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CHAPTER 56

# WATER SERVICES

***Sizing Cold Water Supply Piping, Procedure for Sizing Cold Water Systems, Cooling Water Piping, Estimating Heating Load and Storage Capacity, Methods of Heating Water, Direct-Fired, Electric, and Indirect Water Heaters, Computing Heat Transfer Surface, Hot Water Supply Piping, Control of Service Water Temperature, Safety Devices, Solar Water Heaters, Domestic Hot Water by Heat Pump***

PROPER design of the water distributing system in a building is necessary in order that the various fixtures may function properly. The amount of either hot or cold water used in any building is variable, depending on the type of structure, usage, occupancy, and time of day. It is necessary to provide piping, water heating, and storage facilities of sufficient capacity to meet the peak demand without wasteful excess in either piping or equivalent cost.

## SIZING COLD WATER SUPPLY PIPING

One of the important items that must be determined before any part of the water-piping system can be sized, is the probable rate of flow in any particular reach of piping. The rate of flow in the service line, risers, and main branches, however, will rarely be equal to the sum of the rates of flow of all connected fixtures. In fact, the probability that every fixture in a large group will be in use at the same time is so remote that it would be very poor engineering practice to design the piping to take care of such simultaneous flow.

The demand load in building water supply systems cannot be determined exactly and is not readily standardized. The two main problems to be considered are: (1) the satisfactory supply of water for a given fixture, and (2) the number of fixtures which may be assumed to be in use at the same time.

The minimum flow that will be satisfactory to the consumer depends greatly on the consumer, his standard of living, his professional needs, size of family, garden requirements, and similar factors. Depending on these factors, the per capita water consumption for domestic use usually varies between 20 and 80 gal per day. Experience indicates that the type of dwelling also has considerable influence on the water consumption.

In *apartment houses* the per capita daily water consumption is generally higher than in single-family houses. This is due to the use of a central metering system which is not conducive to the saving of water, and to the long hot water lines which cause high heat losses and an increase in the wasting of the cooled water. In designing water supply systems for apartment houses, a daily per capita water consumption of 50 gal may be considered a safe design figure.

Although a considerable number of *housing projects* have been developed throughout the United States, conclusive water consumption data have not yet been gathered. Nevertheless, it seems that the daily per capita water consumption in *housing projects* falls in between the consumption in apartment houses and that in single dwellings at the same geographical location. In general, a daily per capita water consumption of 40 gal can be used as a safe design figure for *housing projects*.

Table 1 gives the rate of flow desirable for many common types of fixtures, and the average pressure necessary to give this rate of flow. The pressure necessarily varies with fixture design, a much greater pressure being necessary with some fixtures to give the same rate of flow as in others. In general, the lower the quality of the faucet the greater will be the pressure required.

In estimating the load, the rate of flow is frequently computed in *fixture units*. One *fixture unit* is equivalent to 7.5 gal per min. Table 2 gives the demand weights in terms of fixture units for different plumbing fixtures under several conditions of service, and Fig. 1 gives the estimated demand in gallons per minute corresponding to any total number of *fixture units*. Fig. 2 shows an enlargement of Fig. 1 for a range up to 250 *fixture units*.

The estimated demand load for fixtures used intermittently on any supply pipe will be obtained by multiplying the number of each kind of fixture supplied through that pipe by its weight from Table 2, adding the products, and then referring to the appropriate curve of Figs. 1 or 2 to find the demand corresponding to the total fixture units. In using this method it should be noted that the demand for fixture or supply outlets other than those listed in the table of fixture units is not yet included in the estimate. The demands for outlets (such as hose connections, air-conditioning apparatus, etc.) which are likely to impose continuous demand during times of heavy use of the weighted fixtures, should be estimated separately and added to the demand for fixtures used intermittently, in order to estimate the total demand.

So far, the information presented makes possible the de-

**Table 1 . . . . Proper Flow and Pressure Required During Flow for Different Fixtures**

| Fixture | Flow Pressure[a] | Flow gpm |
|---|---|---|
| Ordinary basin faucet | 8 | 3.0 |
| Self-closing basin faucet | 12 | 2.5 |
| Sink faucet—3/8 in. | 10 | 4.5 |
| Sink faucet—1/2 in. | 5 | 4.5 |
| Bathtub faucet | 5 | 6.0 |
| Laundry tub cock—1/4 in. | 5 | 5.0 |
| Shower | 12 | 5.0 |
| Ball-cock for closet | 15 | 3.0 |
| Flush valve for closet | 10–20 | 15–40[b] |
| Flush valve for urinal | 15 | 15.0 |
| Garden hose, 50 ft, and sill cock | 30 | 5.0 |

[a] Flow pressure is the pressure in the pipe at the entrance to the particular fixture considered.
[b] Wide range due to variation in design and type of flush-valve closets.