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 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.

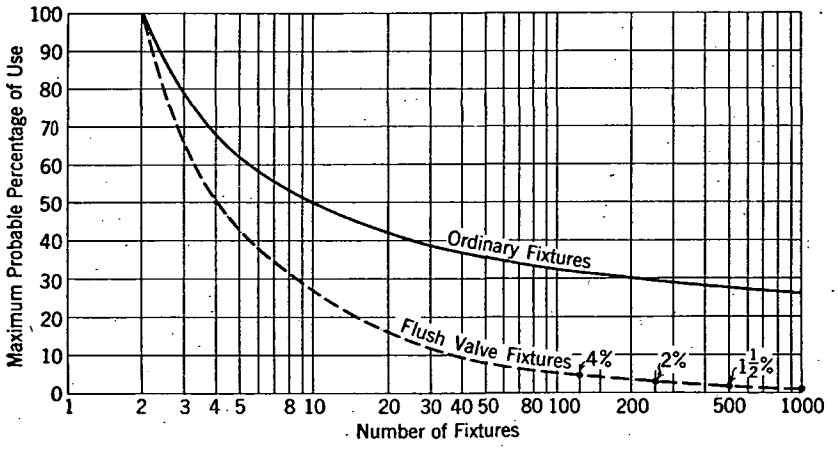

FIG. 1. CHART SHOWING RELATION BETWEEN NUMBER OF FIXTURES AND MAXIMUM PROBABLE PERCENTAGE OF USE

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.

Factor of Usage

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. On the other hand it is probable that outside of flush valve fixtures, the factor of usage would never be less than about 25 per cent no matter how many fixtures were installed, provided no fixtures in excess of those required for the actual occupancy were included.

TABLE 1. APPROXIMATE FLOW FROM FIXTURES UNDER NORMAL WATER PRESSURES

FIXTURES	COLD WATER (GALLONS PER MINUTE)	HOT WATER (GALLONS PER MINUTE)
Water-closets, flush valve	50[a]	0
Water-closets, flush tank	18	0
Urinals, flush valve	40[a]	0
Urinals, flush tank	18	0
Urinals, automatic tank	1	0
Urinals, perforated pipe per foot	10	0
Lavatories	3	3
Showers, 5 to 6½ in. heads	3	3
Showers, tubular	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	4	4
Wash trays	3	3

[a]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 50 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.

This factor, beginning at 100 per cent for two ordinary fixtures, decreases rapidly until 5 fixtures is reached and then becomes almost constant, as shown in the upper curve, Fig. 1. This applies to a normal building and not to institutions where the inmates may all be required, for instance, to bathe on certain days of the week and at certain hours of those days. In such special cases a new factor of usage must be developed based on the maximum probable usage under the conditions involved. For flush valve fixtures the quantity of water is greater, but owing to the short duration of the flush, the simultaneous usage drops more rapidly so as to reach 1 per cent for 1000 fixtures as shown, on lower curve, Fig. 1[2].

[2]This can be proved by assuming, for example, 1000 water-closets which would not be used more than six times per hour (or once every 10 minutes) and which require from 5 to 7 gal per flush or an average of about 6 gal. If these closets were all being used at their utmost capacity, the water demand would be 600 gpm. But average use would be about one-third of this and peak conditions would be in the neighborhood of twice the average, or about 400 gpm as the maximum that would ever develop. Assuming 50 gpm as the maximum rate of flow per closet and 1 per cent of the total closets in operation, the rate would be 50 gpm × 1 per cent of 1000 or 500 gpm. This is 100 gpm higher than obtained by the first method indicating an additional factor of safety over the first method.