

potable system. Such and other potentially dangerous situations in water systems are termed cross connections.

Spafford¹² reports that the 40 water-borne epidemics recorded from 1907 to 1953 in Illinois have resulted in 13,000 known cases of illness and 200 deaths. Eighteen of the outbreaks, almost half of the total, were caused by some type of faulty piping or plumbing arrangement that permitted sewage or other contaminated water to enter a safe water system, either at the source or in the distribution facilities. This experience is in agreement with the general observation that cross connections between safe and raw or unsafe water systems have been the greatest single cause of water-borne epidemics.

Contamination of the potable water supply by means of cross connections or defective plumbing fixtures may take place (1) by the occurrence of a vacuum in the supply lines causing back-siphonage of contaminated material; (2) by the development of pressure in the fixture, appliance, or piping system to which the water supply is connected that is greater than that in the supply system itself; and (3) through the activities or actions of vermin, birds, or small animals in parts of the supply system not under pressure, or by dust reaching water-holding devices.¹³

Periods when reduced pressure or partial vacuum situations may occur within a potable water system result from the following circumstances or by a combination of a number of them:

1. The interruption of the supply for maintenance of the municipal or service supply main.
2. Excessive demand placed upon the supply mains during fire or other emergencies.
3. Complete failure of the supply due to breaks in the mains, interruption of pumping, either by mechanical failure or power shut-off, or deficient water supply.
4. Freezing of mains or service lines in extremely cold weather.
5. Excessive friction losses due to inadequate size of mains or service lines, or due to reduction of the effective diameter of pipes caused by deposits and encrustations.
6. Occurrence of negative water hammer pressure waves.
7. Operation of long pump suction lines.
8. Condensation of steam within boilers, hot water systems or such units as hospital sterilizers.

F. ELIMINATION OF CROSS CONNECTIONS

The safest method of making two supplies available to a building is by the use of an unobstructed vertical fall through the free atmosphere between the

¹² H. A. Spafford, Cross connection hazards and protection, *J. Am. Water Works Assoc.*, 46, 993-998 (1954).

¹³ A. B. Cronkright and A. P. Miller, Plumbing and public health, *U. S. Pub. Health Bull.* No. 256, 1940.

lowest opening from any pipe supplying water to a reservoir and the highest possible level the water may reach in the reservoir. The minimum air gap thus provided should be two times the diameter of the effective opening and in no case less than four inches. In addition a float valve arrangement should be installed to cut off the supply when the water reaches the free overflow level. The overflow channel or pipe should allow free discharge to the atmosphere with no enclosed connection to the sewer (Figure 1). A suitable swing ell may be utilized where the potable supply and the secondary supply are not required to be available at all times (Figure 2).

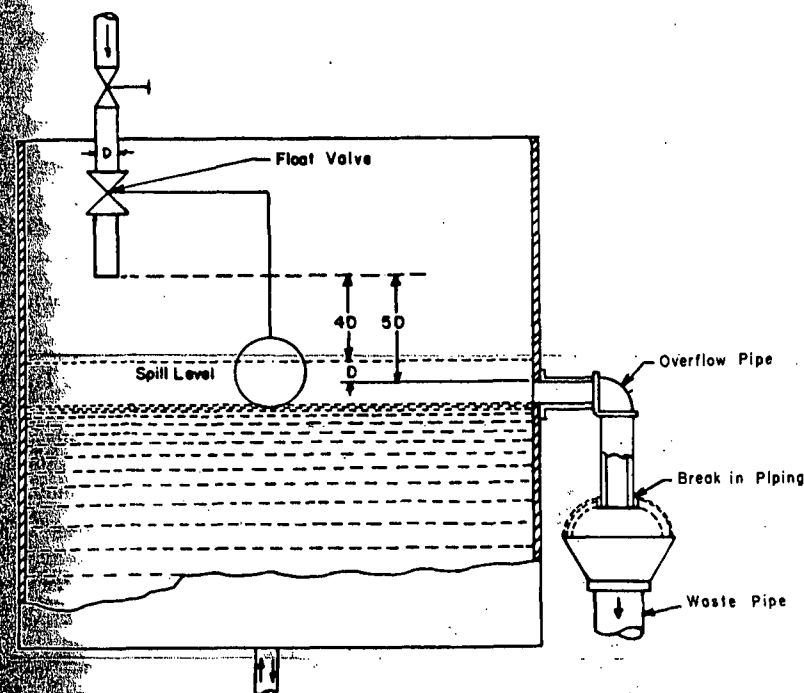


Figure 1. A method of connecting a public water supply to a private water supply through a tank or reservoir.

To prevent backflow from fixtures in which the outlet end may at times be submerged, such as a hose and spray, direct flushing valves and other devices in which the surface of the water is exposed to atmospheric pressure, a vacuum breaker should be installed. There are two general types of vacuum breakers: (a) moving part and (b) nonmoving part. Whichever type is used it should meet