

*sectionalizing* is for the purpose of avoiding excessive pressures on the fixtures in the lower stories of each system. This limits the consideration of water pipe sizes to horizontal mains and to risers not exceeding 20 stories in height or about 200 ft.

For the purpose of this chapter the following terms will be used and should be clearly distinguished from one another:

**Maximum Possible Flow:** The flow which would occur if the outlets on all fixtures were opened simultaneously. This condition is seldom, if ever, obtained in actual practice except in cases of gang showers controlled from one common valve, and similar conditions.

**Maximum Probable Flow:** The maximum flow which any pipe is likely to carry under the peak conditions. This is the most important amount to be considered in pipe sizing.

**Average Probable Flow:** The flow likely to be required through the line under normal conditions.

It is evident that any pipe adequate to take care of the *maximum*

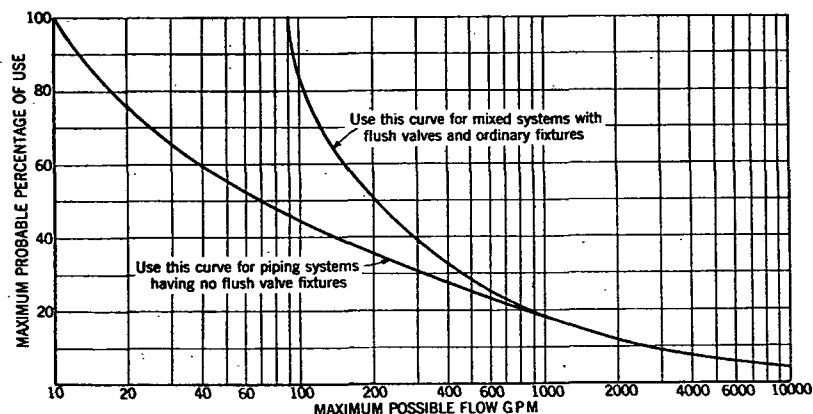


FIG. 1. CHART SHOWING RELATION BETWEEN MAXIMUM POSSIBLE FLOW AND MAXIMUM PROBABLE PERCENTAGE OF USE

*probable flow* will also be more than able to take care of the *average probable flow*, and hence the latter has no bearing on the pipe size.

### MAXIMUM PROBABLE FLOW

There are two factors to be considered in calculating the maximum probable flow, namely, (1) the quantity of water that will flow from the outlets when they are open, and (2) the number of outlets likely to be open *at the same time*. Table 1 shows the maximum approximate rate of flow from each fixture when it is in use, and will serve as a guide in estimating maximum probable flow demands although there is considerable variation in different fixtures and valves. Probably the flow under normal water pressures, or with the pressure properly throttled, will not differ greatly from the values stated. With the aid of this table it is possible to calculate the maximum possible flow with all outlets open in both the hot and cold water lines.

To obtain the maximum probable flow it is necessary to multiply the maximum possible flow by a factor of usage, and this factor varies with the installation and the number of fixtures in the installation. It is evident that with two fixtures it is quite possible that both will at some time be in operation simultaneously. With 200 fixtures, it is unlikely the entire 200 would ever operate at the same time. Consequently, the factor of usage reduces as the number of fixtures becomes greater, all other things being equal.

TABLE 1. APPROXIMATE FLOW FROM FIXTURES UNDER NORMAL WATER PRESSURES

| FIXTURES                                | COLD WATER<br>(GALLONS PER<br>MINUTE) | HOT WATER<br>(GALLONS PER<br>MINUTE) |
|-----------------------------------------|---------------------------------------|--------------------------------------|
| Water-closets, flush valve.....         | 45 <sup>a</sup>                       | 0                                    |
| Water-closets, flush tank.....          | 10                                    | 0                                    |
| Urinals, flush valve.....               | 30 <sup>a</sup>                       | 0                                    |
| Urinals, flush tank.....                | 10                                    | 0                                    |
| Urinals, automatic tank.....            | 1                                     | 0                                    |
| Urinals, perforated pipe per foot.....  | 10                                    | 0                                    |
| Lavatories.....                         | 3                                     | 3                                    |
| Showers, 4 in. heads, ½ in. inlets..... | 3                                     | 3                                    |
| Showers, 6 in. heads or larger.....     | 6                                     | 6                                    |
| Needle bath.....                        | 30                                    | 30                                   |
| Shampoo spray.....                      | 1                                     | 1                                    |
| Liver spray.....                        | 2                                     | 2                                    |
| Manicure table.....                     | 1½                                    | 1½                                   |
| Baths, tub.....                         | 5                                     | 5                                    |
| Kitchen sink.....                       | 4                                     | 4                                    |
| Pantry sink, ordinary.....              | 2                                     | 2                                    |
| Pantry sink, large bibb.....            | 6                                     | 6                                    |
| Slop sinks.....                         | 6                                     | 6                                    |
| Wash trays.....                         | 3                                     | 3                                    |
| Laundry tray.....                       | 6                                     | 6                                    |
| Garden hose bibb.....                   | 10                                    | 0                                    |

<sup>a</sup>Actual tests on water-closet flush valves indicate 40 gpm as the maximum rate of flow with 30 lb pressure at the valve; this would increase to 60 gpm (about 50 per cent) at 90 lb pressure. The 45 gpm has been taken as an average flow; possibly, with very low pressures just sufficient to operate the flush valve, 30 gpm could be allowed with safety. Urinal flush valves would vary proportionately in the same manner.

In practice all the elements will vary according to conditions; in the case of flush valve closets the duration of flush with the kind and condition of supply apparatus, the interval between flushes with the number of people using the system and their habits; and the length of the rush period with the type of installation and its location. The effect of each of these time elements on the results should be considered in connection with any data on which it is based before passing judgment on the selection of the factor of usage. The longer the duration of the flush the greater is the probability of overlapping flow. In selecting the factor of usage shown in Fig. 1 for systems having flush valves, 10 seconds was chosen as the maximum duration of flush, a value that represents an approximate average as water closets are installed.

While the curve has been calculated for systems composed of water closets alone, it is possible to calculate probabilities for mixed systems of water closets and other smaller fixtures. It has been found however that for two systems both having the same maximum possible flow, one composed entirely of water closets and the other a mixed system of water