet	2	2	3
Lavatory	Faucet	1.5	1.5	2
Pedestal urinal	Flush valve		10	10
Restaurant sink	Faucet	3	3	4
Service sink	Faucet	1.5	1.5	2
Shower head	Mixing valve	3	3	4
Stall or wall urinal	Flush valve		5	5
Stall or wall urinal	Flush tank		3	3
Water closet	Flush valve		10	10
Water closet	Flush tank		5	5

[1]For fixtures not listed, factors may be assumed by comparing the fixture to a listed one using water in similar quantities and at similar rates.

[2]For fixtures with both hot and cold water supplies, the weights for maximum separate demands may be taken as three-fourths of the total supply fixture unit value.

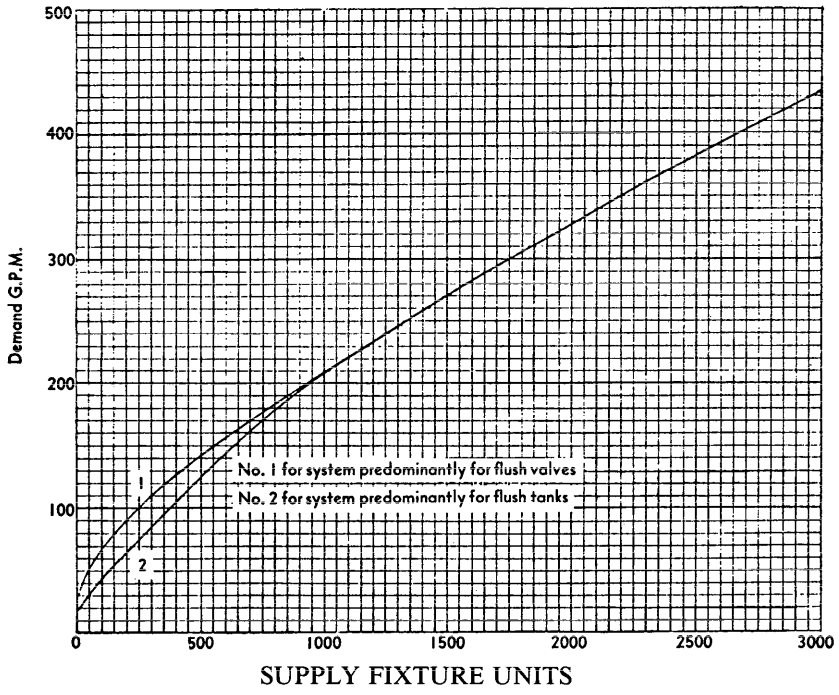
Subp. 3. **Calculation of demand.** When the water supply fixture units are used to estimate the supply demand, the supply fixture unit values as given in subpart 2 shall be used in conjunction with subpart 4.

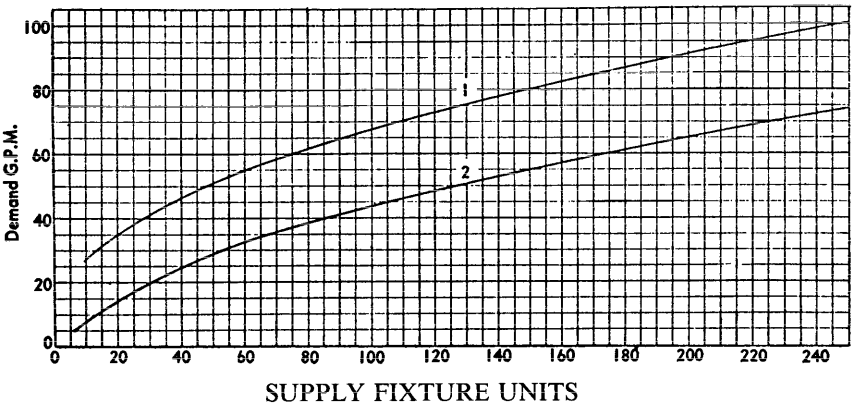
Subp. 4. **Supply demand for various loads in supply fixture units.**

Load	Supply demand	
	Flush valve water closets predominate (subpart 5, curve 1)	Tank water closets predominate (subpart 5, curve 2)
Supply fixture units:	gpm	gpm
5	22	4
10	27	8
20	35	14
30	42	20
40	46	24
50	51	28
60	54	32
88	64	40
124	74	48
160	81	56
226	98	72
300	108	85
400	127	106
470	135	118
500	143	124
600	157	143
660	162	152
700	170	161
800	183	178
850	189	185
900	197	195
1,000	208	208
1,060	216	216
1,280	243	243

1,510	270	270
1,990	324	324
2,480	378	378
2,990	432	432

Subp. 5. **Graph of supply demand for various loads in supply fixture units.**





The estimated demand load in gallons per minute for fixtures used intermittently on any water supply pipe shall be obtained by multiplying the total number of each kind of fixture, supplied through that pipe by its supply fixture unit value from subpart 2, adding the products, and then, referring to the appropriate columns of subpart 4, or using subpart 5, select the demand in GPM. Examples are given below. The additional load of any continuously flowing outlets such as hose outlets shall be computed separately and added to the total demand of intermittently used fixtures. See subpart 6.

Subp. 6. **Example.** Assume a water line serving a public washroom in which are three flushometer pedestal urinals, six flushometer closets and six lavatories with hot and cold water. First prepare a tabulation as shown.

Name of plumbing fixture	Number on system (or section)[1]	Supply fixture unit value per fixture (Subpart 2)			Total supply fixture units		
		Hot	Cold	Total	Hot	Cold	Total
Pedestal Urinal, Flush Valve	3		10	10		30	30
Flushometer Closet	6		10	10		60	60
Lavatory	6	1.5	1.5	2	9	9	12
Total					9	99	102
Supply demand in GPM					7	67	68

[1]See subpart 8.

Referring to subpart 2 for these fixtures, it is found that the total demand in supply fixture units for hot was 9 s.f.u., for cold was 99 s.f.u., and for a total demand of 102 s.f.u. By using subpart 5 curve number 2 it is determined that the supply demand in GPM for hot water is 7 and by using the same figure but curve 1 it is determined that the demand for cold water in GPM is 67 and the total demand in GPM is 68. This breakdown is used in order to size the hot water supply branch, the cold water supply branch and the building service line.

Subp. 7. **Example.** Assume an apartment building (private type occupancy) having 200 bathroom groups with flushometer closets and 200 kitchen sinks. The apartment lawn has installed in it a sprinkler system operating from (7) sill cocks. What is the demand flow for which the water service to the apartment must be designed? The intermittent use fixtures are figured as in subpart 6 to have a demand of 326 GPM.

Name of fixture	Number on system	Supply fixture unit value per fixture (Subpart 2)			Total supply fixture units		
		Hot	Cold	Total	Hot	Cold	Total
Bathroom group	300	3	6	8	600	1,200	1,600
Kitchen sink	200	1.5	1.5	2	300	300	400

Total	900	1,500	2,000
Demand in GPM (Subpart 4)	208	270	326

The lawn sprinkler system outlets have a demand of 5 GPM each, part 4715.1770. The total sprinkler system demand is, therefore, 35 GPM. This is added to the total demand (326) of the intermittently used fixtures making a total water demand of 361 GPM. This total figure would then be used to determine the size of the building service pipe. The 35 GPM demand figure would also be added to the cold water demand figure of 270 giving total cold water demand of 305 GPM and this figure would be used in sizing the cold water distribution piping.

Subp. 8. **Selection of pipe size.** Pipe sizes may be selected according to the following water pipe sizing procedure except that in no case shall a pipe size be less than shown in part 4715.1730, subpart 2, nor in the case of water service lines, less than specified in part 4715.1710.

The water pipe sizing procedure is based on a system of pressure requirements and losses, the sum of which must not exceed the minimum pressure available at the street main or other source of supply. These pressures are expressed as follows:

A. Pressure required at fixture to produce adequate flow – See part 4715.1770.

B. Static Pressure loss – This is computed at 0.43 psi per ft of pipe rise or drop and is added or subtracted respectively.

C. Loss through water meter – Pressure or friction losses for various size meters are shown in subpart 9 or 10.

D. Loss through taps in water main – Losses for various size taps are shown in subpart 12.

E. Losses through special devices such as filters, water softeners, backflow preventers, etc. – These must be obtained from the manufacturer, or estimated and added to the total.

F. Loss through fittings and valves – Losses for these devices are computed by converting the fittings or valves to equivalent straight sections of pipe and adding this length to the total for the pipe section being considered. Subpart 11 shows equivalent lengths of pipe for fittings and valves.

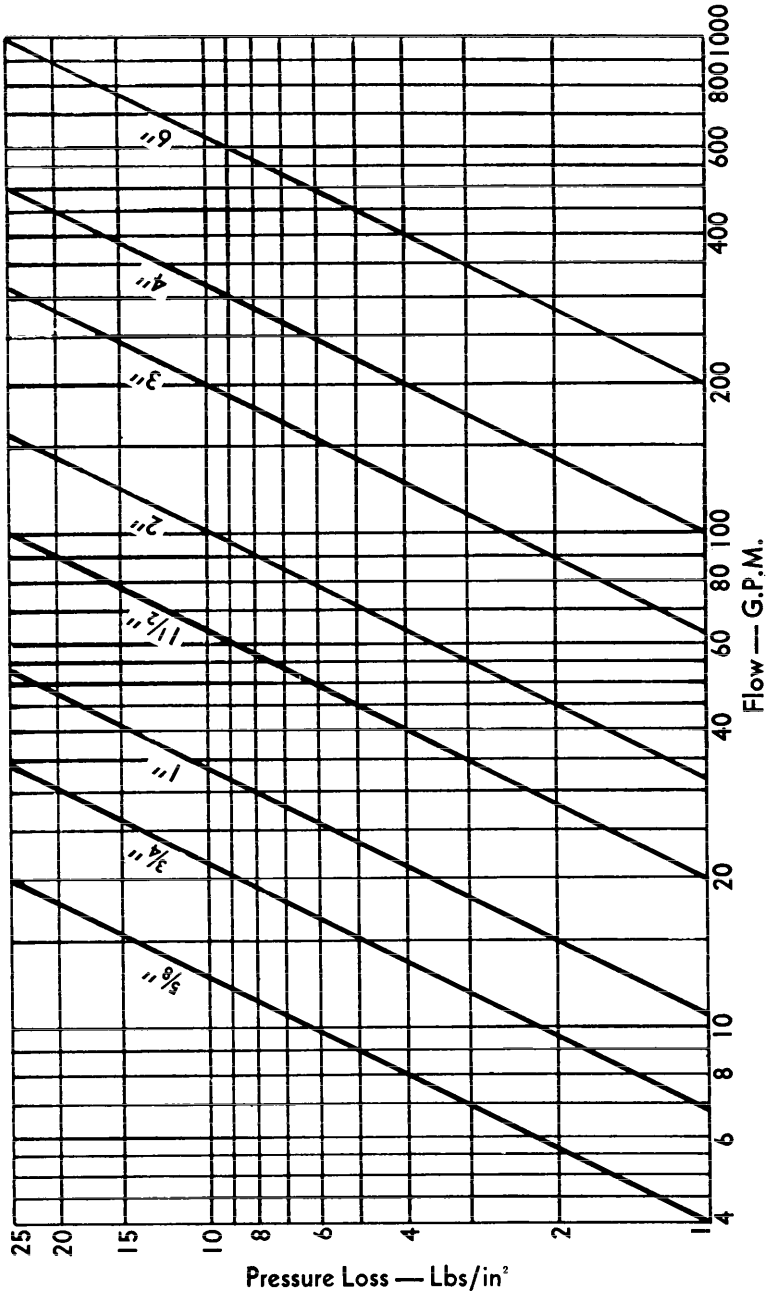
G. Loss due to pipe friction – This loss may be readily computed when the pipe size, its length and the flow through the pipe are known. When these three factors are known the friction loss can be determined from either the tables in subparts 13 and 19 or the figures in subparts 14, 16, 18, and 20. The table and the figure used depends on the type of pipe used. An example of this sizing procedure is given in subpart 21.

Subp. 9. **Loss of pressure through disk-type meters in pounds per square inch.**

	Size of meter							
Gallons per minute	5/8"	3/4"	1"	1-1/2"	2"	3"	4"	6"
4	1.0							
5	1.6							
6	2.2							
7	3.0	1.1						
8	4.0	1.4						
9	5.0	1.7						
10	6.1	2.1						
15	14	5.0	2.0					
20		8.8	3.5	1.0				
30		19	8.0	2.3				
40			14	4.0	1.6			
50			22	6.2	2.4			
60				9.0	3.6			
70				12	4.9	1.3		
80				16	6.2	1.7		
90				20	8.0	2.0		
100					10	2.5	1.0	
120					14	3.7	1.3	
140					20	5.1	2.0	
160						6.2	2.4	
180						8.1	3.3	
200						10	4.0	1.0
250						16	6.1	1.7
300						23	9.0	2.3
350							13.0	3.0
400							16.0	4.0

500	25.0	6.1
600		9.0
700		13
800		16
900		20

Subp. 10. **Graph of loss of pressure through disk-type meters in pounds per square inch.**



Subp. 11. **Allowance in equivalent length of pipe for friction loss in valves and threaded fittings.**

Diameter of fitting, inches	90° std. ell, feet	45° std. ell, feet	90° side tee, feet	Coupling or straight run of tee, feet	Gate valve, feet	Globe valve, feet	Angle valve, feet
3/8	1	0.6	1.5	0.3	0.2	8	4
1/2	2	1.2	3	0.6	0.4	15	8
3/4	2.5	1.5	4	0.8	0.5	20	12
1	3	1.8	5	0.9	0.6	25	15
1-1/4	4	2.4	6	1.2	0.8	35	18
1-1/2	5	3	7	1.5	1.0	45	22
2	7	4	10	2	1.3	55	28
2-1/2	8	5	12	2.5	1.6	65	34
3	10	6	15	3	2	80	40
3-1/2	12	7	18	3.6	2.4	100	50
4	14	8	21	4.0	2.7	125	55
5	17	10	25	5	3.3	140	70
6	20	12	30	6	4	165	80

Subp. 12. **Loss of pressure through taps and tees in pounds per square inch.**

Gallons per minute	Size of tap or tee						
	5/8 in.	3/4 in.	1 in.	1-1/4 in.	1 in.	2 in.	3 in.
10	1.35	0.64	0.18	0.08			
20	5.38	2.54	0.77	0.31	0.14		
30	12.1	5.72	1.62	0.69	0.33	0.10	
40		10.2	3.07	1.23	0.58	0.18	
50		15.9	4.49	1.92	0.91	0.28	
60			6.46	2.76	1.31	0.40	
70			8.79	3.76	1.78	0.55	0.10
80			11.5	4.90	2.32	0.72	0.13

90	14.5	6.21	2.94	0.91	0.16
100	17.94	7.67	3.63	1.12	0.21
120	25.8	11.0	5.23	1.61	0.30
140	35.2	15.0	7.12	2.20	0.41
150		17.2	8.16	2.52	0.47
160		19.6	9.30	2.92	0.54
180		24.8	11.8	3.62	0.68
200		30.7	14.5	4.48	0.84
225		38.8	18.4	5.67	1.06
250		47.9	22.7	7.00	1.31
275			27.4	7.70	1.59
300			32.6	10.1	1.88

Subp. 13. **Pressure loss of water in pounds per square inch per 100 feet of fairly smooth pipe.**

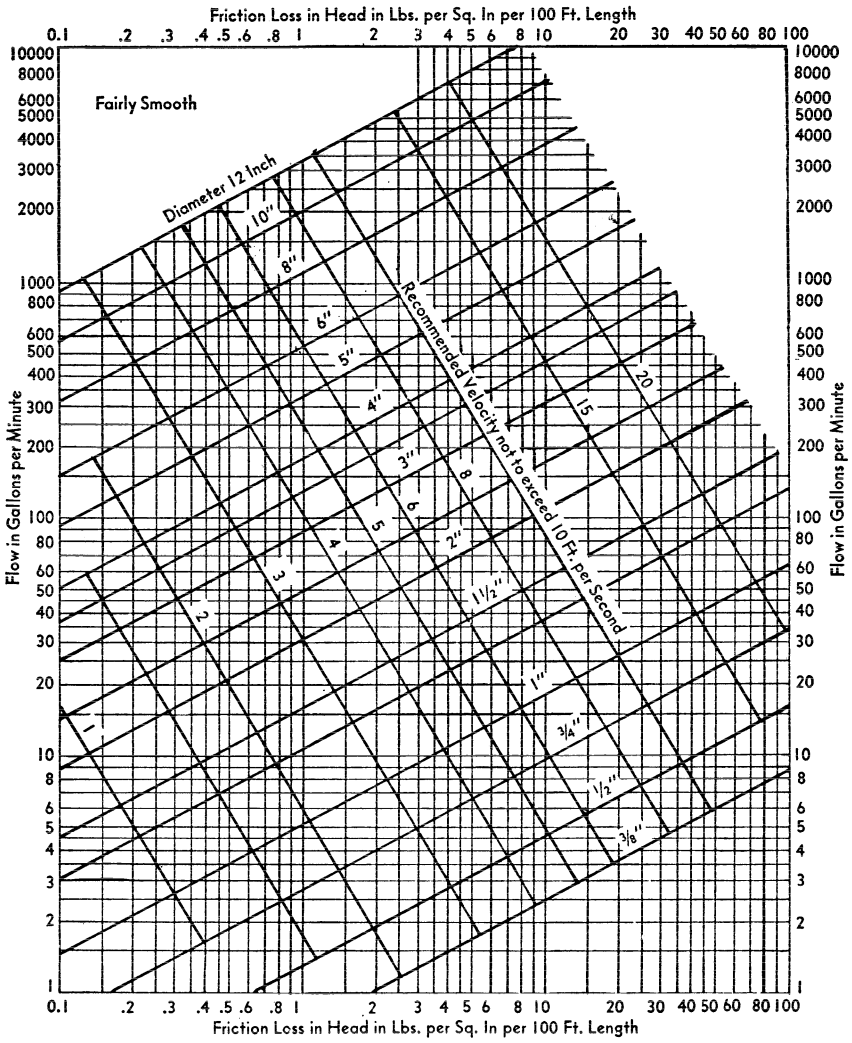
Gallons per minute	3/4"	1"	1-1/4"	1-1/2"	2"	2-1/2"	3"	4"	5"	6"	8"	10"	12"
1	0.16	-------	------	------	------	------	-----	-----	-----	-----	-----	-----	-----
2	0.57	0.17	------	------	------	------	-----	-----	-----	-----	-----	-----	-----
3	1.2	0.37	0.1	------	------	------	-----	-----	-----	-----	-----	-----	-----
4	2.0	0.61	0.17	------	------	------	-----	-----	-----	-----	-----	-----	-----
5	3.0	0.95	0.25	0.12	------	------	-----	-----	-----	-----	-----	-----	-----
10	11	3.5	0.9	0.43	0.13	------	-----	-----	-----	-----	-----	-----	-----
15	22	7.1	1.8	0.9	0.26	0.11	-----	-----	-----	-----	-----	-----	-----
20	[1]39	13	3.0	1.5	0.45	0.18	-----	-----	-----	-----	-----	-----	-----
25	[2]58	18	4.7	2.3	0.68	0.28	0.10	-----	-----	-----	-----	-----	-----
30	-------	[1]25	6.6	3.2	0.93	0.4	0.13	-----	-----	-----	-----	-----	-----
35	-------	[1]35	8.5	4.3	1.2	0.53	0.18	-----	-----	-----	-----	-----	-----
40	-------	[2]43	11	5.5	1.6	0.63	0.22	-----	-----	-----	-----	-----	-----
45	-------	-------	14	6.7	2.0	0.8	0.3	-----	-----	-----	-----	-----	-----
50	-------	-------	[1]17	8.1	2.4	1.0	0.35	0.1	-----	-----	-----	-----	-----
60	-------	-------	[1]23	12	3.3	1.3	0.5	0.13	-----	-----	-----	-----	-----
70	-------	-------	[2]32	[1]15	4.4	1.8	0.63	0.17	-----	-----	-----	-----	-----
80	-------	-------	------	[1]19	5.7	2.3	0.83	0.23	-----	-----	-----	-----	-----
90	-------	-------	------	[1]24	7.0	2.9	1.1	0.27	-----	-----	-----	-----	-----
100	-------	-------	------	[2]30	8.5	3.7	1.3	0.35	0.12	-----	-----	-----	-----
150	-------	-------	------	------	[1]17	7.8	2.6	0.7	0.23	-----	-----	-----	-----
200	-------	-------	------	------	[2]30	[1]13	[1]4.5	1.2	0.4	0.16	-----	-----	-----
250	-------	-------	------	------	------	[2]18	6.3	1.8	0.59	0.23	-----	-----	-----
300	-------	-------	------	------	------	------	[1]9.0	2.4	0.8	0.34	-----	-----	-----
350	-------	-------	------	------	------	------	[2]13	3.3	1.1	0.45	0.12	-----	-----
400	-------	-------	------	------	------	------	-----	[1]4.2	1.3	0.59	0.15	-----	-----
450	-------	-------	------	------	------	------	-----	[1]5.1	1.7	0.7	0.19	-----	-----

500	-------	-------	------	------	------	------	-----	[1]6.2	2.1	0.85	0.23	-----	-----
600	-------	-------	------	------	------	------	-----	[2]9.0	2.9	1.2	0.32	0.11	-----
700	-------	-------	------	------	------	------	-----	-----	[1]3.9	1.6	0.43	0.14	-----
800	-------	-------	------	------	------	------	-----	-----	[1]4.9	2.0	0.56	0.18	-----
900	-------	-------	------	------	------	------	-----	-----	-----	[1]2.5	0.69	0.23	-----
1,000	-------	-------	------	------	------	------	-----	-----	-----	[1]3.0	0.81	0.28	0.12
1,500	-------	-------	------	------	------	------	-----	-----	-----	[2]6.5	[1]1.8	0.59	0.24
2,000	-------	-------	------	------	------	------	-----	-----	-----	-----	[1]3.0	0.98	0.4
2,500	-------	-------	------	------	------	------	-----	-----	-----	-----	[2]4.5	[1]1.5	0.61
3,000	-------	-------	------	------	------	------	-----	-----	-----	-----	-----	[1]3.0	0.89

[1]Velocity at or exceeding 10 fps.

[2]Velocity exceeds 15 fps.

Subp. 14. **Graph of pressure loss of water in pounds per square inch per 100 feet of fairly smooth pipe.**



Subp. 15. **Pressure loss of water in pounds per square inch per 100 feet of fairly rough pipe.**

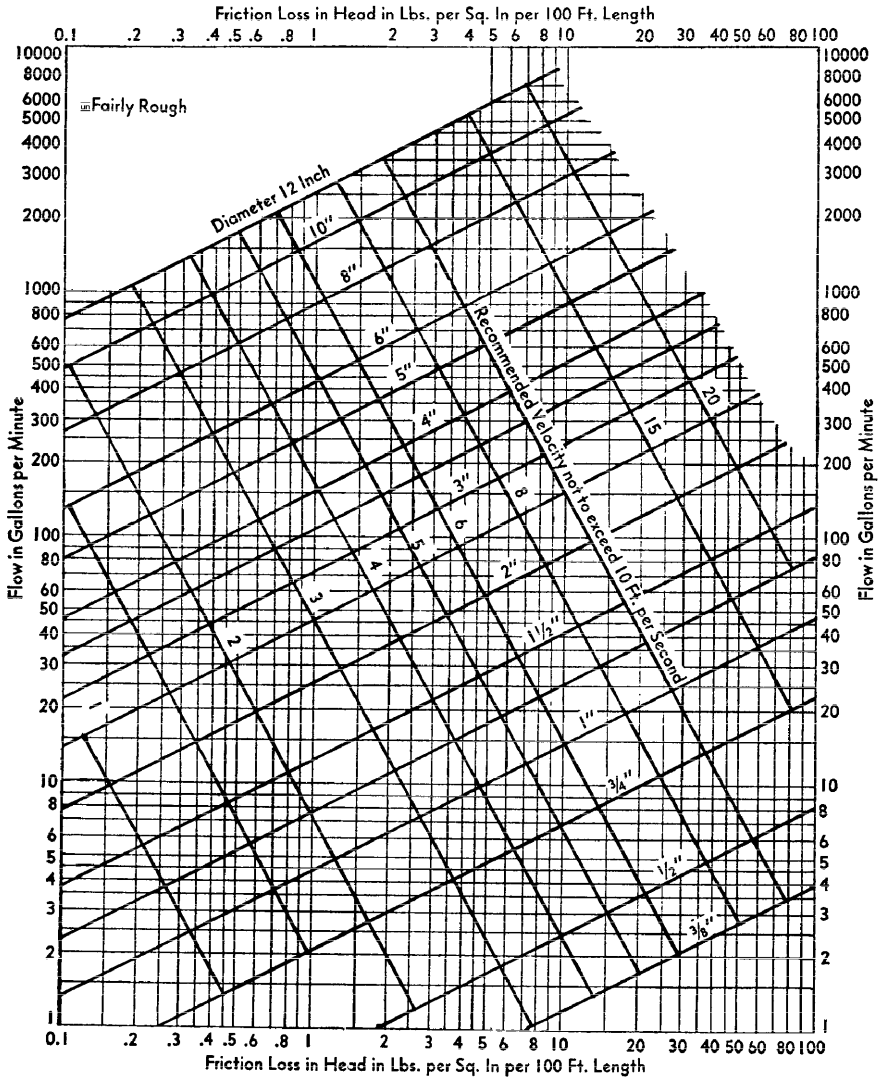
Gallons per minute	3/4"	1"	1-1/4"	1-1/2"	2"	2-1/2"	3"	4"	5"	6"	8"	10"	12"
1	0.26	-------	------	------	------	------	-----	-----	-----	-----	-----	-----	-----
2	0.91	0.22	------	------	------	------	-----	-----	-----	-----	-----	-----	-----
3	2.0	0.47	0.17	------	------	------	-----	-----	-----	-----	-----	-----	-----
4	3.3	0.82	0.30	0.12	------	------	-----	-----	-----	-----	-----	-----	-----
5	5.2	1.3	0.45	0.18	------	------	-----	-----	-----	-----	-----	-----	-----
10	20	4.9	1.7	0.67	0.17	------	-----	-----	-----	-----	-----	-----	-----
15	[1]43	12	3.7	1.4	0.36	0.12	-----	-----	-----	-----	-----	-----	-----

20	[2]80	18	6.2	2.5	0.62	0.20	-----	-----	-----	-----	-----	-----	-----
25	-------	[1]29	9.9	3.9	0.97	0.31	0.13	-----	-----	-----	-----	-----	-----
30	-------	[1]42	14	5.6	1.3	0.45	0.18	-----	-----	-----	-----	-----	-----
35	-------	[1]55	18	7.3	1.8	0.60	0.25	-----	-----	-----	-----	-----	-----
40	-------	[2]70	[1]24	9.3	2.3	0.75	0.32	-----	-----	-----	-----	-----	-----
45	-------	-------	[1]30	12	3.0	0.96	0.42	-----	-----	-----	-----	-----	-----
50	-------	-------	[1]37	15	3.7	1.2	0.51	0.12	-----	-----	-----	-----	-----
60	-------	-------	[2]52	[1]21	5.2	1.7	0.70	0.17	-----	-----	-----	-----	-----
70	-------	-------	------	[1]28	7.0	2.2	0.92	0.22	-----	-----	-----	-----	-----
80	-------	-------	------	[1]37	9.0	2.9	1.3	0.29	0.10	-----	-----	-----	-----
90	-------	-------	------	[2]45	12	3.7	1.5	0.36	0.12	-----	-----	-----	-----
100	-------	-------	------	------	[1]14	4.6	1.8	0.44	0.16	-----	-----	-----	-----
150	-------	-------	------	------	[2]30	10	4.2	1.0	0.34	0.13	-----	-----	-----
200	-------	-------	------	------	------	[1]17	7.0	1.7	0.59	0.23	-----	-----	-----
250	-------	-------	------	------	------	[2]26	[1]11	2.6	0.90	0.35	-----	-----	-----
300	-------	-------	------	------	------	------	[1]15	3.6	1.3	0.50	0.12	-----	-----
350	-------	-------	------	------	------	------	[2]21	4.9	1.7	0.69	0.17	-----	-----
400	-------	-------	------	------	------	------	-----	[1]6.1	2.2	0.88	0.22	-----	-----
450	-------	-------	------	------	------	------	-----	[1]7.6	2.7	1.1	0.27	-----	-----
500	-------	-------	------	------	------	------	-----	[1]9.4	3.3	1.3	0.33	0.11	-----
600	-------	-------	------	------	------	------	-----	[2]13	[1]4.9	1.8	0.46	0.15	-----
700	-------	-------	------	------	------	------	-----	-----	[1]6.2	2.5	0.61	0.20	-----
800	-------	-------	------	------	------	------	-----	-----	[1]8.1	3.3	0.80	0.26	0.11
900	-------	-------	------	------	------	------	-----	-----	[1]11	[1]4.1	1.0	0.33	0.13
1,000	-------	-------	------	------	------	------	-----	-----	[2]13	[1]5.0	1.25	0.40	0.17
1,500	-------	-------	------	------	------	------	-----	-----	-----	[2]12	2.8	0.90	0.37
2,000	-------	-------	------	------	------	------	-----	-----	-----	-----	[1]4.7	1.6	0.63
2,500	-------	-------	------	------	------	------	-----	-----	-----	-----	[2]7.2	[1]2.4	1.0
3,000	-------	-------	------	------	------	------	-----	-----	-----	-----	-----	[1]3.4	1.3

[1]Velocity at or exceeding 10 fps.

[2]Velocity exceeds 15 fps.

Subp. 16. **Graph of pressure loss of water in pounds per square inch per 100 feet of fairly rough pipe.**



Subp. 17. **Pressure loss of water in pounds per square inch per 100 feet of rough pipe.**

Gallons per minute	3/4"	1"	1-1/4"	1-1/2"	2"	2-1/2"	3"	4"	5"	6"	8"	10"	12"
1	0.31	------	-----	------	-----	------	-----	------	-----	------	------	------	------
2	1.20	0.27	-----	------	-----	------	-----	------	-----	------	------	------	------
3	2.7	0.62	0.20	------	-----	------	-----	------	-----	------	------	------	------
4	4.7	1.2	0.36	0.15	-----	------	-----	------	-----	------	------	------	------

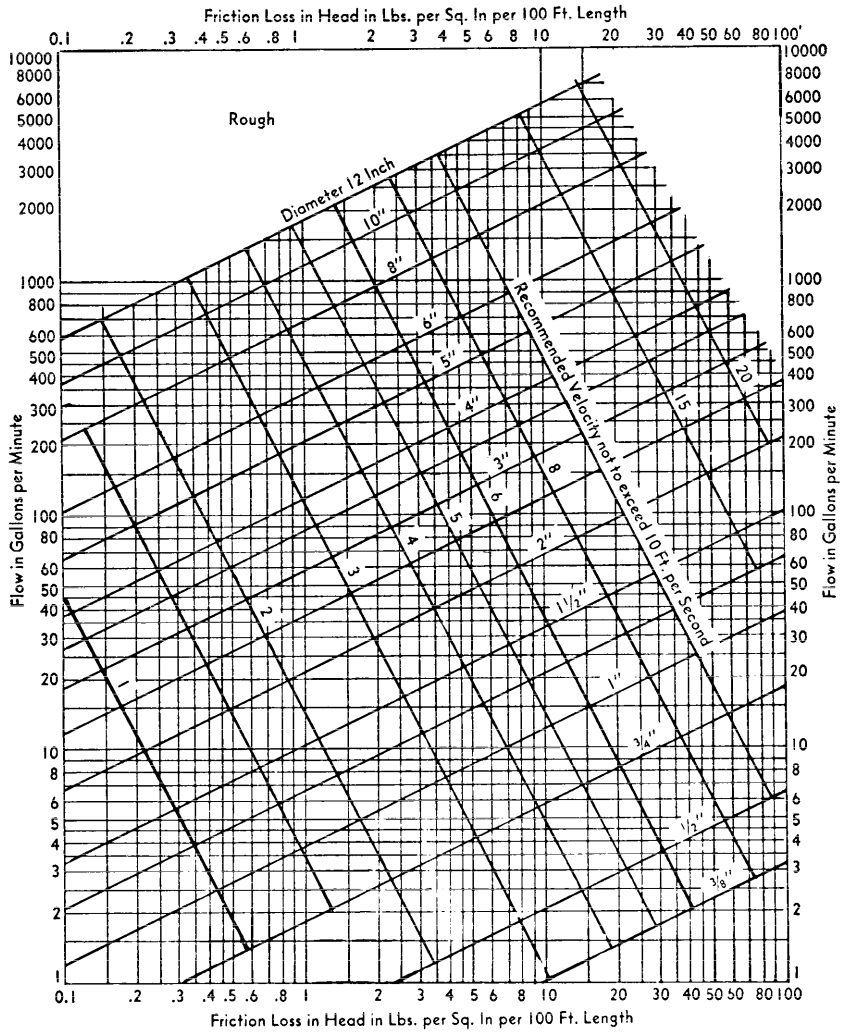
5	6.0	1.4	0.46	0.18	-----	------	-----	------	-----	------	------	------	------
10	30	7.0	2.3	0.94	0.22	------	-----	------	-----	------	------	------	------
15	[1]67	16.0	6.2	2.1	0.49	0.17	-----	------	-----	------	------	------	------
20	-----	27	9.1	3.7	0.89	0.29	0.12	------	-----	------	------	------	------
25	-----	[1]43	14	5.8	1.3	0.45	0.18	------	-----	------	------	------	------
30	-----	[1]62	21	8.5	2.0	0.63	0.27	------	-----	------	------	------	------
35	-----	[1]85	28	12	2.7	0.90	0.36	------	-----	------	------	------	------
40	-----	------	[1]37	14	3.5	1.20	0.47	0.12	-----	------	------	------	------
45	-----	------	[1]47	19	4.5	1.45	0.60	0.14	-----	------	------	------	------
50	-----	------	[1]58	23	5.5	1.8	0.74	0.18	-----	------	------	------	------
60	-----	------	[2]83	[1]33	7.9	2.6	1.10	0.25	-----	------	------	------	------
70	-----	------	-----	[1]46	12	3.5	1.40	0.35	0.12	------	------	------	------
80	-----	------	-----	[1]60	14	4.7	1.85	0.45	0.15	------	------	------	------
90	-----	------	-----	[2]76	18	5.9	2.3	0.58	0.19	------	------	------	------
100	-----	------	-----	------	[1]23	7.2	3.0	0.71	0.23	------	------	------	------
150	-----	------	-----	------	[2]50	17	6.6	1.7	0.53	0.21	------	------	------
200	-----	------	-----	------	-----	[1]29	12	2.9	0.95	0.37	------	------	------
250	-----	------	-----	------	-----	[2]45	[1]18	4.5	1.49	0.58	0.13	------	------
300	-----	------	-----	------	-----	------	[1]26	6.4	2.20	0.80	0.19	------	------
350	-----	------	-----	------	-----	------	[2]36	8.9	2.9	1.20	0.27	------	------
400	-----	------	-----	------	-----	------	-----	[1]12	3.8	1.45	0.35	0.12	------
450	-----	------	-----	------	-----	------	-----	[1]15	4.7	1.8	0.44	0.14	------
500	-----	------	-----	------	-----	------	-----	[1]18	6.0	2.3	0.55	0.18	------
600	-----	------	-----	------	-----	------	-----	[2]25	8.3	3.2	0.78	0.26	0.11
700	-----	------	-----	------	-----	------	-----	------	[1]12	4.5	1.20	0.36	0.14
800	-----	------	-----	------	-----	------	-----	------	[1]16	6.0	1.4	0.47	0.19
900	-----	------	-----	------	-----	------	-----	------	[2]20	[1]7.7	1.8	0.60	0.24
1,000	-----	------	-----	------	-----	------	-----	------	-----	[1]9.4	2.3	0.75	0.31
1,500	-----	------	-----	------	-----	------	-----	------	-----	[2]22	5.1	1.7	0.70
2,000	-----	------	-----	------	-----	------	-----	------	-----	------	[1]9.0	3.0	1.25

2,500	-----	------	-----	------	-----	------	-----	------	-----	------	[2]14	[1]4.7	2.0
3,000	-----	------	-----	------	-----	------	-----	------	-----	------	------	[1]6.8	2.7

[1]Velocity at or exceeding 10 fps.

[2]Velocity exceeds 15 fps.

Subp. 18. **Pressure loss of water in pounds per square inch per 100 feet of rough pipe.**



Subp. 19. **Pressure loss of water in pounds per square inch per 100 feet of copper pipe.**

Gallons per minute	3/4"[1]	1"[1]	1-1/4"	1-1/2"	2"	2-1/2"	3"	4"	5"	6"	8"	10"	12"
0.17	------	-----	------	-----	------	-----	------	-----	------	------	------	------	------

	0.21	------	-----	------	-----	------	-----	------	-----	------	------	------	------
1	0.27	------	-----	------	-----	------	-----	------	-----	------	------	------	------
	0.56	0.16	-----	------	-----	------	-----	------	-----	------	------	------	------
	0.66	0.18	-----	------	-----	------	-----	------	-----	------	------	------	------
2	0.84	0.21	-----	------	-----	------	-----	------	-----	------	------	------	------
	1.15	0.31	-----	------	-----	------	-----	------	-----	------	------	------	------
	1.30	0.37	-----	------	-----	------	-----	------	-----	------	------	------	------
3	1.70	0.42	0.13	------	-----	------	-----	------	-----	------	------	------	------
	1.8	0.51	-----	------	-----	------	-----	------	-----	------	------	------	------
	2.2	0.61	-----	------	-----	------	-----	------	-----	------	------	------	------
4	2.8	0.69	0.22	0.10	-----	------	-----	------	-----	------	------	------	------
	2.7	0.76	-----	------	-----	------	-----	------	-----	------	------	------	------
	3.3	0.90	-----	------	-----	------	-----	------	-----	------	------	------	------
5	4.2	1.05	0.34	0.15	-----	------	-----	------	-----	------	------	------	------
	3.8	1.1	-----	------	-----	------	-----	------	-----	------	------	------	------
	4.5	1.25	-----	------	-----	------	-----	------	-----	------	------	------	------
6	5.7	1.4	0.47	0.21	-----	------	-----	------	-----	------	------	------	------
	5.0	1.4	-----	------	-----	------	-----	------	-----	------	------	------	------
	6.0	1.7	-----	------	-----	------	-----	------	-----	------	------	------	------
7	7.5	1.8	0.61	0.27	-----	------	-----	------	-----	------	------	------	------
	6.1	1.7	-----	------	-----	------	-----	------	-----	------	------	------	------
	7.2	2.1	-----	------	-----	------	-----	------	-----	------	------	------	------
8	9.6	2.4	0.68	0.33	-----	------	-----	------	-----	------	------	------	------
	7.6	2.2	-----	------	-----	------	-----	------	-----	------	------	------	------
	8.9	2.5	-----	------	-----	------	-----	------	-----	------	------	------	------
9	12	2.8	0.93	0.42	0.12	------	-----	------	-----	------	------	------	------
	9.1	2.6	-----	------	-----	------	-----	------	-----	------	------	------	------
	11.5	3.0	-----	------	-----	------	-----	------	-----	------	------	------	------
10	14.5	3.5	1.2	0.50	0.14	------	-----	------	-----	------	------	------	------
	18.5	5.2	-----	------	-----	------	-----	------	-----	------	------	------	------

	[2]23	6.1	-----	------	-----	------	-----	------	-----	------	------	------	------
15	[2]28	7.1	2.4	1.10	0.27	------	-----	------	-----	------	------	------	------
	[2]32	8.9	-----	------	-----	------	-----	------	-----	------	------	------	------
	[2]37	9.9	-----	------	-----	------	-----	------	-----	------	------	------	------
20	[2]45	12	3.8	1.70	0.44	0.16	-----	------	-----	------	------	------	------
	[3]46	13	-----	------	-----	------	-----	------	-----	------	------	------	------
	[3]53	15	-----	------	-----	------	-----	------	-----	------	------	------	------
25	[3]67	[2]17	5.8	2.5	0.68	0.23	-----	------	-----	------	------	------	------
	-----	[2]18	-----	------	-----	------	-----	------	-----	------	------	------	------
	-----	[2]21	-----	------	-----	------	-----	------	-----	------	------	------	------
30	-----	[2]24	8.0	3.5	0.91	0.32	0.13	------	-----	------	------	------	------
	-----	[2]24	-----	------	-----	------	-----	------	-----	------	------	------	------
	-----	[2]27	-----	------	-----	------	-----	------	-----	------	------	------	------
35	-----	[2]32	11	4.6	1.25	0.42	0.17	------	-----	------	------	------	------
	-----	[2]30	-----	------	-----	------	-----	------	-----	------	------	------	------
	-----	[3]33	-----	------	-----	------	-----	------	-----	------	------	------	------
40	-----	[3]38	[2]13	5.8	1.50	0.52	0.22	------	-----	------	------	------	------
	-----	[3]37	-----	------	-----	------	-----	------	-----	------	------	------	------
	-----	[3]43	-----	------	-----	------	-----	------	-----	------	------	------	------
45	-----	[3]48	[2]17	7.1	1.85	0.66	0.28	------	-----	------	------	------	------
50	-----	------	[2]19	8.7	2.3	0.79	0.33	------	-----	------	------	------	------
60	-----	------	[3]27	12	3.1	1.2	0.46	0.12	-----	------	------	------	------
70	-----	------	-----	[2]16	4.2	1.4	0.62	0.16	-----	------	------	------	------
80	-----	------	-----	[2]19	5.2	1.8	0.79	0.20	-----	------	------	------	------
90	-----	------	-----	[3]24	6.2	2.25	0.96	0.24	-----	------	------	------	------
100	-----	------	-----	------	[2]7.6	2.75	1.2	0.30	0.11	------	------	------	------
150	-----	------	-----	------	[3]17	[2]5.8	2.5	0.62	0.22	------	------	------	------
200	-----	------	-----	------	-----	[2]9.3	4.1	1.10	0.36	0.15	------	------	------
250	-----	------	-----	------	-----	[3]14	[2]6.1	1.60	0.52	0.22	------	------	------
300	-----	------	-----	------	-----	------	[2]8.4	2.1	0.72	0.31	------	------	------

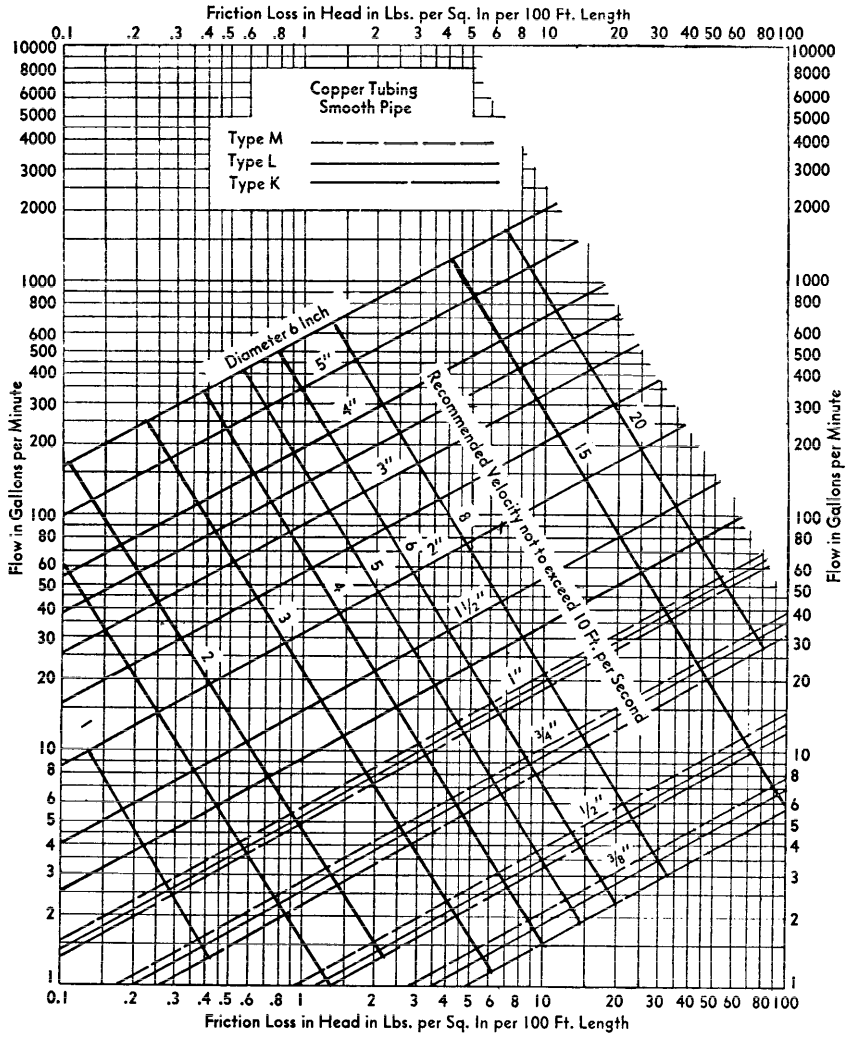
350	-----	------	-----	------	-----	------	[3]12	2.8	0.98	0.41	------	------	------
400	-----	------	-----	------	-----	------	-----	3.5	1.25	0.52	------	------	------
450	-----	------	-----	------	-----	------	-----	[2]4.3	1.6	0.63	------	------	------
500	-----	------	-----	------	-----	------	-----	[2]5.2	1.8	0.76	------	------	------
600	-----	------	-----	------	-----	------	-----	[3]7.2	[2]2.7	1.15	------	------	------
700	-----	------	-----	------	-----	------	-----	------	[2]3.4	1.4	------	------	------
800	-----	------	-----	------	-----	------	-----	------	[2]4.4	1.8	------	------	------
900	-----	------	-----	------	-----	------	-----	------	[3]5.2	[2]2.2	------	------	------
1,000	-----	------	-----	------	-----	------	-----	------	-----	[2]2.7	------	------	------

[1]For the 3/4" and 1" pipe sizes the three values shown opposite each flow figure are, reading from the top, for Types M, L and K copper tubing respectively.

[2]Velocity at or exceeding 10 fps.

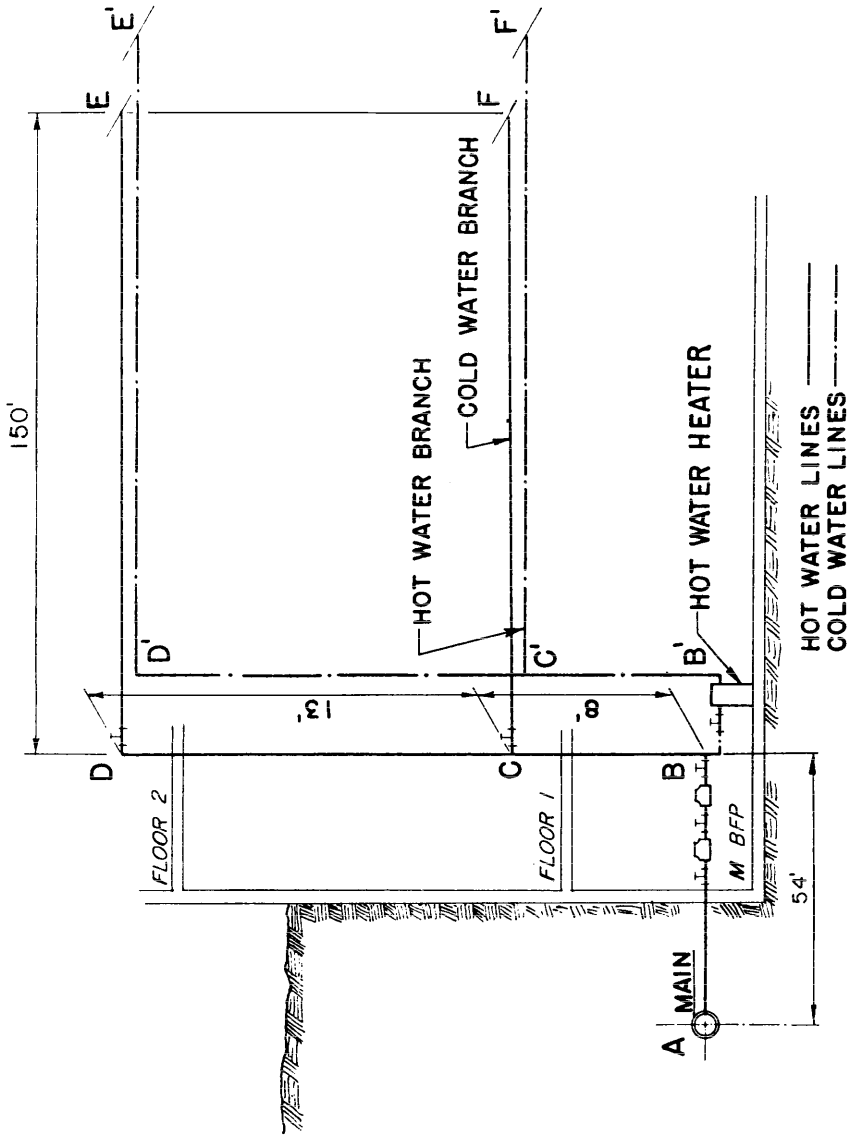
[3]Velocity exceeds 15 fps.

Subp. 20. **Graph of pressure loss of water in pounds per square inch per 100 feet of copper pipe.**



Subp. 21. **Example.** What size copper water pipe, service and distribution will be required to serve a two story factory building having on each floor, back-to-back, two toilet rooms each equipped with four flushometer closets, two flushometer pedestal urinals and four lavatories with hot and cold water? The highest fixture is 21 feet above the street main which is tapped with 2-1/2 inch corporation at which point the minimum pressure is 55 psi. In the building basement a two-inch meter and three-inch reduced pressure zone backflow preventer with a maximum pressure drop of 9 psi are to be installed. The system is shown by the following diagram. To be determined are the pipe sizes for the service main, and the cold and hot water distribution pipes. A tabular arrangement such as shown in subpart 10 should first be constructed. The steps to be followed in solving the problem are indicated by the table itself as they are in sequence, columns 1 through 8 and lines a through 1.

Subp. 22. **Illustration.**



Subp. 23. **Recommended tabular arrangement for use in solving pipe sizing problems.**

	Line	Description	Lbs. per square inch-psi
	a	Minimum pressure available at main	55.00
	b	Highest pressure required at a fixture (part 4715.1770, subpart 2)	15.00
Service and	c	Meter loss 2" meter (subpart 9)	11.00

cold water distribution piping	d	Tap in main-loss 2-1/2" tap (subpart 12)	1.29
	e	Static head loss 21 x 0.43 psi	9.03
	f	Special fixture loss–backflow preventer	9.00
	g	Special fixture loss–filter	0.00
	h	Special fixture loss–other	0.00
	i	Total overall losses and requirements, sum of lines b through h	45.32
	j	Pressure available to overcome pipe friction, line a minus sum of lines b to h.	9.68

1	2	3	4	5	6	7	8	
Pipe section	Gal. per min. through section (determined as in subpart 3)	Length of section (ft.)	Trial pipe size (in.)	Equivalent length of fittings and valves (subpart 11)	Total equivalent length col. 3 and col. 5 (100 ft.)	Friction loss per 100' of trial size pipe (subpart 19)	Friction loss in equivalent length col. 6 x col. 7 (psi)	
AB	107	54	2-1/2	12.8	0.67	3.0	2.00	
BC	101	8	2-1/2	8	0.16	2.8	0.45	
CF	76	150	2-1/2	1.6	1.52	1.7	2.58	
CD	76	13	2-1/2	8	0.21	1.7	0.36	
DE	76	150	2-1/2	1.6	1.52	1.7	2.58	
	k	Total pipe friction losses (cold) 7.97 psi						7.97
	l	Difference line j minus line k						1.71
Hot Water Distribution Piping								
AB'	107	54	2-1/2	12.8	0.67	3.0	2.00	
B'C'	37	8	2	15.3	0.23	1.2	0.22	
C'F'	28	150	2	1.3	1.51	0.8	1.21	
C'D'	28	13	1-1/2	5	0.18	3.2	0.58	
D'E'	28	150	1-1/2	1.0	1.51	3.2	4.84	

	k	Total pipe friction losses (hot) 8.85 psi	8.85
	l	Difference line j minus line k	0.83

Subp. 24. **Directions for constructing tabular arrangement.** Step 1, column 1: divide the system into sections breaking at major changes in elevation or where branches lead to fixture groups. After point (B) (see sketch in subpart 22) separate consideration will be given to the hot and cold water piping. Enter the sections to be considered in the service and cold water piping in column 1 of the tabular arrangement.

Column 3: According to the method given in subpart 3 determine the GPM of flow to be expected in each section of the system. These flows range from 28 to 107 GPM.

Step 2, line a: enter the minimum pressure available at the main source of supply. This is 55 psi.

Line b: determine from part 4715.1770, subpart 2 the highest pressure required for the fixtures on the system, which is 15 psi to operate a flushometer valve.

Line c: select from subpart 9 the pressure loss for the meter size given or assumed. The total water flow from the main through the service as determined in step 1 will serve to aid in the meter selected.

Line d: select from subpart 12 and enter the pressure loss for the tap size given or assumed.

Line e: determine the difference in elevation between the main or source of supply and the highest fixture on the system and multiply this figure, expressed in feet, by 0.43 psi. Enter the resulting psi product on line e.

Line f, g, h: the pressure losses through filters, backflow preventers, or other special fixtures must be obtained from the manufacturer or estimated and entered on these lines.

Step 3, line i: the sum of (lines b through h) the pressure requirements and losses which affect the overall system is entered on this line.

Step 4, line j: subtract line i from line a. This gives the pressure which remains available for overcoming friction losses in the system. This figure is a guide to the pipe size which is chosen for each section as the total friction losses through all the sections should not exceed this value.

Step 5, column 3: enter the length of each section.

Step 6, column 4: select a trial pipe size. A rule of thumb is that size will become progressively smaller as the system extends farther from the main or source of supply.

Step 7, column 5: select from subpart 11 the equivalent lengths for the trial pipe size of fittings and valves on the section. Enter the sum for each section in column 5. (The number of fittings to be used in the installation of this piping must be an engineering estimate.)

Step 8, column 6: add the figures from column 3 and column 5, and enter in column 6. Express the sum in hundreds of feet.

Step 9, column 7: select from subpart 19 the friction loss per 100 feet of pipe for the GPM flow in a section (column 2) and the trial pipe size (column 4).

Step 10, column 8: multiply the figures in columns 6 and 7 for each section and enter in column 8.

Step 11, line k: enter the sum of the values in column 8.

Step 12, line l: subtract line k from line j. The result should always be a positive or plus figure. If it is not, it is necessary to repeat the operation utilizing columns 4, 5, 7 and 8 until a balance or near balance is obtained. If the difference between lines j and k is positive and large, it is an indication that the pipe sizes are too large and may, therefore, be reduced thus saving materials. In such a case the operations utilizing columns 4, 5, 7, and 8 should again be repeated.

Answer: the final figures entered in column 4 become the design pipe size for the respective sections. Repeating this operation a second time using the same sketch but considering the demand for hot water, it is possible to size the hot water distribution piping. This has been worked up as a part of the overall problem in the tabular arrangement used for sizing the service and cold water distribution piping. It should be noted that consideration must be given the pressure losses from the street main to the water heater (section AB) in determining the hot water pipe sizes.

Statutory Authority: *MS s 16B.62; 326.37 to 326.45; 326B.121; 326B.43 to 326B.49*

History: *19 SR 590; L 2007 c 140 art 4 s 61; art 6 s 15; art 13 s 4*

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