METHOD OF SIZING UP-FEED SYSTEMS

Example 3. A typical layout of cold water lines for a 3-story, nine-family apartment house is shown in Fig. 3. The branch to each apartment supplies 1 lavatory, 1 bath tub, 1 flush valve closet, and 1 kitchen sink. Pressure in the street main is 70 lb per square inch and a minimum pressure of 15 lb per square inch must be maintained on the top floor. Find the sizes of all parts of the system.

Solution: The first step toward the solution of such a problem is the determination of the probable flow in the various parts of the system. In Section *A*, which supplies cold water to a single apartment, the maximum flow would be as follows:

1 water closet	45 gpm
1 lavatory	3 gpm
1 tub	5 gpm
1 sink	4 gpm
	57 gpm

From Fig. 1, the probable usage for 57 gpm maximum flow in a mixed system is 100 per cent. Therefore, Section *A* should be sized for 57 gpm.

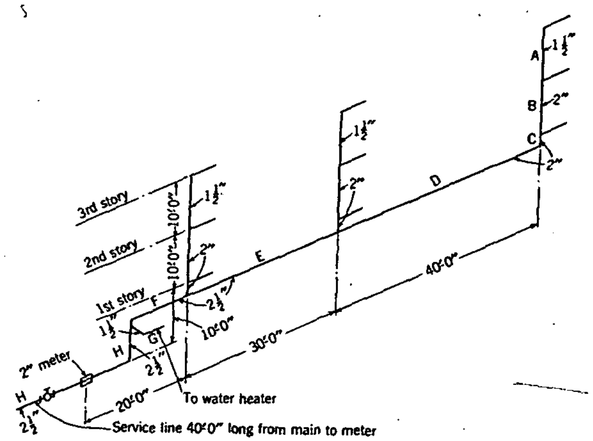

FIG. 3. UP-FEED COLD WATER SYSTEM WITH FLUSH VALVES

Section *B*, which supplies two apartments will have a maximum flow of 2 × 57 gpm = 114 gpm. From Fig. 1, the probable usage for 114 gpm is approximately 75 per cent and the probable flow in Section *B* = 114 × 0.75 = 86 gpm.

Similarly, the probable flow in Section *C* is found to be 98 gpm. Since all risers in this particular example are supplying the same number of fixtures, the probable flow in risers 1 and 2 is the same as determined for riser 3.

To determine the probable flow in Section *E*, add the maximum flow in risers 2 and 3, and multiply the sum by the probable usage for the sum, thus:

(171 + 171) × 0.35 = 120 gpm probable flow in *E*. Similarly, the probable flow in Section *F* is determined.

It should be noted that the probable flow in *E* cannot be determined by adding the probable flow in risers 2 and 3.

Initially it was decided to size only the cold water lines in this example, but it is also necessary to determine the maximum flow in line *G* to the water heater, since this is a

part of the water supplied by the cold water service line. Total hot water requirements are as follows:

9 lavatories	9 × 3 = 27 gpm
9 tubs	9 × 5 = 45 gpm
9 sinks	9 × 4 = 36 gpm
Maximum flow	= 108 gpm

The probable flow in all sections of the system are determined as described previously, and tabulated in Table 4.

The next step in the solution is the determination of the allowable pressure drop:

Loss in a 2 in. meter for 149 gpm, from Table 2	= 22 lb per square inch
Hydrostatic head = 30 ft (30 × 0.43)	= 13 lb per square inch
Pressure at top fixture	= 15 lb per square inch
Total	50 lb per square inch
Allowable pressure loss = 70 − 50 lb	= 20 lb per square inch

To determine the allowable pressure loss per 100 ft of pipe, the longest run to the highest fixture must be used. In Fig. 3 this would be the length to the top fixtures on riser No. 3. The developed length from the meter to the top of riser 3 is 120 ft, and the

TABLE 4. SUMMARY OF RESULTS FOR EXAMPLE 3

Section	Maximum Flow Gpm	Probable Usage Per Cent	Probable Flow Gpm	Allowable Loss Lb per 100 Ft	Pipe Size In.
A	57	100	57	9.1	1½
B	114	75	86	9.1	2
C–D	171	57	98	9.1	2
E	342	36	123	9.1	2½
F	513	28	144	9.1	2½
G	108	43[a]	46	9.1	1½
H	621	24	149	9.1	2½

[a]From curve for fixtures having no flush valves.

equivalent length, allowing 50 per cent for fittings is 180 ft. The service line is 40 ft long, making a total equivalent length of 220 ft from the main to the farthest fixture. Since the service line is usually straight, no allowance has been made for fittings.

The total allowable loss is 20 lb per square inch, and the developed length of piping is 220 ft. Therefore, the allowable loss per 100 ft of pipe is $\frac{20 \times 100}{220} = 9.1$ lb.

Knowing the probable flow in all lines and the allowable loss per 100 ft of pipe, it is possible to determine the pipe sizes from Fig. 2 by reading the pipe size indicated at the intersection of the two known factors. Pipe sizes for all parts of the system are given in Table 4.

Ordinarily the size above the intersection on the chart is selected. However, it is permissible to select a pipe slightly undersize if the next section of the line is oversize. This is illustrated in the sizing of sections *A* and *B*. The pipe size of 1½ in. is slightly small for *A*, but 2 in. is enough oversize for *B*, so that the average loss in the two is less than 9.1 lb per 100 ft.

In this example, all risers have been sized for the same loss per 100 ft of pipe. Where the main is long it is frequently possible to increase the pressure drop per 100 ft of pipe in the risers near the meter, and thus reduce their size. For example, the total friction loss from the meter to the top of riser 1 in Fig. 3, could be as great as the total loss from the meter to the top of riser 3. However, all parts of the main must always be sized to assure sufficient pressure at the last riser. In a small system, such as shown in Fig. 3, no appreciable reduction in pipe sizes can be made by taking advantage of the possibility just described.