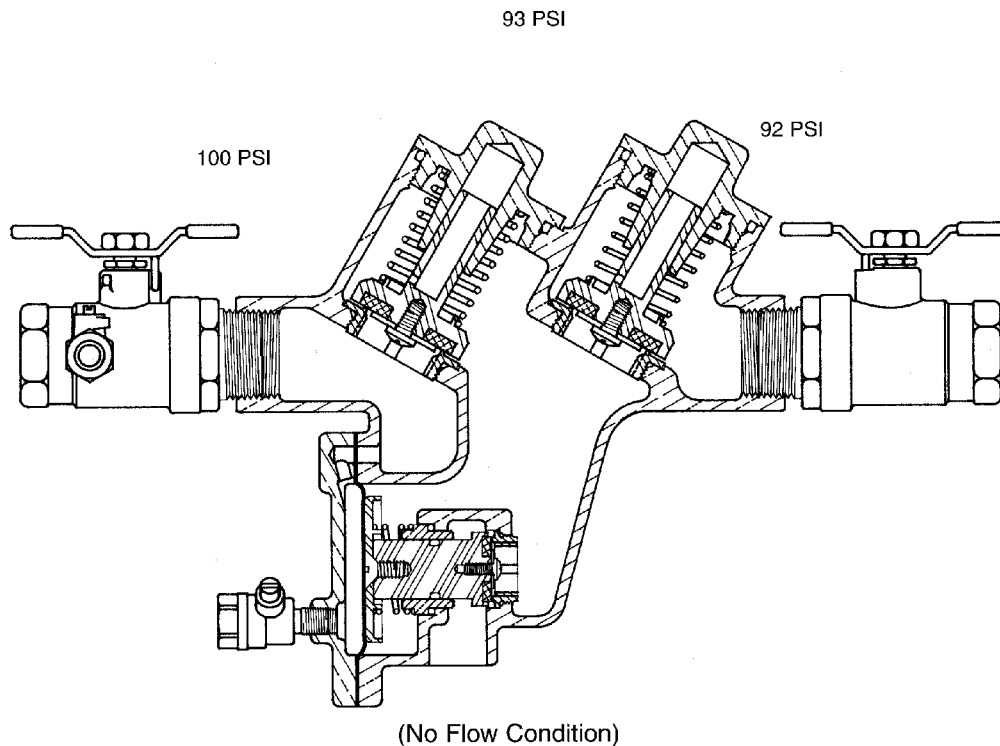


# Public Water Supply Manual



## PART VII CROSS-CONNECTION CONTROL/ BACKFLOW PREVENTION



COMMONWEALTH OF PENNSYLVANIA  
Department of Environmental Protection

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**DEPARTMENT OF ENVIRONMENTAL PROTECTION**  
**Bureau of Water Supply and Wastewater Management**

**Document Number:** 383-3100-111

**Title:** Public Water Supply Manual - Part VII  
Cross-Connection Control/Backflow Prevention

**Authority:** Pennsylvania's Safe Drinking Water Act (35 P.S. §721.1 *et seq.*) and regulations at 25 Pa. Code Chapter 109

**Effective Date:** October 1, 1997  
Minor changes made to pages i, iv and 30 (February 1, 1999)  
Minor changes made to pages i, ii, 16, 21, 26, 27 and 30 (February 5, 2001)  
Minor changes made to pages i, ii (June 18, 2001)

**Policy:** Department of Environmental Protection (DEP) staff will follow the guidance and procedures presented in this document to direct and support implementation of cross-connection control/backflow prevention activities under the drinking water management programs.

**Purpose:** The purpose of this document is to establish a rational and reasonable basis for staff decisions which will promote quality, timely and consistent service to the public and regulated community.

**Applicability:** This guidance will apply to public water systems which implement a cross-connection control/backflow prevention program.

**Disclaimer:** The guidance and procedures outlined in this document are intended to supplement existing requirements. Nothing in this document shall affect more stringent regulatory requirements.

The guidance and procedures herein are not an adjudication or a regulation. There is no intent on the part of DEP to give this document that weight or deference. The guidance and procedures merely explain how and on what basis DEP will administer and implement its responsibilities with respect to cross-connections control/backflow prevention activities. DEP reserves the discretion to deviate from the guidance and procedures in this document if circumstances warrant.

**Page Length:** 36 pages

**Location:** Volume 25, Tab 05

**Definitions:** See 25 Pa. Code Chapter 109

## **PUBLIC WATER SUPPLY MANUAL USER'S GUIDE**

The Public Water Supply Manual is a comprehensive publication designed to provide necessary, useful information to public water suppliers concerning Pennsylvania's Safe Drinking Water Program administered by the Department of Environmental Protection (DEP). The manual contains essentially everything the public water supplier will need to know about the Safe Drinking Water Program, including: design and construction standards; water quality standards; monitoring, reporting and operating requirements; emergency measures; and information on government agency programs and contacts.

**Technical guidance documents are on DEP's world wide website ([www.dep.state.pa.us](http://www.dep.state.pa.us)) at the public participation center.**

**The "Final Documents" heading is the link to a menu of the various DEP bureaus and from there to each bureau's final technical guidance documents.**

**The "Draft Technical Guidance" heading is the link to DEP's draft technical guidance documents.**

**DEP encourages the use of the internet to view guidance documents. When this option is not available, persons can order bound paper copy of the latest inventory or an unbound paper copy of any of the final documents listed on the inventory by calling DEP at (717) 783-3795.**

The following is a summary of the Public Water Supply Manual Parts. Following the summary is a Table of Contents for each part in the Public Water Supply Manual.

### **Part I - Summaries of Key Requirements**

Part I is no longer published as a compilation of all the summaries of key requirements. The summaries of key requirements are available as individual documents. Additional summaries are added as new rules and regulations are adopted.

### **Part II - Community System Design Standards**

Part II provides detailed design and construction standards for all community water systems except bottled water systems, bulk water haulers, vended water systems and retail water facilities. Part II also contains instructions for submitting a public water system permit application.

### **Part III - Bottled Water, Bulk Water Hauling, Water Vending Machines and Retail Water Facilities**

Part III provides detailed design and construction standards for bottled water systems, bulk water haulers, vended water systems and retail water facilities including information on submitting a public water system permit application.

### **Part IV - Noncommunity System Design Standards**

Part IV provides detailed design and construction standards for noncommunity water systems, including information on the procedures to be followed to obtain DEP's approval.

### **Part V - Operations and Maintenance**

Part V provides the needed information to develop an Operations and Maintenance Plan as required under Section 109.702 of DEP's Safe Drinking Water Regulations. This is a comprehensive guidance document covering all aspects of public water system operations including operation and maintenance standards.

Part V has been developed as two separate documents. Each is designed for specific type systems:

- Sections I and II is for surface water systems and the larger groundwater systems.
- Appendix A, Operations and Maintenance for Small Groundwater Systems, is a condensed version containing information needed by small groundwater systems having limited treatment (disinfection and corrosion control).

#### **Part VI - Emergency Response**

Part VI discusses the measures which a water supplier should take to prepare for emergency circumstances and explains how to prepare an emergency response plan.

#### **Part VII - Cross-connection Control/Backflow Prevention**

Part VII provides the basic information needed by a public water supplier to establish an effective cross-connection control program.

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## **PART VII**

### **CROSS-CONNECTION CONTROL/BACKFLOW PREVENTION**

#### **INTRODUCTION**

The Department of Environmental Protection (DEP) is authorized under the Pennsylvania Safe Drinking Water Act to establish standards for the construction of a water supply to assure compliance with the provisions of the act. Accordingly, Section 109.608 of DEP's rules and regulations, requires that "a public water system may not be designed or constructed in a manner which creates a cross-connection." In addition, Section 109.709(b) further requires that "At the direction of DEP, the public water supplier shall develop and implement a comprehensive control program for the elimination of existing cross-connections or the effective containment of sources of contaminations, and prevention of future cross-connections." The purpose of this part of the Public Water Supply Manual is to provide the basic information needed to develop this program.

## PART VII

### CHAPTER 1 - DEFINITIONS

For the purpose of this part of the Public Water Supply Manual, the following words shall have the meaning indicated unless clearly indicated otherwise in the text:

1. **Air Gap Separation** - The unobstructed vertical distance through the free atmosphere between the lowest opening from any pipe or faucet supplying potable water to a tank, plumbing fixture, or other device and the flood level rim of the receptacle. The differential distance shall be at least double the diameter (2 x D) of the supply pipe measured vertically above the top of the rim of the vessel. In no case, shall the air gap be less than one inch.
2. **Approved** - A backflow prevention device or method that has been accepted by the public water supplier as suitable for the proposed use.
3. **Atmospheric Vacuum Breaker (AVB)** - A fixture outlet device containing an optional shutoff valve followed by a valve body containing a soft-seated float-check, a check seat and an air inlet port. If the shutoff valve is open, the flow of water causes the float to close the air inlet port. If the shutoff valve is closed, the float falls and forms a check valve against backsiphonage and at the same time opens the air inlet port. If no shutoff valve is provided, the flow of water will determine the opening and closing of the air inlet port.
4. **Auxiliary Water System** - Any water source or system on the premises of, or available to, the customer except connections to other approved community water supply systems.
5. **Backflow** - A flow condition, induced by a differential in pressure, that causes the flow of water or mixtures of water and other substances into the distribution pipes of a potable water supply system from a source other than its intended source. Backflow can result from either backsiphonage or backpressure.
6. **Backflow Preventer** - A device or other means which will prevent the backflow of water or any other substance into the public water supply system.
7. **Backpressure** - The backflow of water or a mixture of water and other substances from a plumbing fixture or other customer source, into a public water supply system due to an increase of pressure in the fixture or customer source to a value that exceeds the system pressure.
8. **Backsiphonage** - The backflow of water or a mixture of water and other substances from a plumbing fixture or other customer source, into a public water supply system due to a temporary negative or sub-atmospheric pressure within the public water supply system.
9. **Consumer** - The owner or person in control of any premises supplied by or in any manner connected to a public water supply system.
10. **Consumer's Water System** - Any water system, located on the consumer's premises, supplied by or in any manner connected to a public water supply system. A household plumbing system is considered to be a consumer's water system.
11. **Containment** - Cross-connection control which isolates the customer's entire facility from the public water supply system so as to provide the protection necessary to prevent contamination of the public water supply in the event of backflow from the customer's facility. Though containment control prevents contamination of the public water supply, it offers no protection to the water distribution system within the facility. Reduced pressure zone devices are used for containment control.

12. **Contamination** - The degradation of the quality of the drinking water by wastewaters, processed fluids, or any water of a quality less than accepted drinking water quality to a degree which would create an actual hazard to the public health through poisoning or through the spread of disease.
13. **Cross-connection** - An arrangement allowing either a direct or indirect connection through which backflow, including backsiphonage, can occur between the drinking water in a public water system and a system containing a source or potential source of contamination, or allowing treated water to be removed from any public water system, used for any purpose or routed through any device or pipes outside the public water system, and returned to the public water system. The term does not include connections to devices totally within the control of one or more public water systems and connections between water mains.
14. **Degree of Hazard** - An evaluation of the potential risk to health and the adverse effect upon the public water supply system.
15. **Double Check Valve Assembly (DCVA)** - An assembly composed of two single, independently acting, soft-seated, spring-loaded check valves including tightly closing shutoff valves located at each end of the assembly and suitable connections for testing the water tightness of each check valve.
16. **Fixture Outlet Protection** - Cross-connection control which isolates all free-flowing fixture outlets (i.e., faucets) from the water distribution system within a facility. Fixture outlet protection prevents backflow contamination of both the facility water system and the public water supply. Examples of fixture outlet protection devices include atmospheric vacuum breakers, hose-bibb vacuum breakers, and pressure vacuum breakers.
17. **Health Hazard** - Any condition, device, or practice in a water system or its operation that creates, or may create, a danger to the health and well-being of its users. The word "severe", as used to qualify "health hazard", means a hazard to the health of the user that could reasonably be expected to result in significant morbidity or death.
18. **Hose-Bibb Vacuum Breaker (HBVB)** - A fixture outlet device which contains a soft-seated, spring-loaded, air inlet valve and is designed to be attached to an outlet having a hose connection thread.
19. **Interchangeable Connection** - An arrangement or device that will allow alternate, but not simultaneous, use of two sources of water.
20. **Internal Protection** - Cross-connection control which isolates all non-outlet, water-use appliances within a facility (e.g., kitchen appliances, air conditioners, boilers, process tanks, photo developing equipment) from the water distribution system within the facility. Internal protection prevents backflow contamination of both the facility water system and the public water supply. Reduced pressure zone devices and double check valve assemblies are used for internal protection.
21. **Non-Health Hazard** - Any condition, device or practice in a water system or its operation that creates, or may create, an impairment of the quality of the water to a degree which does not create a hazard to the public health, but which does adversely and unreasonably affect the aesthetic qualities of such water for domestic use.
22. **Non-Potable Water** - Water not safe for drinking, personal, culinary, or any other type of domestic use.
23. **Person** - Any individual, partnership, association, company, corporation, municipality, municipal authority, political subdivision or any agency of federal or state government. The term includes the officers, employees and agents of any partnership, association, company, corporation, municipality, municipal authority, political subdivision or any agency of federal or state government.
24. **Pollution** - The presence in water of any foreign substance that tends to degrade its quality so as to constitute a hazard, or to impair the usefulness or quality of the water to a degree which does not

create an actual hazard to the public health, but which does adversely and unreasonably affect such waters for domestic use.

25. **Potable Water** - Water which is satisfactory for drinking, personal, culinary, and domestic purposes and meets the requirements of DEP.
26. **Pressure Vacuum Breaker (PVB)** - A fixture outlet device containing an independently operating, soft-seated, spring-loaded check valve and an independently operating, soft-seated, spring-loaded, air inlet valve on the discharge side of the check valve.
27. **Process Fluids** - Any fluid or solution which may be chemically, biologically or otherwise contaminated or polluted in a form or concentration such as would constitute a health, pollutional, or system hazard if introduced into the public or a consumer's water system. This includes, but is not limited to:
  - a. Polluted or contaminated waters;
  - b. Process waters; sanitary quality;
  - d. Cooling waters;
  - e. Contaminated natural waters taken from wells, lakes, streams, or irrigation systems;
  - f. Chemicals in solution or suspension;
  - g. Oils, gases, acids, alkalis, and other liquid or gaseous fluids used in industrial or other processes, or for fire fighting purposes;
  - h. Heating system waters from boilers or heat pumps.
28. **Public Water Supplier** - A person who owns or operates a public water system.
29. **Public Water Supply System** - A system which provides water to the public for human consumption which has at least 15 service connections or regularly serves an average of at least 25 individuals daily at least 60 days out of the year. The term includes any collection, treatment, storage, and distribution facilities under control of the operator of the system and used in connection with the system. The term includes collection or pretreatment storage facilities not under such control which are used in connection with the system. The term also includes a system which provides water for human consumption via bottling, vending machines, retail sale, or bulk hauling methods.
30. **Reduced Pressure Zone Device (RPZD)** - A device which contains two independently acting, soft-seated, spring-loaded check valves, together with a soft-seated, spring-loaded, diaphragm-activated, pressure differential relief valve located between the two check valves. During normal flow and at the cessation of normal flow, the pressure between these two checks shall be less than the supply pressure. In case of leakage of either check valve, the differential relief valve, shall maintain the pressure between the checks at less than the supply pressure by opening to the atmosphere. The device must include tightly closing shutoff valves located at each end, and each device shall be fitted with properly located test cocks.
31. **Residential Dual Check Valve (RDCV)** - A non-testable backflow prevention device that is used for containment control of residential homes and consists of two independently operating, soft-seated, spring-loaded, consecutive check valves.
32. **Service Connection** - The terminal-end of a service line from the public water supply system. If a meter is installed at the end of the service line, then the service connection means the downstream end of the meter.
33. **System Hazard** - A condition posing an actual or potential threat of damage to the physical properties of the public water system or to the consumer's potable water system.

## PART VII

### CHAPTER 2 - CROSS-CONNECTION CONTROL PROGRAM

The following guidelines have been developed to assist in the creation of an effective cross-connection control program. Each community water supplier should carefully consider the following steps as it is important that all aspects of a properly planned program be thoroughly understood before implementing any particular portion. Though a successful program has the benefit of providing protection for the customer, the need for control is often a surprise to the customer. For this reason it is suggested that a public education and awareness program be initiated as soon as possible.

#### **Step 1:** Know and Understand Cross-Connection Control Concepts

The first major element in developing an effective cross-connection control program is the need to have a thorough understanding of the cross-connection, backflow and backsiphonage concepts and the control measures needed to eliminate them. This is of particular importance when trying to explain your program to your customers or company officials.

To ensure uniformity, one person or section should be assigned all the responsibilities for implementing the program. In this manner, a focal point is established which can properly respond to customer inquiries and maintain accurate records on the types, dates and locations of installed devices, your equipment needs and program costs.

#### **Step 2:** Establish the Legal Foundation

Section 109.709 of DEP's rules and regulations (25 Pa. Code Chapter 109) provides the legal basis for the establishment of a cross-connection control program. However, a local ordinance which specifically outlines the water supplier's jurisdiction, responsibilities and enforcement procedures should be adopted by each municipality which is served by the supplier.

The elements of an ordinance should include, but not be limited to:

- a. The adoption of a plumbing code (See Table VII-4.1);
- b. Authority to enter customers premises;
- c. Provisions for discontinuance of service;
- d. Installer and inspector certification;
- e. Inspection frequency;
- f. Penalties;
- g. Hydrant use restrictions;
- h. Exterminator restrictions;
- i. Provisions for the installation of specific cross-connection control devices which will be required based on the degree of hazard.

#### **Step 3:** Establish a Priority System

Before a cross-connection control program can be implemented, a public water supplier first must put a major emphasis on identifying those facilities that pose the greatest hazard in the most vulnerable portion(s) of the distribution system.

To do this, use the billings for your service area and the list provided in Table VII-2.1 (Degree of Hazard) to develop three master lists with the following titles:

- a. Hazardous Facilities;
- b. Aesthetically Objectionable Facilities;
- c. Nonhazardous Facilities.

Next, a review of the distribution system records must be made to identify areas of chronic low pressures, leakage and breaks.

A distribution map now should be used to outline the problem areas and locate the customers in categories a. and b. above.

With this information, the following priority list can be established:

- |                     |   |
|---------------------|---|
| <b>1st Priority</b> | Those hazardous facilities located within the most vulnerable portion of your distribution system;        |
| <b>2nd Priority</b> | Those aesthetically objectionable facilities located within the most vulnerable area;                     |
| <b>3rd Priority</b> | Those hazardous facilities not within the most vulnerable portion of your distribution system;            |
| <b>4th Priority</b> | Those aesthetically-objectionable facilities not within the most vulnerable areas;                        |
| <b>5th Priority</b> | Nonhazardous facilities where reasonable doubt may exist regarding protection of the water supply system. |

**Step 4:** Estimate Customer Implementation Costs

It will be helpful to know the economic impact on the customer, industrial groups, the community and your water system. The installation of backflow prevention devices is relatively expensive and may require budget planning. Implementation timetables must consider budget implications.

A rough installation cost estimate can be made by using the following assumptions and procedures:

- a. Assume that all 'hazardous facilities' will use RPZDs (air gaps usually are more expensive since elevated tanks or ground storage tanks with pumping facilities would be required);
- b. Assume that each water service line on your priority list requires a backflow prevention device;
- c. Assume that the average RPZD installation includes separate above-grade housing, drainage and heat;
- d. Assume that the average DCVA installation includes a pit and heating;
- e. From your records, determine the number of water service lines for each customer in your priority listings.

The total cost per facility will be the cost for a device installed per water service line times the number of service lines. Manufacturer's technical representatives can provide the most recent equipment costs.

**Step 5:** Develop Proposed Implementation Timetable

You now should have sufficient data to begin implementation. Develop a reasonable timetable plan. The following is an example:

- 1st Year:** Develop program plan  
Get management approval  
Amend local regulations if needed  
Start educational program
- 2nd Year:** Notify priority #1 & #2 customers of requirements  
Receive and approve plans for priority customers  
Continue educational program
- 3rd Year:** Priority #1 & #2 devices installed  
Notify priority #3 & #4 customers of requirements  
Receive and approve plans for priority #3 & #4 customers  
Continue educational program
- 4th Year:** Priority #3 & #4 devices installed  
Get first testing results from priority #1 & #2 customers  
Follow up and update functions
- 5th Year:** Get first testing results from priority #3 & #4 customers  
Follow up and update functions  
Consider enforcement actions

**Step 6:** Review Your Data and Proposed Procedures with Governmental Agencies

At this point you should review the information developed with the municipalities involved, the local health agencies, and DEP. Discuss the various aspects of your plan and proposed implementation schedule, and make adjustments to everyone's mutual satisfaction.

The program requirements and the potential impact can be developed to this point by water company personnel with assistance from the department, where needed. It is important to gather this information prior to program implementation as this will help in obtaining support for the program.

It is suggested that prior to holding meetings with governmental agencies, the water supplier develop draft copies of the forms to be used in implementing and maintaining the program.

The following is a list of some typical forms which may be needed:

- a. Notice of program implementation and intent to conduct an inspection;
- b. Cross-connection control survey report form;
- c. Notice of results of inspection and need to install a backflow prevention device;
- d. Notice of need to conduct periodic test with return report form;
- e. Follow-up letter (second notice) for Item d;
- f. Notice of discontinuance of service;
- g. Notice to repair or replace the backflow prevention device;
- h. New service investigation and report forms;

- i. Device/installation approval form;
- j. List of approved backflow prevention device installers and/or testers;
- k. Notice of temporary shutdown of water service.

**Step 7:** Educate the Public

In reality, this step can be implemented coincidentally with any of the previous steps.

The amount and degree of sophistication you provide largely will depend on the type of customers in your system and the categories which you propose to regulate. However, the more education or public awareness you can provide, the better your chances are of receiving public acceptance. If done early enough, you also can avoid problems with local plumbing supply firms or plumbers who may not be ready to supply or install the required devices.

**Step 8:** Notify Affected Customers

Notify by letter first and second priority customers that require containment control.

The letter should be brief, clear, and solicit their cooperation. A joint meeting between you and the customer should be suggested to answer questions. A tour of the facility should be conducted to confirm your information on the number of service connections and/or the degree of potential hazard.

If new information dictates, revise the priority listing of the customer or the timetable for achieving compliance.

If the customer challenges your requirements, explain your legal authority in a second letter. Solicit help from your legal counsel or from DEP as necessary.

Attempt to develop agreement on what needs to be done and on a specific customer timetable for compliance. Once agreement has been achieved, confirm the agreement in writing.

**Step 9:** Monitor Program Progress

Follow up as necessary to determine that customer compliance and overall program implementation is progressing satisfactorily.

Advise the department at least once a year of the progress you are making in your cross-connection control program.

**Step 10:** Initiate Testing Requirements

Once containment devices have been approved and installed, review the testing requirements with each customer, including frequency of testing (a yearly-test should be considered a minimum), and how to report the testing results.



**Table VII-2.1  
Degree of Hazard**

**A. Hazardous Facilities**

The following partial listing gives examples of the types of facilities which would **require an acceptable reduced pressure zone device (RPZD) or air gap** to be installed in the service connection to the public water distribution system. Additional facilities needing RPZDs or air gaps can be found in Table VII-3.1.

<u>Type of Facility</u>	<u>Potential Hazard</u>
Sewage, industrial wastewater treatment plants & pumping stations, sewer flushers, etc.	Sewage, industrial wastewater, contaminated water, toxic chemicals, etc.
Paper manufacturing or processing, dye plants, petroleum processing and storage facilities, printing plants, chemical manufacturing or processing, industrial fluid systems, steam generation, rubber processing, tanneries	Toxic chemicals, water conditioning compounds Examples: Toxic dyes, acids, alkalies, solvents, quaternary ammonia compounds, mercury, chromium, etc.
Canneries, breweries, food processing, milk processing, ice manufacturing, meat packers, poultry processing, rendering companies, etc.	Process wastewater, steam, detergents, acids, caustics, refrigeration lines
Hospitals, clinics, laboratories, veterinary hospitals, mortuaries, embalmers, shipyards, marinas, nuclear reactor facilities	Bacterial cultures, laboratory solutions, blood & tissue waste, toxic materials, sea water, sewage, contaminated water, etc.
Metal-plating, photo-processing, laundries, commercial car washes, commercial refrigeration systems, dry cleaning establishments caustic & acid solutions, etc.	Toxic chemicals, concentrated cleaning agents, solvents Examples: Cyanides, fluorides, copper, chromium,
Commercial greenhouses, spraying & irrigation systems using weedicides, herbicides, exterminators	Toxic chemicals Examples: Ammonium salts, phosphates, 2,4-D sodium arsenite, lindane, malathion, etc.
Boiler systems, cooling towers or internal fire-fighting systems using conditioners, inhibitors, etc. Typically: Apartment buildings, cooling towers, warehouses	Toxic chemicals Examples: Hydrazine, anti-freeze solutions, etc.

**Table VII-2.1 Degree of Hazard (continued)**

**B. Aesthetically Objectionable Facilities**

The following partial listing gives examples of the types of facilities which **would require an acceptable double check valve assembly (DCVA)** device to be installed in the service connection to the public water distribution system. Additional facilities needing DCVAs can be found in Table VII-3.1.

<u>Type of Facility</u>	<u>Potential Hazard</u>
Customer fire protection loops, fire storage tanks with no chemical additives, fire systems with external pumping connections supplied by an auxiliary source	Stagnant water, objectionable tastes, odors
High temperature potable water	Objectionable temperatures
Utilization of food grade dyes	Objectionable color
Complex plumbing systems in commercial buildings Examples: Barber shops, beauty salons, supermarkets	Plumbing errors, obsolete plumbing equipment, poor plumbing inspection/correction programs

## PART VII

### CHAPTER 3 - RECOMMENDED CROSS-CONNECTION CONTROL AND BACKFLOW PREVENTION DEVICES

#### 3.0 General

In selecting for use of the devices outlined in this section, it is vital that the degree of protection provided be commensurate with the degree of hazard present. It also is important that the limitations of each device be understood since the degree of protection provided will depend on the type of backflow prevention device and the maintenance program employed.

Acceptable backflow prevention devices used for cross-connection control are as follows:

- A. Air Gap
- B. Double Check Valve Assembly (DCVA)\*
- C. Reduced Pressure Zone Devices (RPZD)\*
- D. Residential Dual Check Valve (RDCV)
- E. Atmospheric Vacuum Breaker (AVB)
- F. Hose-Bibb Vacuum Breaker (HBVB)
- G. Pressure Vacuum Breaker (PVB)

\*DCVAs and RPZDs should conform to ANSI/AWWA Standards C510 and C511, respectively.

#### 3.1 Air Gap

An air gap separation provides a complete physical separation between the free flowing discharge end of a potable water supply line, faucet, plumbing fixture, or other device and the flood level rim of an open or nonpressure receiving vessel. An acceptable air-gap separation shall be at least double the diameter of the supply line. In no case shall the air gap be less than one inch. See Figure VII-3.1.

##### *Advantages:*

By preventing backflow caused by both backsiphonage and backpressure, air gap installations provide the maximum degree of protection against backflow. Air gaps are recommended for health hazard risks.

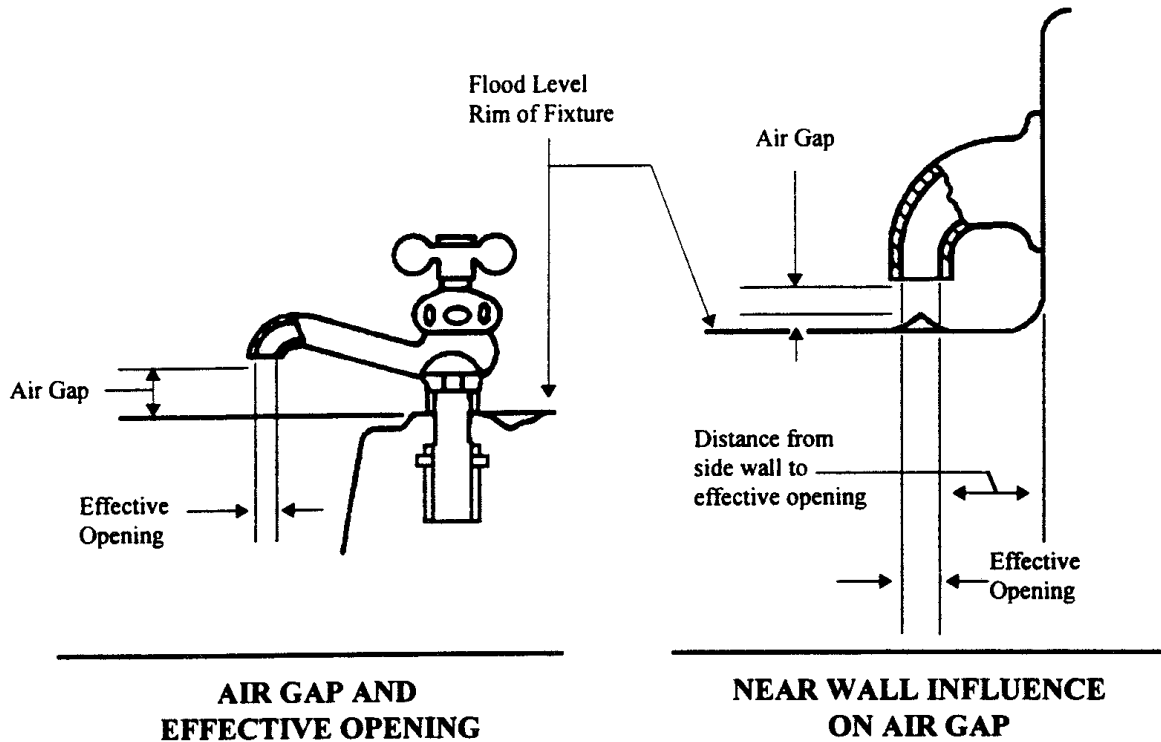
##### *Limitations:*

Air gap separations can be defeated by the thoughtless addition of a hose that in effect extends the discharge end of the pipe to a point below the highest possible water level of the fixture. Fixture outlet devices should be installed when there is any possibility of hose installation.

Under some conditions the cost of an air gap separation may be high when compared to a mechanical backflow prevention device.

Air gaps cause a loss of line pressure. Therefore, certain commercial processes will need to re-establish pressure through pumps or elevation.

**Figure VII-3.1 Air Gap**



**Minimum Air Gaps for Plumbing Fixtures Fixture**

Fixture	When Not Affected By Near Wall (*) (Inches)	When Affected By Near Wall (**) (Inches)
Laboratories and other fixtures with effective opening not greater than 1/2 inch diameter	1	1-1/2
Sink, laundry trays, goose-neck bath faucets and other fixtures with effective openings not greater than 3/4inch diameter	1-1/2	2-1/4
Over rim bath fillers and other fixtures with effective openings not greater than one inch diameter	2	3
Effective openings greater than one inches	2X Diameter of Effective Opening	3X Diameter of Effective Opening

\* Side walls, ribs or similar obstructions do not effect air gaps when spaced from inside edge of spout opening a distance greater than three times the diameter of the effective opening for a single wall, or a distance greater than four times the diameter of the effective opening for two intersecting walls.

\*\* Vertical walls, ribs, or similar obstructions extending from the water surface to or above the horizontal plane of the spout opening require a greater air gap when spaced closer to the nearest inside edge of spout opening than specified in (\*) above. The effect of three or more such vertical walls or ribs has not been determined. In such cases, the air gap shall be measured from the top of the wall.

### **3.2 Double Check Valve Assembly (DCVA)**

The DCVA consists of two independently acting, soft-seated, spring-loaded, check valves mounted in series with two tightly closing shutoff valves and four test cocks (see Figure VII- 3.2).

#### *Advantages:*

The primary advantage of a DCVA is that when its two check valves are in the wide open position, there is relatively little resistance to flow. The head loss through the device ranges between 3 and 11 psi, depending on the rate of flow and diameter of pipe.

Double check valve assemblies prevent backflow caused by both backsiphonage and backpressure.

#### *Limitations:*

Because DCVAs lack the differential pressure relief valve that RPZDs have, they are recommended only for non-health hazard risks.

DCVAs have the inherent weakness of possible failure without giving exterior indication that a failure has occurred.

DCVAs are mechanical devices that require periodic inspection and maintenance.

### **3.3 Reduced Pressure Zone Device (RPZD)**

This device consists of two soft-seated, spring-loaded check valves operating in series, and a soft-seated, spring-loaded, diaphragm-activated, pressure differential relief valve, located in the zone between the check valves (see Figure VII-3.3). Two tightly closing shutoff valves and four test cocks complete the assembly. These devices will indicate leakage through one or both check valves or the relief valve by the discharge of water from the relief valve port. This factor is an important advantage over the double check valve assembly.

#### *Advantages:*

The RPZD, when periodically tested and properly maintained, may be used for backflow protection in situations where it would be extremely difficult, or impractical, to provide an air gap separation.

Malfunctioning of the RPZD is indicated by discharge of water from the relief port. The RPZD provides protection from backflow caused by both backsiphonage and backpressure, and is recommended for health hazard risks.

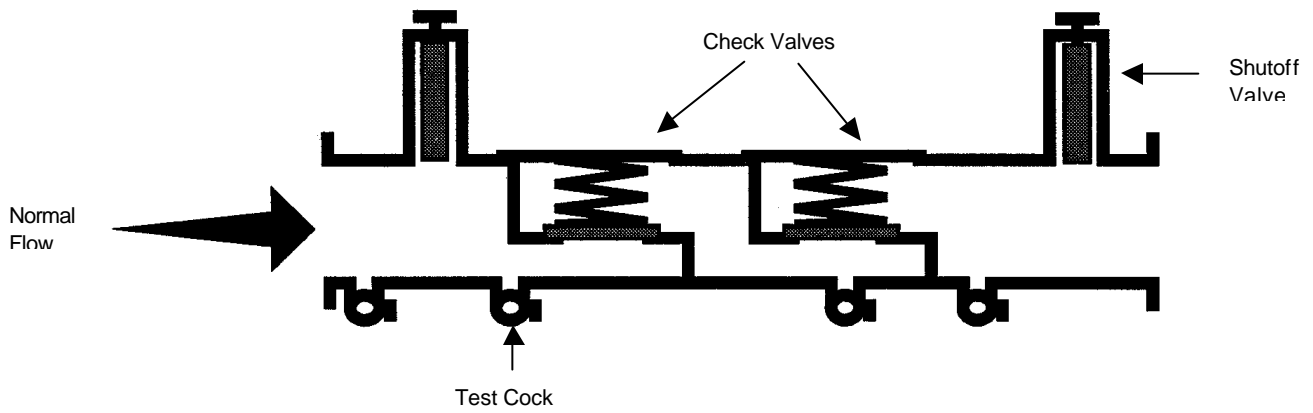
#### *Limitations:*

RPZDs are mechanical devices that require periodic testing and maintenance.

Pressure loss through RPZDs may be expected to average between 10 and 30 psi, depending upon the size and flow rate of the device.

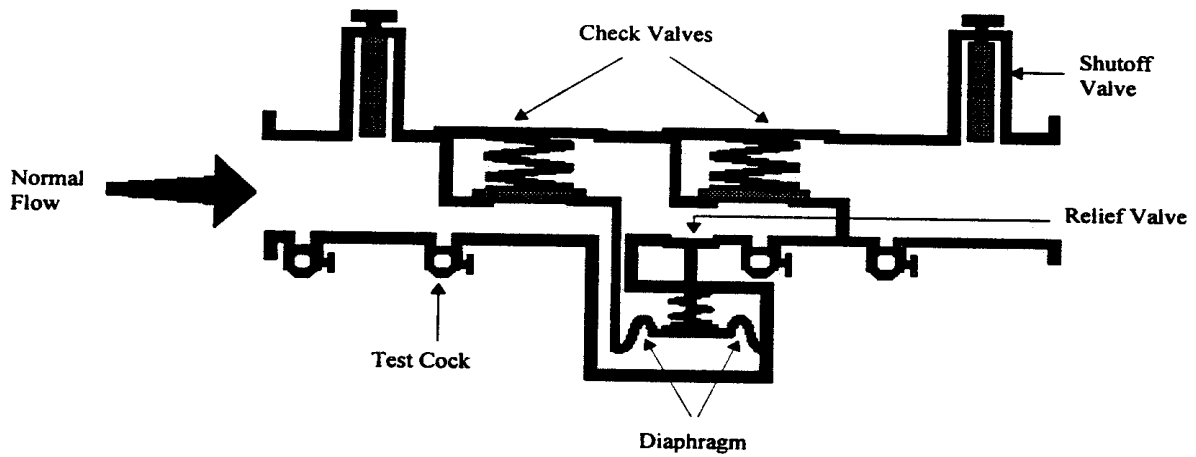
RPZDs should not be installed below ground level, must be protected from freezing, and must be provided with adequate space to facilitate maintenance and testing.

**Figure VII-3.2 Double Check Valve Assembly**



**Note:** Check valves are in the backflow position.

**Figure VII-3.3 Reduced Pressure Zone Device**



**Note:** Check valves are in the backflow position. The relief valve is in the normal flow position.

### **3.4 Residential Dual Check Valve (RDCV) and the Vacuum Breakers**

Only the air gap, DCVA and RPZD are testable devices that prevent backflow caused by both backsiphonage and backpressure.\* The RDCV prevents backflow caused by both backsiphonage and backpressure, but is non-testable.

\* The air gap can be considered “testable” in the sense that it can be visually inspected.

#### **Residential Dual Check Valve:**

The RDCV is a practical, non-testable device that can be installed for containment protection at residential homes. The RDCV is installed in-line and downstream of the service meter, and contains no shutoff valves. The RDCV prevents backflow caused by both backsiphonage and backpressure, but is recommended only for residential homes which are considered to be a nonhealth hazard (see Figure VII-3.4).

#### **Atmospheric Vacuum Breaker:**

The AVB is a non-testable device that is installed at fixture outlets. The AVB prevents backflow caused by backsiphonage, but not backpressure. The AVB must not be kept under continuous pressure for more than 12 hours in any 24-hour period. Because of this requirement, no shut-off valve should ever be installed downstream of the AVB. A shutoff valve upstream of the AVB is recommended. The AVB should be installed at least six inches above the fixture outlet (see Figure VII-3.5).

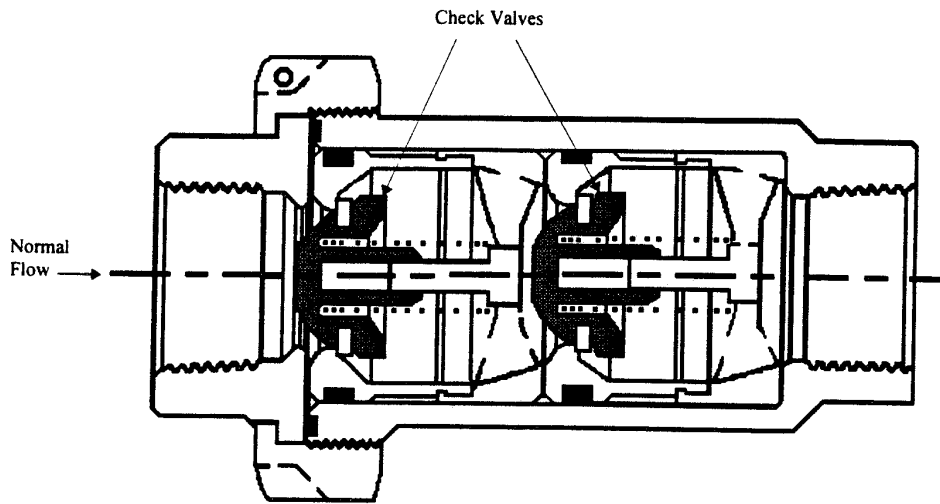
#### **Hose-Bibb Vacuum Breaker:**

The HBVB is a non-testable device that is installed at fixture outlets. The HBVB prevents backflow caused by backsiphonage, but not backpressure (see Figure VII-3.6).

#### **Pressure Vacuum Breaker:**

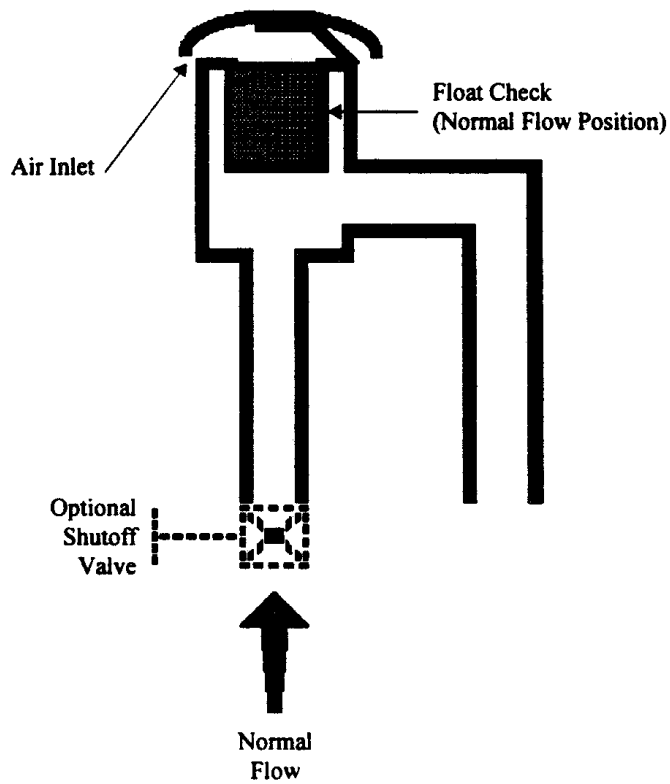
The PVB is a testable device that is equipped with test cocks and shutoff valves, and is installed at fixture outlets. The PVB prevents backflow caused by backsiphonage, but not backpressure (see Figure VII-3.7).

**Figure VII-3.4 Residential Dual Check Valve**



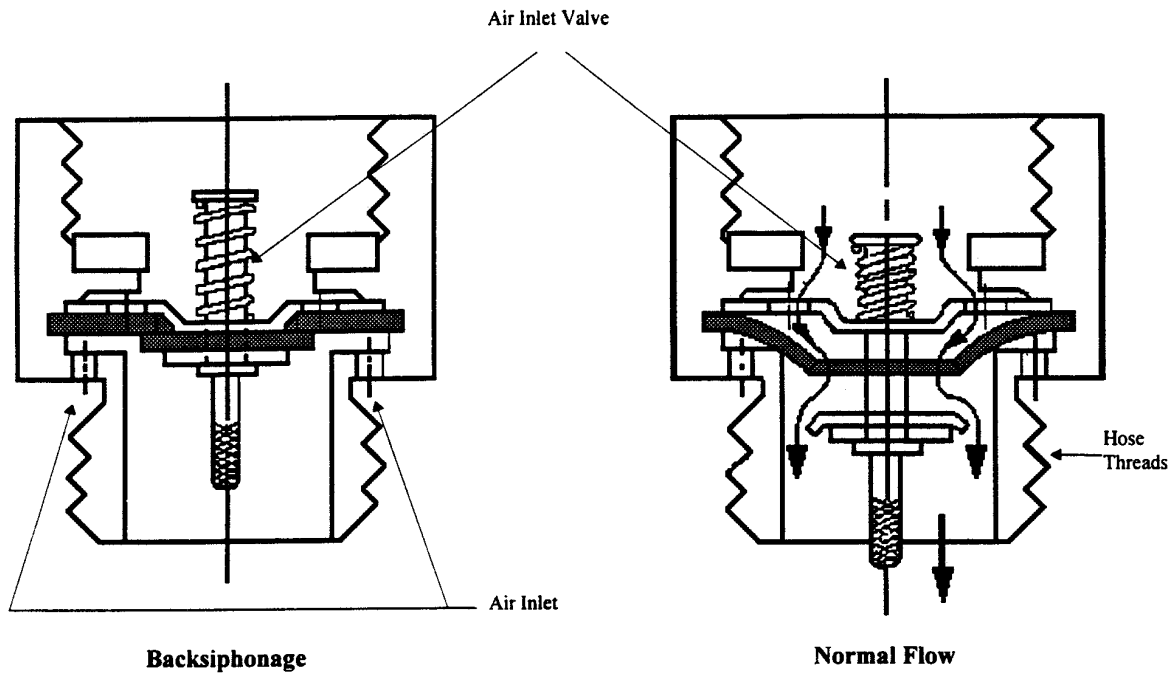
**Note:** Check valves are in the backflow position.

**Figure VII-3.5 Atmospheric Vacuum Breaker**

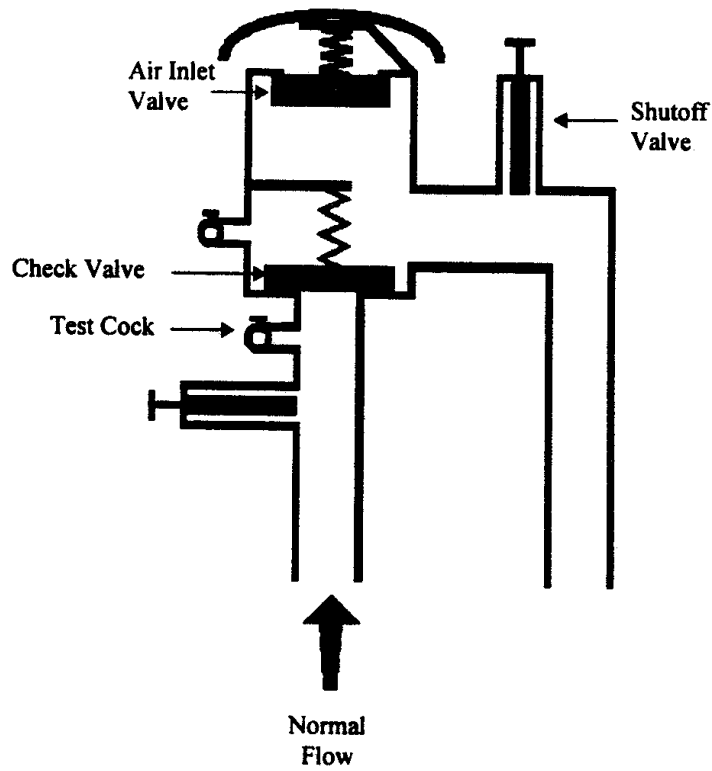




**Figure VII-3.6 Hose-Bibb Vacuum Breaker**



**Figure VII-3.7 Pressure Vacuum Breaker**



**Table VII-3.1  
Recommended Backflow Prevention Devices**

The following table outlines the applicability of the air gap, RPZD, and DCVA for the protection of a community water supply. This is a partial list and is not intended to supplant any ordinances or standards developed by a water company. Additional facilities requiring these type of devices can be found in Table VII-2.1.

<u>PLANT or FACILITY</u>	<u>TYPE OF DEVICE TO BE USED</u>		
	<u>Air Gap</u>	<u>RPZD</u>	<u>DCVA</u>
1. Aircraft and Missile Plants	X	X	
2. Automatic Car Wash	X	X	
3. Automated Manufacturing Plants	X	X	
4. Auxiliary Water Systems	X	X	
5. Beverage Bottling Plants			X
6. Breweries/Distillers	X	X	
7. Chemical Plants (Manufacturing, Processing, Compounding, or Treatment)	X	X	
8. Dairies and Cold Storage Plants	X	X	
9. Dye Works	X	X	
10. Film Processing	X	X	
11. Irrigation Systems (Green House, Park, Golf Course, Playgrounds, Estates, Cemeteries, etc.)	X	X	
12. Laboratories	X	X	
13. Laundries	X	X	
14. Meat Packing and Rendering Plants	X	X	
15. Metal Plating Plants	X	X	
16. Paper and Paper Products (Wet Process)	X	X	
17. Petroleum or Gas Processing or Storage Plants	X	X	
18. Plating Plants	X	X	
19. Power Plants (Heating, Ventilation, Refrigeration, or Commercial Power)	X	X	
20. Rubber Plants (Natural or Synthetic, Mfg. Rubber Goods or Tires)	X	X	
21. Sand and Gravel Plant	X	X	
22. Sewage or Stormwater Treatment/Processing Facility; Ejector or Pumping Station	X	X	
23. Swimming Pools			X
24. Water Front Facilities and Industries	X	X	
25. Where a Cross-Connection is to be Maintained	X	X	
26. Radioactive Materials or Substances, Processing Plants or Facilities Handling	X		

**Table VII-3.1  
Recommended Backflow Prevention Devices (continued)**

<u>PLANT or FACILITY</u>	<u>TYPE OF DEVICE TO BE USED</u>		
	<u>Air Gap</u>	<u>RPZD</u>	<u>DCVA</u>
27. Manufacturing, Processing, and Fabrication Plants Using Toxic Materials	X	X	
28. Manufacturing, Processing, and Fabrication Plants Using Nontoxic Materials			X
<b><u>BUILDINGS</u></b>			
29. Convalescent Home			X
30. Medical Clinic	X	X	
31. Medical/Dental Building	X	X	
32. Multipurpose Commercial Buildings (Over three stories)			X
33. Office Building (Over three stories)			X
34. Hospitals	X	X	
35. Home for the Aged			X
36. Mortuary	X	X	
37. Morgue	X	X	
38. Nursing Home			X
39. Elementary, High Schools, Trade Schools, and Colleges			X
40. Schools with Laboratories	X	X	
41. Apartment and/or Hotel with Restaurant			X
42. Apartment and/or Hotel (Over three stories)			X
43. Apartment and/or Hotel with House Pump and/or Water Storage Tank	X	X	
44. Apartment and/or Hotel with House Pump and/or Water Storage Tank			X
45. Public Building (Federal/State/City)			
a. Potential Health Threat	X	X	
b. Potential Pollution			X
c. Restricted/Classified or Closed Facilities	X	X	
46. Restaurant (Any Food Handling Establishment)			X
47. Supermarket			X
48. *Building with House Pump and/or Water Storage Tank			X
49. *Building with Sewage Ejectors	X	X	
50. *Buildings or industries using interchangeable connections (swing connectors or four-way valves) for non-potable, auxiliary water supplies		X	

\*Apply to any building regardless of building purpose

**Table VII-3.1**  
**Recommended Backflow Prevention Devices (continued)**

**FIRE PROTECTION SYSTEMS**

**A. No Protection (No Device Required)**

1. Wet system, no pumper connection on buildings three stories or less.
2. Dry system, no pumper connection.

**B. Double Check Valve Assembly**

1. Any system (wet or dry) with a pumper connection.
2. Wet system only within line booster pump on building over three stories high.
3. Any system with private hydrants.

**C. Reduced Pressure Zone Device**

1. Any system where anti-freeze or inhibitors are used.
2. Any system where an auxiliary water source is available and connected to the fire system.

## PART VII

### CHAPTER 4 - MODEL OF AN ORDINANCE FOR THE CONTROL OF BACKFLOW AND CROSS-CONNECTIONS

Note: The following model of an ordinance has been taken in large part from a document published by the Foundation for Cross-Connection Control and Hydraulic Research, University of Southern California, Los Angeles, California. This model has gained wide-spread acceptance, with modifications not only in Pennsylvania but in many other states.

The following format is suggested for municipalities that need to adopt a cross-connection control ordinance to support the public water supplier providing water to their community or to support their own municipal water department. Privately-owned or investor-owned community water suppliers also should submit the necessary revisions to their tariff to the Pennsylvania Public Utility Commission (PUC) for the necessary approvals by that agency.

The content of this model ordinance should not be considered rigid. Changes and modifications most likely will be needed before final adoption to adapt it to your specific water system.

As the statutory authority empowered to Pennsylvania's cities, boroughs, and townships varies according to municipal code (e.g., 2nd class township, 3rd class city), each water supplier or municipality should have the following model ordinance reviewed by their legal counsel to ensure compliance with their code and local requirements. Privately-owned and investor-owned water suppliers must be sure their ordinance complies with municipal codes and PUC requirements.

### MODEL OF AN ORDINANCE FOR THE CONTROL OF BACKFLOW AND CROSS-CONNECTIONS

#### Section 1 General Policy

1.0 Purpose. The purpose of this ordinance is:

- a. To protect the public water supply from contamination or pollution by isolating, within the consumer's water system, contaminants or pollutants which could backflow through the service connection into the public water supply system.
- b. To promote the elimination or control of existing cross-connections, actual or potential, between the public or consumer's water supply and non-potable water systems, plumbing fixtures and sources or systems containing process fluids.
- c. To provide for the maintenance and continuation of a cross-connection control program which prevents the contamination or pollution of the public and consumer's water supply.

1.1 Application. The public water supplier and the consumer have the joint responsibility for protection of the public water supply from contamination or pollution due to backflow. If the public water supplier requires an approved backflow prevention device, the supplier shall give notice to the consumer to install such an approved backflow prevention device at each service connection to his premises. The consumer should immediately install such an approved device or devices at his own expense. Failure, refusal, or inability on the part of the consumer to install such a device or devices shall constitute grounds for discontinuing water service to the premises until such a device or devices have been installed.

#### Section 2 Definitions

Note: For the purposes of this section, the definitions provided in Chapter 1 should be used.

### **Section 3 Water System**

- 3.1 The water system shall be considered as made up of two parts: the public water supply system and the consumer's water system.
- 3.2 The public water supply system shall consist of the source facilities and the distribution system, and shall include all those facilities of the public water supply system under the control of the public water supplier up to the point where the consumer's water system begins.
- 3.3. The source shall include all components of the facilities utilized in the production, treatment, storage, and delivery of water to the public distribution system.
- 3.4. The public distribution system shall include the network of conduits used for delivery of water from the source to the consumer's water system.
- 3.5. The consumer's water system shall include all facilities beyond the service connection which are utilized in conveying water from the public distribution system to points of use.

### **Section 4 Cross-Connections Prohibited**

- 4.1 No water service connection shall be installed or maintained to any premises where actual or potential cross-connections to the public water supply system or consumer's water system may exist, unless such cross-connections are abated or controlled to the satisfaction of the public water supplier.
- 4.2 No connection shall be installed or maintained whereby water from an auxiliary water supply may enter a public or consumer's water system unless such auxiliary water supply, as well as the method of connection and use of such supply, has been approved.

### **Section 5 Surveys and Investigations**

- 5.1 The consumer's premises shall be open at all times to the public water supplier, or its authorized representative, for the purposes of surveying for, or investigating, actual or potential cross-connections.
- 5.2 On request by the public water supplier, the consumer shall furnish information on water use practices within his premises.
- 5.3 It shall be the responsibility of the water consumer to conduct periodic surveys of water use practices on his/her premises to determine whether there are actual or potential cross-connections to his/her water system.

### **Section 6 Where Protection is Required**

- 6.1 An approved backflow prevention device shall be installed prior to the first branch line leading off each service line to a consumer's water system where, in the judgement of the public water supplier, an actual or potential hazard to the public water supply system exists.
- 6.2 An approved backflow prevention device shall be installed on each service line to a consumer's water system where the following conditions exist:
  - a. Systems having an auxiliary water supply, unless such auxiliary supply is accepted as an additional source by the public water supplier and approved by DEP.
  - b. Systems where any substance is handled in such a fashion as to create an actual or potential hazard to the public water supply system. This shall include systems having sources or auxiliary systems, which contain process fluids or waters originating from the

public water supply system, which are no longer under the sanitary control of the water purveyor.

- c. Systems having internal cross-connections that are not correctable, or intricate plumbing arrangements which make it impractical to determine whether or not cross-connections exist.
  - d. Systems where, because of security requirements or restrictions, it is impossible or impractical to make a complete cross-connection survey.
  - e. Systems having a repeated history of cross-connections.
  - f. Others specified by the public water supplier.
- 6.3 An approved backflow prevention device shall be installed on each service line to a consumer's water system serving, but not necessarily limited to, the following types of facilities unless the public water supplier determines that no actual or potential hazards to the public water supply system exist:
- a. hospitals, mortuaries, clinics, nursing homes;
  - b. laboratories;
  - c. piers, docks, waterfront facilities;
  - d. sewage treatment plants, sewage pumping station or storm water pumping station;
  - e. food or beverage processing plants;
  - f. chemical plants;
  - g. metal plating industries;
  - h. petroleum processing or storage plants;
  - i. radioactive material processing plants;
  - j. car Wash or truck wash; or
  - k. others specified by the water purveyor.

## **Section 7 Type of Protection Required**

- 7.1 The type of protection required under Section 6.1, 6.2, and 6.3 of this ordinance shall depend on the degree of hazard which exists as follows:
- a. An approved air gap separation shall be installed where the public water supply system may be contaminated with substances that are dangerous to public health and could cause a severe health hazard, and where such a device would be technically feasible and/or practical.
  - b. An approved air gap separation or an approved reduced pressure zone device shall be installed where the public water supply system may be contaminated with a substance that could cause a system or health hazard.
  - c. An approved air gap separation, an approved reduced pressure zone device, or an approved double check valve assembly shall be installed where the public water supply system may be polluted with substances that would be objectionable but not dangerous to health.

## **Section 8 Backflow Prevention Devices**

- 8.1 Any backflow prevention device required by this ordinance shall be of a model or construction approved by the public water supplier and shall comply with the following:

- a. Air gap separation to be approved shall be at least twice the diameter of the supply pipe, measured vertically above the top rim of the receiving vessel, but in no case less than one inch.
- b. A double check valve assembly or a reduced pressure zone device shall be approved by the public water supplier and shall mean a device that has been manufactured in full conformance with standards established by the American Water Works Association (AWWA) entitled:

ANSI/AWWA C510 Standard for Double Check  
Valve Backflow-Prevention Assembly.

and

ANSI/AWWA C511 Standard for Reduced-Pressure  
Principle Backflow-Prevention Assembly

Said AWWA standards are herein adopted by the public water supplier. Final approval, however, of the reduced pressure zone device and the double check valve assembly shall be evidenced by a certificate of full approval, issued by an approved testing laboratory, certifying full compliance with the said AWWA standards.

- 8.2 Existing backflow prevention devices approved by the public water supplier at the time of installation and properly maintained shall, except for inspection and maintenance requirements, be excluded from the requirement of Section 8.1 of this ordinance provided the public water supplier is assured that they will satisfactorily protect the public water supply system. Whenever the existing device is moved from the present location, or requires more than minimum maintenance, or when the public water supplier finds that the maintenance of the device constitutes a hazard to health, the device shall be replaced by a backflow prevention device meeting the requirements of this ordinance.

## **Section 9 Installation**

- 9.1 Backflow prevention devices required by this ordinance shall be installed at a location, and in a manner, approved by the public water supplier. The device(s) shall be installed by a person properly qualified. Installation of the devices shall be at the expense of the water consumer.
- 9.2 Backflow prevention devices installed on the service line to a consumer's water system shall be located on the consumer's side of the water meter, as close to the meter as is reasonably practical, and prior to any other connection.
- 9.3 Pits or vaults shall be water-tight, flood-free, and maintained free from standing water by means of either a sump and pump or a suitable drain. Such a pump or drain shall not connect to a sanitary sewer, nor permit flooding of the pit or vault by reverse flow from its point of discharge. An access ladder and adequate lighting, natural or artificial, shall be provided to permit maintenance, inspection, and testing of the backflow prevention device.

## **Section 10 Inspection and Maintenance**

- 10.1 It shall be the duty of the consumer at any premises on which backflow prevention devices are required by this ordinance to have inspections, tests, and overhaul made in accordance with the following schedule, or more often where inspections indicate a need.
  - a. Air separation shall be inspected at the time of installation, and at least every 12 months thereafter.



- b. Double check valve assemblies shall be inspected and tested for tightness at the time of installation, and at least every 12 months thereafter. These devices shall be dismantled, inspected internally, cleaned, and repaired whenever needed, and at least every 30 months.
  - c. Reduced pressure zone devices shall be inspected and tested for tightness at the time of installation, and at least every 12 months thereafter. These devices shall be dismantled, inspected internally, cleaned, and repaired whenever needed and at least every five years.
  - d. Pressure vacuum breakers shall be inspected and tested for the capability to prevent backsiphonage at the time of installation and at least every 12 months thereafter. These devices shall be dismantled, inspected internally, cleaned, and repaired whenever needed and at least every 12 months.
- 10.2 Inspections, tests, and overhaul of backflow prevention devices shall be made at the expense of the water consumer, and shall be performed by the public water supplier or a person certified to inspect, test, and overhaul backflow prevention devices.
- 10.3 Whenever backflow prevention devices required by this ordinance are found to be defective, they shall be repaired or replaced at the expense of the consumer without delay.
- 10.4 The water consumer must maintain a complete record of each backflow prevention device from purchase to retirement. This shall include a comprehensive listing that includes a record of all tests, inspections, and repairs. Records of inspections, tests, repairs, and overhaul shall be submitted to the public water supplier upon request.
- 10.5 Backflow prevention devices shall not be bypassed, made inoperative, removed, or otherwise made ineffective without specific authorization by the water supplier.

## **Section 11    Booster Pumps**

- 11.1 Where a booster pump has been installed on the service line to, or within, any premises, such a pump shall be equipped with a low pressure cut-off device designed to shutoff the booster pump when the pressure in the service line on the suction side of the pump drops to 10 pounds per square inch gauge or less for a period of 30 seconds or longer.
- 11.2 It shall be the duty of the water consumer to maintain the low pressure cut-off device in proper working order and to certify to the public water supplier, at least once a year, that the device is operating properly.

## **Section 12    Violations**

- 12.1 The public water supplier may deny or discontinue, after issuing reasonable notice, the water service to any premises wherein any backflow prevention device required by this ordinance is not installed, tested, and maintained in a manner acceptable to the public water supplier, or if it is found that the backflow prevention device has been removed or by-passed, or if an unprotected cross-connection exists on the premises, or if a low pressure cut-off device required by this ordinance is not installed and maintained in working order.
- 12.2 Water service to such premises shall not be restored until the consumer has corrected or eliminated such conditions or defects in conformance with this ordinance and to the satisfaction of the public water supplier.

## Part VII

### Table VII-4.1 Plumbing Codes

The following is a list of plumbing codes which DEP is aware of at the time of the development of this part of the Public Water Supply Manual. The purpose of this list is to provide information on the availability of various plumbing codes and not to recommend a preference for one code over another. Revisions of this list will be made in the future, as information on other plumbing codes becomes available.

1. The BOCA Plumbing Code

The Building Officials and Code Administrators International, Inc.  
4051 West Flossmoor Road  
Country Club Hills, Illinois, 60478  
Telephone (708) 799-2300  
[www.bocai.org](http://www.bocai.org)

2. The International Plumbing Code

The Building Officials and Code Administrators International, Inc.  
4051 West Flossmoor Road  
Country Club Hills, Illinois, 60478  
Telephone (708) 799-2300  
[www.bocai.org](http://www.bocai.org)

3. The Uniform Plumbing Code

The International Association of Plumbing and  
Mechanical Officials  
20001 Walnut Dr. South  
Walnut, CA 91789  
Telephone (909) 595-8449  
[www.iapmo.com](http://www.iapmo.com)

## DEP REGIONAL OFFICES

- The completed form is to be addressed to: PA DEP - Safe Drinking Water and sent to the address of the appropriate district office or county health department (CHD) having jurisdiction over the water system.
- District and CHD addresses by county can be found within DEP document number 3930-FM-BSDW0560. This document can be located by searching under "forms" for document number 3930-FM-BSDW0560 on eLibrary at the following link: <http://www.depgreenport.state.pa.us/elibrary/GetFolder?FolderID=3195>.

This and related environmental information are available electronically via Internet. For more information, visit us through the PA PowerPort at <http://www.state.pa.us> or visit DEP directly at <http://www.dep.state.pa.us> (directLINK "Drinking Water Publications").



[www.GreenWorks.tv](http://www.GreenWorks.tv) - A web space dedicated to helping you learn how to protect and improve the environment. The site features the largest collection of environmental videos available on the Internet and is produced by the nonprofit Environmental Fund for Pennsylvania, with financial support from the Pennsylvania Department of Environmental Protection, 877-PA-GREEN.

**Bureau of Water Supply and Wastewater Management**  
**P.O. Box 8467**  
**Harrisburg, PA 17105-8467**

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