EPA
United States
Environmental Protection
Agency

Cross-Connection Control: A Best Practices Guide

Introduction	
Purpose	This Guide discusses the importance of controlling cross-connections and preventing backflow occurrences from unprotected cross-connections in the water system.
Target Audience	This Guide is intended for owners and operators of all public water systems serving fewer than 10,000 persons.

Key Cross-Connection Terms and Definitions	
Term	***Definition***
Cross-connection	Any actual or potential connection between the public water supply and a source of contamination or pollution.
Backflow	The flow of water or other liquids, mixtures, or substances into the distributing pipes of a potable supply of water from any source or sources other than its intended source. Backsiphonage is one type of backflow.
Backpressure	Backflow that occurs when the pressure in an unprotected downstream piping system exceeds the pressure in the supply piping.
Backsiphonage	Resulting from negative pressures in the distributing pipes of a potable water supply.

Where Can Cross-Connections Occur?

Cross-connections can occur at many points throughout a distribution system and a community's plumbing infrastructure. Cross-connections can be identified by looking for physical interconnections (or arrangements) between a customer's plumbing and the water system. Some specific examples of backflow incidents that can occur are:

- Lawn chemicals backflowing (backsiphoning) through a garden hose into indoor plumbing and potentially into the distribution system.
- Backsiphonage of "blue water" from a toilet into a building's water supply.
- Carbonated water from a restaurant's soda dispenser entering a water system due to backpressure.
- Backsiphonage of chemicals from industrial buildings into distribution system mains.
- Backflow of boiler corrosion control chemicals into an office building's water supply.

Cross-Connection Control and Backflow Prevention Programs

Why is it Important to Have a Cross-Connection Control and Backflow Prevention Program?

Having a program in place to control cross-connections and prevent backflow is critical to ensuring the safety of the drinking water you provide to your customers:

- Cross-connections are ever-present dangers that exist in most water systems and can result in serious chemical or microbiological contamination events in drinking water systems.
- Cross-connections should be protected in order to prevent backflow, which can be hard to detect.
- In any distribution system, potential cross-connections and therefore sources of contamination can be numerous, varied, and unpredictable.
- Having these programs in place can help you avoid the costs of responding to a contamination incident.

What Do Cross-Connection Control and Backflow Prevention Programs Involve?

Cross-Connection Control and Backflow Prevention Programs vary by state and municipality. For more information, talk with your state primacy drinking water program, state building code or plumbing authority, or health department. Cross-Connection Control Programs may involve:

- Authority to implement and enforce a Cross-Connection Control Program.
- Compliance with state or primacy agency plumbing and building codes or plumbing authority and local ordinances.
- Public education programs.
- Training for water system operators and other personnel on hazard surveys; cross-connection identification; and backflow device installation, testing, repair, and maintenance.
- Record keeping and reporting.
- Installation and testing of devices that prevent backflow consistent with the level of hazard.
- Periodic inspection and testing of devices by certified testers.

How Can I Start Implementing a Cross-Connection Control and Backflow Prevention Program?

You are responsible for ensuring that the water you provide to customers meets all federal and state standards and that its quality is not compromised within your distribution system. Developing a comprehensive Cross-Connection Control and Backflow Prevention Program is one way to ensure the quality of your water and prevent any problems that could occur in your distribution system. If you do not already have a program in place, consider taking the following steps:

- Contact your state primacy or other agency for more information on the basic concepts of cross-connection control and backflow prevention and information on other water systems in your area that have developed a program.
- Determine if you will have to take any legal steps to establish local cross-connection control and backflow prevention ordinances, with assistance from your state and local government.
- List the goals for your program in order of priority. For example, is it more important to develop a public education campaign or to conduct a survey of backflow devices at industrial and commercial facilities served by your system?
- Develop a proposed timeline for implementing your program.
- Review the plan with your local government, state, and any other key stakeholders.
- Hold public meetings and send notices to customers to educate the community about the need for a program and how it may affect them.
- Plan to monitor your progress in implementing your program and protecting public health.
- Conduct initial hazard testing, as required.

How Can I Reduce and Prevent Cross-Connections?	
Plumbing and Distribution System Operation Practices	◆ Hire approved personnel for the installation of any contaminant backflow prevention devices to ensure that local codes and manufacturer's recommendations are met. ◆ Use only assemblies or devices approved by the appropriate state or local authority. ◆ Test all backflow prevention devices at the frequencies recommended or required by your state. ◆ Provide backflow prevention in new construction through coordination with the local building inspector's office.
Inspections	◆ For existing buildings, develop a program in-house or with plumbing or water system personnel to inspect for the adequacy of cross-connection control. Prioritize inspections based upon the expected degree of risk. ◆ Make sure that a backflow inspector conducts inspections for hazards to be controlled. ◆ For both new construction and existing buildings, require continued inspection and testing of backflow devices.
Fire Hydrant Connection Procedures	◆ Ensure that construction contractors or anyone using a hydrant to fill a tank intended to carry potable water exercises safe fire hydrant connection procedures to prevent backflow.

What Technologies are Available to Control Cross-Connections and Prevent Backflow?

The type of backflow that is most likely to occur in your system (either from backpressure or backsiphonage) and the related health effects will determine which backflow prevention technology is best for your water system. The available technologies are described briefly below.

Technology	*Description*
Atmospheric Vacuum Breaker	◆ Consists of float check, check seat, air inlet port, and possibly a shutoff valve immediately upstream. ◆ Allows air to enter the downstream water connection to prevent backsiphonage. ◆ Used for backsiphonage conditions only.
Pressure Vacuum Breaker Devices	◆ Consist of vacuum breakers with a loaded check valve and a loaded air inlet valve. ◆ Used for backsiphonage conditions only.
Double Check Valve Devices	◆ Consist of two independently acting, tightly closing, resilient seated check valves in series with test ports. ◆ Have tightly closing, resilient seated shutoff valves attached at each end of the assembly. ◆ Prevent backflow under backsiphonage and backpressure conditions. ◆ Typically approved for only low to medium hazards.
Air Gaps	◆ Physical separation between a potable water system and a receiving vessel or source of contamination. ◆ Air gap between the outlet of the potable system and the flood level rim of the receiving vessel or any source of contamination must be at least twice as large as the diameter of the potable water outlet and never smaller than 1 inch. ◆ May require additional pumping downstream of air gap. ◆ Safest and simplest means under backsiphonage and backpressure conditions. ◆ Useful for all hazard levels.
Reduced Pressure Zone Backflow Devices	◆ Similar to the double check valve devices, but also contain an independently acting pressure relief valve between the two check valves (which sits lower than the first check valve). ◆ Protect against high water pollution hazards. ◆ Protect against backsiphonage and backpressure.

What Should I Do in Case of a Backflow Event?	
Step 1	◆ Stop the pressure differential that caused backflow of contamination, if possible. ◆ Identify and remove the cross-connection.
Step 2	◆ Contact appropriate state or local authorities to report the incident. ◆ In areas where public exposure to harmful contaminants is suspected, provide immediate notice to affected consumers regarding water usage and consumption and contact appropriate state or local authorities to report the incident. Public notice should explain the cause of the contamination and corrective actions that are underway and should include any appropriate health effects language. ◆ Provide updated public notification as appropriate during and after removal of contamination from the system.
Step 3	◆ If the contamination is limited to a small area, proceed to step 6. ◆ If the extent of the contamination is unknown or is extensive, proceed to step 4. (If sampling and testing of the water can be arranged immediately, the results could be used to determine the extent of the contaminants involved.)
Step 4	◆ Develop a plan for systematic cleaning or flushing of the system to minimize the risk of drawing contaminants into uncontaminated areas. ◆ The plan should indicate the amount of water and the length of time needed to completely flush the system. The direction of flow should draw clean water through the contaminated site and prevent any contaminated water from entering uncontaminated areas. Depending upon the nature of the contamination, some wastes may be discharged into the sanitary sewer system and some may need special handling or treatment.
Step 5	◆ Throughout the situation, continue to sample within and outside the suspected contaminated area to assess the extent of the damage. Skip step 6.
Step 6	◆ Perform system flushing and, where necessary, cleaning of the customer's system.
Step 7	◆ After flushing and any necessary cleaning, test the drinking water in affected areas to ensure the contamination has been removed.
Step 8	◆ Ensure that the source of contamination has been removed or that the risk of contamination has been eliminated using backflow prevention measures that meet local and state requirements.

For additional information:
Call the Safe Drinking Water Hotline at 1-800-426-4791, visit the EPA Web site at www.epa.gov/safewater/smallsys.html, or contact your State drinking water representative.

Office of Water September 2006 EPA 816-F-06-035