

APPENDIX A

RECOMMENDED RULES FOR SIZING THE WATER SUPPLY SYSTEM

Because of the variable conditions encountered, it is impractical to lay down definite detailed rules of procedure for determining the sizes of water supply pipes in an appendix, which must necessarily be limited in length. For a more adequate understanding of the problems involved, refer to Water-Distributing Systems for Buildings, Report BMS 79 of the National Bureau of Standards; and Plumbing Manual, Report BMS 66, also published by the National Bureau of Standards.

The following is a suggested order of procedure for sizing the water supply system.

A 1 Preliminary Information.

A 1.1 Obtain the necessary information regarding the minimum daily service pressure in the area where the building is to be located.

A 1.2 If the building supply is to be metered, obtain information regarding friction loss relative to the rate of flow for meters in the range of sizes likely to be used. Friction-loss data can be obtained from most manufacturers of water meters. Friction losses for disk-type meters may be obtained from Chart A-1.

A 1.3 Obtain all available local information regarding the use of different kinds of pipe with respect both to durability and to decrease in capacity with length of service in the particular water supply.

A 2 Demand Load.

A 2.1 Estimate the supply demand for the building main and the principal branches and risers of the system by totaling the fixture units on each, Table A-2, and then by reading the corresponding ordinate from Chart A-2 or A-3, whichever is applicable.

A 2.2 Estimate continuous supply demands in gallons per minute (liters per second) for lawn sprinklers, air conditioners, etc., and add the sum to the total demand for fixtures. The result is the estimated supply demand of the building supply.

A 3 Permissible Friction Loss.

A 3.1 Decide what is the desirable minimum residual pressure that shall be maintained at the highest fixture in the supply system. If the highest group of fixtures contains flushometer valves, the residual pressure for the group shall not be less than fifteen (15) psi (103 kPa). For flush tank supplies, the

available residual pressure shall not be less than eight (8) psi (55 kPa).

A 3.2 Determine the elevation of the highest fixture or group of fixtures above the water (street) main. Multiply this difference in elevation by forty-three hundredths (0.43). The result is the loss in static pressure in psi (pounds per square inch) (kPa).

A 3.3 Subtract the sum of loss in static pressure and the residual pressure to be maintained at the highest fixture from the average minimum daily service pressure. The result will be the pressure available for friction loss in the supply pipes, if no water meter is used. If a meter is to be installed, the friction loss in the meter for the estimated maximum demand should also be subtracted from the service pressure to determine the pressure loss available for friction loss in the supply pipes.

A 3.4 Determine the developed length of pipe from the water (street) main to the highest fixture. If close estimates are desired, compute with the aid of Table A-3 the equivalent length of pipe for all fittings in the line from the water (street) main to the highest fixture and add the sum to the developed length. The pressure available for friction loss in pounds per square inch (kPa), divided by the developed lengths of pipe from the water (street) main to the highest fixture, times one hundred (100), will be the average permissible friction loss per one hundred (100) foot (30,480 mm) length of pipe.

A 4 Size of Building Supply.

A 4.1 Knowing the permissible friction loss per one hundred (100) feet (30,480 mm) of pipe and the total demand, the diameter of the building supply pipe may be obtained from Charts A-4, A-5, A-6, or A-7, whichever is applicable. The diameter of pipe on or next above the coordinate point corresponding to the estimated total demand and the permissible friction loss will be the size needed up to the first branch from the building supply pipe.

A 4.2 If copper tubing or brass pipe is to be used for the supply piping and if the character of the water is such that only slight changes in the hydraulic characteristics may be expected, Chart A-4 may be used.

A 4.3 Chart A-5 should be used for ferrous pipe with only the most favorable water supply in regards corrosion and caking. If the water is hard or corrosive, Chart A-6 or A-7 will be applicable. For extremely hard water, it will be advisable to make

additional allowances for the reduction of capacity of hot-water lines in service.

A 5 Size of Principal Branches and Risers.

A 5.1 The required size of branches and risers may be obtained in the same manner as the building supply, by obtaining the demand load on each branch or riser and using the permissible friction loss computed in Section A 3.

A 5.2 Fixture branches to the building supply, if they are sized for the same permissible friction loss per one hundred (100) feet (30,480 mm) of pipe as the branches and risers to the highest level in the building, may lead to inadequate water supply to the upper floor of a building. This may be controlled by (1) selecting the sizes of pipe for the different branches so that the total friction loss in each lower branch is approximately equal to the total loss in the riser, including both friction loss and loss in static pressure; (2) throttling each such branch by means of a valve until the preceding balance is obtained; (3) increasing the size of the building supply and risers above the minimum required to meet the maximum permissible friction loss.

A 5.3 The size of branches and mains serving flushometer tanks shall be consistent with sizing procedures for flush tank water closets.

A 6 General.

A 6.1 Velocities shall not exceed 10 feet/second (3.0 m/sec.) or the maximum values given in the appropriate Installation Standard, except as otherwise approved by the Authority Having Jurisdiction.

A 6.2 If a pressure-reducing valve is used in the building supply, the developed length of supply piping and the permissible friction loss should be computed from the building side of the valve.

A 6.3 The allowances in Table A-3 for fittings are based on nonrecessed threaded fittings. For recessed threaded fittings and streamlined soldered fittings, one-half (1/2) the allowances given in the table will be ample.

A 7 Example.

A 7.1 Assume an office building of four (4) stories and basement; pressure on the building side of the pressure-reducing valve of fifty-five (55) psi (379 kPa) (after an allowance for reduced pressure falloff at peak demand); an elevation of highest fixture above the pressure-reducing valve of forty-five (45) feet (13,716 mm); a developed length of

pipe from the pressure-reducing valve to the most distant fixture of two hundred (200) feet (60,960 mm); and fixtures to be installed with flush valves for water closets and stall urinals as follows:

If the pipe material and water supply are such that Chart A-5 applies, the required diameter of the building supply is three and one-half (3-1/2) inches (88.9 mm) and the required diameter of the branch to the hot-water heater is one and one-half (1-1/2) inches (40 mm).

The sizes of the various branches and risers may be determined in the same manner as the size of the building supply or the branch to the hot-water system, by estimating the demand for the riser or branch from Chart A-2 or A-3 and applying the total demand estimate from the branch, riser, or section thereof to the appropriate flowchart.

Chart A-1
Friction Losses for Disk-Type Water Meters

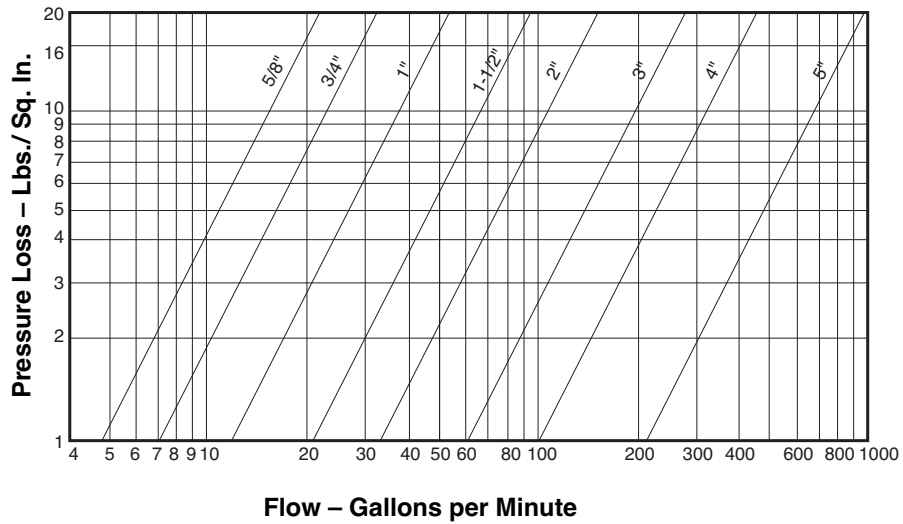


Chart A-1 (Metric)
Friction Losses for Disk-Type Water Meters

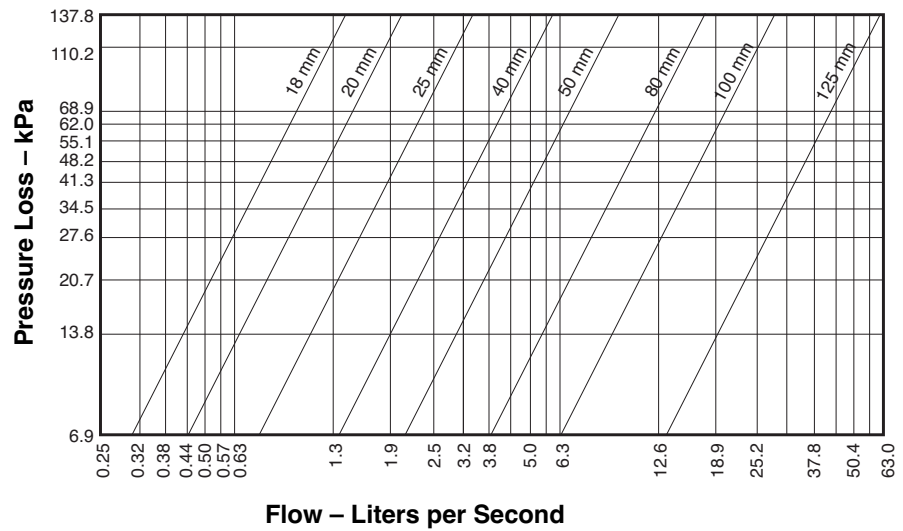


TABLE A-2
Water Supply Fixture Units (WSFU) and Minimum Fixture Branch Pipe Sizes³

Inch	mm		Minimum Fixture Branch Pipe Size ^{1,4}	Private	Public	Assembly ⁶	
1/2	15	Appliances, Appurtenance, or Fixtures ²					
3/4	20	Bathtub or Combination Bath/Shower (fill).....	1/2"	4.0	4.0		
1	25	3/4" Bathtub Fill Valve.....	3/4"	10.0	10.0		
		Bidet.....	1/2"	1.0			
		Clothes Washer.....	1/2"	4.0	4.0		
		Dental Unit, cuspidor.....	1/2"		1.0		
		Dishwasher, domestic.....	1/2"	1.5	1.5		
		Drinking Fountain or Watercooler.....	1/2"	0.5	0.5	0.75	
		Hose Bibb.....	1/2"	2.5	2.5		
		Hose Bibb, each additional ⁷	1/2"	1.0	1.0		
		Lavatory.....	1/2"	1.0	1.0	1.0	
		Lawn Sprinkler, each head ⁵		1.0	1.0		
		Mobile Home, each (minimum).....		12.0			
		Sinks					
		Bar.....	1/2"	1.0	2.0		
		Clinic Faucet.....	1/2"		3.0		
		Clinic Flushometer Valve.....					
		with or without faucet.....	1"		8.0		
		Kitchen, domestic.....	1/2"	1.5	1.5		
		Laundry.....	1/2"	1.5	1.5		
		Service or Mop Basin.....	1/2"	1.5	3.0		
		Washup, each set of faucets.....	1/2"		2.0		
		Shower.....	1/2"	2.0	2.0		
		Urinal, 1.0 GPF.....	3/4"	3.0	4.0	5.0	
		Urinal, greater than 1.0 GPF.....	3/4"	4.0	5.0	6.0	
		Urinal, flush tank.....	1/2"	2.0	2.0	3.0	
		Washfountain, circular spray.....	3/4"		4.0		
		Water Closet, 1.6 GPF Gravity Tank.....	1/2"	2.5	2.5	3.5	
		Water Closet, 1.6 GPF Flushometer Tank.....	1/2"	2.5	2.5	3.5	
		Water Closet, 1.6 GPF Flushometer Valve.....	1"	5.0	5.0	8.0	
		Water Closet, greater than 1.6 GPF Gravity Tank.....	1/2"	3.0	5.5	7.0	
		Water Closet, greater than 1.6 GPF Flushometer Valve.....	1"	7.0	8.0	10.0	

Notes:

1. Size of the cold branch outlet pipe, or both the hot and cold branch outlet pipes.
2. Appliances, Appurtenances, or Fixtures not included in this Table may be sized by reference to fixtures having a similar flow rate and frequency of use.
3. The listed fixture unit values represent their total load on the cold water service. The separate cold water and hot water fixture unit value for fixtures having both cold and hot water connections may each be taken as three-quarters (3/4) of the listed total value of the fixture.
4. The listed minimum supply branch pipe sizes for individual fixtures are the nominal (I.D.) pipe size.
5. For fixtures or supply connections likely to impose continuous flow demands, determine the required flow in gallons per minute (GPM) and add it separately to the demand (in GPM) for the distribution system or portions thereof.
6. Assembly [Public Use (See Table 4-1)].
7. Reduced fixture unit loading for additional hose bibbs as used is to be used only when sizing total building demand and for pipe sizing when more than one hose bibb is supplied by a segment of water distributing pipe. The fixture branch to each hose bibb shall be sized on the basis of 2.5 fixture units.

TABLE A-3
Allowance in Equivalent Length of Pipe for Friction Loss in Valves and Threaded Fittings*
Equivalent Length of Pipe for Various Fittings

Diameter of Fitting Inches	90° Standard Elbow Feet	45° Standard Elbow Feet	90° Standard Tee Feet	Coupling or Straight Run of Tee Feet	Gate Valve Feet	Globe Valve Feet	Angle Valve Feet
3/8	1.0	0.6	1.5	0.3	0.2	8	4
1/2	2.0	1.2	3.0	0.6	0.4	15	8
3/4	2.5	1.5	4.0	0.8	0.5	20	12
1	3.0	1.8	5.0	0.9	0.6	25	15
1-1/4	4.0	2.4	6.0	1.2	0.8	35	18
1-1/2	5.0	3.0	7.0	1.5	1.0	45	22
2	7.0	4.0	10.0	2.0	1.3	55	28
2-1/2	8.0	5.0	12.0	2.5	1.6	65	34
3	10.0	6.0	15.0	3.0	2.0	80	40
4	14.0	8.0	21.0	4.0	2.7	125	55
5	17.0	10.0	25.0	5.0	3.3	140	70
6	20.0	12.0	30.0	6.0	4.0	165	80

TABLE A-3 (Metric)
Equivalent Length of Pipe for Various Fittings

Diameter of Fitting mm	90° Standard Elbow mm	45° Standard Elbow mm	90° Standard Tee mm	Coupling or Straight Run of Tee mm	Gate Valve mm	Globe Valve mm	Angle Valve mm
10	305	183	457	91	61	2,438	1,219
15	610	366	914	183	122	4,572	2,438
20	762	457	1,219	244	152	6,096	3,658
25	914	549	1,524	274	183	7,620	4,572
32	1,219	732	1,829	366	244	10,668	5,486
40	1,524	914	2,134	457	305	13,716	6,706
50	2,134	1,219	3,048	610	396	16,764	8,534
65	2,438	1,524	3,658	762	488	19,812	10,363
80	3,048	1,829	4,572	914	610	24,384	12,192
100	4,267	2,438	6,401	1,219	823	38,100	16,764
125	5,182	3,048	7,620	1,524	1,006	42,672	21,336
150	6,096	3,658	9,144	1,829	1,219	50,292	24,384

*Allowances are based on nonrecessed threaded fittings. Use one-half (1/2) the allowances for recessed threaded fittings or streamlined solder fittings.

A 7 Example

Fixture Units and Estimated Demands

Kind of Fixtures	Building Supply Demand				Branch to Hot Water System		
	No. of Fixtures	Fixture Unit Demand	Total Units	Building Supply Demand in gpm (L per sec)	No. of Fixtures	Fixture Unit Demand Calculation	Demand in gallons per minute (L per sec)
Water Closets	130	8.0	1040	–	–	–	–
Urinals	30	4.0	120	–	–	–	–
Shower heads	12	2.0	24	–	12	$12 \times 2 \times 3/4 = 18$	–
Lavatories	100	1.0	100	–	100	$100 \times 1 \times 3/4 = 75$	–
Service Sinks	27	3.0	81	–	27	$27 \times 3 \times 3/4 = 61$	–
Total				1,365,252 gpm (15.8 L/s)			154 55 gpm (3.4 L/s)

Allowing for 15 psi (103.4 kPa) at the highest fixture under the maximum demand of 252 gallons per minute (15.8 L/sec.), the pressure available for friction loss is found by the following:

$$55 - [15 + (45 \times 0.43)] = 20.65 \text{ psi}$$

$$\text{Metric: } 379 - [103.4 + (13.7 \times 9.8)] = 142.3 \text{ kPa}$$

The allowable friction loss per 100 feet (30.4 m) of pipe is therefore:

$$100 \times 20.65 \div 200 = 10.32 \text{ psi}$$

$$\text{Metric: } 30.4 \times 142.3 \div 60.8 = 71.1 \text{ kPa}$$

Chart A-2
Estimate Curves for Demand Load

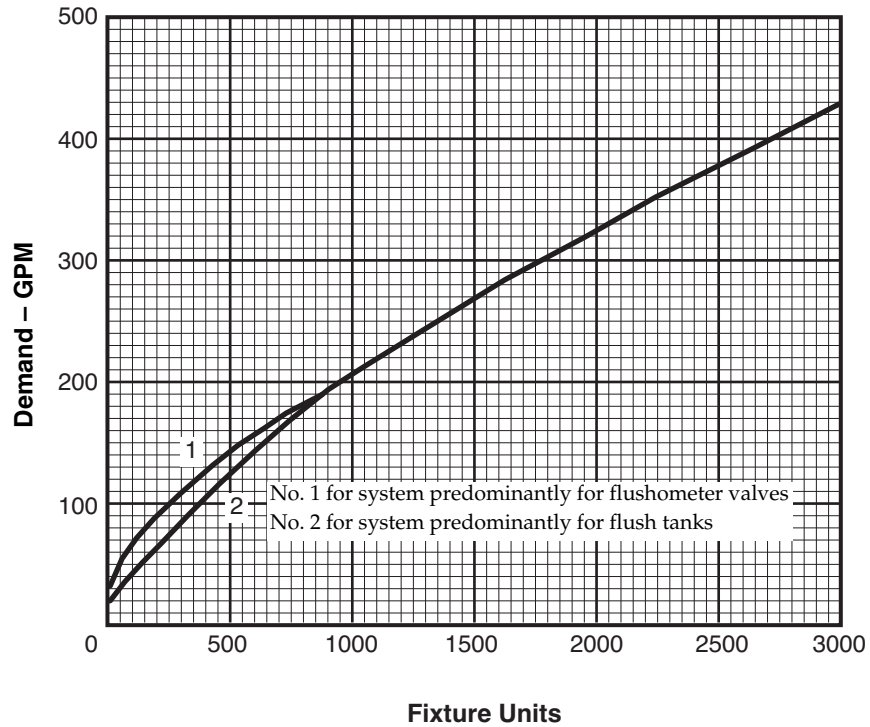
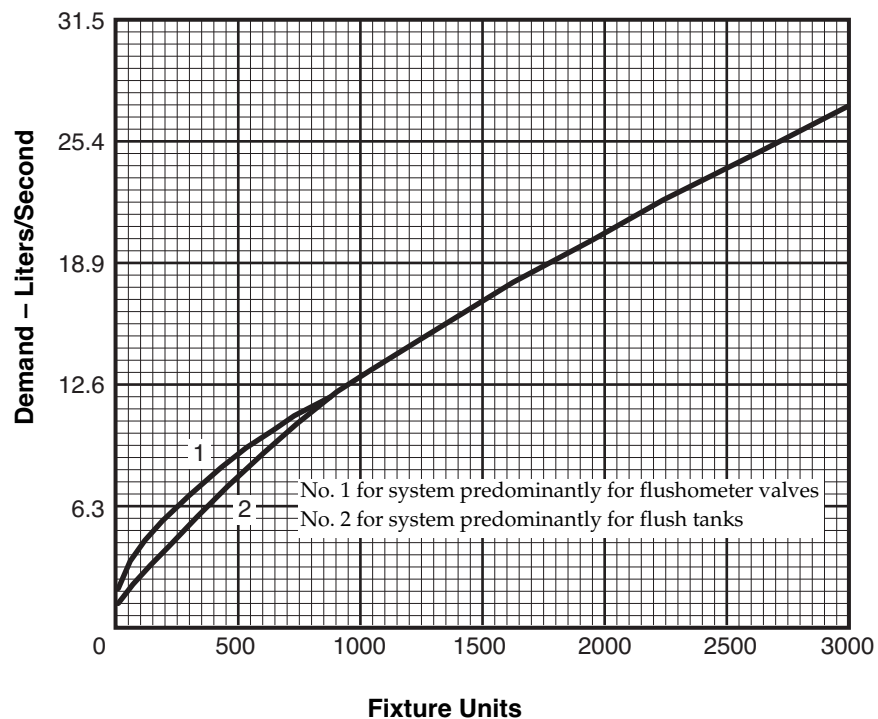
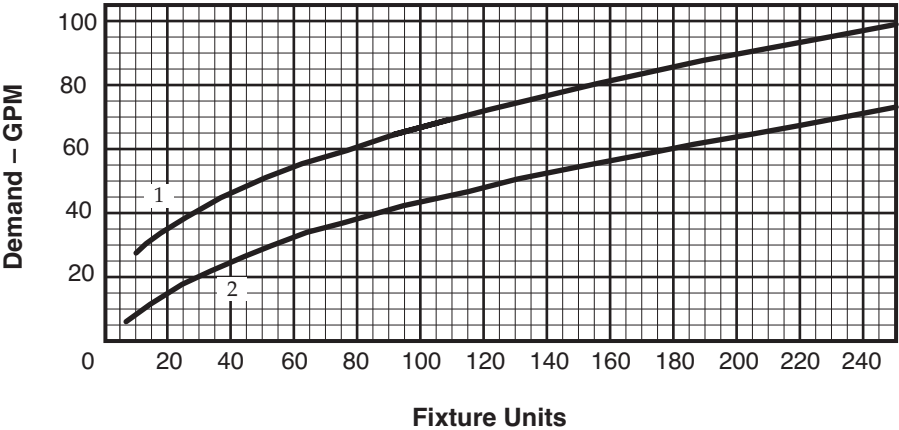


Chart A-2 (Metric)
Estimate Curves for Demand Load



**Chart A-3
Enlarged Scale Demand Load**



**Chart A-3 (Metric)
Enlarged Scale Demand Load**

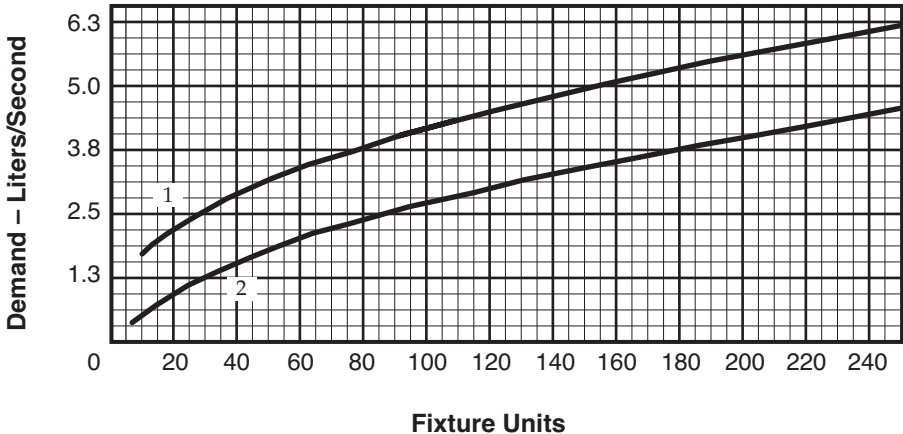


Chart A-4

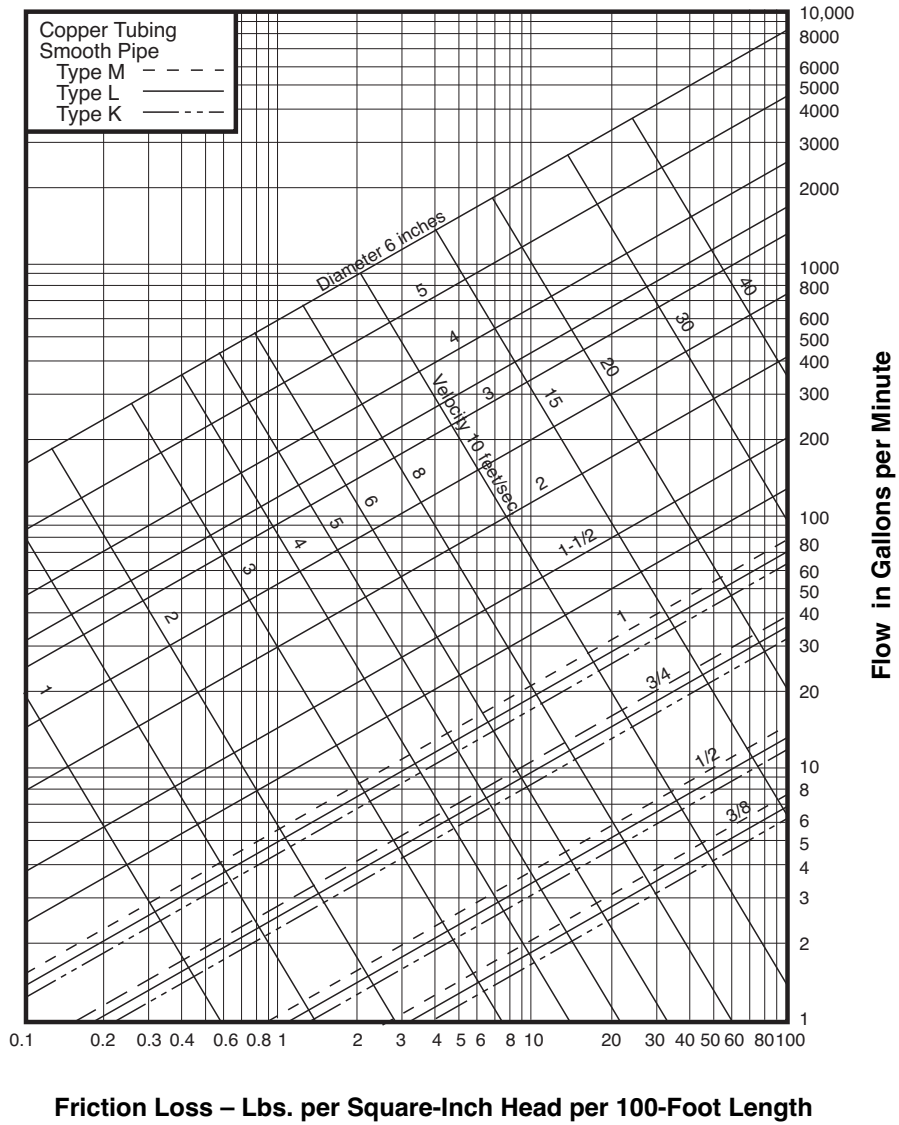


Chart A-4 (Metric)

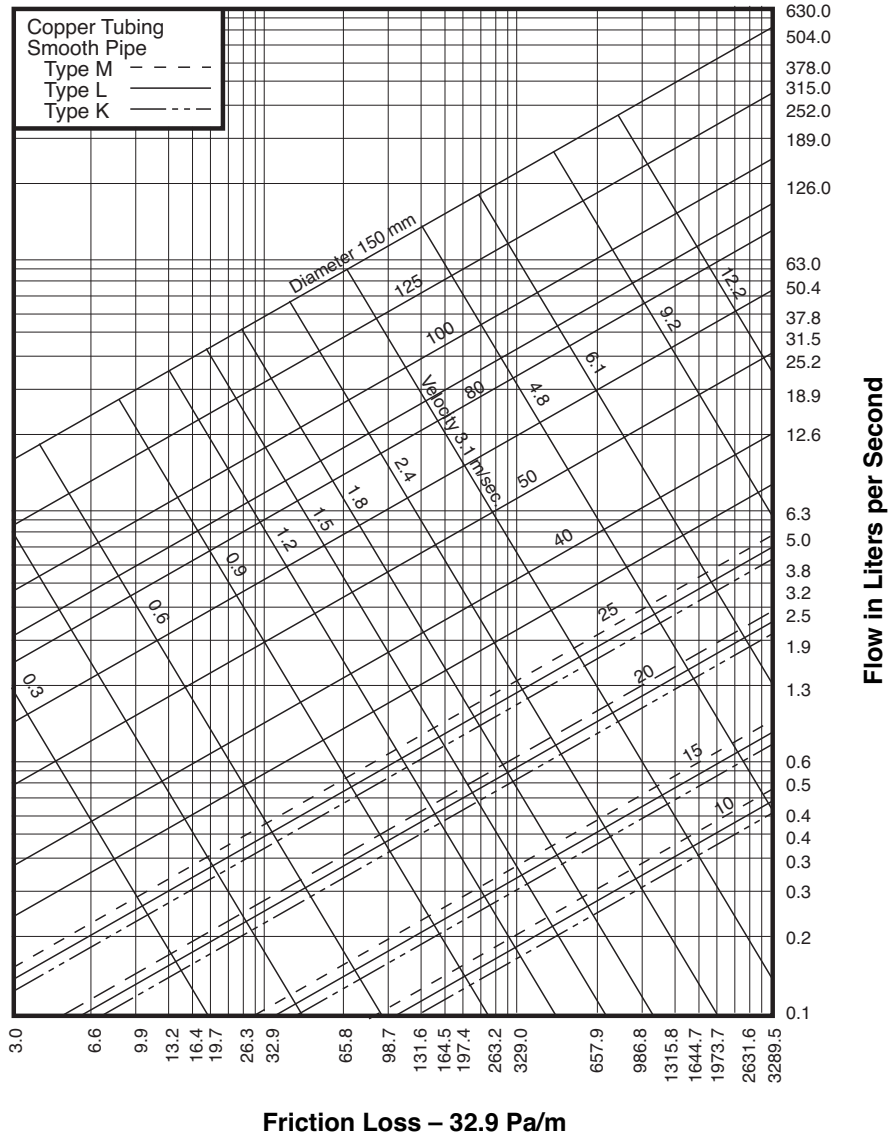


Chart A-5

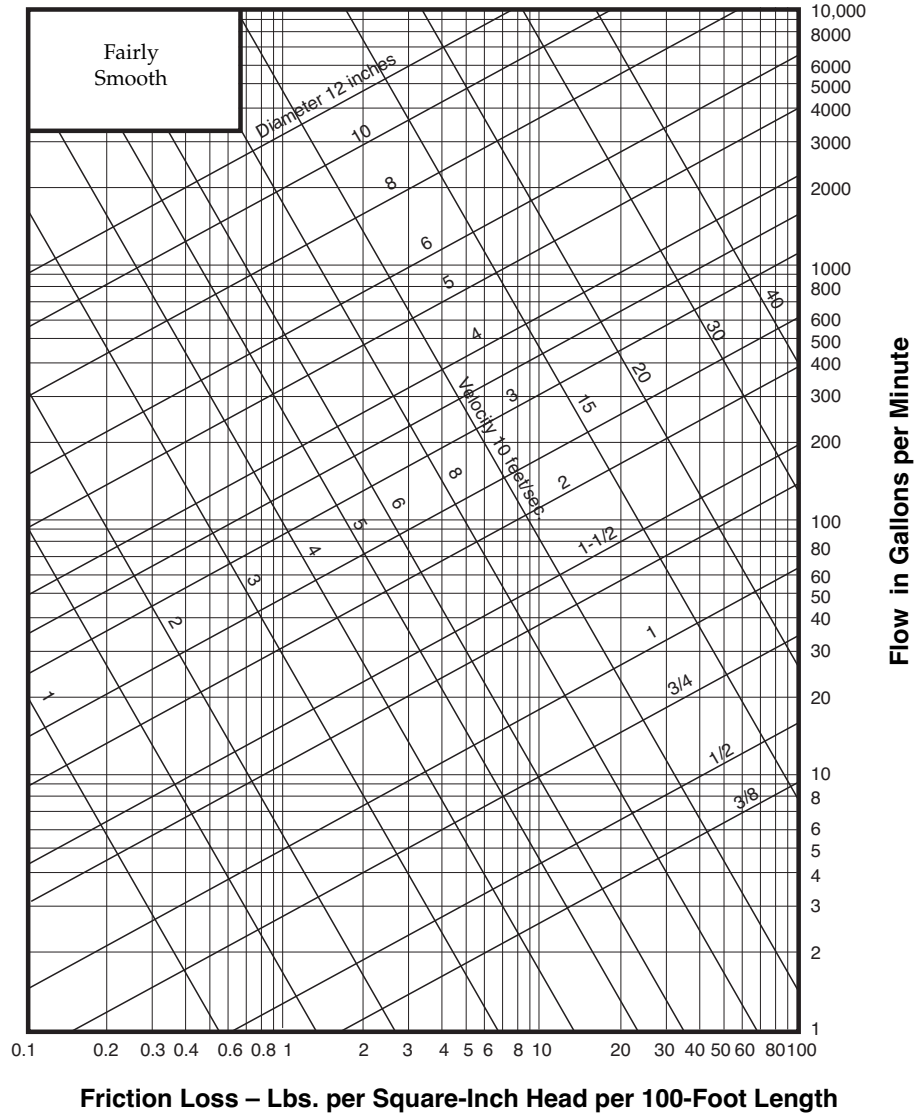


Chart A-5 (Metric)

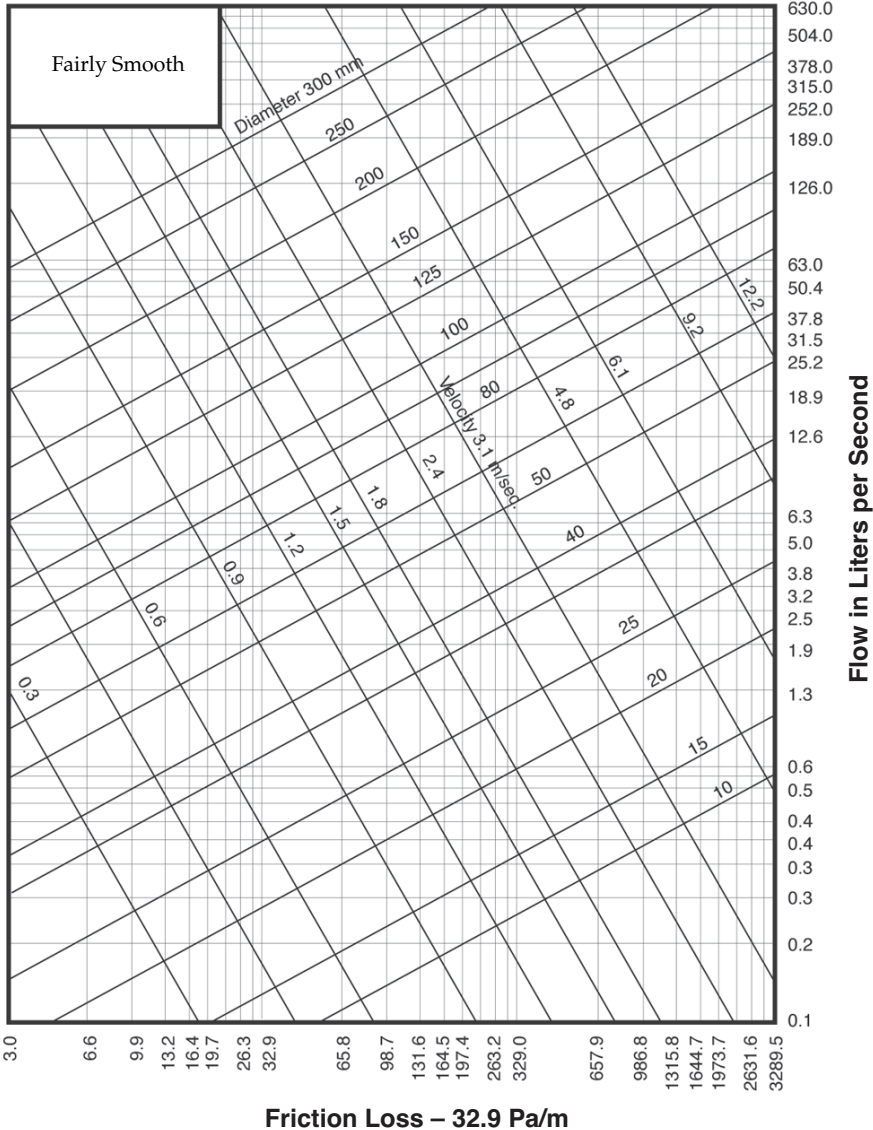


Chart A-6

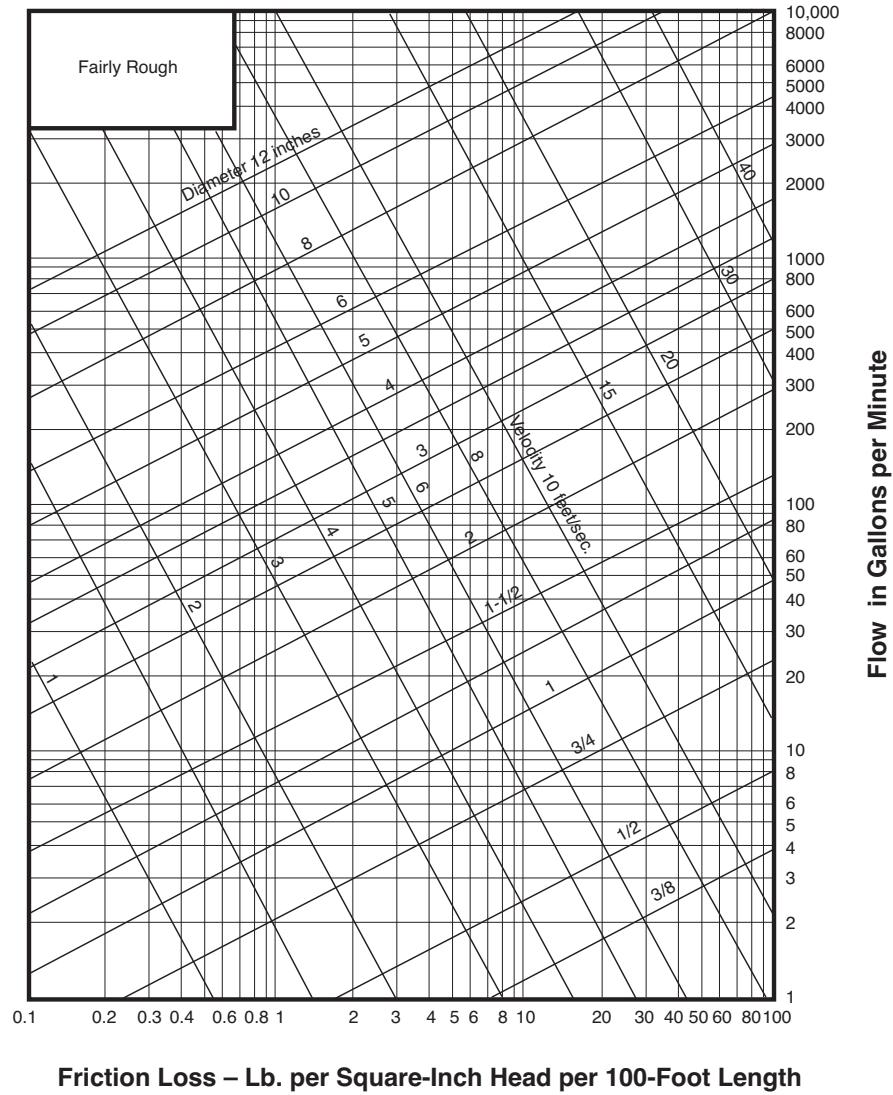


Chart A-6 (Metric)

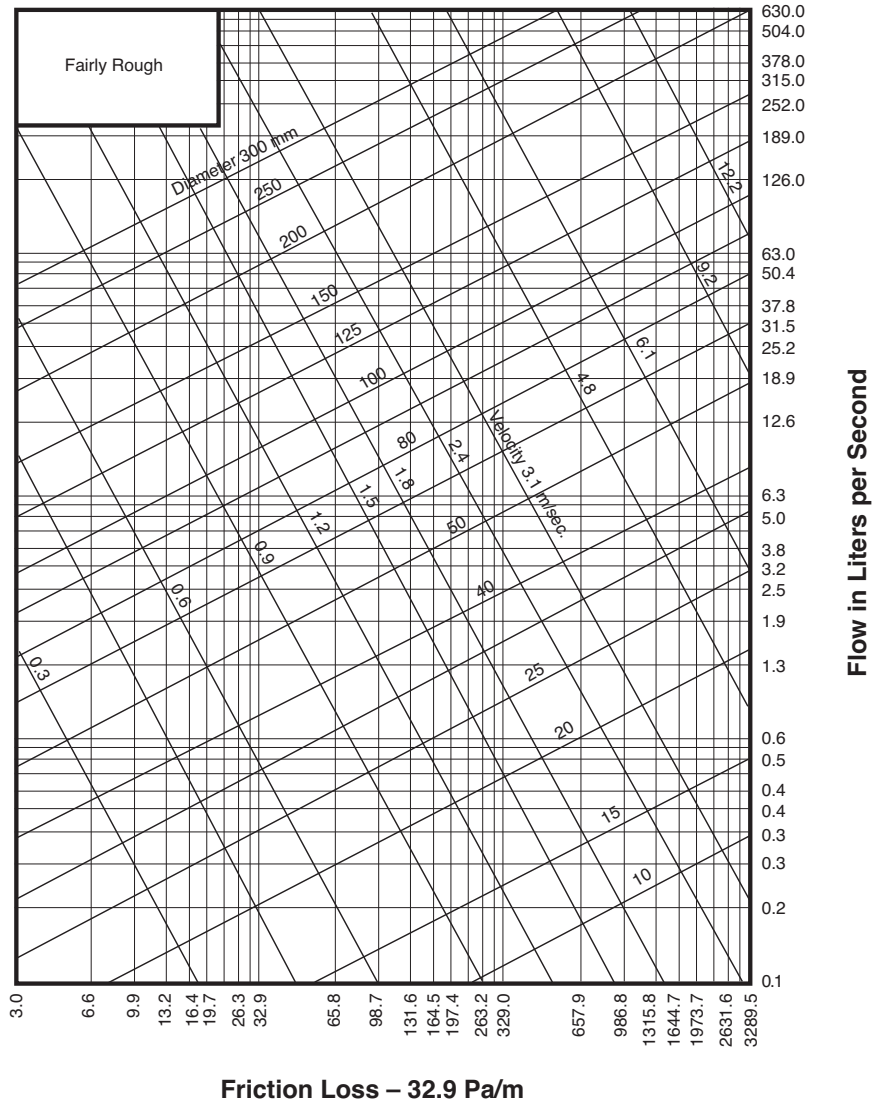


Chart A-7

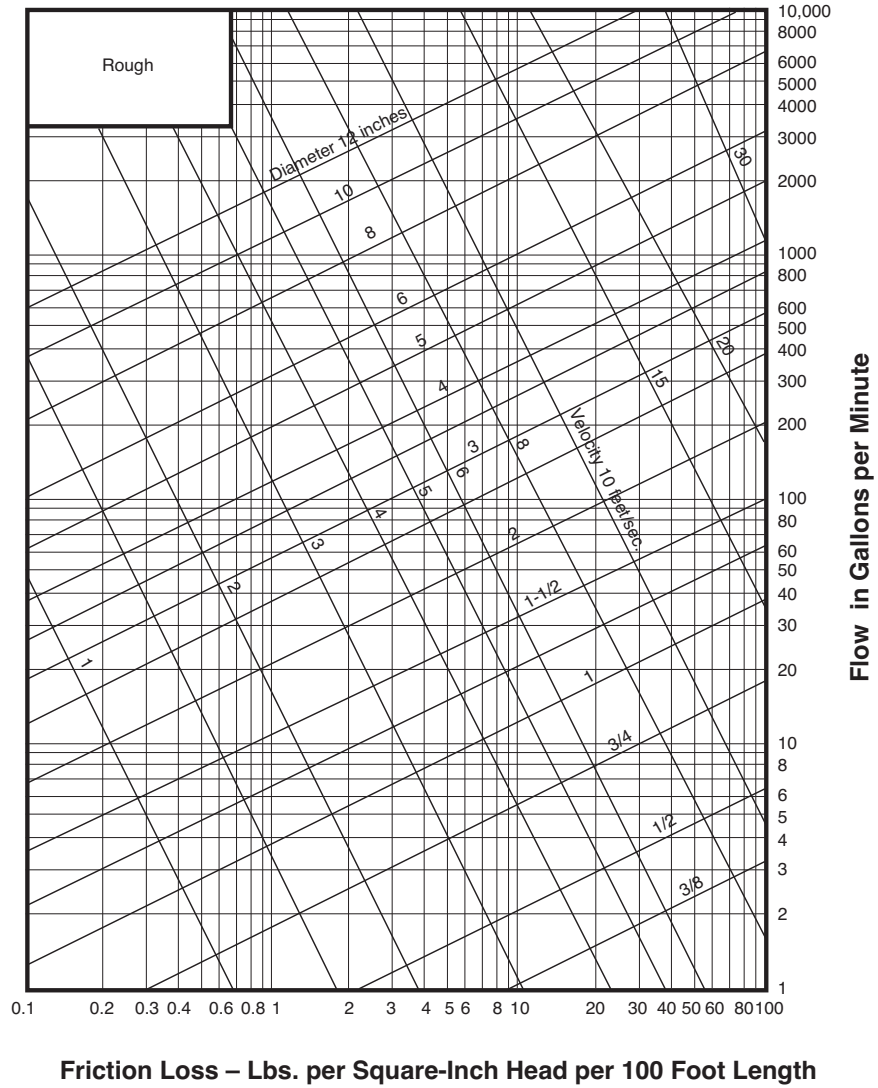


Chart A-7 (Metric)

