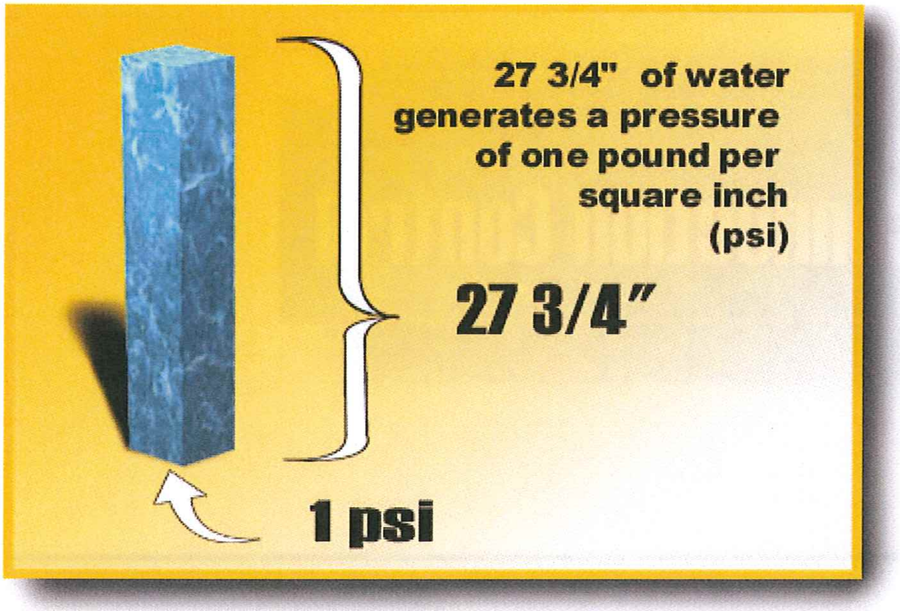
Backflow

The term *backflow* means any unwanted flow of used or non-potable water or substance from any domestic, industrial or institutional piping system into the pure, potable water distribution system. The direction of flow under these conditions is in the reverse direction from that intended by the system and normally assumed by the owner of the system. Backflow may be caused by numerous specific conditions; but, basically the reverse pressure gradient may be due to either a loss of pressure in the supply main called backsiphonage, or by the flow from a customer's pressurized system through an unprotected cross-connection, which is called backpressure. Thus the term backflow covers both a backsiphonage condition and a backpressure condition. A reversal of flow in a distribution main--or in the customer's system--can be created by any change of system pressure wherein the pressure at the supply point becomes lower than the pressure at the point of use. When this happens in an unprotected situation the water at the point of use will be siphoned back into the system; thus, potentially polluting or contaminating the remainder of the customer's system. It is also possible that the contaminated or polluted water could continue to backflow into the public distribution system. The point at which it is possible for a non-potable substance to come in contact with the potable drinking water system is called a cross-connection. To prevent backflow from occurring at the point of a cross-connection a backflow prevention assembly must be installed. However, it is important the backflow prevention assembly match the particular hydraulic conditions at that location and is suitable to protect against the degree of hazard present. The particular type of backflow preventer appropriate for specific needs will be discussed later. First, it is necessary to understand some basic hydraulics which govern the principles of backflow and cross-connection control.

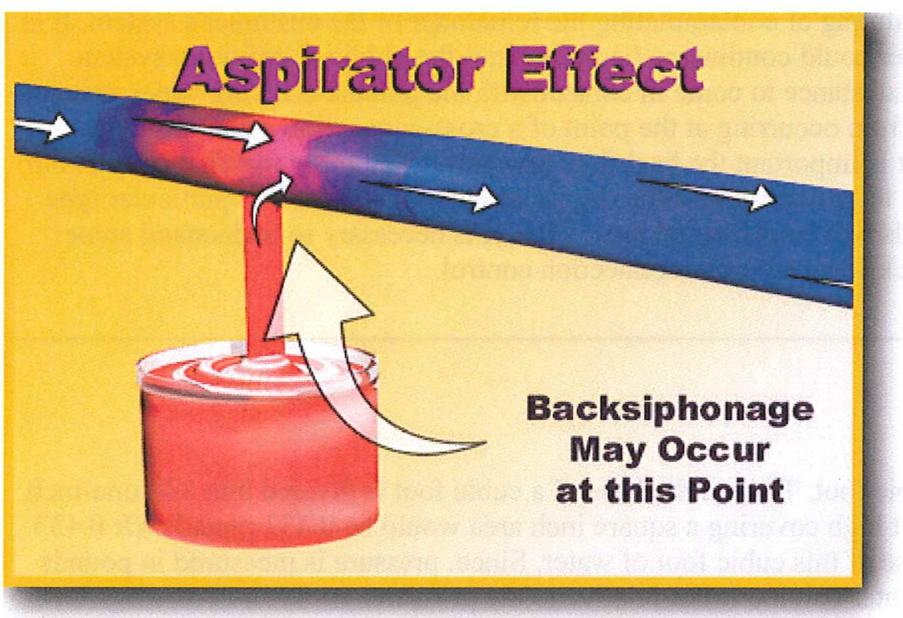
Pressure

Pure water at sea level weighs 62.4 pounds per cubic foot. Thus, if the base of a cubic foot is divided into 144 one-inch squares, the weight of the column of water one foot high covering a square inch area would be 0.433 pounds. Or 0.433 pounds per square inch of pressure exists at the base of this cubic foot of water. Since, pressure is measured in pounds per square inch, the area covered at the base of a water column is not relative to the pressure.



As a rule of thumb, it is said that a column of water one foot high creates a pressure of approximately 1/2 pound per square inch, or psi.

Another term used for measuring pressure aside from psi is inches of mercury, or "Hg. This is because mercury manometers are often used to measure pressure differentials. However, mercury weighs 13.5 times the weight of water. Therefore, one "Hg is approximately 1/2 psi.



Backsiphonage

Technically, if one siphons a fluid out of a container or a pipeline, one causes that fluid to flow up over the rim of the container or top of the pipe and then down into a lower elevation through a piece of tubing or, in this case a piece of pipe that is part of the distribution system. In the vernacular, the unwanted fluid is "sucked" into the potable water line. It is important to understand that it is not necessary for the system main to be under a true vacuum (i.e., zero psia) for backsiphonage to occur. All that is required is a negative difference in pressure and a piece of tubing or pipe that is completely full of fluid.

One of the causes of backsiphonage is a situation that arises when a temporary shutdown of a water main--or an in-plant pipe--becomes necessary for repairs. If the repair is at some point other than that of the highest point in the system, then there will be a potential for a reverse flow if one of the lower points of service is opened while the main valve is closed. Under this condition the water in the internal piping system will drain to the open valve or point of water use, siphoning anything it may be in contact with at the time.

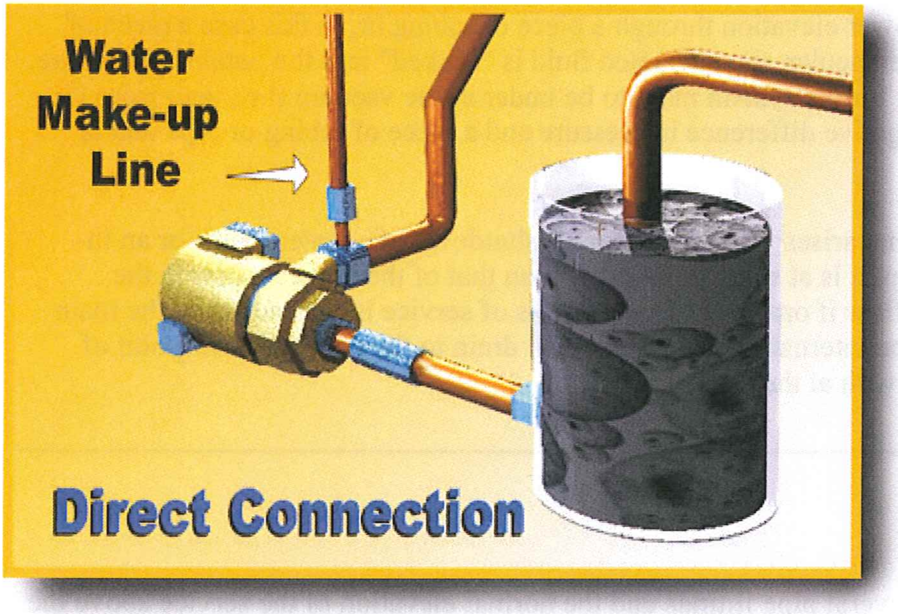
Backpressure

Due to the length of a main distribution pipe, the several pipe fittings and the normal elevation of the service above the distribution main, the pressure gradient within a service decreases as the point of discharge becomes further and further from the main. Consequently, in many processing plants or high-rise buildings there is need to use a booster pump; or, in many instances, a recirculating pump. The use of an in-plant pump can easily increase the in-plant pressure above that of the supply main. Thus, if there is any pathway whereby this pressurized industrial water may enter the potable distribution system, there will be a hazard as the result of this backpressure.

Types of Cross-Connection

A *cross-connection* is any actual or potential connection or structural arrangement between a public or private potable water system and any other source or system through which it is possible to introduce into any part of the potable system any used water, industrial fluids, gas, or substance other than the intended potable water with which the potable system is supplied. By-pass arrangements, jumper connections, removable sections, swivel or change-over arrangements or other "temporary" arrangements through which backflow could occur are considered to be cross-connections

General progress in the elimination of cross-connections has been very slow. It required over a score of years for various water, health and fire insurance representatives to understand that no direct connection should be made between the potable water supply system and polluted auxiliary water supplies. It was not until the Chicago amoebic dysentery outbreak of 1933 that a general move toward correction of plumbing hazards was given impetus. And, since that time the recognition of a backflow prevention program and its value has been very slow, until about 1970.



There are two basic types of cross-connections: a direct cross-connection and an indirect cross-connection. The difference between these two types of cross-connections is very simple. A direct cross-connection is subject to backpressure (as shown above); an indirect cross-connection is not subject to backpressure. An example of a direct cross-connection would be the make-up water line feeding a recirculating system. An over-the-rim inlet used to fill an open receiving vessel would be an example of an indirect cross-connection. Backpressure could not be introduced into the supply line with this type of connection.

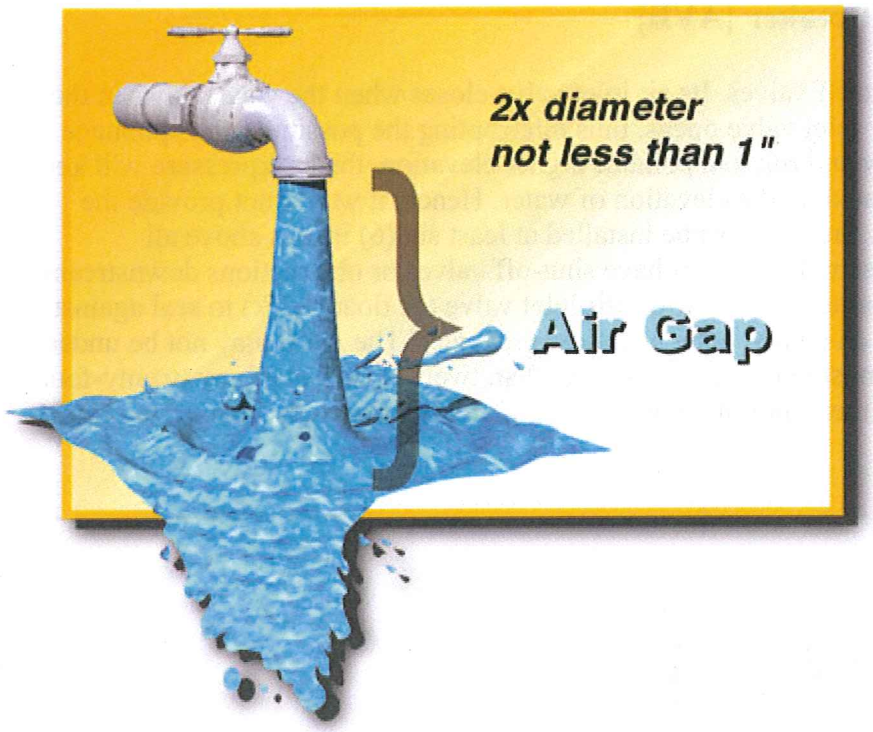
Degree of Hazard

The type of backflow preventer used to prevent backflow from occurring at the point of a cross-connection depends on the type of substance which may flow into the potable water supply. A pollutant is considered to be any substance which would affect the colour or odor of the water, but would not pose a health hazard. This is also considered a non-health hazard. A substance is considered a health hazard if it causes illness or death if ingested. This health hazard is called a contaminant.

Sewage and radioactive materials are considered Lethal Hazards. This is because of the epidemic possibilities associated with sewage and the tremendous dangers associated with radioactive material.

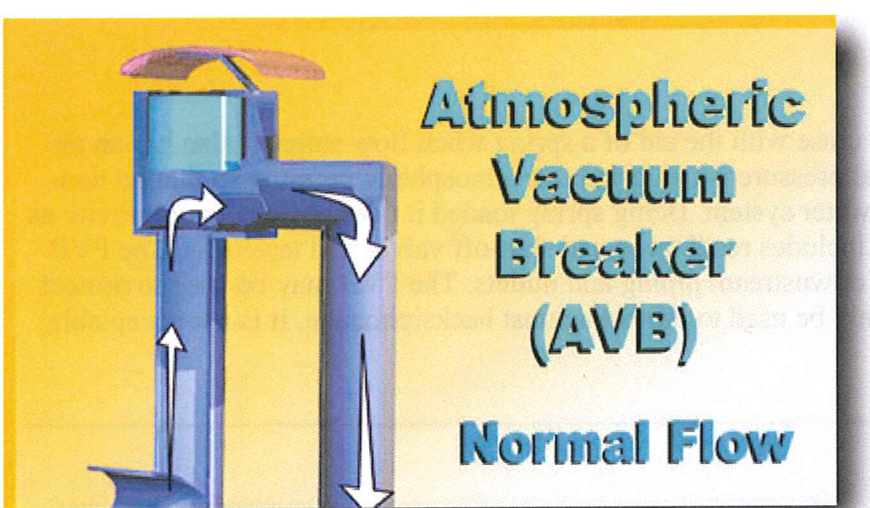
Types of Backflow Preventers

There are five distinct types of piping or mechanical assemblies which are considered to be backflow prevention assemblies; but, it must be stressed that these are not all equally acceptable as protection against all types of hazards. The degree of hazard must be assessed along with they type of cross-connection present to determine which type of backflow prevention assembly is most suitable to the situation.



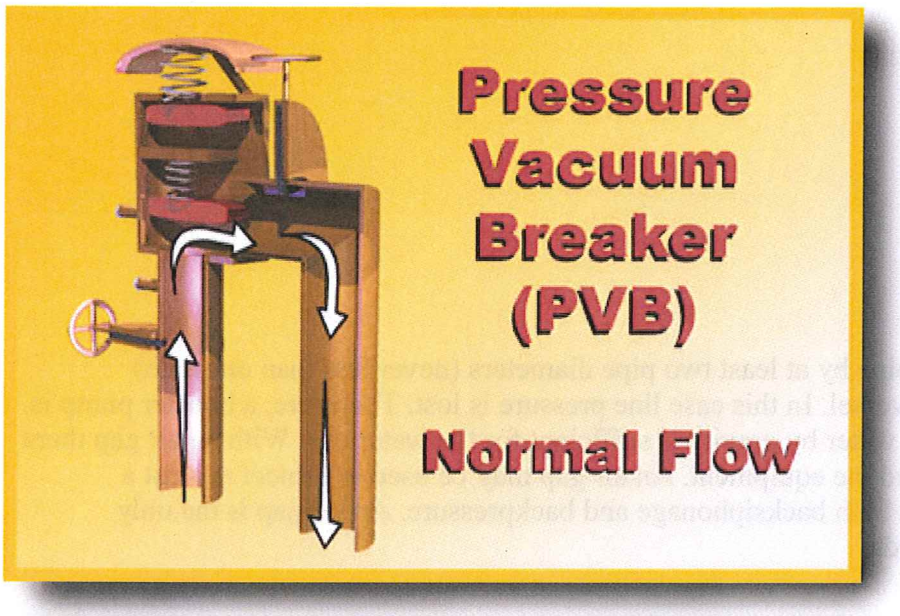
Air Gap

An Air Gap is a physical separation of the supply pipe by at least two pipe diameters (never less than one inch) vertically above the overflow rim of the receiving vessel. In this case line pressure is lost. Therefore, a booster pump is usually needed downstream, unless the flow of the water by gravity is sufficient for the water use. With an air gap there is no direct connection between the supply main and the equipment. An air gap may be used to protect against a contaminant or a pollutant, and will protect against both backsiphonage and backpressure. An air gap is the only acceptable means of protecting against lethal hazards.



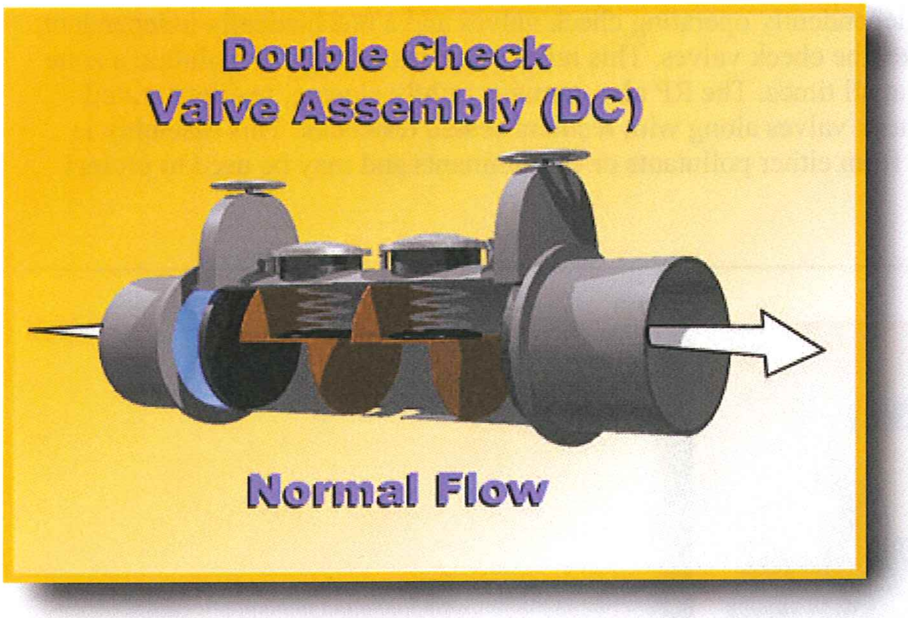
Atmospheric (non-pressure) Type Vacuum Breaker {AVB}

The AVB is always placed downstream from all shut-off valves. Its air inlet valve closes when the water flows in the normal direction. But, as water ceases to flow the air inlet valve opens, thus interrupting the possible backsiphonage effect. If piping or a hose is attached to this assembly and run to a point of higher elevation, the backpressure will keep the air inlet valve closed because of the pressure created by the elevation of water. Hence, it would not provide the intended protection. Therefore, this type of assembly must always be installed at least six (6) inches above all downstream piping and outlets. Additionally, this assembly may not have shut-off valves or obstructions downstream. A shut-off valve would keep the assembly under pressure and allow the air inlet valve (or float check) to seal against the air inlet port, thus causing the assembly to act as an elbow, not a backflow preventer. The AVB may not be under continuous pressure for this same reason. An AVB must not be used for more than twelve (12) out of any twenty-four (24) hour period. It may be used to protect against either a pollutant or a contaminant, but may only be used to protect against a backsiphonage condition.



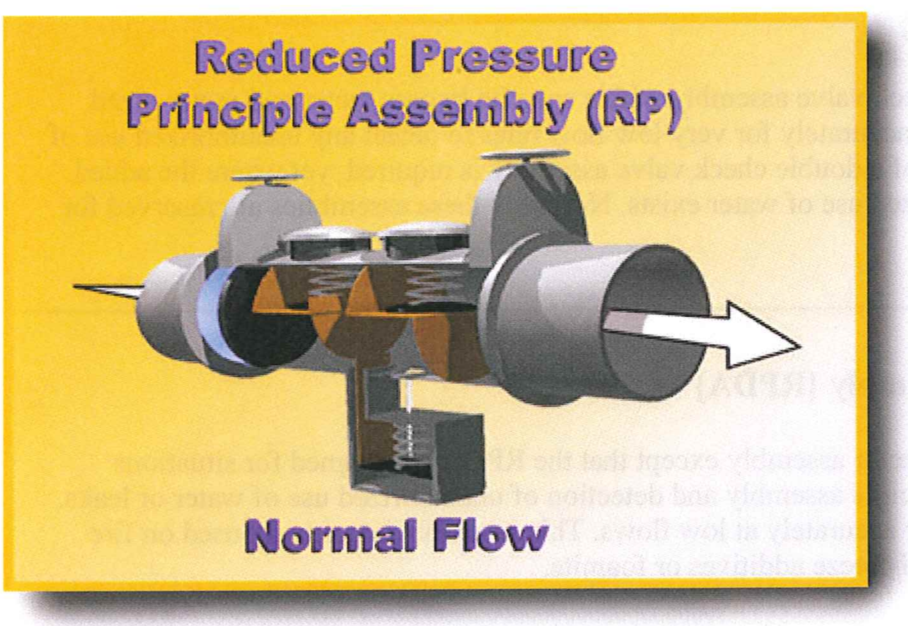
Pressure Vacuum Breaker {PVB}

The PVB includes a check valve which is designed to close with the aid of a spring when flow stops. It also has an air inlet valve which is designed to open when the internal pressure is one psi above atmospheric pressure so that no non-potable liquid may be siphoned back into the potable water system. Being spring loaded it does not rely upon gravity as does the atmospheric vacuum breaker. This assembly includes resilient seated shut-off valves and testcocks. The PVB must be installed at least twelve (12) inches above all downstream piping and outlets. The PVB may be used to protect against a pollutant or contaminant, however, it may only be used to protect against backsiphonage. It is not acceptable protection against backpressure.



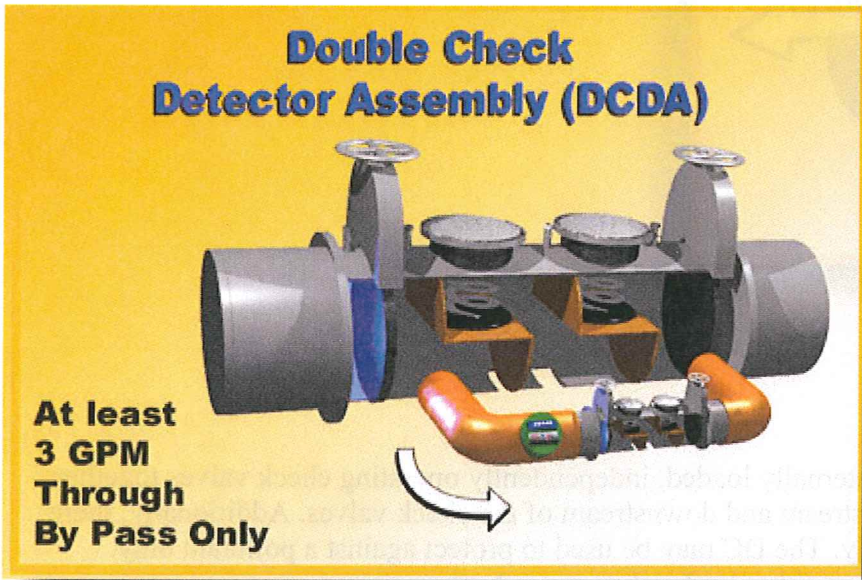
Double Check Valve Assembly {DC}

The Double Check Valve Assembly consists of two internally loaded, independently operating check valves together with tightly closing resilient seated shut-off valves upstream and downstream of the check valves. Additionally, there are resilient seated testcocks for testing of the assembly. The DC may be used to protect against a pollutant only. However, this assembly is suitable for protection against either backsiphonage or backpressure.



Reduced Pressure Principle Assembly {RP}

This assembly consists of two internally loaded independently operating check valves and a mechanically independent, hydraulically dependent relief valve located between the check valves. This relief valve is designed to maintain a zone of reduced pressure between the two check valves at all times. The RP also contains tightly closing, resilient seated shut-off valves upstream and downstream of the check valves along with resilient seated testcocks. This assembly is used for the protection of the potable water supply from either pollutants or contaminants and may be used to protect against either backsiphonage or backpressure.

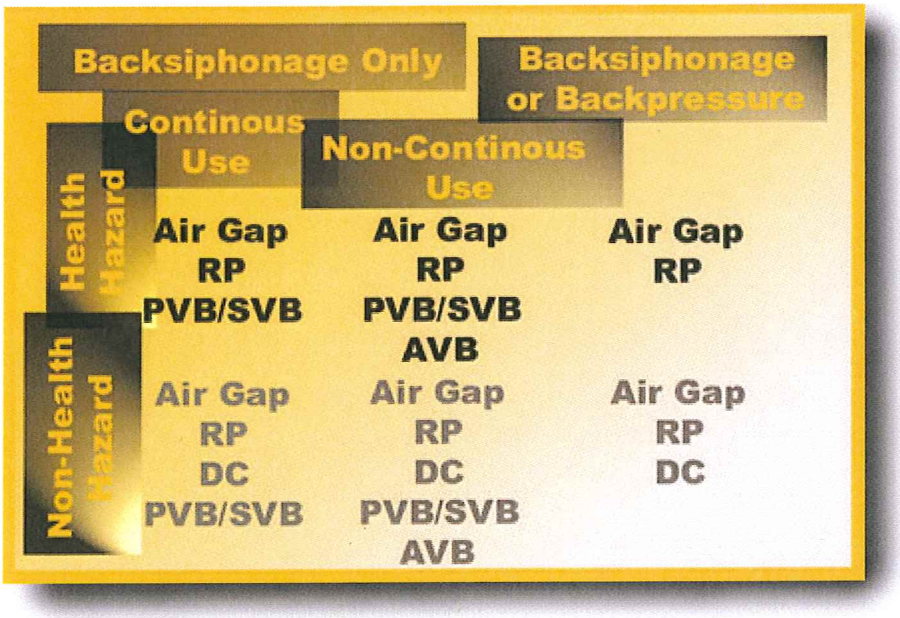


Double Check Detector Assembly {DCDA}

The DCDA is composed of a line-sized double check valve assembly with a specific bypass meter and meter-sized double check valve assembly. The meter registers accurately for very low flow rates to detect any unauthorized use of water. This assembly is used when the protection of a double check valve assembly is required, yet where the added requirement of detecting any leakage or unauthorized use of water exists. Normally these assemblies are reserved for use on fire sprinkler lines.

Reduced Pressure Principle Detector Assembly {RPDA}

The RPDA is very similar to the double check detector assembly except that the RPDA is designed for situations requiring the protection of a reduced pressure principle assembly and detection of unauthorized use of water or leaks. As with the DCDA, the bypass meter must register accurately at low flows. This assembly is normally used on fire lines which may contain contaminants, such as anti-freeze additives or foamite.



The chart above shows which type of assembly is acceptable for use under certain hydraulic conditions and degrees of hazard.

Foundation for Cross-Connection Control and Hydraulic Research
University of Southern California
Kaprielian Hall 200
Los Angeles, CA 90089-2531
(213) 740-2032
FAX: (213) 740-8399

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