AXA XL Risk Consulting

Property Risk Consulting Guidelines

A Publication of AXA XL Risk Consulting

PRC.14.5.0.2

BACKFLOW PREVENTION FOR FIRE SERVICE MAINS

INTRODUCTION

The public expects the water supplied by public utilities to be safe to drink. Yet, there are many ways water distribution systems can become contaminated. To prevent contamination, most states and municipalities regulate the connection of private water systems to public systems.

Fire protection systems can contaminate public water supplies under some conditions. This PRC Guideline discusses some of the potential sources of contamination presented by fire protection systems, the means available to prevent contamination of potable water systems, and the appropriate levels of backflow prevention for the hazards involved. The need to periodically inspect, test and maintain the fire protection system to ensure it is adequate and reliable is also discussed.

POSITION

Fire protection equipment should be installed and operated in a manner that will minimize the potential to contaminate potable water systems. Not all private fire protection systems require backflow prevention. AXA XL Risk Consulting recommends the level of backflow prevention installed be appropriate for the hazard presented. The following practices should be followed:

- Separate fire protection water supplies and distribution systems from potable and service water systems. Separation allows greater isolation and control of the fire protection system and eliminates most of the potential for contamination produced by hazardous cross-connections.
- Take extreme care that drains do not become potentially hazardous cross-connections. Drains should discharge directly to atmosphere (above grade) whenever possible. When drains discharge to sewers, sumps, or sanitary drainage systems, arrange the drains to prevent contamination through backsiphonage or backpressure.
- Do not introduce antifreeze or other chemicals into fire protection piping or equipment fed by potable water systems unless a suitable level of backflow prevention is provided. This includes hydrant additives used to lubricate parts or prevent freezing. Repair hydrants that do not drain or operate properly.
- Use listed backflow prevention assemblies. Since neither Underwriters Laboratories nor FM Global Research tests the ability of these devices to prevent backflow, water authorities may also require that the assemblies be approved by the Foundation for Cross-Connection Control and Hydraulic Research of the University of Southern California or the American Society of Sanitary Engineering (ASSE).

- Follow all applicable state and local regulations. In addition, provide the level of protection prescribed in AWWA M14 for both new and existing systems as modified herein.

Installation Considerations

State or local regulations may dictate when and where backflow prevention devices are installed in the fire protection system. Normally they are located at the service connection.

When installing a backflow preventer:

- Analyze all existing water based extinguishing systems to determine if the additional friction loss created by the backflow preventer installation reduces the water flow and pressure available below that required to properly operate the fire protection system. In some systems, a minimal reduction in the available water pressure may be enough to render sprinklers ineffective. If hydrants are fed from the same system, be sure to include an adequate flow for hose streams.
- Place the backflow preventer on the discharge side of a booster pump and size the pump to make up for the friction loss of the device. NFPA 20 does not recommend installing restricting devices in the suction line of a fire pump. However, placing the device on the discharge side of the pump may require an additional backflow preventer for the jockey pump if it takes suction from the same source and discharges downstream of the fire pump backflow preventer.
- Do not locate reduced pressure zone (RPZ) devices in pits or other areas below grade. RPZ devices routinely discharge water. Providing reliable drainage below grade is difficult and if the drain from the device is submerged, a cross-connection will be created.
- Provide sufficient heat to prevent freezing and adequate drainage for semi-submerged pits or aboveground enclosures containing RPZ devices.
- Install backflow preventers only in the horizontal position unless the preventers are specifically approved for use in the vertical position. Most backflow preventers may only be installed in the horizontal position.
- Install backflow preventers so that they are accessible. Provide sufficient clearance around them for maintenance and testing.
- Do not modify backflow preventers. Substituting shutoff valves, test cocks or other components of backflow preventers may void their approval, even if the replacement components are listed.
- Consider other ways to prevent backflow. When installing a backflow preventer on systems using antifreeze, it may be possible to install dry pendent sprinklers or convert the antifreeze system to a dry system and eliminate the backflow preventer. If this is not feasible, place the backflow preventer at the point where an antifreeze (or foam) system connects to the remainder of the sprinkler or fire protection system. These methods minimize the effects a backflow preventer would have on the fire protection system.

Maintenance and Testing

Backflow preventers require routine testing and maintenance if they are to perform properly. Test personnel are required to be certified in most jurisdictions, therefore, detailed testing procedures will not be discussed here, but can be found in AWWA M14. Testing normally involves the following:

- An operational test of the pressure differential relief valve (RPZ only).
- A test of the second check valve for tightness under conditions of reverse flow.
- A test of the first check valve for tightness under conditions of reverse flow.

The above tests do not evaluate the performance of the backflow preventer under actual fire conditions. A backflow preventer could pass the above tests with the check valves stuck in the closed position. Therefore, AXA XL Risk Consulting recommends performing the following additional tests and maintenance procedures:

- Conduct a flow test representative of the anticipated fire demands, annually. Record the friction loss across the backflow preventer. Increases in the normal friction loss should be investigated and the cause corrected.
- Maintain backflow preventers according to the manufacturers' instructions. Many devices have screens or strainers that must be cleaned regularly.
- Perform an internal examination of all backflow preventers at least every five years. One of the most common causes of excessive friction loss is foreign material buildup above the check valves and around the springs. This buildup can prevent the devices from opening fully.

AWWA M14

AWWA M14 classifies industrial fire protection systems into six groups (Figure 1) based on the water sources available and the arrangement of the supplies. The following classifications and protection recommendations have been reprinted from Chapter 6 of Recommended Practice for Backflow Prevention and Cross-Connection Control, AWWA M14, by permission. Copyright 1990, American Waterworks Association.

Class 1 Direct connections from public water mains only; no pumps, tanks, or reservoirs; no antifreeze or additives of any kind; all sprinkler drains discharge to atmosphere, dry wells, or other safe outlets.

Class 2 Same as Class 1 except that booster pumps are installed in the connections from the street mains (booster pumps do not affect the potability of the system). To avoid drawing too much water from the main, it is necessary that pressure in the water main is not reduced below 10 psi (0.7 bar).

Class 3 Direct connections from public water supply mains, plus one or more of the following: elevated storage tanks; fire pumps taking suction from aboveground covered reservoirs, or tanks; and pressure tanks. (All storage facilities are filled or connected to public water only, the water in the tanks are to be maintained in a potable condition. Otherwise, Class 3 systems are the same as Class 1.)

Class 4 Directly supplied from public mains, similar to Class 1 and Class 2, with an auxiliary water supply dedicated to fire department use and available to the premises, such as an auxiliary supply located within 1700 ft (518 m) of the pumper connection.

Class 5 Directly supplied from public mains and interconnected with auxiliary supplies, such as pumps taking suction from reservoirs exposed to contamination, or rivers and ponds; driven wells; mills or other industrial water systems; or where antifreeze or other additives are used.

Class 6 Combined industrial and fire protection systems supplied from the public mains only, with or without gravity storage or pumps suction tanks."

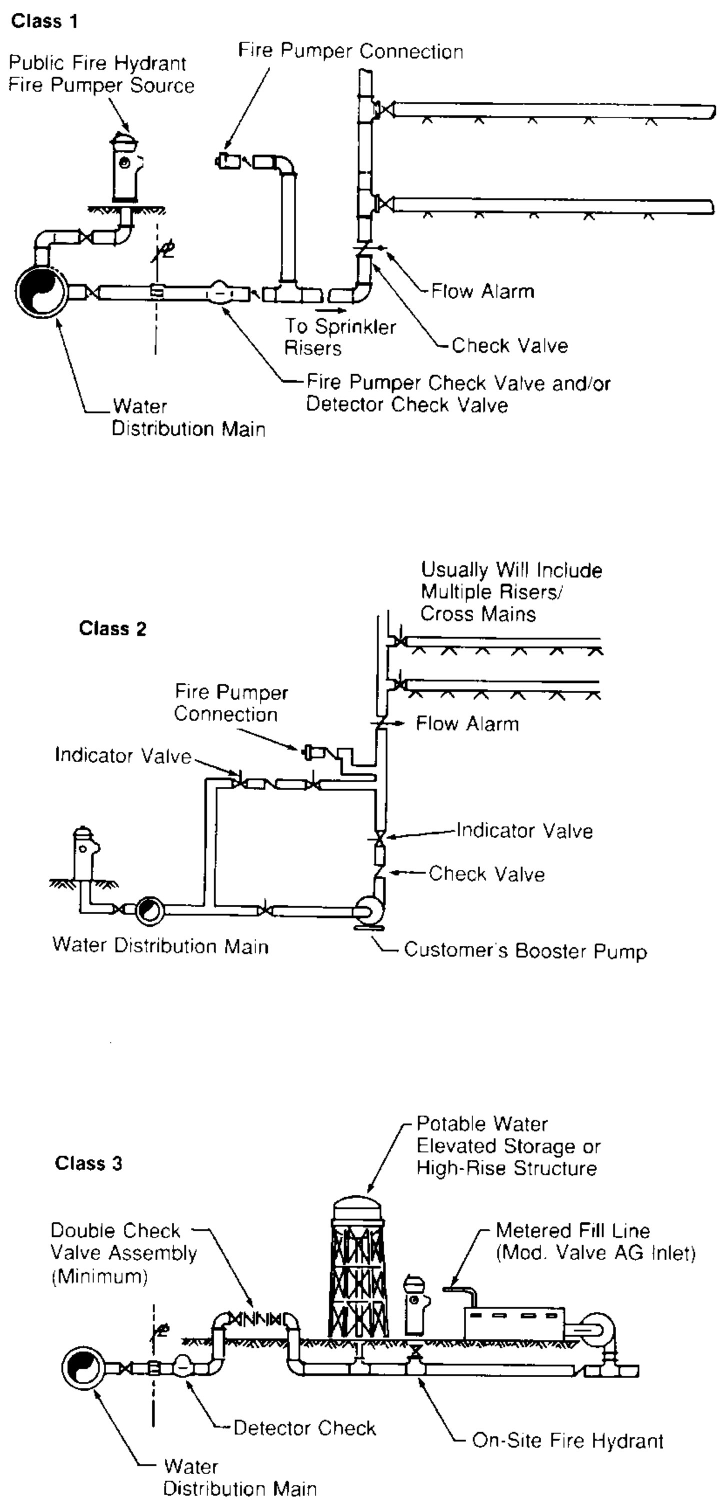
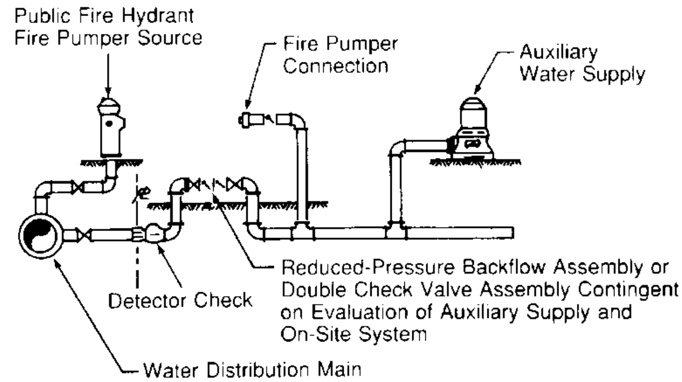


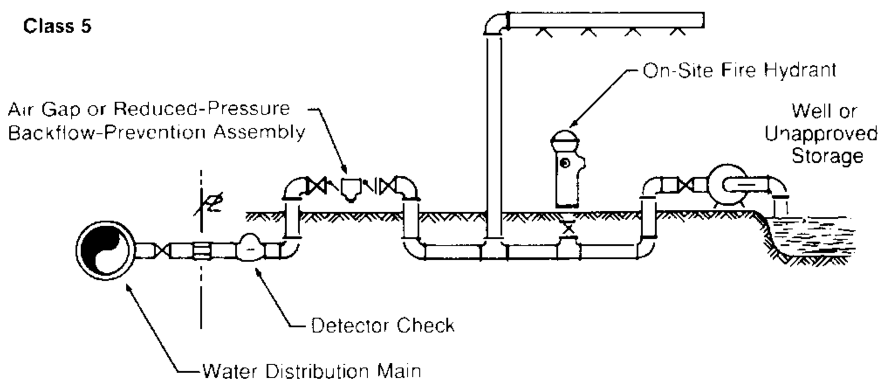
Figure 1. AWWA Classification Of Fire Protection Systems.

NOTE: Figures 1-4 do not show the use of indication control valves and all of the accessories that are typically found in fire protection systems. (See References[2])

Class 4



Class 5



Class 6

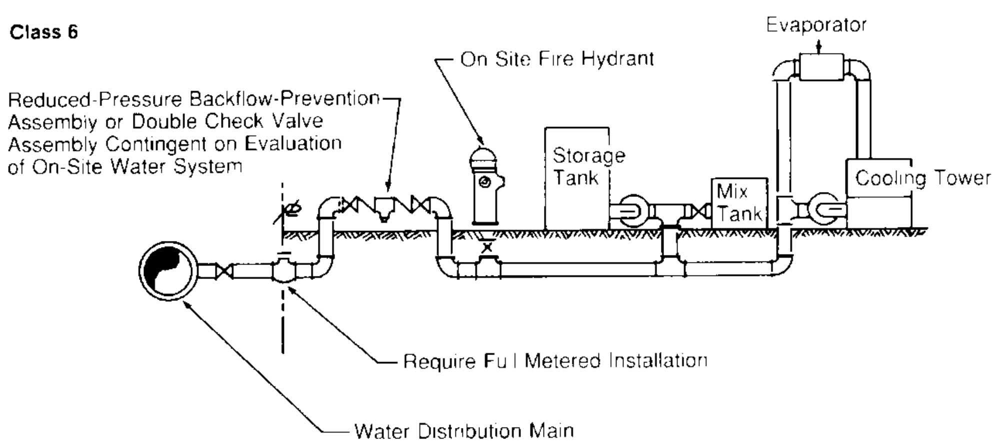


Figure 1. (Cont'd.) AWWA Classification Of Fire Protection Systems.

According to M14, Class 1 and Class 2 systems generally do not require a backflow prevention assembly. The existence of a fire department connection is not cause for concern unless there is a readily available source of nonpotable water that could be introduced into the system through the connection. AWWA M14 does recognize that there are special circumstances that may require protection for Class 1 or 2 systems. These include:

- "underground fire sprinkler pipelines parallel to and within 10 ft (3 m) horizontally of sewer pipelines or other pipelines carrying significantly toxic materials;
- "when water is supplied to a site or an area from two or more services of a water utility or two different water utilities, flow problems should be evaluated;
- "occupancies (or changes in occupancies) that involve the use, storage or handling of types and quantities of materials in a manner that could present a significant health hazard to the domestic supply;
- "premises with unusually complex piping systems (usually these premises will have an approved backflow-prevention assembly on their domestic service piping); and
- "systems with pumper connections in which corrosion inhibitors or other chemicals are added to tanks of fire trucks, or where the water purveyor cannot be assured of the potability of the input to the pumper connection.

"Class 3 systems will generally require minimum protection (approved double check valve assembly) to prevent stagnant waters from backflowing into the public potable water system.

"Class 4 systems will normally require backflow prevention at the service connection. The type (air gap, reduced-pressure backflow-prevention assembly, or double check valve assembly) will generally depend on the quality of the auxiliary supply.

"Class 4 and 5 systems normally would need maximum protection (air gap or reduced-pressure backflow-prevention assembly) to protect the public potable water system.

"Class 6 system protection would depend on the requirements of both industry and fire protection and can only be determined by a survey of the premises.

"A meter (compound or detector check) should not normally be permitted as part of a backflow-prevention assembly. However, an exception can be made if the meter and backflow prevention assembly are specifically designed for that purpose.

"At any time where the fire sprinkler system piping is not an acceptable potable water system material, there shall be a backflow-prevention assembly isolating the fire sprinkler system from the potable water system. There are also chemicals, such as liquid foam concentrates used for fighting certain types of fires, that are toxic and, therefore, require maximum protection.

"Note: Where backflow protection is required on an industrial-domestic service that is located on the same premises, backflow protection should be provided on the fire service connection. The industrial-domestic system and fire system in Classes 3, 4, 5, and 6 should have adequate protection for the highest degree of hazard affecting either system."

Application of the AWWA M14 Guidelines

AXA XL Risk Consulting recommends that reason and logic be used when applying the above guidelines. For example, a pond, open reservoir, or other "auxiliary source" located within 1700 ft (518 m) of a fire department connection may not need backflow prevention if the source is not accessible to the fire department, is not large enough to be of value, or would not be used even under emergency conditions.

Some jurisdictions no longer consider the black steel pipe used in many sprinkler systems as suitable for potable water service. Therefore, the water in a sprinkler system may be classified as nonpotable. The water may have increased turbidity (suspended matter), and a high concentration of dissolved metals, but these conditions are not usually considered a major health hazard. AXA XL Risk Consulting disagrees with the AWWA M14 recommendation to install a backflow preventer simply because of the hazard posed by black steel pipe, unless the preventer is required by the local jurisdiction.

When a booster pump is installed (Class 2 system) AWWA M14 cautions against reducing the suction pressure below 10 psi (0.7 bar). AXA XL Risk Consulting agrees with the caution, but recommends that the water supply be capable of providing 200% of the pump rated capacity at 20 psi (1.4 bar), not 10 psi (0.7 bar).

Finally, when the fire protection system is separated from all potable and industrial water systems as recommended by AXA XL Risk Consulting, the level of backflow prevention should be consistent with the hazards posed by the fire protection system as classified by AWWA M14. AXA XL Risk Consulting does not believe the level of protection for the fire protection system must be the same as that required by the industrial service water system, unless state or local authorities so stipulate.

DISCUSSION

Potential Sources Of Contamination

Under normal circumstances, the water in a sprinkler system does not pose a significant health threat. The National Fire Sprinkler Association (NFSA) in its publication, “Backflow Prevention for Fire Sprinkler Systems” discloses eight independent studies of fire systems. None of these reported a health threat. Contamination of the water in a fire protection system normally occurs by connecting to nonpotable auxiliary sources or introducing toxic chemicals to the system.

Antifreeze systems installed in accordance with NFPA 13 use antifreeze solutions that do not pose a health threat. However, most authorities will require backflow prevention for these systems, because toxic antifreeze solutions are available and may be used to maintain the systems.

Foam or other chemical additives are sometimes used for fire fighting. Foam is commonly used to protect areas handling flammable or combustible liquids. Since fire fighting foams represent a health hazard, they require backflow prevention when the fire protection system is connected to a potable water source.

Chemicals can also be added to fire protection systems when maintenance is performed. Corrosion inhibitors may be added to tanks or fire department pumpers. Maintenance and fire department personnel must be aware of the potential effects these practices have on system potability.

Lubricants and antifreeze solutions have been added to hydrant barrels to make them easier to operate or to prevent hydrants that do not drain properly from freezing. Such practices should not be condoned. Hydrants without drains should be marked and pumped out after each use. Hydrants with plugged drains should be repaired, or marked as having no drains and pumped out after each use. Hydrants that do not operate properly should be repaired.

Fire Department Connections

As previously noted, AWWA M14 does not recommend backflow prevention solely because there is a fire department connection. There has been considerable debate regarding need for backflow prevention when a fire department connection exists.

Some jurisdictions may require backflow protection if a pond or other nonpotable source exists, even though the source is not “dedicated for fire department use.” Jurisdictions assume the fire department will use the water if they need it.

Protection may also be required if the fire department routinely or occasionally uses chemicals in its pumper trucks. Contamination is not likely during a fire, because the water will flow away from the connection toward the fire.

Backpressure and Backsiphonage

There are two ways water systems typically become contaminated other than direct contamination from chemical introduction. Backpressure and backsiphonage can reverse the flow in a water system (backflow).

Backpressure occurs when the system operates at a higher pressure than the potable supply. This could be caused by a pump, elevated tank or other source of pressure acting on the system. The higher pressure forces the water in the direction of the lower pressure potable water system.

Backsiphonage is caused by a negative or reduced pressure in a potable supply line. It can occur any time the pressure in the supply line drops below that in the fire protection system, as would occur with a high rate of water usage in the public water system.

Types of Backflow Prevention Devices

Fire protection systems are typically separated from a potable water supply by at least a single check valve. Often double check valves or detector check valves are used. These valves allow a higher pressure to be maintained in the fire protection system.

A single check valve has never been considered to be a backflow prevention device. Even when check valves with resilient faces are used, the valves can leak and allow nonpotable water to enter and contaminate a potable water system.

Backflow prevention for fire systems is usually provided at the public water connection. Sometimes, it is located at the source of contamination, such as the connection of an antifreeze or foam system.

Three types of devices are normally used for backflow prevention: the air gap (AG), the double check valve assembly (DCV), and the reduced pressure zone or reduced pressure principle backflow-prevention assembly (RPZ or RPBA).

Air Gap: An air gap (Figure 2) provides an open space between the supply pipe and the system to physically separate the systems and prevent contamination. The vertical separation must be twice the diameter of the supply pipe and at least 1 in. (25.4 mm) long.

Air gaps are not common on fire protection water supply systems. They may be provided on fill lines for pump suction tanks or on break tanks that supply fire pumps in jurisdictions where booster pumps are not allowed. Air gaps are also provided on 2½ in. (65 mm) main drain lines in some jurisdictions.

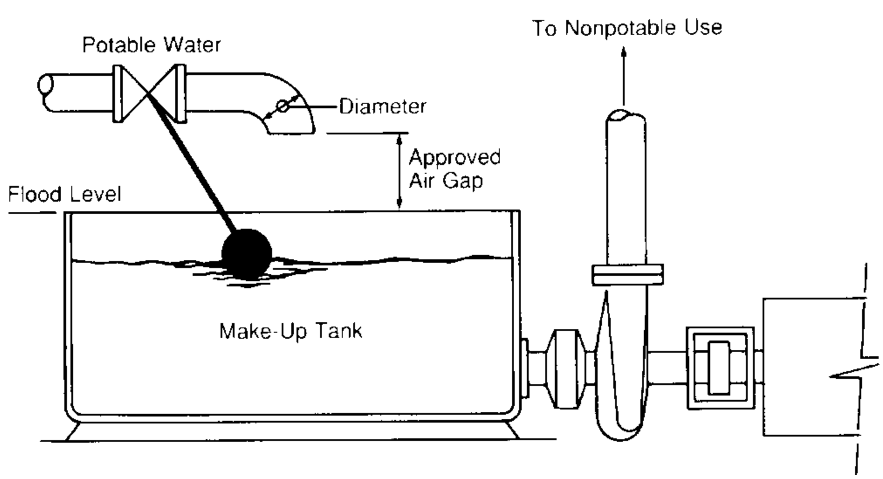


Figure 2. Air PRC.

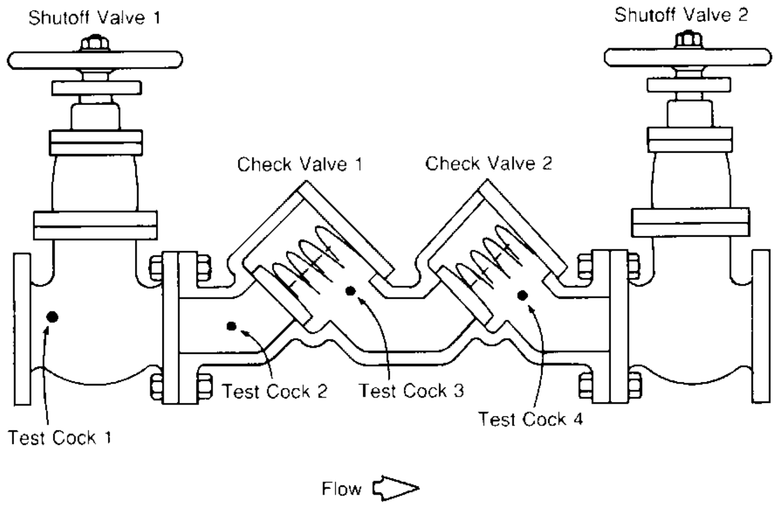


Figure 3. Double Check Valve Assembly.

Double Check Valve Assemblies: Double check valve assemblies (Figure 3) consist of two spring loaded-check valves. The assembly will also have a shutoff valve on either end and petcocks for leak testing. All of the seats will have a covering of rubber or other resilient material to ensure tightness. Note that two single check valves installed in series do not constitute a double check valve assembly. Double check valve assemblies are used only to protect against minimal exposures where contamination is objectionable (odors, color) but no health hazard exists.

Double check valve assemblies are the most desirable backflow prevention devices from a fire protection standpoint. The friction loss of a DCVA is normally 4 psi – 6 psi (0.3 bar – 0.4 bar), much less than an RPZ device.

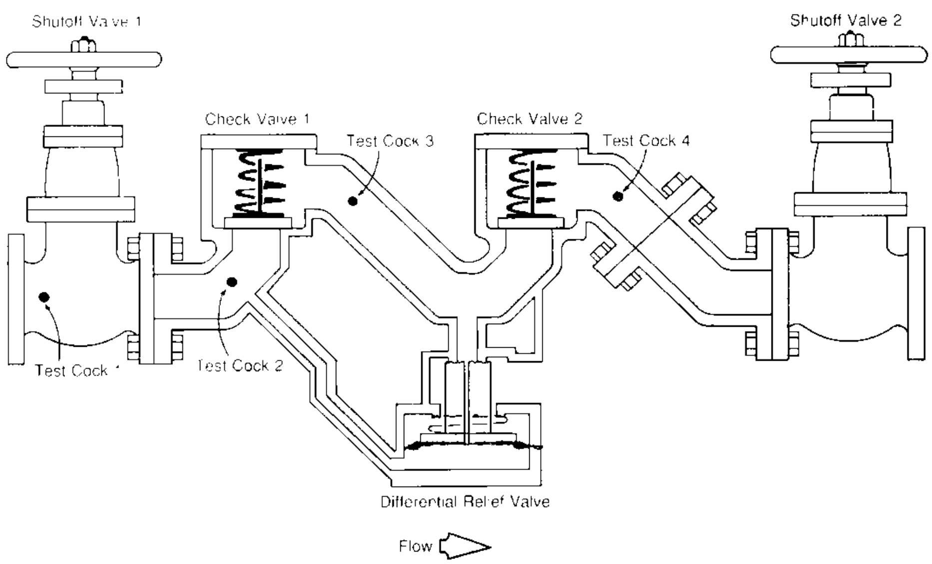


Figure 4. Reduced Pressure Zone Backflow Preventer.

Reduced Pressure Zone Backflow Preventer: The RPZ device (Figure 4) is similar to the double check valve assembly, except a pressure differential relief valve maintains a lower pressure in the chamber between the two check valves, than the pressure that exists on the supply side of the device.

A pressure differential of 2 psi – 5 psi (0.14 bar – 0.35 bar) is normally maintained between the intermediate chamber and the supply. When this differential is not maintained, the relief valve opens up and discharges as much water as necessary from the chamber to maintain the differential. If either check valve fails open, large quantities of water can be discharged through the relief valve. There is typically an additional 2 psi – 5 psi (0.14 bar – 0.35 bar) loss across the second check valve.

The RPZ device is the least desirable from a fire protection standpoint. Friction loss is high, typically 10 psi (0.7 bar) or greater at rated flow, and the water discharged from these devices results in installation problems. However, an RPZ device does offer excellent backflow protection when properly maintained.