Backflow Prevention
Part 2

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Contamination by backflow, backpressure or backsiphonage in distribution mains of a potable water system is always a concern for plumbing designers. Fortunately, this contamination can be avoided by installing the correct backflow preventer that fits the application. There are several types of backflow preventers, which were discussed in part one of this article [July/Aug 2004 *Plumbing Systems & Design*, pp. 48-49]. In this second part, I discuss which backflow preventer to use in a specific application, summarize the different degrees of hazards, and provide rules for protection of water quality.

Use of Backflow Devices

Atmospheric Vacuum Breaker. This type of vacuum breaker is the most commonly used and most misunderstood device. It is applicable for intermittent service, where it will be under pressure for a short period of time. This vacuum breaker can be found to be installed on laboratories and janitorial faucets. It is a simple device that uses a disc float assembly to seal off the atmospheric vent area when water is flowing. When the flow stops or the pressure drops to zero (atmospheric), the float falls and the vent opens to allow air to enter the system and destroy the possibility of a siphon occurring. This device is designed for backsiphonage only; it is not effective against backpressure backflow at all. It should be installed downstream from the last shut-off valve and a minimum of six inches above the highest point of the non-potable water system.

Pressure Vacuum Breaker. A pressure vacuum breaker consists of one or two positive-seating cock valves and a spring-loaded disc float internal assembly. The disc float is set in the normally open position to permit air to enter the system when the line pressure drops to one psi or lower. Pressure vacuum breakers are similar to the atmospheric type, with the exception that they can be used under conditions of continuous pressure. Although these types of vacuum breakers protect primarily against backsiphonage, they also can offer some protection against low-head backpressure backflow.

This device is installed between two shutoff valves and fitted with properly located test cocks. It can be installed on the pressure side of the shutoff valve and is designed to prevent backsiphonage only; it is not effective against backflow due to backpressure. Pressure vacuum breakers should be installed a minimum of twelve inches above the highest point of use. They can be found installed on hose-threaded outlets and laboratory faucets to which hoses can be connected.

Hose Vacuum Breaker. This device attaches directly to the hose threads of a hose bibb and isn't usually an integral part of the valve. It should not be connected to a freezeless-type hydrant unless it is a model designed specifically for this service. Some freezeless-type hydrants come with an integral vacuum breaker and do not require a retrofit. When specifying freezeless-type hydrants, verify if an integral vacuum breaker comes with the unit.

Approved Air Gap. As mentioned in part one, an air gap is a vertical distance, unobstructed, between the lowest opening in any fixture or pipe that flows potable water to a tank, fixture, or other device, and the flood rim of that receiving fixture, tank, or device. This gap must be at least twice the diameter of the device supplying the potable water or other liquid (such as waste or discharge from a pump). If the inside edge of the supply pipe is within three diameters of a vertical surface or four diameters of two adjacent vertical surfaces, the air gap should not be less

Table 1. Guide For Backflow-Prevention-Device Selection

	Degree of Hazard			Recommended Type of Backflow Preventer				
	Severe	Moderate	Minor	Air Gap	RPZ*	PVB*	AVB*	DCV*
I. Direct water connections which may be subject to backpressure:								
A. Pumps, tanks, and lines handling:								
1. Sewage and lethal substances	•			•	•			
2. Toxic substances	•			•	•			
3. Non-toxic substances		•		•	•			•
B. Water connection to steam and steam boiler:								
1. Boiler or steam connection to toxic substances	•			•	•			
2. Boiler or steam connection to non-toxic substances		•		•	•			•
II. Direct or indirect water connections not subject to backpressure:								
A. Sewer connected waste line (not subject to waste stoppages)	•			•	•	•	•	
B. Low inlets to receptacles containing toxic substances	•			•	•	•	•	
C. Low inlets to receptacles containing non-toxic substances		•		•	•	•	•	•
D. Low inlets into domestic water tanks			•	Each case should be treated separately.				
E. Lawn sprinkler systems	•			•	•	•	•	
F. Coils or jackets used as heat exchangers in compressors, degreasers, or other equipment:								
1. In sewer lines	•			•	•			
2. In toxic substances	•			•	•	•	•	
3. In non-toxic substances			•	Each case should be treated separately.				
G. Flush valve water closets and urinals	•						•	
H. Flush tanks water closets and urinals		•		•			•	
I. Valved outlets or fixtures with hose attachments which may constitute a cross-connection:								
1. Toxic substances	•			•	•	•	•	
2. Non-toxic substances		•		•	•	•	•	•

* RPZ: Reduced-Pressure Zone; PVB: Pressure Vacuum Breaker; AVB: Atmospheric Vacuum Breaker; DCV: Double Check-Valve Assembly

than three times the diameter of the supply pipe.

A well-designed and properly maintained air gap is the most positive means available for protection against backflow due to backpressure and/or backsiphonage. Air gaps are found on an air-conditioning condensation drain line where the drain line is routed to a floor drain. Care must be taken to assure that the drain line has been installed and the gap sized properly. So many times, condensate drains are laid on the floor without support under them; as s result, when they reach the floor drain they are laying on the drain grate, which is not an air gap. This situation occurs more times than you think.

Double Check-Valve Assembly. This assembly consists of two independently acting internally loaded check valves. Two shutoff valves should be included with the assembly with a strainer and test cocks for field testing. There are no provisions for discharging water, nor does it provide a visual indication of backflow or unit malfunction. This assembly does not provide the degree of protection of a reduced-pressure device and, therefore, is not widely used. A double check-valve assembly is used where there is a low degree of hazard and the effect is only a change in the color or taste of the potable water. This type of backflow device is used in applications such as fire protection and incoming water lines.

Dual Check-Valve Assembly. This type of backflow preventer is very much like the double check-valve assembly, but used for low-flow conditions and pipe sizes not exceeding 1¼ inches in size and a maximum flow rate of 50 gpm. A dual check-valve assembly shouldn't be direct buried, but can be installed in a meter box.

Reduced-Pressure Zone. Within the device's reduced-pressure zone is a differential pressure-relief valve to maintain the reduced pressure and discharge water to the atmosphere in the event of a malfunction. This type of backflow preventer is used in very high hazard conditions where the nonpotable source is considered to contain toxic substances capable of causing illness or death. These situations include areas such as laboratories, where very high levels of chemicals are used and there is a chance that the water supply system can be contaminated. This type of preventer will also be used in situations where the potable water system is connected to the HVAC systems for makeup water. These HVAC systems (Hot Water and Chilled Water Systems) can contain hazardous chemicals.

Barometric Loop. A barometric loop is an arrangement in the water system designed on the basis that atmospheric pressure cannot raise a column of water more than approximately 34 feet. This type of preventer is formed by constructing a loop in the potable water supply piping, which rises 35 feet or more above the highest point in the system. This system is very rarely used because of space limitations.

Degrees of Hazards

When classifying the rating of a hazard, a plumbing designer should always consult with the proper authority. The following ratings are often used, based on the use, toxicity, nature, and availability of contaminants. Because these ratings can't cover all circumstances or facility types, the plumbing designer must make the final selection by using his/her best judgment. **Table 1** can aid in this selection.

High (severe) Hazard. Any facility that uses chemicals considered toxic or has the potential of discharging any amount of toxic waste is considered high hazard. Types of facilities that fall under this possibility are hospitals, chemical plants, pharmaceutical processors and manufacturers, laboratories, food processors and manufacturers, industrial manufacturers and processors, and water and sewage-treatment plants.[3]

Medium (moderate) Hazard. Fire-protection storage tanks, commercial buildings and establishments and mains with no additives, and facilities that discharge water at higher-than-normal temperatures are considered medium hazards. The fire protection system will have only stagnant water present in the piping.[3]

Non-hazardous (minor) Hazard. Private homes and commercial establishments without complex plumbing or fire-protection systems are minor hazards.[3]

Rules for Protection of Water Quality

The following rules are offered as a guide to minimize the hazard of contamination or pollution of potable water systems.[2]

- ✓ No materials or chemicals should be introduced into the potable water system that could produce toxic effects.
- ✓ Never interconnect a private and public water supply system.
- ✓ Never connect the water-supply piping directly to the drainage system.
- ✓ Never connect the water-supply piping directly to embalming, mortuary, autopsy, operating, or dissection tables.
- ✓ There should be no direct connection for pump priming.
- ✓ There should be no direct connection to sterilizers, aspirators, or similar equipment.
- ✓ Never introduce to the potable water system water used for cooling, heating, or processing.
- ✓ Below-the-rim water-supply connections should never be made, except where the configuration of the equipment makes this impossible. The connection is permitted if special precautions are taken. ■

References

1. Dick Clary, "A Guide to Selection and Installation of Backflow Prevention Devices," Seventh Edition, Spotswood Associates.

2. Alfred Steele, "Advanced Plumbing Technology," Chapter 9, *Backflow Prevention Devices.*

3. Michael Frankel, "Facility Piping Systems Handbook," Chapter 6, *Site Utility Systems.*

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