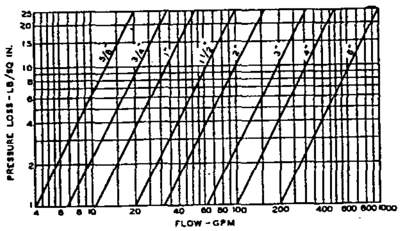


(See manufacturer's data for exact value for meter used)

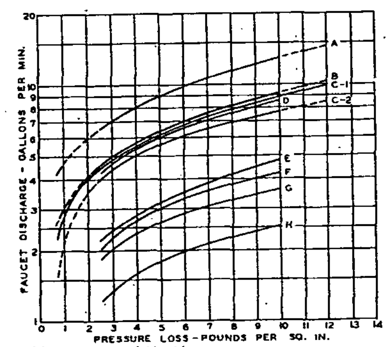
Fig. 6 . . . . Pressure Losses in Water Meters

feed systems are the same. The principal difference in procedure is that in the down-feed system, the difference in elevation between the house tank and the fixtures provides the pressure required to overcome pipe friction.

Procedure for Sizing Cold Water Systems

The recommended procedure for sizing piping systems is outlined in following paragraphs 1 to 6, inclusive.

1. Draw a sketch of the main lines, risers, and branches, and indicate the fixtures to be served. Indicate the rate of flow of each fixture.
2. Using Table 2, compute the demand weights of the fixtures in fixture units.
3. Determine the total demand in fixture units and, using Fig. 1 or Fig. 2, find the expected demand in gallons per minute.



A. ½-in. laundry bibb (old style).
B. Laundry compression faucet.
C-1. ½-in. compression sink faucet (Mfr. 1).
C-2. ½-in. compression sink faucet (Mfr. 2).
D. Combination compression bathtub faucets (both open).
E. Combination compression sink faucet.
F. Basin faucet.
G. Spring self-closing faucet.
H. Slow self-closing faucet.

(Dashed lines indicate recommended extrapolation)

Fig. 7 . . . . Variation of Pressure Loss with Rate of Flow for Various Faucets and Cocks

Table 3 . . . . Performance Requirements of Water Meters[a]

Size, In.	Normal Test-Flow Limits, Gpm	Minimum Test-Flow, Gpm
⅝	1 to 20	¼
¾	2 to 34	½
1	3 to 53	¾
1½	5 to 100	1½
2	8 to 160	2
3	16 to 315	4
4	28 to 500	7
6	48 to 1,000	12

[a] *American Water Works Association Standards:*

Registration. The registration on the meter dial shall indicate the quantity recorded to be not less than 98 percent nor more than 102 percent of the water actually passed through the meter while it is being tested at rates of flow within the specified limits herein under normal test flow limits: There shall be not less than 90 percent of the actual flow recorded when a test is made at the rate of flow set forth under minimum test flow.

4. Determine the equivalent length of pipe in the main lines, risers, and branches. Since the sizes of the pipes are not known, the exact equivalent length for various fittings, etc., cannot be made. Add the equivalent lengths, starting at the street main and proceeding along the service line, the main line in the building, and up the riser to the top fixture of the group served.
5. Determine the average minimum pressure in the street main and the minimum pressure required for the operation of the topmost fixture. This latter pressure should be 8 to 15 psi.
6. Calculate, by means of Equation 1, the approximate design value of the average pressure drop per 100 ft of pipe in the equivalent length determined in paragraph 4.

$$p = [P - 0.43H - 10] \frac{100}{L} \qquad (1)$$

where

p = average pressure loss per 100 ft of equivalent length of pipe, psi.
P = pressure in street main, psig.
H = height of highest fixture above street main, feet.
L = equivalent length determined in paragraph 4, feet.

If the system is of the down-feed supply from a gravity tank, the height of water in the tank, converted to pounds per square

Table 4 . . . . Allowance in Equivalent Length of Pipe for Friction Loss in Valves and Threaded Fittings

Diameter of Fitting, In.	Equivalent Length of Pipe for Various Fittings: 90-Deg Standard Ell, Ft	45-Deg Standard Ell, Ft	90-Deg Side Tee, Ft	Coupling or Straight Run of Tee, Ft	Gate Valve, Ft	Globe Valve, Ft	Angle Valve, Ft
⅜	1	0.6	1.5	0.3	0.2	8	4
½	2	1.2	3	0.6	0.4	15	8
¾	2.5	1.5	4	0.8	0.5	20	12
1	3	1.8	5	0.9	0.6	25	15
1¼	4	2.4	6	1.2	0.8	35	18
1½	5	3	7	1.5	1.0	45	22
2	7	4	10	2	1.3	55	28
2½	8	5	12	2.5	1.6	65	34
3	10	6	15	3	2	80	40
3½	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

Table 5 . . . . Equivalent Lengths of Iron Pipe to Give Same Loss as Special Fittings and Apparatus

Fitting Apparatus	Nominal Diameter of Pipe—Inches: ½	¾	1	1¼
30-gal Vertical hot water tank, ¾-in. pipe	4	17	56	—
30-gal Horizontal hot water tank, ¾-in. pipe	1.2	5	16	—
Water meters (No valves included)				
⅝ in. with ½-in. connections	6.7	28	90	—
⅝ in. with ¾-in. connections	4.8	20	64	—
¾ in. with ¾-in. connections	3.4	14	45	—
1 in. with 1-in. connections	—	9	30	115
1¼ in. with 1-in. connections	—	4.4	14	54
Water softener	—	50–200	—	—

inch by multiplying by 0.43, replaces the street main pressure, and the term 0.43 H in Equation 1 is added instead of subtracted in calculating the term p. In this case, H will be the vertical distance of the fixture below the bottom of the tank.

7. From the expected rate of flow, determined as in paragraph 3, and the value of p, calculated as in paragraph 6, choose the sizes of pipe from Figs. 3, 4, or 5.

Example 2: Assume a minimum street main pressure of 55 psig; a height of topmost fixture above street main of 50 ft; a developed pipe length from water main to highest fixture of 100 ft; a total load on the system of 50 fixture units; and that the water closets are flush-valve operated. Find the required size of supply main.

Solution: From Fig. 2 the estimated peak demand is found to be 51 gpm. From Table 3 it is evident that several sizes of meters would adequately measure this flow. For a trial computation choose the 1½-in. meter. From Fig. 6 the pressure drop through a 1½-in. disc-type meter for a flow of 51 gpm is found to be 6.5 psi.

Then the pressure drop available for overcoming friction in pipes and fittings is $55 - (15 + 50 \times 0.43 + 6.5) = 12$ psi.

At this point it is necessary to make some estimate of the equivalent pipe length of the fittings on the direct line from the street main to the highest fixture. The exact equivalent length of the various fittings cannot now be determined since the pipe sizes of the building main, riser, and branch leading to the highest fixture are not known as yet, but a first approximation is necessary in order to make a tentative selection of pipe sizes. If the computed pipe sizes differ from those used in determining the equivalent length of pipe fittings, a recalculation will be necessary, using the computed pipe sizes for the fittings. For the purposes of this example assume that the total equivalent length of the pipe fittings is 50 ft.

Then the permissible pressure loss per 100 ft of equivalent pipe is $12 \times 100/(100 + 50) = 8$ psi.

Assuming that the corrosive and caking properties of the water are such that Fig. 4 for fairly rough pipe is applicable, a 2-in. building main will be adequate.

Table 6 . . . . Computation of Branch Size in Example 2

Fixtures No. and Kind	Fixture Units (From Table 2 and Note c)	Demand (From Fig. 2) Gpm	Pipe Size (From Fig. 4) In.
3 flush valves	3 x 6 = 18		
2 bathtubs	¾ (2 x 2) = 3		
3 lavatories	¾ (3 x 1) = 2.25		
Total	23.25	38	1½

Table 7 . . . . Pipe Sizes for Cooling Towers[3]

Rated Tons of Refrig.	Cooling Water Gpm	Pipe Sizes (Nominal Inches): Inlet to Tower	Outlet from Tower
3 to 5	10 to 18	1½	1½
7 to 15	20 to 45	2	2
20	65	2½	3
25	86	2½	4
35	115	3	4
50	170	3	4
75	225	5	6
100	300	5	6
150	450	5	8
200	600	6	8
250	750	8	8

The sizing of the *branches* of the building main, the *risers*, and *fixture branches* follows the principles outlined. For example, assume that one of the branches of the building main carries the cold water supply for 3 water closets, 2 bathtubs, and 3 lavatories. Using the permissible pressure loss of 8 psi per 100 ft, the size of branch determined from Table 2 and Figs. 1 and 4 is found to be 1½ in. Items entering the computation of pipe size are given in Table 6.

COOLING WATER PIPING

Water is very frequently used in refrigeration systems, cooling towers, and other similar installations. In designing the piping system of such installations, the principles of hydraulics, as already outlined, are employed. Nevertheless, there are several practical items having particular application to cooling installations which are outlined in the following paragraphs. It is important that the designer be familiar with them.

In choosing pipe material, the problem of corrosion should be kept in mind to prevent failure of the system. If the water is not severely corrosive, wrought-iron or steel piping may be used; otherwise, galvanized-steel piping may be preferred. If sea water is used as the circulating medium, it is advisable to use alloys such as admiralty metal in pipe and tubing. In refrigeration condensers where water is the cooling medium, iron pipe is commonly employed.

In regard to assembly, cast-iron flanges or welded joints are to be preferred to screwed joints wherever possible.

Valves used in circulating systems may be of the globe, gate, or angle types. If water is the circulating medium, brass valves are usually used. However, if the circulating medium is an electrolyte, such as brine, then it is preferable to use valves made of the same material as the piping itself.

The friction loss in the piping may be determined from Fig. 4 for fairly rough pipe. If the coolant is brine, a correction for the proper density must be made. Experience indicates that in sizing piping for cooling systems, a pressure drop of the order of 2 to 3 psi per 100 ft of pipe length, and a fluid velocity of 3 to 8 fps, yield most economical results.

In the case of cooling towers, the amount of circulating water is about 3 gpm per ton of refrigeration, when based on a design wet-bulb temperature of about 76 F. Table 7 gives pipe sizes frequently used for various sizes of cooling towers, assuming a hot water temperature of 95 F and a cold water temperature of 85 F.[3]