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**CROSS-CONNECTION CONTROL  
AT ARMY INSTALLATIONS**

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Public Works Technical Bulletin  
No. 420-49-16

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FACILITIES ENGINEERING  
UTILITIES

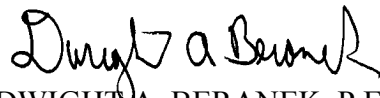
CROSS-CONNECTION CONTROL AT ARMY INSTALLATIONS

1. Purpose. The purpose of this Public Works Technical Bulletin (PWTB) is to provide an overview of cross-connection control and backflow prevention at Army installations with particular emphasis on regulatory aspects, technical guidelines and major elements of cross-connection control program.
2. Applicability. This PWTB applies to all U.S. Army Directorate Public Works activities responsible for providing drinking water to consumers in accordance with requirements of the Safe Drinking Water Act (SDWA) and its amendments, and applicable state and local regulations.
3. References.
  - a. AR 420-49, Facilities Engineering, Utility Services, April 1997.
  - b. AR 40-5, Preventive Medicine, June 1985.
  - c. AR 200-1, Environmental Protection and Enhancement, February 1997
  - d. Public Law 93-523, Safe Drinking Water Act (SDWA), December 1974 and Amendments.
4. Discussion. A description and summary of various aspects of cross-connection control and backflow prevention at Army installations is provided in the enclosed report. The report addresses:
  - Health and operational implications of cross-connections for potable water systems
  - Causes of backflow, classification of hazards and methods of prevention.
  - Requirements for cross-connection control based on Federal, State and Army regulations.
  - Technical guidelines and references for cross-connection control.
  - Key elements of a cross-connection control program.
  - Lessons learned from cross-connection control efforts at Army installations.
5. Points of Contact. HQUSACE is the proponent for this document. The POC at HQUSACE is Bob Fenlason, CEMP-RI, 202-761-8801, or e-mail: [bob.w.fenlason@usace.army.mil](mailto:bob.w.fenlason@usace.army.mil).

Questions and/or comments regarding this subject, should be directed to:

U.S. Army Engineer District, Mobile  
ATTN: CESAM-EN-GE (Melissa Shirley)  
P.O. Box 2288  
Mobile, AL 36628-0001  
Telephone: (251) 690-2616  
Fax: (251) 690-2030  
e-mail: melissa.l.shirley@sam.usace.army.mil

FOR THE COMMANDER:



DWIGHT A. BERANEK, P.E.  
Chief, Engineering and Construction Division  
Directorate of Civil Works

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## **1. INTRODUCTION**

a. Under the Safe Drinking Water Act (SDWA), a water supplier is responsible for preventing polluted or contaminated water, gas, or other substances from entering a public drinking water system. US Army regulations mandate that potable water at all Army installations meets the SDWA and State and local regulations. In addition, Army regulations require particular methods and procedures be followed in the design, operation, and maintenance of potable water systems, and mandate compliance with specific technical guidelines. The development of an organized program that identifies, controls, and/or eliminates the interconnections (cross-connections) between drinking water systems (potable) and other water systems of questionable quality (nonpotable) is also required. To comply with these requirements, a Cross-Connection Control Program must be developed, implemented, and maintained.

b. The purpose of this Public Works Technical Bulletin is to provide an overview of cross-connection control and backflow prevention. Subjects discussed are the following:

- (1) Health and operational implications of cross-connections for potable water systems.
- (2) Causes of backflow, classification of hazards and methods of prevention.
- (3) Requirements for cross-connection control based on Federal, State and Army regulations.
- (4) Technical guidelines and references for cross-connection control.
- (5) Key elements of a cross-connection control program.
- (6) Lessons learned from cross-connection control efforts at Army installations.

## **2. CROSS-CONNECTION CONTROL**

### **a. OVERVIEW**

Drinking water is assumed to be safe. Advanced technology in water treatment presumably provides high quality drinking water to the tap. To ensure this, it is necessary that physical interconnections (cross-connections) between pipes containing safe drinking water and other pipes containing water of questionable quality are eliminated or protected against the possibility of reverse flow. If the questionable water was to enter the safe drinking water, contamination or pollution may result. Surveillance of drinking water systems to identify these interconnections is essential and regulatory. Piping and plumbing systems are continually being installed, repaired, altered, or extended. A program of cross-connection control is imperative to protect the health of the consumer. Additionally, legal implications may be involved since it is the water supplier's responsibility to provide safe drinking water to the consumer.

### **b. HEALTH AND ECONOMIC SIGNIFICANCE**

(1) It is possible for drinking water systems to carry dangerous bacteria, chemicals, or other substances that can cause harm to humans. There are numerous documented cases of injuries and illnesses that have occurred during the past century resulting from the backwards flow of polluted or contaminated water into the drinking water system. A classic

example of illness and even death as a result of cross-connections occurred in Chicago in 1933 where 1,409 persons contracted amebic dysentery from contamination through old, defective, and improperly designed plumbing systems and equipment. Of those people, 98 died. More recently, in 1985, 352 soldiers became ill and 163 were hospitalized with acute gastroenteritis at a military installation. An investigation of the suspected source, a military dining facility, revealed no specific food as the source of contamination. However, numerous unprotected cross-connections were identified in the facility during the investigation. Recent problems with sewer drainage in the food preparation area, and the unprotected cross-connections found during the investigation, were suspected to have been the source and the mechanism for transference.

(2) Although always of highest concern, the impact of contamination in potable water systems resulting from backflow is not solely a health-related issue. It can also be very costly and time-consuming to remediate. In a small Southwest Virginia community, the pesticide chlordane entered a water main by backflow through a hose connection and household plumbing. As chlordane adheres to soil to prevent groundwater contamination, it did the same inside the pipes and all fixtures it contacted. Flushing could not remove the chemical from the mains or the plumbing. Several thousand feet of main had to be replaced as well as the service lines, household plumbing, water heaters, clothes washers, and dishwashers. The chlordane incident did not result in any reported health problems but cost the community more than \$40 million.

(3) At a military installation in 1990, a faulty valve in a roof-mounted air-conditioning unit allowed freon to be siphoned into the potable drinking water piping within the building. Fortunately, the yellowish color of the water at a drinking fountain was discovered in the early morning by an employee who notified his supervisors. Signs and hazard identification tape were immediately placed at all drinking fountains in the building. Samples were taken of the water from the fountains and analyzed for contaminants. A program of consistent flushing of all potable water lines within the building began and continued for almost a year before the levels of contamination in the drinking water were below those recommended by Federal and State Drinking Water Standards. These and other cases where contamination or illness has resulted from cross-connections have led to increased requirements to ensure water distribution and plumbing systems remain safe from contamination due to potential cross-connections.

#### c. CROSS-CONNECTIONS AND BACKFLOW

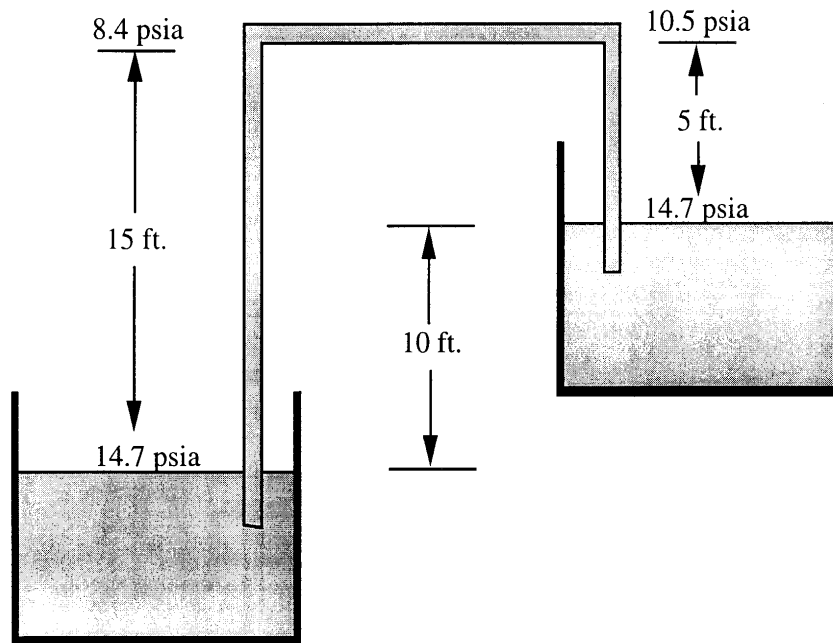
(1) A "cross-connection" is the link through which it is possible for a source of contamination or pollution to enter the potable (drinking) water system. There are two essential factors needed before backflow can occur. First, there must be a link (cross-connection) between two systems, one potable and the other non-potable (water of questionable quality). Second, there must be a force that will move non-potable water toward the potable water. This force in water pipes is caused by pressure or pressure differential. The force (pressure) produces motion. Hence, the liquid in a pipe that has the higher pressure will move toward the liquid in a pipe that has the lower pressure (see **Figure 1**). In cross-connection control terminology, this is called "backpressure."

(2) Another "force" factor is vacuum. Reduced or negative pressure is created when pressure drops below that of the atmosphere. This is commonly called "negative pressure." When negative pressure occurs, atmospheric pressure is exerted on a liquid forcing it toward the lowest point of pressure. This creates a siphoning effect, sucking the nonpotable

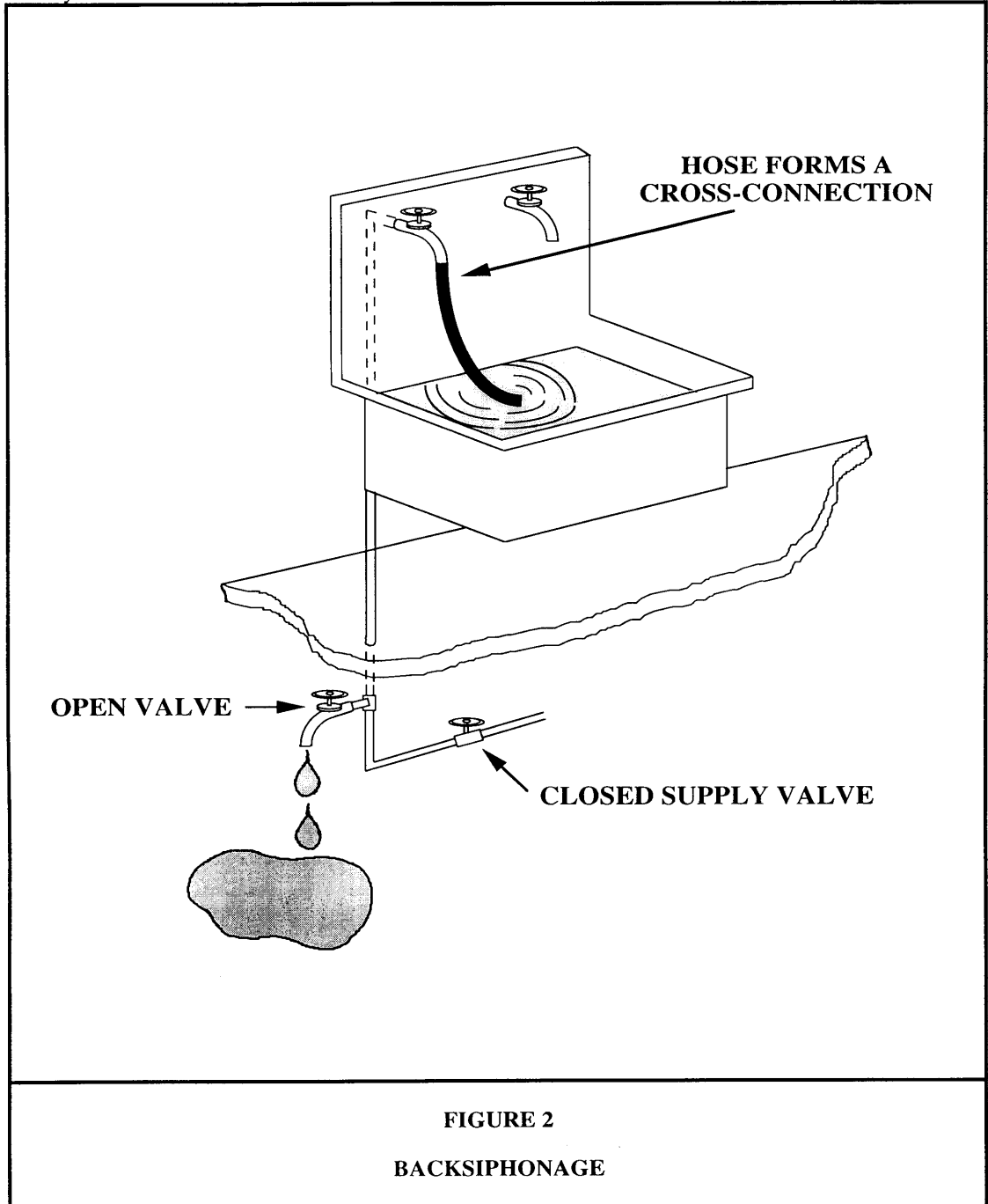


liquid, to the point of lowest pressure. In cross-connection control terminology, this is called "backsiphonage" (see **Figure 2**).

(3) In summary, backflow is the reverse flow of a liquid caused by either backpressure or backsiphonage. As an example, backpressure can be caused by an increase in pressure above that of the potable water system, such as in a pressurized boiler or other vessel



**FIGURE 1**  
**PRESSURE RELATIONSHIPS**



(see **Figure 3**). Backsiphonage can be caused by a vacuum created when a pipe breaks (water main break) or when a valve is left open somewhere downstream in a pipeline (see **Figure 4**). It can also be caused by heavy demand, such as a fire pumper truck pulling water from a hydrant during fire-fighting operations (see **Figure 5**).

d. HAZARD CLASSIFICATION

(1) Cross-connections are classified by the degree of hazard presented by the downstream nonpotable system or equipment served by a supply of potable water. The degree of hazard increases as the probability of backflow or the toxicity of a substance in the nonpotable system or equipment increases. However, the risk associated with a substance's toxicity is always more of a concern than the probability of backflow.

(2) Although some minor differences in the definitions of the degree of hazard may exist in regulations and technical guidance documents related to cross-connection control, the degree of hazard is generally classified as Minor/Low, Moderate/Medium, and Severe/High. In Army guidance documents to be further discussed later, the classification (degree) of hazards are defined as follows (in accordance with MIL-HDBK-1164):

(a) Class I - Minor/Low Degree of Hazard

- The contaminant would only slightly degrade the aesthetic quality of the water, i.e., taste, odor, or color.
- A health hazard would not exist.
- The contaminant would not disrupt service of piped water.

(b) Class II - Moderate/Medium Degree of Hazard

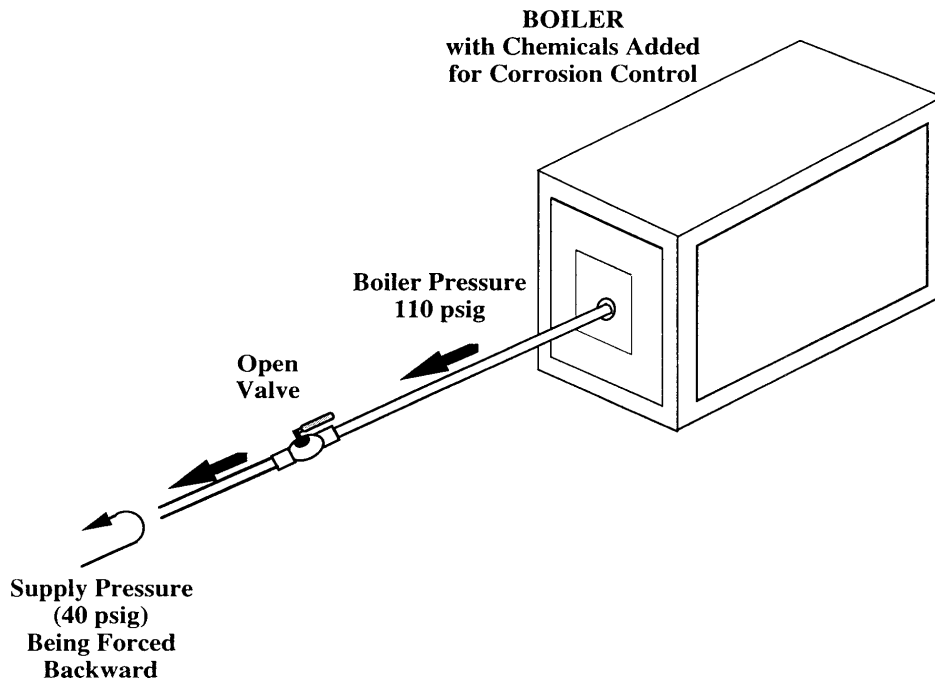
- The contaminant would significantly degrade the aesthetic quality of the water or impair the usefulness of the water.
- A health hazard would not exist.
- The contaminant would not seriously disrupt service of piped water for drinking or domestic use.

(c) Class III - Severe/High Hazards

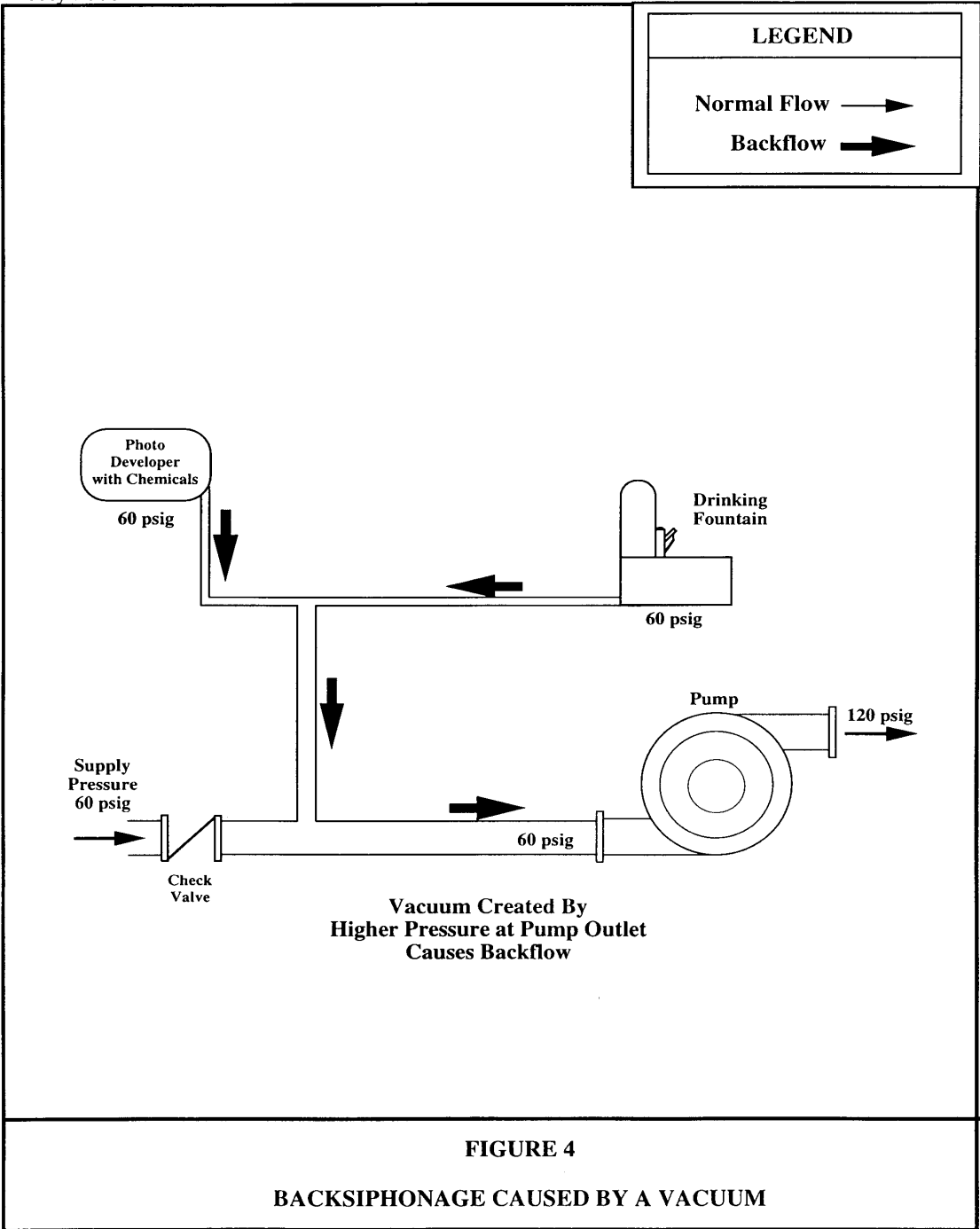
- The contaminant would be toxic, poisonous, noxious, or unhealthy.
- A health hazard would exist. If the contaminant were consumed by humans, it could result in illness or death.
- The contaminant would disrupt service of piped water for drinking or domestic use.

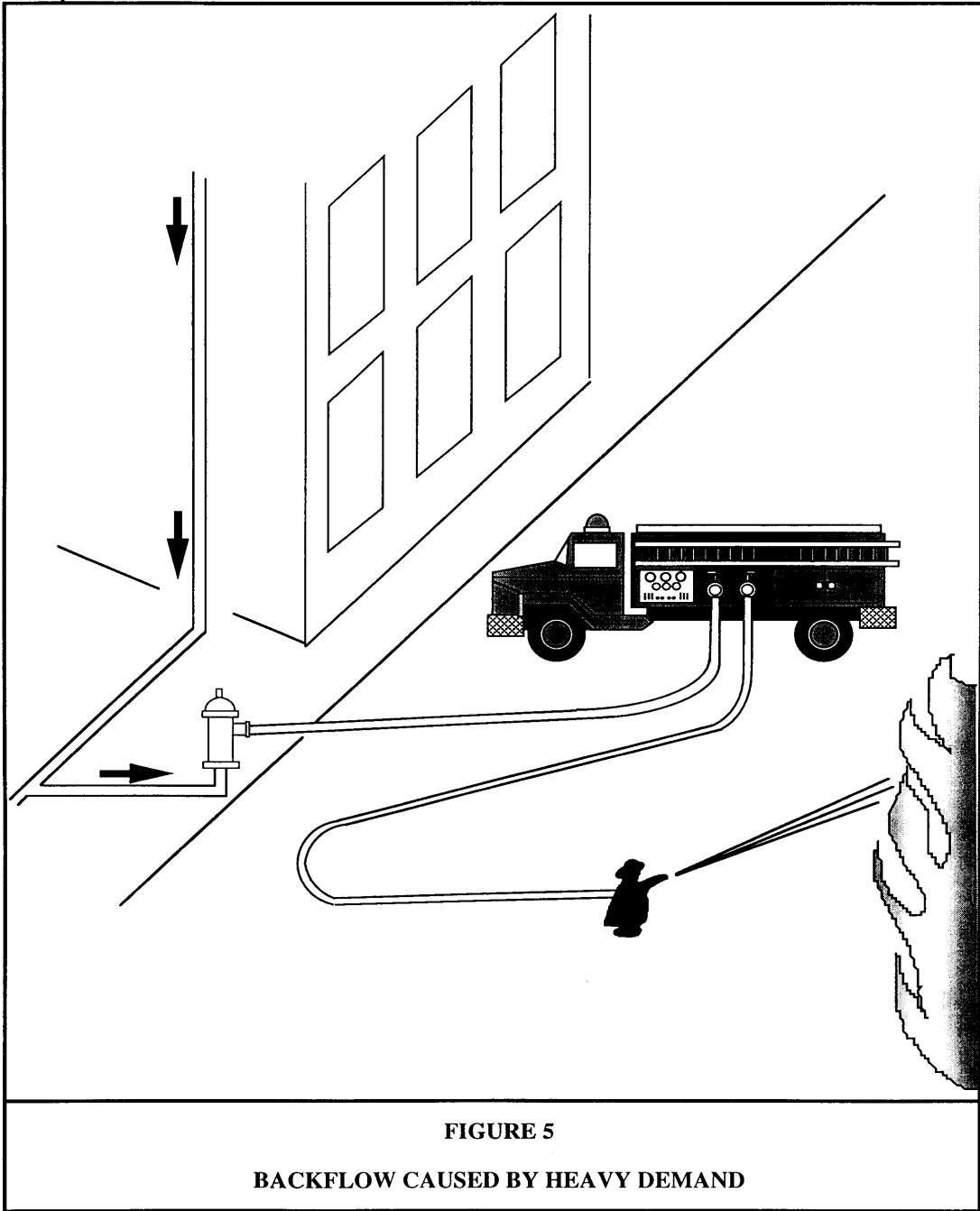
(3) The degree of hazard determines the type of backflow prevention device to

be installed. If the degree of hazard is questionable, it must be assumed that the cross-connection is Class III. A list of buildings representative of those facilities typical to Army installations and the potential cross-connection classification/degree of hazard each presents to the potable water distribution system, is provided in **Table 1**.



**FIGURE 3**  
**BACKPRESSURE CAUSED BY BOILER**







**TABLE 1**  
**TYPICAL US ARMY FACILITIES AND HAZARD CLASSIFICATIONS**

<b><u>Facility</u></b>	<b><u>Classification/Degree Of Hazard</u></b>
Administrative Offices	Class I/Low
Air Conditioning Plants	Class III/High
Aircraft Maintenance Shops	Class II-to-III/Moderate-to-High
Arts and Crafts Facilities	Class I-to-II/Low-to-Moderate
Barracks	Class I/Low
Bath Houses	Class III/High
Child Care Facilities	Class III/High
Clubs w/beverage bars and dining facilities	Class II-to-III/Moderate-to-Low
Dental Clinics	Class III/High
Dining Facilities	Class III/High
Elementary Schools	Class I/Low
Family Housing	Class I/Low
Fueling Stations	Class III/High
Guest Houses	Class I-to-II/Low-to-Moderate
Gymnasiums	Class I-to-III/Low-to-High
Hazardous Waste Storage Facilities	Class III/High
Heating/Boiler Plants	Class III/High
High Schools	Class I-to-III/Low-to-High
Insecticide Herbicide Shops	Class III/High
Intermediate Schools	Class I-to-III/Low-to-High
Kennels	Class III/High
Laundries/Dry Cleaning Plants	Class II-to-III/Moderate-to-High
Medical Clinics	Class III/High
Military Schools	Class I-to-III/Low-to-High
Museums	Class I-to-III/Low-to-High
Optometry Clinics	Class III/High
Photography Laboratories	Class I-to-III/Low-to-High
Religious Activity Facilities	Class I-to-III/Low-to-High
Resource Recovery Plants	Class III/High
Small Arms Repair Shops	Class III/High
Stables	Class III/High
Swimming Pools	Class III/High
Trade Shops	Class I-to-III/Low-to-High
Vehicle Maintenance Shops	Class II-to-III/Moderate-to-High
Vehicle Washing Facilities	Class II-to-III/Moderate-to-High
Veterinary Clinics	Class III/High
Warehouses	Class I/Low
Wastewater Pumping/Lift Stations	Class III/High
Wastewater Treatment Plants	Class III/High
Water Booster Pumping Stations	Class I-to-III/Low-to-High
Water Treatment Plants	Class III/High



## e. METHODS OF BACKFLOW PREVENTION

Prevention of backflow can be accomplished by either using an air gap or a mechanical device specifically designed to prevent backflow. Selection of the method or device is dependent on the potential degree of hazard presented by the downstream nonpotable water system. The hazard results from pollutants or contaminants that are likely to taint the potable water in the event that backflow were to occur as a result of either backsiphonage or backpressure. These methods and devices are further discussed below and illustrated in figures presented.

### (1) Air Gap

The first method is a physical separation between the potable water pipe and the nonpotable water pipe, commonly referred to as an "air gap" (see **Figure 6**). Air gaps are non-mechanical and provide the most reliable means of prevention. An air gap: Can be used regardless of pressure conditions or the degree of hazard; Is commonly used at the end of a pipe that supply reservoirs, tanks, or other open top vessels; Is 100 percent effective, so long as it cannot be bypassed or defeated; Must be twice the diameter of the potable water supply pipe, but never, in any situation, less than one inch. As an example, the air gap between a 4-inch pipe supplying a swimming pool must be at least 8-inches above the highest overflow level of the pool.

### (2) Backflow Prevention Devices

(a) The second method is by using mechanical devices installed between the potable and nonpotable water pipes to stop the reverse flow of a liquid. The devices are called "backflow prevention devices" or "backflow preventers." They are designed and manufactured specifically for the purpose of preventing backflow. There is a wide selection of backflow prevention devices, in a variety of sizes, available on the commercial market. However, there are four basic types of mechanical devices, as follows:

- The Reduced Pressure Principle (RP) device or Reduced Pressure Zone (RPZ) (see **Figure 7**). The RP is used to protect a water system from pollutants or contaminants that would constitute a hazard to the health of the consumer. It consists of two independently operating, spring-loaded check valves with a reduced pressure zone between the check valves and a pressure relief valve on the underside of the device. The RP:

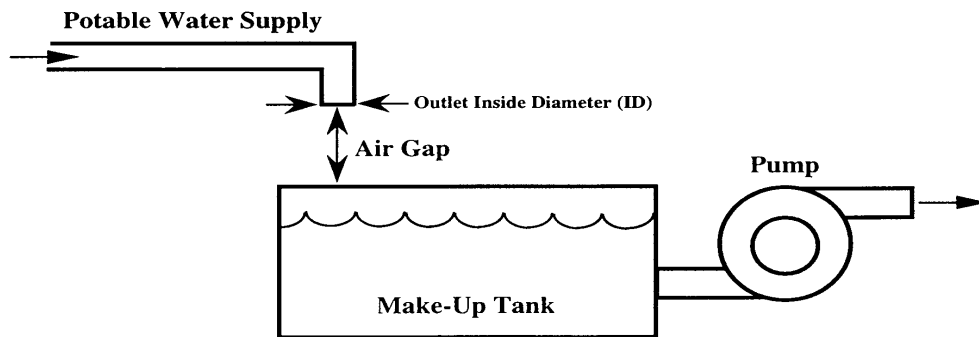
- Protects against both backsiphonage and backpressure.
- Protects against all degrees of hazard.
- Can be subjected to continuous supply pressure (defined as constant pressure for more than 12 hours per day).

- The Double Check Valve (DCV) assembly (see **Figure 8**). The DCV is used to protect a water system from pollutants or contaminants that would not constitute a health hazard, but might be objectionable insofar as color, odor, or taste. It consists of two independently operating, spring-loaded or internally weighted check valves. The DCV:

- Protects against both backsiphonage and backpressure.
- Protects against a low degree of hazard only.

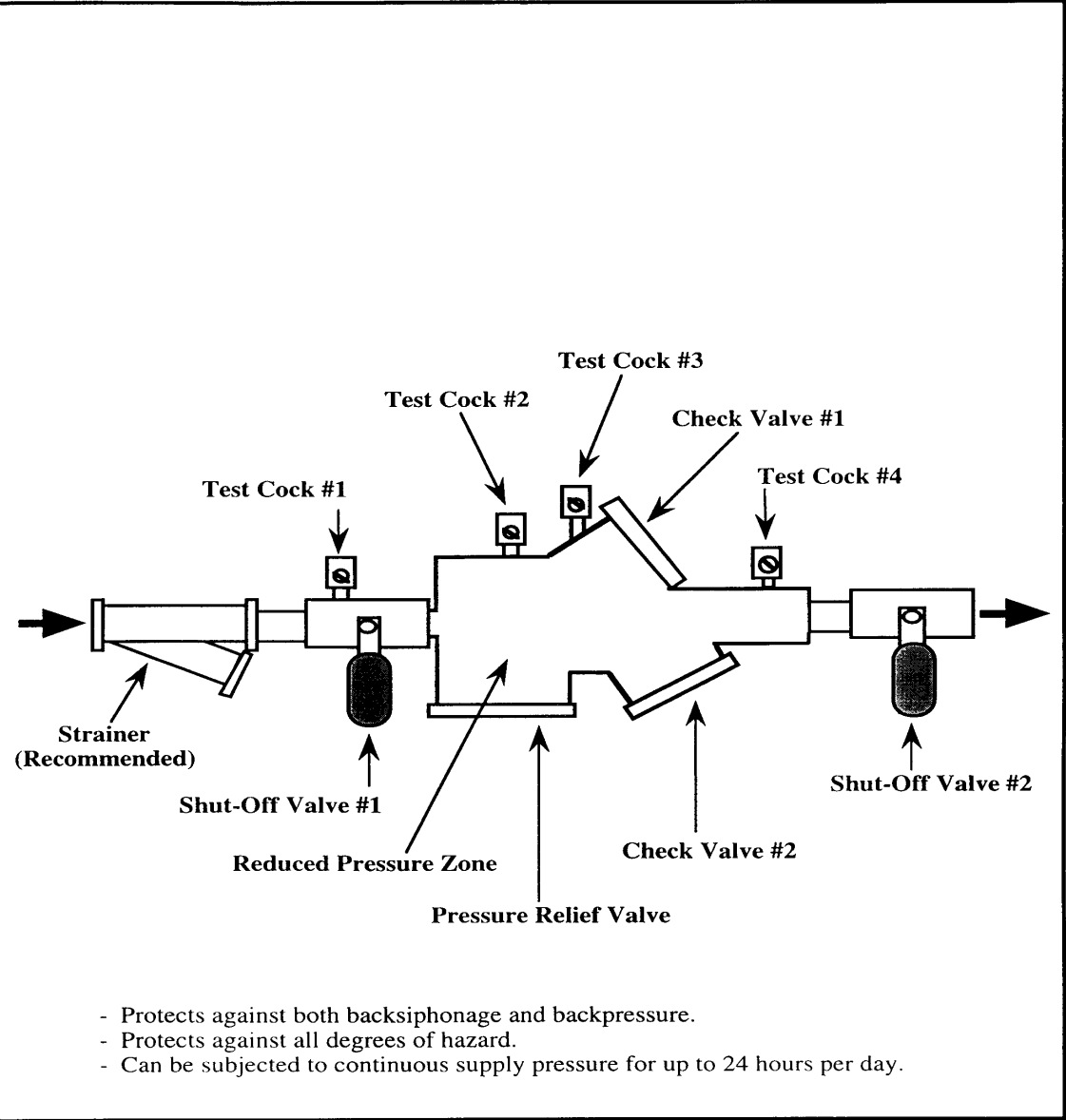
- Can be subjected to continuous supply pressure.

**Minimum Distance from  
Outlet to Tank Overflow  
Level Must Be  
2X Outlet ID**

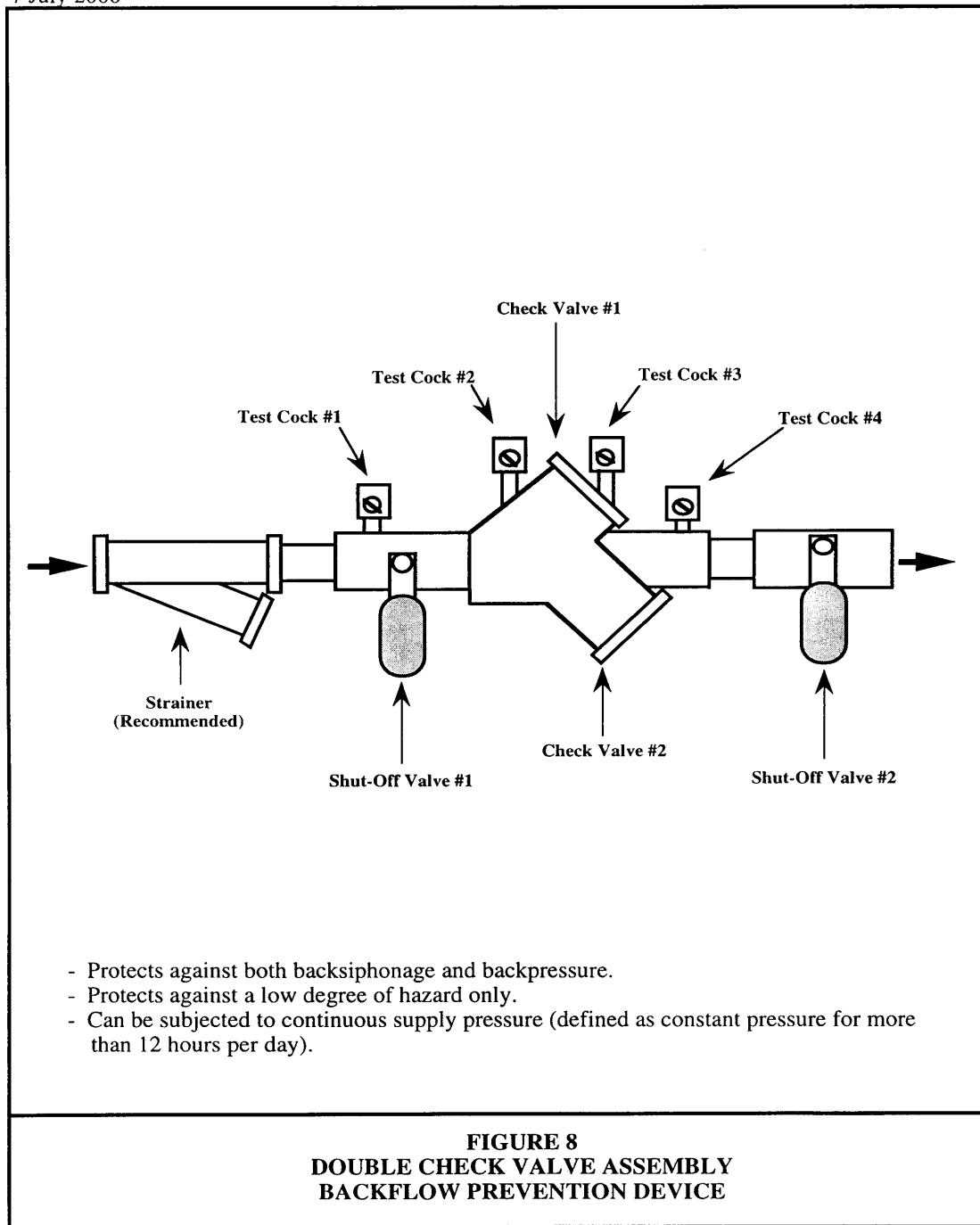


- Can be used regardless of pressure conditions or the degree of hazard.
- Is 100 percent effective, so long as it cannot be bypassed or defeated.
- Are commonly used at the end of a pipe that supply reservoirs, tanks, or other open top vessels
- Must be twice the diameter of the potable water supply pipe, but never, in any situation, less than one inch.

**FIGURE 6  
AIR GAP**



**FIGURE 7**  
**REDUCED PRESSURE PRINCIPLE**  
**BACKFLOW PREVENTION DEVICE**



- The Pressure Vacuum Breaker (PVB) (see **Figure 9**). The PVB can be used to protect against a health hazard. However, if used to protect from a health hazard, consideration must be given to the possibility of the device being bypassed. It consists of one or two independently operating, spring-loaded check valves and an independently operating, spring-loaded air inlet valve. The PVB:

- Protects against backsiphonage only.
- Protects against all degrees of hazard but is generally recommended for protection against non-health hazards only.
- Can be subjected to continuous supply pressure.

- The Atmospheric Vacuum Breaker (AVB) (see **Figure 10**). The AVB can be used for protection against health hazards; however, as with the PVB, if the AVB is used to protect from a health hazard, consideration must be given to the possibility that the device may be bypassed. It consists of a float check valve, seat check valve, and an air inlet port. The AVB:

- Protects against backsiphonage only.
- Is generally recommended for protection against non-health hazards only.
- Cannot be subjected to continuous supply pressure (i.e., cannot be subjected to constant pressure for more than 12 hours per day).

(b) In addition to these four basic devices, there are several variations of each type designed for specific applications, such as a vending machine or a laboratory faucet (see **Figure 11**).

### **3. OVERVIEW OF FEDERAL REGULATIONS**

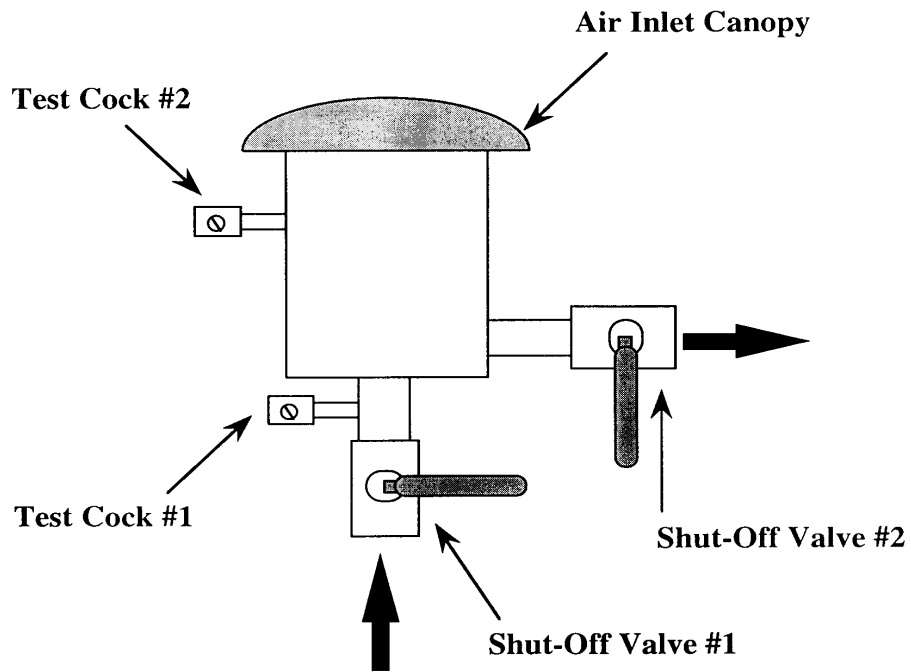
#### **a. SAFE DRINKING WATER ACT (SDWA)**

(1) Under the provisions of the SDWA of 1974 and the Amendments of 1986 and 1988, the Federal Government established national standards for safe drinking water. Individual states are responsible for enforcing these standards and overseeing public water systems. A water purveyor (supplier) is responsible for complying with the provisions of the SDWA. This includes ensuring water meets the safe drinking water standards and its quality is not compromised during delivery to the consumer through the distribution system. Applicable sections of the SDWA as enacted as Title XIV of the Public Health Service Act, is found at 42 United States Code §§ 300f-300j-26, Safety of Public Water Supplies, as follows:

(a) Section 1412 - National Drinking Water Regulations . "National interim primary drinking water regulations promulgated under paragraph (1) shall protect health to the extent feasible using technology, treatment techniques, and other means, which the Administrator determines are generally available (taking costs into consideration) on the date of enactment of this title."

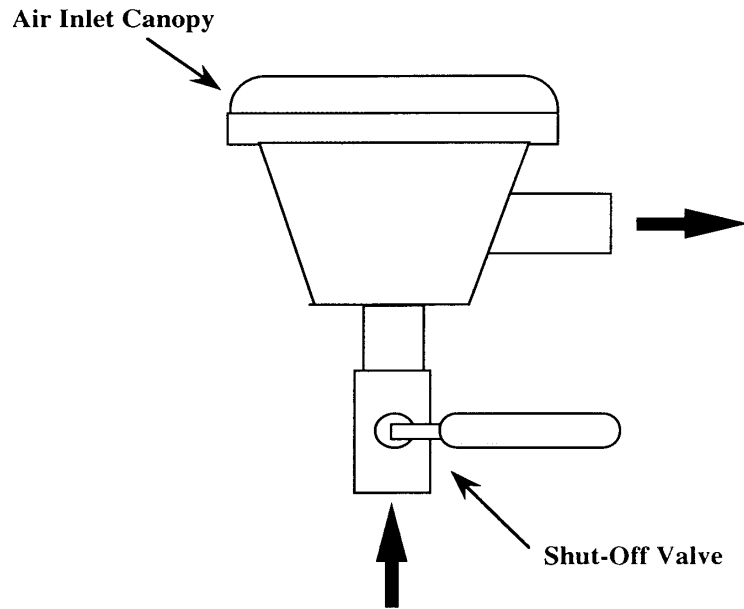






- Protects against backsiphonage only.
- Protects against all degrees of hazard, but is generally recommended for protection against non-health hazards only.
- Can be subjected to continuous supply pressure.

**FIGURE 9**  
**PRESSURE VACUUM BREAKER**  
**BACKFLOW PREVENTION DEVICE**

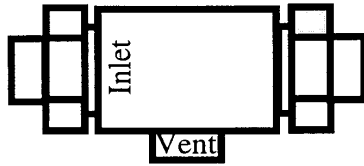


**NOTE: NO DOWNSTREAM SHUT-OFF VALVE**

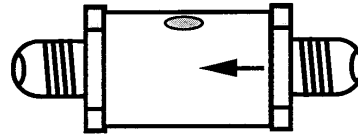
- Protects against backsiphonage only.
- Is generally recommended for protection against non-health hazards only.
- Cannot be subjected to continuous supply pressure.

**FIGURE 10  
ATMOSPHERIC VACUUM BREAKER  
BACKFLOW PREVENTION DEVICE**

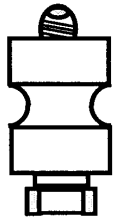
**SPECIALTY TYPE BACKFLOW PREVENTERS**



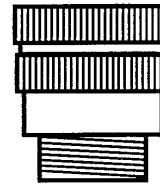
**DUAL CHECK WITH  
INTERMEDIATE  
ATMOSPHERIC VENT**



**BACKFLOW PREVENTER  
FOR VENDING MACHINE  
WATER SUPPLY LINES**



**LABORATORY FAUCET  
BACKFLOW PREVENTER**



**HOSE CONNECTION  
VACUUM BREAKER**

**FIGURE 11  
VARIATIONS OF  
BACKFLOW PREVENTION DEVICES**

(b) Section 1431 - Emergency Power. "(A) Notwithstanding any other provision of this title, the Administrator, upon receipt of information that a contaminant that is present or is likely to enter a public water system, may present an imminent and substantial endangerment to the health of persons, may take such actions as he may deem necessary in order to protect the health of such persons."

(2) Occupation Safety and Health Administration (OSHA). The OSHA Act of 1970 requires, in part, that every employer covered under the Act provide employment and a place of employment which are free from recognized hazards that are causing or are likely to cause death or serious physical harm to his employees. The applicable section of 29 Code of Federal Regulations (CFR), Part 1910, the Occupational Safety and Health Standards, is Subpart J - General Environmental Controls, Section 1910.141 - Sanitation.

- Water supply
- Non-potable water. Construction of nonpotable water systems or systems carrying any other nonpotable substance shall be such as to prevent backpressure or backsiphonage into a potable water system.

#### b. OVERVIEW OF STATE REGULATIONS

(1) In the past decade, the protection of potable water from the potential of backflow has moved forward in priority for state regulatory authorities. This has been accented by the adoption and enforcement of regulations focusing on the elimination of cross-connections and/or their control by the installation of backflow prevention devices, the establishment and implementation of specific management programs, and updated or revised plumbing and building codes to reflect cross-connection control.

(2) A brief description of State rules and regulations applicable to cross-connection control and backflow prevention is provided in Appendix B. Appendix B also includes a matrix that summarizes whether certain aspects of cross-connection control and backflow prevention are recommended or mandatory in specific states. More detailed information related to each state's cross-connection control requirements is available from the Installation Support Center (ISC) of the US Army Corps of Engineers.

(3) The current status and key aspects of state cross-connection control regulations is summarized below.

(a) A total of 47 states have specific or applicable regulations for cross-connection control and backflow prevention. Of those not having specific regulations, plumbing codes have been adopted within these states that require cross-connection protection at specified water outlets, plumbing fixtures, and/or particular water using equipment. Additionally, installation methods, maintenance, and testing requirements are also specified in the codes. Therefore, a framework for cross-connection control exists in every state in the nation.

(b) Regulations, codes, standards, and guidelines are consistently being revised and updated, as are frequent changes in which state agency or individual within an agency is designated with the responsibility for enforcement of cross-connection control regulations. The extent of cross-connection regulations in various states ranges from a single paragraph to comprehensive requirements comprised of several hundred pages.

(c) The US Environmental Protection Agency (EPA) is currently considering the promulgation of federal or state-mandated regulations requiring a cross-connection control program (Federal Register, July 29, 1994).

(d) A total of 24 states mandate the establishment and implementation of a written cross-connection control program or plan. Additionally, the majority of those states also require approval of program or plan by the applicable regulatory authority prior to implementation, and specify key elements that must be contained within.

(e) The majority of states with cross-connection regulations commonly provide specific technical guidelines within the regulations, have prepared and published in-state guidelines, or specify, adopt, or refer to guidance manuals produced and published by the American Water Works Association (AWWA), the Foundation for Cross-Connection Control and Hydraulics Research (FCCCHR), and/or the American Society of Sanitary Engineering (ASSE).

(f) The majority of states do not approve or disapprove the types of backflow prevention device that can be used. However, third party approvals, such as those granted by the ASSE and FCCCHR, are the most commonly accepted and specified.

(g) A total of 38 states with cross-connection control regulations specify particular installation requirements for backflow prevention devices. In addition, plumbing codes also generally specify backflow prevention device installation requirements. When regulations within a particular state require specific installation methods, the majority differentiate between containment (installation of devices in a buildings water service main) and isolation percent of the states with cross-connection control regulations require the installation of backflow prevention devices in fire sprinkler systems.

(h) All states with cross-connection control regulations require backflow prevention devices to be tested. These requirements range from a basic statement saying that the devices must be tested, to specifying particular testing frequencies. In addition, several states specify different testing frequencies for different types of backflow prevention devices.

(i) A total of 31 states with cross-connection control regulations mandate certification of persons who test backflow prevention devices. Several states require testers to be licensed plumbers or contractors. Some states do not specify certification or licensing of testers, however, repair of such devices must be performed by licensed plumbers. Other states have requirements for certification of testers for those devices installed as containment protection, but tests on devices installed for isolation purposes must be performed by licensed plumbers.

#### c. OVERVIEW OF US ARMY REGULATIONS

The Army Regulations described in more detail below, are the impetus for cross-connection control in the Army. In summary, these regulations:

- Require compliance with federal, state, and local regulations.

- Prohibit cross-connections.
- Require the establishment of a cross-connection control program.
- Prescribe installation management principles and responsibilities.
- Specify the technical manuals to be followed.

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- Provide additional sources of information for cross-connection control and backflow prevention.

(1) AR 200-1, Environmental Protection and Enhancement, February

1997

- This regulation has been recently updated and provides an overview of the US Army's environmental programs and requirements. Additionally, it identifies key management controls for guarding and improving the environment and assigns responsibilities for the management of natural resources. It applies to Active Army, Army National Guard, US Army Reserve, civil works activities under the jurisdiction of the US Army Corps of Engineers, tenants, other Federal agencies, contractor activities, and supporting lessee activities located on real property under the jurisdiction of the US Army.

- Key elements of AR 200-1 applicable to cross-connection control are found in Chapter 2, Water Resources Management Program. In summary, this chapter states the Army will:

- Provide drinking water to fixed facilities in accordance with the requirements of the SDWA and applicable state and local regulations, including plans and programs to safeguard water quality and quantity, both at the source and in the distribution system.
- Obtain and comply with all required waterworks permits.
- Identify and implement pollution prevention initiatives.

(2) AR 420-49, Utility Services, April 1997

- This newly revised regulation has consolidated the following seven previously issued regulations into one:
  - AR 420-15 - Certification of Utility Plant Operators and Personnel Performing Inspection and Testing of Vertical Lift Devices.
  - AR 420-43 - Electrical Services.
  - AR 420-46 - Water Supply and Wastewater.

- AR 420-47 - Solid and Hazardous Waste Management
- AR 420-49 - Heating, Energy Selection and Fuel Storage, Distribution, and Dispensing Systems.
- AR 420-54 - Air-Conditioning and Refrigeration.
- AR 420-55 - Food Service and Related Equipment.

- The new regulation, in Chapter 4 - Water Supply and Wastewater, establishes the Army's policy and criteria for the operation, maintenance, repair, and construction of distribution, collection, treatment, and disposal facilities for water supply, wastewater, stormwater, and industrial waste. This regulation stipulates that:

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- Potable water will be supplied in accordance with the SDWA and all applicable state and local regulations.
- Sanitary control and surveillance of potable water supplies will be in accordance with AR 40-5 and Technical Bulletin (TB) Medical (MED) 576 or applicable state and local regulations.
- Operation, maintenance, and repair of water supply systems will be in accordance with MIL-HDBK-1164.

- More specifically, paragraph 4-7, Water Supply, Treatment, and Surveillance, specifies that Army installations located within states that have been granted primary enforcement responsibility by the Environmental Protection Agency (EPA) will comply with the state's regulations. Additionally, paragraph 4-7 k., states: "A cross-connection control program will be established at each installation. Cross-connection control plans will be prepared to regulate those areas in the distribution system where potable water may come in contact with nonpotable water. The plan will list the existing and potential cross-connections and develop a plan for the installation of backflow prevention devices, as well as a schedule for testing, inspection, and maintenance. A routine inspection and maintenance program for backflow prevention devices performed by State certified personnel will include backflow prevention devices for those facilities that have the potential to contaminate the water supply system (for example, pest control shops, photographic laboratories, and medical facilities). Design, operation, and maintenance of cross-connection control components will be in accordance with TM 5-660 and TB MED 576."

(3) AR 40-5, Preventive Medicine, June 1985. This regulation provides the Army's policy, guidelines, procedures, and actions required for preserving and promoting health and preventing disease and injury. Chapter 12, Sanitation, Section 12-2, paragraph f., Cross-Connections, states: "Cross-connections between potable and nonpotable distribution systems are not permitted. TB MED 576 and MIL-HDBK-1164 discuss cross-connection and provide proper references. The current National Standard Plumbing Code will be followed in the testing, maintenance, and renovation of water distribution systems and in the selection of all plumbing fixtures."



(4) AR 5-3, Installation Management and Organization, 1992. This regulation establishes an organization framework for Army installations, describes management principles and responsibilities, provides commanders with signature authority to delegate responsibility and the flexibility to structure installation staff to achieve maximum effectiveness.

#### **4. TECHNICAL GUIDELINES AND REFERENCES**

There are several technical guidelines and references available for cross-connection control and backflow prevention. Those most frequently referenced or specified, with particular emphasis placed on the relevant sections, are described below.

##### **a. US ARMY GUIDELINES**

In accordance with US Army Regulations previously described, several Technical Manuals (TMs) and Military Handbooks (MIL-HDBKs), described in more detail below, provide guidance related to cross-connection control and backflow prevention. They detail the construction, operation, maintenance, repair, and surveillance of potable water supply and distribution systems at Army installations. In summary, these technical guidelines:

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- Prohibit interconnections between potable water and sanitary sewer systems.
- Require an organized program of cross-connection control.
- Require inspections to identify and eliminate cross-connections, and prevent backsiphonage.
- Require instruction in cross-connection control, and backflow prevention methods.
- Reference particular sources of additional information for cross-connection control and backflow prevention.
- Describe hazard classifications and degrees of hazard.
- List the types of backflow prevention devices which can be used for each particular hazard classification.
- Describe the functions of, and list, the types of approved backflow prevention devices that can be used.
- Describe backflow prevention device installation practices.
- List and describe backflow prevention methods that are not approved for use.
- List inspection, testing, and maintenance procedures and schedules for backflow prevention devices in particular hazard classifications.

- Describe record keeping requirements and procedures for cross-connection control and backflow prevention devices.

(1) TB MED 576, Sanitary Control and Surveillance of Water Supplies at Fixed Installations, March 1982. Chapter 4, Water Distribution Systems, in summary, states that:

- No interconnection between a potable water distribution system and a sanitary sewage system shall be permitted.
- Each installation shall undertake an organized program that includes instruction, inspection, and required improvements in order to detect and remove all potential and existing cross-connections, and to ensure that proper measures (e.g., air gaps and backflow prevention devices) are taken to prevent backsiphonage.
- EPA Publication 430/9-73-002 and AWWA Publication No. 20106 provide excellent information for cross-connection control.

(2) MIL-HDBK-1164, Operation and Maintenance of Water Supply Systems, 3 March 1997. Section 10, Cross-Connection Control and Backflow Prevention, provides specific guidelines for the control of cross-connections by the use of backflow prevention devices. Subsections of this technical reference contain:

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- General information on backflow prevention devices and cross-connection control.
- Specific information on degree of hazard classifications and approved types of backflow prevention devices for the degree of hazard.
- Descriptions of each approved type of backflow prevention device.
- Backflow prevention device installation practices (for each specific type).
- Descriptions of unapproved methods and devices.
- Frequencies of testing and inspecting backflow prevention devices.
- Maintenance of backflow prevention devices.
- Record keeping procedures.

(3) TM 5-813-1, Water Supply Sources and General Considerations, June 1987. Chapter 2, Water Requirements, Section 2-3 a., provides specific guidelines for the control of cross-connections and installation of backflow prevention devices. Subsections of this technical reference contain:

- A statement prohibiting cross-connections.
- Backflow prevention device requirements for irrigation systems.
- The plumbing code which must be followed in the installation of backflow prevention devices.
- The types of check valves that cannot be used.

(4) TM 5-813-5, Water Supply, Water Distribution, November 1986. Chapter 1, General, Section 1-4, Cross-Connections, provides cross-connection control guidelines as summarized below.

- Separate distribution systems must be used to deliver water if fires are to be fought with both potable and nonpotable water.
- Fire-fighting reservoirs that are filled with both potable and nonpotable water shall be filled with potable water only through a 12-inch air gap.
- Pump seal water must be stored in a tank with an air gap at the end of the potable supply line and the top of the tank.

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- Air gaps should be at least twice the diameter of the water supply line.
- Reduced Pressure Principle backflow prevention devices should meet the criteria of the American Water Works Association Standard C506.
- Double Check Valves for backflow prevention are not considered suitable and should not be used.
- Backsiphonage can be prevented with air gaps, atmospheric vacuum breakers, or pressure vacuum breakers.

This agency, formerly the US Army Environmental Hygiene Agency, prepared a document titled "Information Paper No. 42, Cross-Connection Control and Backflow Prevention," in August 1987. This document provided general and specific information as follows:

- Cross-connections and the causes of backflow.
- The types of devices available for controlling cross-connections and preventing backflow.
- Guidance for development of a cross-connection control program.
- A suggested protocol for the conduct of a cross-connection control survey.

c. OTHER TECHNICAL GUIDELINE AND REFERENCE SOURCES

(1) US Environmental Protection Agency (USEPA). The document titled "Cross-Connection Control Manual," Publication 430/9-73-002, was published originally in 1973, and reprinted in the two following years and again in 1989. This document provides:

- (a) Descriptions of cross-connections and the causes of backflow, theory of backflow and backsiphonage, health aspects and case histories of backflow.
- (b) Descriptions, methods, and devices for the prevention of backflow including illustrations of backflow and backflow prevention devices.
- (c) Procedures for testing backflow prevention devices.
- (d) Requirements for the administration of a cross-connection control program.
- (e) Plumbing hazards associated with cross-connection control.
- (f) Illustrations of backflow and backflow prevention devices.
- (g) Samples of record keeping forms.

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(2) American Water Works Association (AWWA) The document titled "Recommended Practice for Backflow Prevention and Cross-Connection Control," Manual M14, is one of the American Water Works Association's many technical guidelines in the series of Manuals of Water Supply Practices. Manual M14 was originally produced in 1966 (Second Edition). It was last revised in 1990 and is one of the most widely used references in the industry. This document provides:

- (a) Descriptions of the administration requirements, responsibilities, authority, enforcement, education, and record keeping necessary for developing and implementing a cross-connection control program.

- (b) Definitions and descriptions of backflow principles.
- (c) Descriptions of hazard classifications and backflow control methods.
- (d) Lists of typical hazards, cross-connections, and the recommended type of protection.
- (e) Descriptions of backflow prevention in fire protection systems and recommended type of protection.
- (f) Descriptions and detailed procedures for maintenance and testing of backflow prevention devices.

(3) Foundation For Cross-Connection Control And Hydraulics Research (FCCCHR). The document titled "Manual of Cross-Connection Control," produced by the University of Southern California (USC), was last revised and published in December 1993 (Ninth Edition). It is one of the most widely used references in the industry. The information provided in the manual is similar to that in the AWWA manual. However, it is more detailed and contains specific information as follows:

- (a) Descriptions and illustrations of backflow prevention devices.
- (b) Descriptions and illustrations of typical and specific types of cross-connections found in general industry.
- (c) Recommendations for the type and location of backflow prevention devices needed to protect the public water system from cross-connections.
- (d) Detailed and illustrated backflow prevention device maintenance and testing procedures.
- (e) Design, material, and performance specifications for backflow prevention devices.

(4) The FCCCHR, USC testing laboratory is one of the most recognized organizations for the approval of the design, material, and performance of backflow prevention devices.

(5) National Standard Plumbing Code (NSPC). The National Standard Plumbing Code (NSPC), 1996, is published by the National Association of Plumbing-Heating-Cooling Contractors (NAPHCC), Falls Church, Virginia. This particular code book is widely used throughout the United States. It was developed as a recommended code of plumbing

practice, design, and installation, including performance criteria based on the need for safety and health. The code does not have legal standing unless it is adopted by reference or inclusion in state, county, or municipal government statutes or regulations.

(6) Several chapters of the NSPC have requirements for backflow protection on particular types of plumbing fixtures, equipment, or systems. However, there are chapters that specifically describe and detail cross-connection control and backflow prevention requirements. Applicable chapters of its contents are summarized as follows:

(a) Chapter 10, Water Supply and Distribution:

- Requires potable water supplies to be protected against cross-connections.
- Requires cross-connection control by containment and isolation.
- Requires backflow prevention devices on plumbing fixtures, appliances, and water supply outlets.
- Lists requirements for types of backflow prevention devices according to degree of hazard and pressure conditions.
- Requires specific backflow prevention device installation locations and methods.
- Requires backflow prevention device testing and maintenance frequencies.
- Requires certification of backflow prevention device testers and describes training requirements.
- Describes backflow prevention devices for tanks, vats, carbonated beverage machines, fire systems, lawn sprinklers and irrigation systems, heat exchangers, hose connections and special equipment.

(b) Chapter 14, Special Requirements for Health Care Facilities:

- Requires cross-connection control and backflow prevention.
- Requires specific types of backflow prevention devices for specific types of medical equipment.

(c) Chapter 17, Potable Water Supply Systems:

- Prohibits cross-connections between public potable water supplies and private water supplies.

(7) American Society of Sanitary Engineering (ASSE) Standards. The ASSE, organized in the early 1900's, is an association of contractors, engineers, manufacturers, inspectors, health officials, and other interested parties. The association developed the "Standards" for plumbing system components used by plumbing code administrators nationwide. These include, but are not limited to, performance requirements for:

- Eight separate types of backflow prevention devices.
- Water closet flush tank ball cocks.
- Water pressure reducing valves.
- Home and commercial laundry equipment and dishwashers.
- Food waste disposal units.
- Water hammer arresters.
- Flow restrictors, traps, valves, and drains

(8) The ASSE Standards are the most often referenced in State regulations, prior to their meeting approval for use in a particular state.

(9) In addition to the development and publication of Standards, the ASSE offers the following certification programs:

- Backflow Prevention Assembly Tester
- Backflow Prevention Assembly Repairer
- Cross-Connection Control Survey Inspector (under development).

(10) Furthermore, the ASSE offers several technical publications related to the plumbing industry, including:

- A booklet on the selection and use of backflow prevention devices.
- A plumbing dictionary.
- Plumbing inspector's manuals.
- Technical training course refresher books.
- Energy and water conservation guidelines and tips.

## **5. IMPLEMENTING AN EFFECTIVE CROSS-CONNECTION CONTROL PROGRAM AT US ARMY INSTALLATIONS**

The water supplier has the responsibility to provide clean, safe water to the consumer. To ensure protection against contaminants and pollutants, an effective program to control cross-connections is essential. The control of cross-connections is regulatory in nature and should be implemented through the authority of Federal, State, and Army regulations previously discussed.

The implementation of a successful and effective cross-connection control program can be performed in phases as described below.

(a) PHASE I - FORMATION OF A CROSS-CONNECTION CONTROL COMMITTEE. Prior to implementation of a program, it is strongly suggested that a cross-connection control committee be formed. The committee should be comprised of representatives from each of the following:



<u>Installation Office</u>	<u>Purpose of Representation</u>
Installation Command Representative	Establish policy.
Directorate of Public Works	Prepare and recommend policy; direct the program.
Environmental Management	Provide guidance on current regulations.
Public Affairs Office	Assist in providing consumer education.
Staff Judge Advocate Office	Define legal procedures in implementing, operating, and regulating the program.

(1) The primary purpose of the committee would be to establish policy and provide guidance for the installation's overall cross-connection control program. Additional duties of the committee could include:

- Assigning program responsibilities, including operation, maintenance, record keeping, and enforcement.
- Approving policies and documents applicable to the program.

(2) It is also suggested that the committee meet regularly to determine the status of the cross-connection control program and take any actions that may be necessary or required to ensure the success and effectiveness of the program.

(b) PHASE II - DEVELOPMENT OF CROSS-CONNECTION CONTROL POLICY. A policy statement or directive is a key element of an effective cross-connection control program. It should contain the following general points:

(1) Legal Authority (which regulations establish the authority for the program) - (For example: *Pursuant to Chapter \_\_\_ of the State of \_\_\_\_\_ Drinking Water Regulations, Chapter 2 of AR 200-1, Chapter 4 of AR 420-49, and Chapter 12 of AR 40-5, Fort \_\_\_\_\_ is responsible for protecting its drinking water by implementing and enforcing a cross-connection control program*).

(2) A purpose (why the policy is necessary) - (For example: *to protect the water system; to eliminate and control existing and potential hazards; to prevent future cross-connections*).

(3) Requirements of the program, including: Responsibilities - (For example: *The DPW Utilities Branch is responsible for maintenance of the distribution system; the consumer is responsible for avoiding any action which may cause pollutants or contaminants to enter the potable water system*); Prohibitions - (For example: *Cross-connections between the potable water distribution system and non-potable water systems, equipment, fixtures, piping, and outlets are prohibited*); Protection Required - (For example: *An approved air gap separation or backflow prevention device shall be installed on each potable water service line in accordance with the installation's Cross-Connection Control Plan.*); Inspections - (For example:

*Authorized DPW representatives shall be permitted to enter all properties for the purpose of inspection, observation, maintenance, and testing in accordance with the installation's Cross-Connection Control Plan); Denial or Discontinuance of Service - (For example: Water service*

*shall be denied or discontinued if an unprotected cross-connection is determined to exist and appropriate corrective actions have not been taken after official receipt of notification); and Effective Date - (For example: This policy shall be in effect as of     (date)    ).*

(c) PHASE III - PREPARATION OF A CROSS-CONNECTION CONTROL PLAN

(1) Implementing an effective and successful cross-connection control program should be complemented by the preparation of a plan of action, specifically, a Cross-Connection Control Plan. The plan should provide detailed guidance for installation personnel, contractors, and consumers. It should:

- Incorporate policy and authority statements.
- Identify responsibilities and outline the cross-connection control program chain-of-command.
- Describe the purpose and scope of the program.
- Describe cross-connections and backflow prevention methods and devices.
- Establish procedures for installing, testing and maintaining the devices.
- Establish and describe procedures for containment of contamination or pollution and notification of water users should backflow contaminate the potable water system.
- Describe record keeping requirements.
- Define terminology.

(2) The DPW should be responsible for the Cross-Connection Control Plan since this Directorate will have the major responsibility for management of the installation's cross-connection control program. Divisions, branches, sections, and trade shops under the direction of the DPW that will have program responsibilities usually include:

- Operation and Maintenance Division
- Utility Branch, to include:
  - Interior and Exterior Plumbing
  - Heating, Ventilation, Air Conditioning, and Refrigeration
  - Water and Wastewater Treatment Sections
- Engineering Plans and Services Division

(3) The plan should be prepared based on current regulations, in accordance with AR 420-49, paragraph 4-7 f. Individual state regulations may require particular elements that must be included. It is suggested that the regulations be reviewed prior to preparation of the plan.

(4) All representatives of the Cross-Connection Control Committee should review the Cross-Connection Control Plan. The installation's Divisions, Branches, and

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Departments having responsibilities for the cross-connection control program should also review the Plan, become familiar with its requirements, and accept the responsibilities as assigned.

(d) PHASE IV - CONDUCT OF CROSS-CONNECTION SURVEYS

(1) A major element of a cross-connection control program is the survey and inspection of facilities, buildings, nonpotable water systems, plumbing equipment, fixtures, pipes and outlets. This is imperative for identifying existing and potential cross-connections, assigning a hazard classification to each, and determining the method or device required to eliminate or prevent backflow. Procedures to accomplish this task must be included in the Cross-Connection Control Plan and should include initial and follow-on inspections. Cross-connections are ever present dangers that appear in subtle forms and in unsuspecting places. New cross-connections are formed every day through new construction, renovations, and extensions of plumbing and piping systems. Even the most subtle form of cross-connection, the garden hose, can change the degree of hazard from low-to-high by the simple connection of the hose to a faucet, depending on surrounding circumstances.

(2) Commonly, private engineering firms have been contracted to conduct initial surveys to identify cross-connections and recommend corrective actions necessary to eliminate or control potential hazards.

(3) The tasks generally associated with initial cross-connection control efforts at Army installations typically include:

- Building Surveys - Conducting a building survey to identify existing and potential unprotected cross-connections, and existing backflow prevention devices and generally consists of:
  - Tracing the potable water piping systems in, and throughout, each selected building.
  - Identifying nonpotable water systems, uses, equipment, and fixtures.
  - Identifying existing and potential interconnections (cross-connections) between the potable and nonpotable systems, equipment, and fixtures.
  - Determining the risk (class/degree of hazard, potential pollutant or contaminant) of each cross-connection, or the nonpotable water use, presents to the potable water distribution system in the event backflow should occur.
  - Deciding the type of protection (facility containment and/or point-of-use isolation) and particular type of backflow

prevention device that is required to properly protect the potable water system and/or the building's internal plumbing from the existing or potential hazard(s).

- Identifying previously installed backflow prevention devices, pressure testing those devices equipped with test instrument connections, inspecting devices for adequacy according to the potential class/degree of hazard, and installation methods that comply with regulations and plumbing codes or follow standards and technical guidelines.

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- Survey Report - Preparing a report of the results of the building surveys, including necessary and recommended corrective actions, and estimated costs for correcting the deficiencies identified.
- Training - Providing classroom and hands-on cross-connection control and backflow prevention technical training to military and civilian workers.

## 6. LESSONS LEARNED

Cross-connection control and backflow prevention programs have been implemented at various Army installations nationwide. A review of these cross-connection control efforts and experiences in conducting surveys at selected Army Installations has allowed the identification of several "lessons learned" which are summarized below:

- a. Approximately 90% of the total cross-connections identified are unprotected; only 10% have existing devices installed to protect against backflow.
- b. Approximately 95% of unprotected cross-connections require backflow protection; only 5% can be eliminated.
- c. There are an average of 5 cross-connections in each building surveyed. Therefore, approximately 5 backflow prevention devices are required per building.
- d. The majority of buildings and plumbing systems at Army installations were designed, constructed, and installed prior to the implementation of more stringent laws, regulations, and codes for cross-connection control and backflow prevention.
- e. Plumbers on Army installations are usually not licensed and trained according to State requirements.
- f. Existing backflow prevention devices in the distribution system are generally ignored once installed and seldom inspected, tested, or maintained. The lack of maintenance generally results in replacement versus repair, and ultimately, increased maintenance costs.

- g. Installation of devices according to regulations, guidelines, and plumbing codes is rare. The devices are found installed against ceilings, walls or floors, in confined spaces, and directly over top of electrical equipment, making access difficult and/or dangerous.
- h. As-built drawings are, for the most part, not up-to-date. Piping valve charts are rarely available and frequently do not reflect current conditions. In older buildings, piping is generally not color-coded or marked.

## **APPENDIX A REFERENCES**

1. Title XIV of the Public Health Service Act, 42, United States Code §§ 300f-300j-26, Safety of Public Water Supplies, Public Law (PL) 93-523, Safe Drinking Water Act (SDWA), 16 December 1974; plus 1986 amendments (Public Law (PL) 99-399).
2. Title 29, Code of Federal Regulations (CFR), Part 1910, Occupational Safety and Health Standards
3. AR 200-1, Environmental Protection and Enhancement, Department of the Army, 21 February 1997.
4. AR 420-49, Utility Services, Department of the Army, 28 April 1997.
5. AR 40-5, Preventive Medicine, Department of the Army, 14 June 1985.
6. AR 5-3, Installation Management and Organization, Department of the Army, 1992.
7. TB MED 576, Sanitary Control and Surveillance of Water Supplies at Fixed Installations, Department of the Army, March 1982.
8. MIL-HDBK-1164, Operation and Maintenance of Water Supply Systems, 3 March 1997.
9. TM 5-813-1, Water Supply Sources and General Considerations, Headquarters, Departments of the Army, the Navy, and the Air Force, 4 June 1987.
10. TM 5-813-5/AFM 88-10, Volume 5, Water Supply, Water Distribution, Department of the Army, November 1986.
11. Information Paper No. 42, Cross-Connection Control and Backflow Prevention, US Army Environmental Hygiene Agency (AEHA), August 1987.
12. Publication 430/9-73-002, Cross-Connection Control Manual, US Environmental Protection Agency, 1989.
13. Manual of Practice M14, Recommended Practice for Backflow Prevention and Cross-Connection Control, American Water Works Association, 1990.
14. Manual of Cross-Connection Control, Ninth Edition, Foundation for Cross-Connection Control and Hydraulics Research, University of Southern California, December 1993.
15. National Standard Plumbing Code, National Association of Plumbing, Heating, and Cooling Contractors, 1996.
16. Cross-Connection Protection Device Booklet, Third Edition, American Society of Sanitary Engineering, 1994.

17. Manual of Cross-Connection Control, National Association of Plumbing-Heating-Cooling Contractors, 1996.



## APPENDIX B

### SUMMARY OF STATE CROSS-CONNECTION CONTROL REQUIREMENTS

A brief overview of individual state cross-connection control program requirements is provided below. Table B-1 provides more specific information regarding criteria, guidelines, and codes and standards for individual states.

- Alabama - Regulations mandate premises containment by the installation of backflow prevention devices in facilities where it is determined that there are existing or potential cross-connections. A cross-connection control program is required. Device types, testing, maintenance, and installation methods are not specified. Record keeping is not specified.
- Alaska - Regulations mandate point-of-use isolation of equipment or systems by the installation of backflow prevention devices. A cross-connection control program or plan is not specified. Backflow prevention device design and performance standards are specified. Device testing, maintenance, and installation methods are not specified. Tester certification is not specified. Record keeping is not specified.
- Arizona - Regulations mandate premises containment and point-of-use isolation of equipment or systems by the installation of backflow prevention devices. A cross-connection control program or plan is not specified. Regulations specify backflow incident reporting requirements. Backflow prevention device design and performance standards are not specified. However, devices used in the state must be those approved by the Foundation for Cross-Connection Control and Hydraulics Research (FCCCHR) or other agency as specified by the state's Department of Environmental Quality. Regulations specify backflow prevention device installation and testing requirements. Certification of testers is required. Record keeping is required.
- Arkansas - Regulations mandate a cross-connection control program with specific key elements. Additionally, facility inspections, premises containment, and point-of-use isolation of equipment or systems by the installation of backflow prevention devices is required. Device design requirements and installation methods are specified in the State Plumbing Code. Testing requirements are specified. Certification of testers is required, and repairers of devices must be a Master Plumber. Record keeping is required.
- California - Regulations mandate a cross-connection control program with specific key elements. Additionally, facility inspection, premises containment, and point-of-use isolation of equipment or systems is required. Backflow prevention device design and performance standards are specified. Device testing is specified. Certification of testers is required. Record keeping is required.
- Colorado - Regulations mandate cross-connection control. A cross-connection control program is required. However, regulations require identifying cross-connections and require the installation, testing, and maintenance of backflow prevention devices. Certification of testers is required. Record keeping is required.
- Connecticut - Regulations mandate premises containment and point-of-use isolation of equipment or systems by the installation of backflow prevention devices. A cross-connection control program is required. Backflow prevention device design and

performance standards, installation methods, and testing are specified. Certification of testers is required. Record keeping is required.

- Delaware - There are no cross-connection control regulations in this State.

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- District of Columbia - There are currently no cross-connection control regulations. However, applicable regulations are under development. The Building Officials and Codes Administrators (BOCA) National Plumbing Code, 1990 Edition, has been adopted by the DC Government and amended.
- Florida - Regulations mandate a cross-connection control program and written plan. Premises containment by the installation of backflow prevention devices is required. Current regulations are under revision. Proposed revisions include backflow prevention device design and performance standards, installation locations and methods, testing frequencies, maintenance requirements, and tester certification.
- Georgia - Regulations prohibit cross-connections. Brief guidelines are provided in the regulations along with additional references. A written cross-connection control plan approved by the state is required when requested by the Division of Environmental Protection. Backflow prevention device types, installation methods, testing, and maintenance is not specified. Record keeping is not specified.
- Hawaii - Regulations mandate a cross-connection control program. Premises containment and point-of-use isolation by the installation of backflow prevention devices is required. Device design and performance standards are specified. Device installation methods and locations are Specified. Device maintenance and testing requirements are specified. Certification of testers is required. Record keeping is required.
- Idaho - Regulations mandate a cross-connection control program. Facility inspections are required. Device design and performance standards are specified for Atmospheric Vacuum Breaker and Pressure Vacuum Breaker backflow prevention devices. The state maintains a list of approved types of backflow prevention devices. Device testing is specified. Certification of testers is required. Record keeping is not specified.
- Illinois - Regulations mandate protection of public water systems by the prohibition of cross-connections. A state approved written cross-connection control program is required. Regulations require point-of-use isolation by the installation of backflow prevention devices at selected plumbing outlets and fixtures, and containment by the installation of backflow prevention devices at the water service connection. Guidelines are provided in the regulations. Types of devices, installation methods, maintenance, and testing is specified. Testers licensing and certification requirements are specified. Record keeping is specified.
- Indiana - Regulations mandate protection of the public water system by the prohibition of cross-connections. A cross-connection control program is not required, but suggested. Guidelines are provided in the states Cross-Connection Control Manual, revised and reprinted in February 1996. Regulations require facility containment and point-of-use isolation by the installation of backflow prevention devices. Types of devices, installation

methods, maintenance, and testing is specified. Tester certification is specified. Record keeping is specified.

- Iowa - Regulations mandate cross-connection control by the installation of backflow prevention devices. A cross-connection control program is required. Point-of-use isolation is required. Containment is not specified. Backflow prevention devices must be those types approved by the state Department of Natural Resources. Device design and performance standards are specified. Backflow prevention device installation methods, testing, and maintenance is not specified. Record keeping is not specified.

## B-2

- Kansas - Regulations mandate a cross-connection control program. Specific elements of the program are specified and additional guidelines are referenced. Premises containment and point-of-use isolation are specified. Design and performance standards are not specified. However, devices must be those approved for use by a designated agency. Device installation methods, testing, and maintenance are specified. Tester certification is not specifically required. However, those persons performing tests must have received training recognized by the local water purveyor. Record keeping is specified.
- Kentucky - Regulations prohibit cross-connections. The use of backflow prevention devices must be approved by the state Natural Resources and Environmental Protection Cabinet. Regulations mandate identification and elimination of cross-connections. Guidelines for the use and installation of backflow prevention devices are provided in the State Plumbing Code. Certification of testers is the responsibility of the State Plumbing Division. Record keeping is not specified.
- Louisiana - Regulations prohibit cross-connections. A cross-connection control program is not required. Cross-connection protection is required through the use of air gaps only. Backflow prevention devices are not considered adequate protection for cross-connections.
- Maine - Regulations mandate a written cross-connection control program for all water systems serving 1,000 or more people, and all industrial facilities. Application and permits are required for all cross-connections. Facility inspections are not specified. Premise containment is not specified. Equipment and system isolation is specified. Design, performance, or approved types of backflow prevention devices are not specified. Installation methods are not specified. Device testing and maintenance is specified. Certification of testers is not required.
- Maryland - Regulations mandate a written cross-connection control program approved by the state. Record keeping is not specified. Guidelines and requirements for backflow prevention are provided in the State Plumbing Code. Testers must be licensed plumbers.
- Massachusetts - Regulations mandate a written cross-connection control plan approved by the Department of Environmental Protection (DEP). Premises inspection, containment, and system and equipment isolation by the installation of backflow prevention devices are required. Devices must be those approved for use by the Board of State Plumbing Examiners

and/or the DEP. Device location, installation, testing, and maintenance is specified. Certification of testers is required. Record keeping is required, including annual reports.

- Michigan - Regulations mandate a written cross-connection control program approved by the Department of Public Health (DPH). Guidelines are specified. Premises inspections are required every 3 to 6 months depending on type of system or equipment. Premises containment and/or point-of-use isolation is dependent on type of facility, system, or equipment. Backflow prevention device types are specified. Design and performance standards are not specified. However, an approved list of devices is retained by the DPH. Device location, installation methods, and testing requirements are specified. Certification of testers is not required. Record keeping is specified.
- Minnesota - Regulations prohibit cross-connections and mandate cross-connection control by the installation of backflow prevention devices. System and equipment point-of-use isolation is specified. A cross-connection control program or plan is not specified. However, development and implementation of a program is recommended by the Department of Health. Regulations require backflow prevention devices be tested and maintained on a continuing basis to ensure proper operation. Devices must be those approved by a testing laboratory recognized by the state Department of Health. Types of devices and installation methods and locations are specified. Certification of testers is specified. Record keeping is not specified.

### B-3

- Mississippi - There are no cross-connection regulations in this State.
- Missouri - Regulations mandate cross-connection control. Premises containment and point-of-use system or equipment isolation is specified. Device design and performance standards are not specified. However, devices used must be those approved by the Department of Natural Resources. Device location, installation methods, and testing frequencies are specified. Certification of testers is specified. Record keeping is specified.
- Montana - Regulations mandate cross-connection control. A cross-connection control plan is not required. Backflow prevention device types, installation methods, and testing are specified in the adopted plumbing code. Tester certification is not required. Regulations are under revision. New regulations will be more stringent. Expected adoption is in the fall of 1997.
- Nebraska - Regulations mandate a cross-connection control program approved by the state Department of Health. Specific program elements are specified. Additional guidelines are referenced. Premises containment and point-of-use system or equipment isolation is specified. Device design and performance standards are not specified. However, devices used must be those approved by a specified testing agency. Device location, installation methods, and testing frequencies are specified. Certification of testers is specified. Record keeping is specified.
- Nevada - Regulations mandate a cross-connection control program approved by the State or local health authority. Components of the program are specified. Premises containment and point-of-use system or equipment isolation is specified. Device design and performance standards are specified. Device location, installation methods, and testing frequencies are specified. Certification of testers is specified. Record keeping is specified.

- New Hampshire - Regulations mandate a cross-connection control program approved by the state Department of Environmental Services (DES). Program responsibilities are specified. Premises containment and point-of-use system or equipment isolation is specified. Device design and performance standards are not specified. However, devices used must be those approved by the DES. Device location, installation methods, and testing frequencies are specified. Certification of testers is specified. Record keeping is specified.
- New Jersey - Regulations mandate cross-connection control through the states Physical Connection Program. A written or plan is required. State permits are required for all physical connections. Premises containment and point-of-use system or equipment isolation is specified. Device design and performance standards are specified. Device location, installation methods, and testing frequencies are specified. Certification of testers is not specified. Record keeping is specified.
- New Mexico - Regulations mandate protection of water systems by the installation of a backflow prevention device. A cross-connection control program or plan is not specified. Premises containment and point-of-use isolation is not specified. Design and performance standards are not specified. However, devices used must be approved by the state Environment Department or other agency acceptable to the state. Device locations, installation methods, and testing are not specified. Certification of testers is not specified. Record keeping is not specified.

#### B-4

- New York - Regulations mandate cross-connection control. A program is required. Guidelines are provided in the state Cross-Connection Control Manual. Premises containment and point-of-use isolation by the installation of backflow prevention devices is specified. Design and performance standards are specified. Device type and approval is specified. Device locations, installation methods, testing, and maintenance is specified. Certification of testers is specified. Record keeping is specified. Plans and drawings with specific elements must be submitted and approved by the State Department of Health prior to the installation of any backflow prevention device.
- North Carolina - Regulations mandate cross-connection control. A program or plan is not specified. Guidelines for cross-connection control are provided as a supplement to the state Rules Governing Public Water Supplies. Premises containment is not specified. System or equipment point-of-use isolation is specified. Design and performance standards are specified. Device location is specified. Device testing and maintenance is not specified. Certification of testers is not specified. Record keeping is not specified.
- North Dakota - Regulations mandate cross-control. A program or plan is not specified. Device type is specified. Training and certification of testers is recommended..
- Ohio - Regulations mandate cross-connection control. A program or plan is recommended. Suggested elements of a program are provided in the states Backflow Prevention and Cross-

Connection Control Manual. Premises containment and system or equipment point-of-use isolation are specified. Design and performance standards are specified. Device location, installation methods, testing frequencies, and maintenance is specified. Certification of testers is required. Record keeping is required.

- Oklahoma - Regulations prohibit cross-connections. A cross-connection control program is not required. Backflow prevention devices are required and specified by the State Plumbing Code. Certification of testers is not required.
- Oregon - Regulations mandate a cross-connection control program. Specific elements of the program are specified. Premises containment and system or equipment point-of-use isolation are specified. Device design and performance standards are specified. Device location, installation methods, and testing are specified. Certification of testers is specified. Record keeping is specified.
- Pennsylvania - Regulations mandate a cross-connection control program approved by the state Department of Environmental Resources. Elements of the program are specified. Premises containment and system or equipment point-of-use isolation are specified. Device design and performance standards are specified. Device location, installation methods, and testing is specified. Certification of testers is specified.
- Puerto Rico - There are no cross-connection control regulations in this US Territory.
- Rhode Island - There are no cross-connection regulations in this State.
- South Carolina - Regulations mandate a cross-connection control program. Elements of the program are specified. Premises containment and system or equipment point-of-use isolation is not specified. Device design and performance standards are not specified. However, devices used must be those approved and listed by the state. Device location, installation methods, and testing requirements are specified. Certification of testers is specified. Record keeping is specified.

#### B-5

- South Dakota - Cross-connection control is mandated in the State Plumbing Code. The code acts as the state's only requirements and as the guidelines. A cross-connection control program is not required. Backflow prevention device types, installation methods, and testing and maintenance requirements are specified in the code. Tester certification is not required. Record keeping is not specified.
- Tennessee - Regulations mandate a cross-connection control plan approved by the state Department of Environment and Conservation. Elements of the plan are specified. Premises containment and system or equipment point-of-use isolation are specified. Device design and performance standards are specified. Device location, installation methods, and testing frequencies are specified. Certification of testers is specified. Record keeping is specified.
- Texas - Regulations mandate cross-connection control. A written program or plan is not specified. Premises containment is not specified. System or equipment point-of-use

isolation is specified. Device design and performance standards are specified. Device location and installation methods are not specified. Device testing is required upon installation. Additional testing is recommended annually. Certification and licensing of testers is required by the State Plumbing Code and administered by the State Board of Plumbing Examiners. Record keeping is not required. However, device test and maintenance reports are recommended.

- Utah - Regulations mandate cross-connection control. A written cross-connection control program approved by the state is required. Suggested elements of the program are provided in the state guidelines. Premises containment is recommended. Plumbing code requires point-of-use isolation by the installation of backflow prevention devices at selected fixtures and outlets. Devices must be installed in accordance with state guidelines and plumbing code. A list of approved devices is maintained by the state. Initial and annual device testing is specified. Program administration, device tester, and instructor certification is required. Record keeping procedures are specified.
- Vermont - Regulations do not mandate cross-connection control. However, if the inspection of a water system by the Agency of Natural Resources, Department of Environmental Conservation (ANRDEC) discovers that a cross-connection exists, the water supplier must take action to eliminate the cross-connection or install a backflow prevention device. Devices must meet American Water Works Association standards. No additional requirements are specified.
- Virginia - Regulations mandate a written cross-connection control program approved by the local office of the Department of Health. Suggested elements of the program are provided. Facility inspections are specified. Premises containment is specified. However, system or equipment point-of-use isolation is not specified. Devices used must conform to the requirements specified in the Uniform Statewide Plumbing Code (USPC). A list of approved devices is maintained by the Department of Health. Device location is specified. Installation methods are specified in the USPC. Testing is required annually. Certification of testers is not currently required. However, testers must be licensed by the state beginning 1 July, 1997. Record keeping is not specified. However, it is recommended and elements are suggested.
- Washington - Regulations mandate a cross-connection control program acceptable to the state Department of Health. Premises containment and system or equipment point-of-use isolation is specified. Device design and performance standards are not specified. However, a list of approved devices is maintained by the state Department of Health. Device location and installation methods are specified. Device testing is required annually. Certification of testers is required. Record keeping is specified.

#### B-6

- West Virginia - Regulations mandate a cross-connection control program approved by the state Department of Health and Human Services (DHHS). Premises containment and system or equipment point-of-use isolation are specified. Performance and design standards are specified. Device location and installation methods are specified. Testing is required. Certification of testers is required.

- Wisconsin - Regulations mandate a written cross-connection control program. The program must be annually reviewed by the state Department of Natural Resources (DNR). Elements of the program are specified. Premises containment and system or equipment point-of-use isolation is specified. Device performance and design standards are specified. Location and installation methods are specified in the State Plumbing Code. Testing frequencies are specified. Certification of testers is specified. Record keeping is required for the location, manufacturer, model, size, serial number, date of the last test of the device, and the name of the tester.
- Wyoming - Regulations mandate cross-connection control. A program or plan is not specified. Premises containment and system or equipment point-of-use isolation is specified. Device design and performance standards are not specified. However, device approval is specified. Device installation location is not specified. Device installation method is specified for Pressure Vacuum Breaker devices and physical air gaps. Testing and maintenance of devices is not specified. Certification of testers is not specified. Record keeping is not specified.

The following definitions/clarifications are included as a supplement to Table B-1. Note that a blank cell indicates no particular state mention or requirement for that item.

1. State

State in which requirements apply.

2. Cross-Connection Control (Criteria)

Broad-based criteria regarding cross-connection in appropriate state.

- CCC - Cross-Connection Control Program - Regulatory requirement for the implementation to some degree of a physical cross-connection control program.
- CCCP - Cross-Connection Control Plan - Written document detailing the cross-connection control program.

3. Cross-Connection Control (Applicable Guidelines, Codes, and Other References)

General cross-connection control requirements for a given state are detailed in the reference(s) indicated.

- FCCCHR - Foundation for Cross-Connection Control and Hydraulic Research
- AWWA - American Water Works Association
- BOCA - Building Officials and Code Administration
- State Reg. - Specific guidelines detailed in the state regulations.
- State PC/BC - State Plumbing or Building Code



- State CCC Manual - State Cross-Connection Control Manual
- Other - Any number of less common references (i.e. National Fire Protection Association (NFPA) Standards).

4. Backflow Prevention Device Approval/Standards

Approved and/or acceptable backflow prevention devices for a given state are detailed in the reference(s) indicated.

- FCCCHR - Foundation for Cross-Connection Control and Hydraulic Research
- ANSI - American National Standards Institute
- AWWA - American Water Works Association
- ASSE - American Society of Sanitation Engineers
- State - State regulations include specific device approvals and standards
- Other - Any number of less common references

5. Backflow Prevention Device Tester

Specific state requirements placed on backflow prevention device testers may include any or all of the following.

- Certificate - A certificate offered by the state or a state approved agency is required/recommended in order to test backflow prevention devices.
- Training - Some minimum level of training is required/recommended in order to test backflow devices. Verification of this training is typically required.
- License - A state license is required/recommended in order to test backflow prevention devices. Potential licenses include plumbing licenses, fire inspector licenses, and cross-connection licenses.







**TABLE B-1 (continued)**  
**STATE CROSS-CONNECTION CONTROL REGULATORY REQUIREMENTS SUMMARY**

State	Cross-Connection Control								Backflow Prevention Device Approval/Standards						Backflow Prevention Device Testers			Comments
	Criteria		Applicable Guidelines, Codes, and Other References						FCCHR	ANSI	AWWA	ASSE	State	Other	Certif-icate	Training	License	
	CCC	CCCP	FCCHR	AWWA	BOCA	State Reg.	State PC/BC	State CCC Manual										
Maryland	M	M							R*							M	M	*Codes adopted by counties
Massachusetts	M	M				M	M			M		M	M	M	M*	M	F	*FM/UL
Michigan	M	M				M	M							M			R	
Minnesota	M	R		M		M	M					M			M*	M	M	*Any testing lab acceptable to administrative authority
Mississippi									M*									NO REGULATIONS *Southern Building Code
Missouri	M					M								M		M		
Montana	M					M	M							F		F	F	
Nebraska	M	M	R	R		M	M			M	M				M*			*IAMPO/UL/NSF
Nevada	M	M	R	R		M			R*		M	M		M	M**	M		*IAMPO/UPC **NSF International
New Hampshire	M	M			M	M								M		M	M	
New Jersey	M	M				M	M		M*									*US EPA CCCM
New Mexico	M									M								
New York	M	M						R	M*	M		M	M			M	M	*State Sanitary Code
North Carolina	M						M	M		M			M		M*			*Any testing lab acceptable to administrative authority
North Dakota	M					M										R	R	
Ohio	M	R					M	R			M	M	M	M	M*	R	R	M** *CSA **Plumbing lisenace for isolation/ Fire Inspectors for fire systems
Oklahoma	M					M	M							M				

R - Recommended, M - Mandatory, F - Anticipated in the near future

**TABLE B-1 (continued)**  
**STATE CROSS-CONNECTION CONTROL REGULATORY REQUIREMENTS SUMMARY**

State	Cross-Connection Control									Backflow Prevention Device Approval/Standards						Backflow Prevention Device Testers			Comments
	Criteria		Applicable Guidelines, Codes, and Other References							FCCHR	ANSI	AWWA	ASSE	State	Other	Certificate	Training	License	
	CCC	CCCP	FCCHR	AWWA	BOCA	State Reg.	State PC/BC	State CCC Manual	Other										
Oregon	M	M					M			M		M		M	M*	M	M		*NSF
Pennsylvania	M	M			R		M	R	M*			M							*National PC
Puerto Rico																			
Rhode Island	F								R*										*New England WW Association
South Carolina	M	M							M*		M			M	M**	M	M		*NSPC ** NSF Standard
South Dakota	M					M	M							M		M*			*Only required if specified in individual local CCCPs
Tennessee	M	M	R		R			R	M*	M			M	M	M**	M	M		*Standard PC/ National PC **ASA
Texas	M		R	R					R*	M		M				M	M		*Local plumbing codes
Utah	M	M				M	M		M*	M			M	M	M**				*Local authority ordinance **IAMPO
Vermont	M											M							
Virginia	M	M			M	M				M			M		M*		M	F**	*BOCA **Cross-Connection License
Washington	M	M		M		M	M		M*					M	M**	M	M		*IAMPO **Uniform Fire Code Standards/ IAMPO
Washington D.C.	F				M		M												NO REGULATIONS
West Virginia	M	M				M		R		M		M	M	M		M	F		
Wisconsin	M	M						M					M	M		M	M		
Wyoming	M					M	M			M									

R - Recommended, M - Mandatory, F - Anticipated in the near future