COMMONWEALTH of MASSACHUSETTS

DEPARTMENT OF ENVIRONMENTAL PROTECTION

DRINKING WATER PROGRAM

CROSS-CONNECTION CONTROL PROGRAM MANUAL

Prepared by: J. Otavio S. DePaula-Santos
Created May 1998
Revised February 2009

TABLE OF CONTENTS

I. OVERVIEW

Cross Connections between a potable water line and a nonpotable water systems or equipment have long been a concern of the Department of Environmental Protection (MassDEP). It is for this purpose that Chapter 111, Section 160 A of the Massachusetts General Laws was enacted in 1960.

The public water distribution system and the plumbing within a facility are continuously jeopardized by such connections unless appropriate backflow prevention devices are installed and maintained in accordance with 310 CMR 22.22. MassDEP established regulations to protect the public health of water consumers from contaminants due to backflow events.

The purpose of this manual is to supplement these regulations and to assist the water officials in the implementation of their cross connection control program. In order to have a more effective cross connection control program it is required the cooperation and involvement of other city officials, such as: plumbing inspectors, fire chiefs, health agents and building inspectors.

II. CROSS CONNECTION CONTROL PRACTICES

1. Inspection and Testing of Devices

Pressure Vacuum Breakers and Spill Proof Pressure Vacuum Breakers

As established in 310 CMR 22.22 (14), pressure vacuum breakers may be tested at any time by the supplier of water or by the Department. As such, the supplier, at his/her discretion, may prescribe a routine testing schedule for these devices, given appropriate manpower and time requirements.

Due to the large volume of irrigation systems being installed with pressure vacuum breakers, and the associated hazard, the Department strong recommends this type of device be tested by the owner at least once a year to assure proper operation.

Reduced Pressure Backflow Preventers (RPBP) and Double Check Valve Assemblies (DCVA)

The Massachusetts Cross-connection Control Program Regulations, 310 CMR 22.22, requires the following:

- All installations of reduced pressure backflow preventers (RPBP) which are registered by a PWS must be tested semiannually by a MassDEP Certified Backflow Tester. Any RPBP that is on line for less than six months of the year must be tested at least once a year. The ideal schedule is to have the devices tested at least six months after the first semiannual test.

- All installations of double check valve assemblies (DCVA) which are registered by a PWS must be tested annually by a MassDEP Certified Backflow Device Tester.

Care must be taken to insure that these devices are protected against freezing, flooding, and mechanical damage.

If a supplier of water has concerns with particular hazards or finds that certain devices have developed a tendency to fail, he/she may require more frequent testing of a RPBP or DCVA.

The following are important requirements and procedures to be followed:

- All tests must be conducted by Massachusetts Certified Backflow Prevention Device Testers in accordance with methods and procedures described on EPA's *Cross Connection Control Manual*, EPA 570/9-89-007 publication or USC's *Manual of Cross-Connection Control*, 9th Edition.
- The result of these tests should be recorded on an Inspection and Maintenance Report Form
- The test reports that are not conducted by the PWS should be sent to the cross connection coordinator in the city/town where the devices are located within thirty days of the inspection.
- Any device and assembly that fails a routine test or is found to be defective must be repaired, or replaced, and retested within 14 days from the date of the failed test or from discovering the problem.

2. Cross-connection Surveying

Surveying water users for unprotected cross connections is the most challenging and difficult part of any cross connection control program. It is, however, of prime importance in the protection of both water supply distribution mains in the street and internal potable water supply systems within a facility. Without an active surveying program, the water supply system remains continually jeopardized by unprotected cross connections maintained by water users. These connections may contaminate water supply systems in the event of backflow, and such contamination may occur regardless of source water quality or elaborate treatment processes applied at the source.

In order to effectively initiate a cross connection survey program, it is vital that all cross connection surveyors first understand the hydraulic conditions which cause backflow, and the devices and methods used to prevent cross connection contamination. A**ll cross connection surveys shall be conducted by a MassDEP Certified Cross Connection Surveyor.**

GENERAL INFORMATION

Two concepts fundamental to surveying are containment protection and in-plant protection. Containment protection involves installation of backflow prevention devices at the meter or property line, in such a manner that there are no tees or upstream connections between the water service from the main and the backflow prevention device. In-plant protection involves the isolation of cross connections in a water user's plumbing system through installation of backflow prevention devices on the potable water feed lines to one or more non-potable sources, systems, or equipment. While containment protection only provides protection for water mains in the street, in-plant protection affords protection for potable water plumbing systems within a facility. While recognizing the need for containment, the safety of any consumer with regard to cross connection contamination clearly relies on the success of an in-plant protection program.

As outlined in Section 22 of the MassDEP Drinking Water Regulations, MassDEP has specific requirements for the installation of both containment and in-plant backflow prevention devices for any industrial, commercial, or institutional premises served by a public water supply system. While the water user bears responsibility for the installation of devices, the public water supplier is charged with the responsibility of surveying premises for cross connections and causing such installations to be made through issuing violation letters to affected users. It is of course, the water supplier who is responsible for the safety of his or her system and it would be remiss of any supplier to neglect protecting consumers against the hazards of backflow.

The surveying program is best implemented when coordinated with other local officials, notably the plumbing inspector, health agent, city/town engineer, and fire official. These officials are all mutually concerned about public health and safety and can prove to be a valuable enforcement tool. In the

course of their inspections, they can eliminate violations which come to their attention or notify the water official about hazardous situations. Confusion, frustration, and ultimately failure of the program are imminent when these officials and water users lack an understanding of the program and are not aware of the requirements. An outreach program can be very helpful in informing and educating water users and achieving compliance.

The starting point for any survey program should be those facilities and premises which present the highest degree of health hazard, specifically those facilities so designated in the Drinking Water Regulations:

- Nuclear reactors or other facilities where radioactive materials are used;
- Sewage treatment plants and pumping stations;
- Piers, docks, marinas, and shipyards;
- Chemical Plants;
- Metal Plating Industries;
- Hospitals, mortuaries, medical clinics, dental offices and clinics;
- Laboratories

These types of facilities as well as others (as determined by the Department or the public water systems) which present similar health hazards must have reduced pressure backflow preventers installed at each service connection (containment protection) in addition to all devices required as internal protection (in-plant protection).

Ultimately, the survey program should extend to all industrial, commercial, municipal, and institutional premises. These are the facilities which most commonly present cross connection hazards. Although cross connections may exist in residential homes, it is often impractical to survey such users because of their sheer numbers and generally non-hazardous nature. A public educational program should be developed by the local water officials with the purpose to inform and educate the general public about cross connection and the health hazardous that it creates.

STEPS FOR CONDUCTING A CROSS-CONNECTION SURVEY

Step 1: Meet with the Water User

Prior to beginning the survey, there should be a meeting between the inspector and a representative of the facility, preferably the chief engineer, manager, or operator of the facility. A letter sent to the owner giving advance notice of the inspection can benefit both the inspector and the owner. At this time, the inspector should indicate the purpose of the survey, and inform the owner about the responsibilities of the water supplier and owner with regard to cross connection control. Any written information on the significance and threat from cross connections to water supply systems can be provided at this time. It is important that the owner understand the purpose of the inspection and the need for cross connection control.

After discussing the survey with the owner's representative, the inspector should request the service of the chief maintenance person or plumber on staff who is the most knowledgeable on the water system within the facility. This individual should accompany the inspector throughout the entire survey and be able to answer questions which may arise. Any as-built plumbing plans which exist for the facility can be reviewed at this time to target those areas which are likely to require backflow prevention devices.

Step 2: Begin the Survey

The survey should begin at the water service entrance and continue throughout as much of the internal plumbing system as realistically possible. The survey should not be rushed and appropriate safety equipment should be at the inspector's disposal, such as safety goggles, hard hats, flashlights, etc. The inspector should maintain a professional demeanor and gain the respect and confidence of the water user.

The attached Cross Connection Violation Form should be used to record all pertinent information on the facility owner and all cross connections found to exist as the survey progresses. It can also be used to detail cross connections through sketches of plumbing systems in mechanical rooms, at fire service entrances, or to detail the location of storage tanks, auxiliary sources, cooling towers, etc. It is important to have good field notes to document inspection findings and to ensure compliance in follow-up inspections. MassDEP Drinking Water Regulations 310 CMR 22.22, Table 22-1 should be used as a guide to target those fixtures/equipment requiring protection. In addition, Table 22-1 has been included here to provide the surveyor with more detailed information.

The guiding principles in determining the necessary type of protection are type of backflow possible and degree of health hazard:

BACKFLOW CAUSED BY	HEALTH HAZARD	ACCEPTABLE DEVICES OR ASSEMBLIES				
		AG	RPBP	DCVA	PVB or AVB	BPIAV
BACKSIPHONAGE	HIGH	X	X			
	MODERATE	X	X	X	X	
	LOW	X	X	X	X	X
BACKPRESSURE	HIGH		X			
	MODERATE		X	X		
	LOW		X	X		X

AG - Air Gap
RPBP - Reduced Pressure Backflow Preventer
DCVA - Double Check Valve Assembly
AVB - Atmospheric Vacuum Breaker
PVB - Pressure Vacuum Breaker
BPIAV - Backflow Preventer with Intermediate Atmospheric Vent

As the survey progresses, the inspector should write down all cross connections found to exist and whether or not an appropriate backflow prevention device has been installed for protection of the potable water supply. Any reduced pressure backflow preventers and double check valve assemblies required by 310 CMR 22.22 found on the premises must be issued a permit by the Department. The inspector's survey report should indicate the presence of these devices and whether permits have been issued.

Cross-Connection Survey Report Form & Violation Notice
(Print Clearly)

Date of CC Survey _____/_____/_____ PWS ID# ____/____/____/____/____/____/____

PWS Name _____ City/Town _____

Facility Information

1. Facility Name (Business, Co., Corp.):_____
2. Facility Address:_____, MA __
3. Mailing Address:_____
4. Contact Person:_____ Phone # (____)_____-_____
5. Type of facility: ☐ Industrial ☐ Commercial ☐ Institutional ☐ Municipal ☐ Other_____
6. Describe the facility use(i.e. motel, school):_____
7. Size of service connection:_____ inch. Is service connection metered? ☐ YES ☐ NO
8. Is supplemental protection at the meter required (containment device)? ☐ YES ☐ NO
   If YES, what type of backflow device is in use? ☐ Reduce Pressure Backflow Preventer (RPBP)
   ☐ Double Check Valve Assembly (DCVA)
9. Does this facility require non-interrupted water service? ☐ YES ☐ NO
10. Does the boiler feed utilize chemical additives? ☐ YES ☐ NO
    If YES, is the boiler protected with a backflow device? ☐ YES ☐ NO
11. Does this facility have an air conditioning cooling tower? ☐ YES ☐ NO
    If YES, is the cooling tower protected with a backflow device? ☐ YES ☐ NO
12. Is a water saver in use on condensing lines or cooling tower? ☐ YES
    ☐ NO
    If YES, is the make-up supply line protected with a backflow device? ☐ YES ☐ NO
13. Is process water in use in this facility? ☐ YES ☐ NO
    If YES, is the process water "potable" water or "raw" water? ☐ Potable ☐ Raw
14. Is the process water lines protected with a backflow device? ☐ YES ☐ NO
15. Does this facility have a fire protection system? ☐ YES ☐ NO
    If YES, is the fire protection system supplied by a dedicated water line? ☐ YES ☐ NO
16. What type of backflow device is being used on the fire protection system?
    ☐ Single swing check valve (SSCV) ☐ Reduce Pressure Backflow Preventer (RPBP)
    ☐ Double Check Valve Assembly (DCVA) ☐ Other_____

Violation(s) Found

☐ **NO violation(s) was/were found at the time of this cross-connection survey was conducted.**

Exact Location of Cross-connection	Degree of Hazard ☒	Comments
	☐ High ☐ Moderate ☐ Low	
	☐ High ☐ Moderate ☐ Low	
	☐ High ☐ Moderate ☐ Low	
	☐ High ☐ Moderate ☐ Low	

I certified that the above cross-connection survey findings are true *(Signatures required)*

- **Cross-connection Survey Conducted by:** (MA-DEP Certified Cross-connection Surveyor)

MassDEP Cert. CC Surveyor Name (Print)	*MA DEP Cert. ID#*	*/ /* *Expiration. Date*	*Signature*

- **Cross-connection Survey Witnessed by:** (Facility Owner/Representative)

Facility Owner/Representative Name (Print)	*Signature*	Date

Note:
- **Use the attached table for protection options.**
- **Provide to the facility owner/representative a copy of this form.**

TABLE 22-1

Types of Backflow Prevention Devices Required: Subject to the provisions of 310 CMR 22.22(10), Table 310 CMR 22-1 shall serve as the guide for the type of protection required.

AG	- Air Gap		AVB	- Atmospheric Vacuum Breaker
RPBP	- Reduced Pressure Backflow Preventer		PVB	- Pressure Vacuum Breaker
DCVA	- Double Check Valve Assembly		BPIAV	- Backflow Preventer with Intermediate Atmospheric Vent

	Acceptable Types of Backflow Preventers						
Types of Hazard on Premises	**AG**	**RPBP**	**DCVA**	**AVB**	**PVB**	**BPIAV**	**Comments***
1. Sewage Treatment Plant	X	X					
2. Sewage Pumping Station	X	X					
3. Food Processing	X	X	X*				* If no health hazard exists
4. Laboratories	X	X	X*				* If no health hazard exists
5. Fixtures with hose threads on inlets	X	X	X	X			In addition to an air gap separation, all fixtures that have a threaded hose type connection shall at a minimum, be equipped with a AVB in accordance with 248 CMR 2.14
6. Hospitals, Mortuaries, Clinics	X	X					
7. Plating Facilities	X	X					
8. Irrigation Systems	X	X		X*	X**		Each case should be evaluated individually. * An AVB can be used if no back pressure is possible and no health hazard exists. ** Pressure Vacuum Breakers can be installed if back pressure is not possible
9. Systems or Equipment Using Radioactive Material	X	X					
10. Submerged Inlets	X	X		X*			* If no health hazard exists and no back pressure is possible
11. Dockside Facilities	X	X					
12. Valved outlets or fixtures with hose	X	X		X*			Each case should be evaluated individually * If no health hazard exists and no back pressure is possible
13. Commercial Laundries and Dry Cleaners	X	X					
14. Commercial Dishwashing Machines	X	X		X*			* If no health hazard exists
15. High and Low Pressure Boilers	X	X*					* If chemicals are added
16. Low Pressure Heating Boilers						X	Residential and small commercial, having no chemicals added
17. Photo Processing Equipment	X	X					
18. Reservoirs – Cooling Tower Re-circulating Systems	X	X					
19. Fire Protection Systems: For cross connection control, fire protection systems may be classified on the basis of water source and arrangement of supplies as follows:							
19. Fire Protection Systems (continued) a. Class 1: Direct connection from public water system mains only; no pumps, tanks, or reservoirs; no physical connection from other water supplies; no antifreeze or other additives of any kind; all sprinkler drains discharge to atmosphere, dry wells, or other safe outlets. These systems may or may not have fire department connections. Refer to 310 CMR	X	X	X				A backflow prevention assembly does not have to be installed on existing fire protection systems installed prior to March 21, 1997, provided that the fire protection system is registered with the public water system, equipped with a UL listed alarm check valve that is properly maintained in accordance with NFPA 25 and has not undergone substantial modification defined

22.22(9)(d)1.							within 310 CMR 22.22(9)(d)3. Alarm check maintenance records must be available for inspection by the Department, its designee or the public water system
b. Class 2: Same as Class 1 except that booster pumps may be installed in the connections from the street mains .These systems may or may not have fire department connections. Refer to 310 CMR 22.22(9)(a).	X	X	X				A backflow prevention assembly does not have to be installed on existing fire protection system installed prior to March 21, 1997, provided that the fire protection system is registered with the public water system and equipped with a UL listed alarm check valve that is properly maintained in accordance with NFPA 25. Alarm check maintenance records must be available for inspection by the Department, its designee or the public water system
c. Class 3: Direct connection from public water system mains, plus one or more of the following: elevated storage tanks; fire pumps taking suction from aboveground covered reservoirs, or tanks; and pressure tanks.	X	X*	X*				* RPBP or DCVA contingent on evaluation of auxiliary supply and on-site system in accordance with 310 CMR 22.22(9)(d)1.
d. Class 4: Directly supplied from public water system mains, similar to Class 1 and Class 2 with an auxiliary water supply dedicated to fire department use and available to the premises, such as an non-potable water source located within 1700 feet of the fire department connection, (FDC).	X	X*					* RPBP on evaluation of auxiliary supply and on-site system in accordance with 310 CMR 22.22(9)(d)1.
e. Class 5: Directly supplied from public water system mains, and interconnected with auxiliary supplies, such as pumps taking suction from reservoirs exposed to contamination, or rivers and ponds; driven wells; mills or other industrial water systems; or where antifreeze or other additives are used.	X*	X*					* RPBP or air gap contingent on evaluation of auxiliary supply and on-site system. Refer to 310 CMR 22.22(9)(d)1.
f. Class 6: Combined industrial and fire protection systems supplied from the public water mains only, with or without gravity storage or pump suction tanks.	X	X*			X	X	* RPBP contingent on evaluation of on-site water system Refer to 310 CMR22.22 (9)(d)1.
g. Residential fire protection systems for one and two family detached dwellings and manufactured homes only. Fire protection systems in three family dwellings meeting NFPA 13D requirements as provided in 780 CMR, Chapter 9, are included in this section.	X	X	X				Non testable devices and flow through systems should be used whenever possible. Systems are typically designed and installed in accordance with NFPA 13D: "Installation of Sprinkler systems in One and Two Family Dwellings and manufactured homes." These systems are authorized to use food grade antifreeze with no additional requirements when potable piping (PB, CPVC, and copper tube) is employed. If non-grade antifreeze is utilized, the system may be classified as a Class 5. If a fire department connection is used, the requirements for a Class 1 or 2 apply.
h. Residential fire protection systems for other than those described in Table 22-1-19.g.	X	X	X				Fire protection system in this category shall comply with the requirements set forth in class 1 through 4 as appropriate.
20. Solar Energy Systems	X	X				X*	Residential and small commercial having no

							chemicals or only USP Glycenne added to water
21. Single Jacketed Heat Exchangers	X	X					Each case should evaluated individually

SECONDARY SOURCE, SYSTEM, OR EQUIPMENT	AG	RPBP	DCVA	AVB or PVB	BFPAV	Other
HVAC Systems						
Boiler Systems						
w/ chemical treatment	X	X				
high pressure (715 psi)	X	X				
blowdown		X	X			
low pressure - no treatment					X	
Forced Hot Water Heating						
w/ chemical treatment	X	X				
low pressure - no treatment					X	
Chilled Water System	X	X				
Cooling Tower	X	X				
Compressors - water cooled						AG at drain
Treatment or Return tanks	X	X				
Heat Exchangers						
single jacketed	X	X				
double jacketed						AG at drain
Fire Systems *						* See 310 CMR 22.22 Table 22-1
Irrigation Systems						
w/ underground sprinkler heads	X	X		X		
w/ auxiliary supply	X	X				
w/ possible back pressure	X	X				
General						
Slop sinks	X			X		
Hose Spigots				X		
Urinals, toilets	X			X		
Swimming pool makeup	X	X				
Photo developing	X	X				
Hospital Equipment						
X-ray Developers	X	X				
Dialysis Units	X	X				

SECONDARY SOURCE, SYSTEM, OR EQUIPMENT	AG	RPBP	DCVA	AVB or PVB	BFPAV	Other
Sterilizers (autoclaves)	X	X				
Mortuary	X	X				
Vacuum Pumps	X	X		X		
Bedpan washers	X	X		X		
Laboratories *						* Services to high hazard labs. must be contained in addition to fixture outlet protection
Bench fixtures	X			X		
Pipette washers	X			X		
Cup sinks	X			X		
Industrial						
Cooling Water *	X	X				* if non-contact
Plating, processing tanks	X	X				AG at drain
Closed tanks, reactors	X	X				
Solar heating	X	X				
Laundry						
Submerged inlet washers	X	X		X		
Chemical aspiration	X	X		X		
Dry cleaning equipment				X		
Kitchen						
Chemical aspirators	X	X		X		
Dishwashers	X	X		X		
Steam jacketed vessels				X		
Degreasers	X	X				
Garbage disposals	X	X		X		
Sewage & Waste Lines						
Priming lines/sewage pumps	X	X				
Blowdown	X	X				
Trap primers	X	X				

Step 3:End the Survey

After completing the survey of the premises, the inspector should meet again with the chief engineer, manager, or operator and inform him or her about the findings of the survey, including identification of those areas where

corrective actions will be required. The inspector should also inform the owner about any violation letters which will be issued as a result of the survey as well as provide the owner with a business card or telephone number where he or she can be reached for further questions.

Step 4:Notify Owner in Writing of Violations

The owner of a facility found in violation must be notified in writing of the need for backflow protection. This can be done by issuing a letter detailing the cross connections found on the premises and the devices required. The letter should indicate the need for plan submittal and approval and should have a date by which actions must be taken. Any necessary paperwork should also be attached, such as a local policy statement on cross connections, a design data sheet, a plumbing permit application, etc. The DEP, local plumbing inspector, and Board of Health should also receive copies of this notice.

3. New Construction and Retro-fitted Facilities

New construction or modifications to existing facilities should be evaluated for backflow prevention requirements in the design stage. It is easier and much less expensive for an owner to comply with device requirements at this stage than it is after a facility is constructed. Retrofitting of devices on fire systems, HVAC systems, or other systems can prove to be very costly and very often difficult due to confined spaces or extensive distribution systems. Waterworks officials should make every effort to ensure proper backflow protection for all new construction so that the public water system is not jeopardized and the burden to an owner is minimized. The waterworks official should:

- Provide information on device requirements and approval and permit requirements to any water user or contractor requesting a connection to the public water system.

- If possible, review building plans jointly with the local plumbing inspector, so that all cross connections are properly protected and permits are issued.

- Notify local fire officials of device requirements and associated pressure drops, so fire systems will operate efficiently and the water system will be protected.

- Retain sign-off on certificates of occupancy so that a site inspection can be done prior to activating the water service with the support of other local officials, efforts to achieve compliance on new construction can be very successful, while at the same time provide awareness of the importance of cross connection control to officials and water users alike.

With the support of other local officials, efforts to achieve compliance on new construction can be very successful, while at the same time provide awareness of the importance of cross connection control to officials and water users alike.

4. Coordination with Local Plumbing Inspectors

Local Plumbing Inspectors, authorized by Chapter 142 of the Massachusetts General Laws, administer and enforce the state plumbing code. As a part of their duties, pursuant to section 2.14(6)(c), the plumbing inspector shall prohibit cross connections between potable water systems and other systems or equipment containing water or other substances of unknown or questionable safety except when and where, as approved by the Department of Environmental Protection, suitable protective devices such as the reduced pressure backflow preventer or equal are installed tested and maintained to insure proper operation on a continuing basis.

As such, water suppliers should make an attempt to coordinate efforts with the local plumbing inspector to assure that all cross connections are protected by an appropriate device, and that all approvals of installations are made by the appropriate reviewing authority. Bear in mind it is much easier to incorporate backflow prevention a device in the design stage then it is to retrofit devices on existing plumbing systems.

The plumbing inspector can also be a good source of information on any questions arising from surveying which pertain to the purpose and design of any plumbing materials, equipment, or fixtures.

5. Enforcement

After any violations of the Cross Connection Regulations are found, in surveys or otherwise, the supplier must send out a Cross Connection Violation Form detailing the violation(s) and a procedure for corrective action. This normally includes a requirement for plan submittal and should indicate the deadline for such submittal and who the reviewing authority will be (either the Department or the water supplier). Normally 30 days is given for plan submittal unless a more appropriate schedule is necessary in the judgment of the inspector.

If the owner of any premises does not initiate corrective actions by the prescribed deadline, the water supplier should then issue a follow-up letter indicating that the owner remains in violation and under 310 CMR 22.22 Section 2(b) will have his service terminated unless corrective work is initiated within 15 days.

If the owner of any premises remains in noncompliance after the deadline established in this second letter, the property should be posted for shut off and the water service should be terminated. The owner should be notified of this in writing.

It is important to note that frequently violations may be found in great numbers and may have large financial impacts on the owners of any premises. In these circumstances, a creative enforcement strategy must be undertaken whereby corrective work is staggered over a reasonable period of time. However, the public water supply distribution mains should never be at risk and containment devices should be a priority at any high hazard facility.

On occasion problems may arise on enforcement where termination of the water supply would result in unreasonable risk to the public health of the community. In these circumstances, the Department should be notified and other enforcement strategies will be necessary, including but not limited to the assessment of an administrative penalty to any person in noncompliance with section 22 of the Drinking Water Regulations of Massachusetts.

6. Incident Response

Each utility as part of its standard operating procedure should have a response plan for suspected backflow incidents.

Upon a report of contamination, the water utility's cross connection inspector should investigate the nature of contamination and in light of the circumstances found to exist, determine if in fact a backflow incident did or is occurring. The Drinking Water Regulations of Massachusetts, 310 CMR 22.22, Section 10 (b) 5, states that the supplier must take appropriate action to eliminate hazardous conditions. This may include shutting off the water service to any premises suspected of contaminating the public water supply.

In any event where backflow is (or was) either suspected or confirmed, the following agencies should be notified immediately:

- The appropriate regional office of the Department of Environmental Protection
- Local Health Department or health authority

In addition, samples should be taken to a certified laboratory for analysis to determine the nature of the contamination, if any. The scope of the incident should be determined and all consumers affected by the contamination must be notified immediately if there is any threat to public health.

Any remedial action to mitigate the contamination should be initiated as soon as possible. This would normally include installation of backflow prevention devices, disconnecting systems or equipment, or flushing and

chlorinating affected water lines. No water in the affected area should be used for drinking, bathing, or cooking until such time as further sampling and analysis dictates that no threat to the public health exists.

Any and all actions taken must be well documented by the supplier, as backflow incidents frequently involve significant losses, and liability concerns can be expected to follow.

III. PROGRAM IMPLEMENTATION PLAN

As required by 310 CMR 22.22, each public water supplier must submit a cross connection control program plan on a time schedule indicated in section (10). This plan shall represent each utility's approach to protecting the potable water supply system from cross connection contamination.

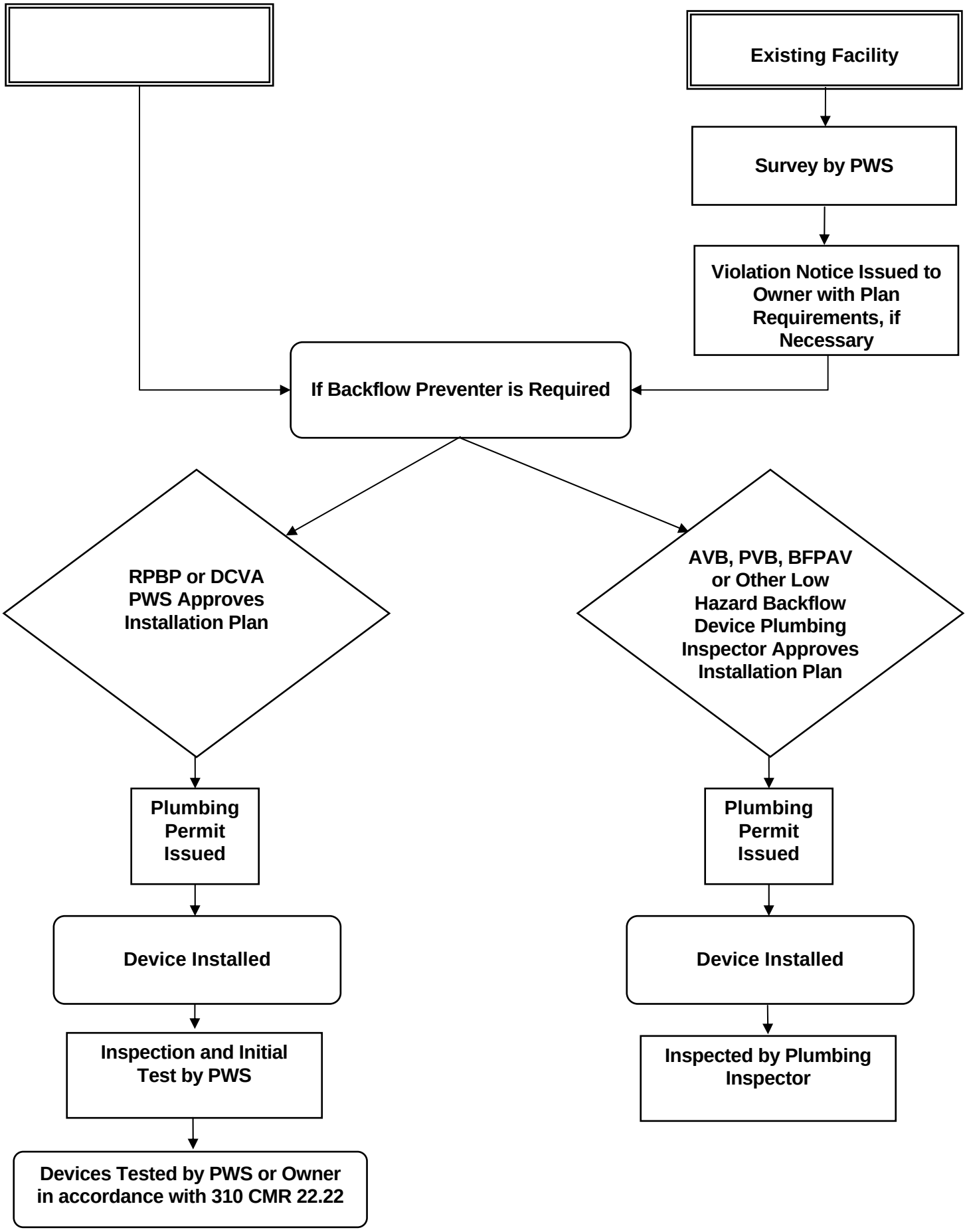
As part of the plan, each supplier must fill out the MassDEP Cross Connection Control Implementation Plan in order to characterize their systems and develop a strategy for protecting all consumers. This data sheet must be completely filled out and signed by the superintendent. Any local ordinance or by-law pertaining to cross connection control should be attached.

Each specific implementation plan (part E of the program plan) should be developed in light of the circumstances particular to any water system. For instance, if a particular system serves a largely residential population and only has a few industrial, commercial, or institutional services, then it may be feasible to survey all of these services connections within a year. On the other hand a large water system serving a vast number of industrial, commercial, and institutional facilities may develop a plan to survey all such facilities over a 5 year period (or longer.)

Be advised that any CCCP plan submittal which involves containment only will not be approved. A containment first / in-plant later approach will only be approved if conditions on a system exist which will warrant this approach. The goal of the program plan is to afford protection to all consumers, who continually use potable water at the free flowing taps.

In order to further aid water suppliers in initiating cross connection control programs, a model cross connection control program ordinance has been included in this section. This ordinance is intended to strengthen the program at the local level and elaborate on proper cross connection control practices, and included in it is material not covered in MassDEP regulations such as testing fees, installation of strainers, and containment on residential services. Bear in mind that it is not required that this ordinance be established, but each supplier may want to consider adopting this or a similar ordinance to enhance their cross connection program.

3.1. Flow Chart of a Local Program



3.2. Cross Connection Control Program Procedures

1. Need to survey determined and priority assigned according to known or suspected hazard on premises.
2. Customer notified and appointment set.
3. Premises surveyed - customer receives notice if violations are found and such notice includes schedules for required actions.
4. Customer submits plans to water supplier for approval, including device design data sheets.
5. Water supplier accepts or rejects plans in writing. Customer is notified of time frame allowed for installations.
6. After approval, protective devices are installed after obtaining plumbing permit.
7. Customer notifies water supplier when installations are complete.
8. Installation is inspected and devices are tested by water supplier.
9. Water supplier sends copy of Inspection and Maintenance Report Form to DEP for issuance of Massachusetts Cross Connection Device Identification Number. The annual permit application will be sent to the owner at the end of each year.
10. Each reduced pressure backflow preventer is put on a semi-annual testing schedule and each double check valve assembly is put on an annual testing schedule with reports of such inspections sent to MassDEP.
11. Records maintained of surveys and inspections for seven years, available at the request of authorities.
12. Re-surveys are done as necessary, when suspected or known hazards warrant such action.

Notes

A. Normal time frame allowed for plan submittal is 30 days from survey date + 14 days to accept/reject plan + 30 days for installation + 14 days for inspection = 90 days total.

B. Extensions granted from above schedule in cases involving extensive plumbing modifications and/or large financial impact.

C. MassDEP will be accesses for technical assistance and on complex enforcement issues as necessary.

D. Plumbing inspector, town engineer, water and sewer superintendents will be utilized as necessary when approving installations.

E. Shut-off procedures will be initiated on owners who refuse, fail, or are unable to install protective devices within allotted time frames.

Model Cross Connection Control Ordinance

(Water Department Name) Cross-Connection Control Program

I. Purpose

A. To protect the public potable water supply served by the _____ Water Department from the possibility of contamination or pollution by isolating such contaminants or pollutants which could backflow or back-siphon into the public water system.

B. To promote the elimination or control of existing cross connections, actual or potential, between its customers in-plant potable water system, and non-potable systems.

C. To provide for the maintenance of a continuing program of cross connection control which will effectively prevent the contamination or pollution of all potable water systems by cross connection.

II. Authority

A. As provided for in the Federal Safe Drinking Water Act of 1974, (Public Law 93-523), and the Commonwealth of Massachusetts Drinking Water Regulations, 310 CMR 22.22, the water purveyor has the primary responsibility for preventing water from unapproved sources, or any other substances, from entering the public potable water system.

B. _____ Water Department, Rules and Regulations, adopted (date).

III. Responsibility

The Water Commission shall be responsible for the protection of the public potable water distribution system from contamination or pollution due to the backflow or backsiphonage of contaminants or pollutants. If, as a result of a survey of the premises, the Commission determines that an approved backflow prevention device is required at the town's water service connection or as in-plant protection on any customer's premises, the commission, or its delegated agent, shall issue a cross connection violation form to said customer to install approved backflow prevention devices. The customer shall, within a time frame determined by the Commission, install such approved device or devices at his own expense, and failure or refusal or inability on the part of the customer to install said device or devices within the specified time frame shall constitute a ground for discontinuing water service to the premises until such device or devices have been properly installed.

IV. Definitions

A. Approved - Accepted by the Reviewing Authority as meeting an applicable specification stated or cited in this regulation, or as suitable for the proposed use.

B. Approved Backflow Prevention Device or Device - A testable or non-testable cross connection control device that is approved by the MassDEP for use in Massachusetts.

C. Auxiliary Water Supply - Any water supply, on or available, to the premises other than the purveyor's approved public potable water supply.

D. Backflow - The flow of water or other liquids, mixtures or substances, under positive or reduced pressure in the distribution pipes of a potable water supply from any source other than its intended source.

E. Backflow Preventer - A device or means designed to prevent backflow or backsiphonage. Most commonly categorized as air gap, reduced pressure principle device, double check valve assembly, pressure vacuum breaker, atmospheric vacuum breaker, hose bibb vacuum breaker, residential dual check, double check with intermediate atmospheric vent, and barometric loop.

E.1. Air Gap - The method of preventing backflow through the use of an unobstructed vertical distance through the free atmosphere between the lowest opening from any pipe or faucet supplying water to a tank, plumbing fixture, or other device and the flood level rim of the receptacle. The air gap separation shall be at least twice the internal diameter of the supply pipe discharge line but in no case less than one inch.

E.2. Atmospheric Vacuum Breaker - A device which prevents backsiphonage by creating an atmospheric vent when there is either a negative pressure or subatmospheric pressure in a water system.

E.3. Barometric Loop - A fabricated piping arrangement rising at least thirty five (35) feet at its topmost point above the highest fixture it supplies. It is utilized in water supply systems to protect against backsiphonage.

E.4. Double Check Valve Assembly - An assembly of two (2) independently operating spring loaded check valves with tightly closing shut off valves on each side of the check valves, plus properly located test cocks for the testing of each check valve.

E.5. Double Check Valve with Intermediate Atmospheric Vent - A device having two (2) spring loaded check valves separated by an atmospheric vent chamber.

E.6. Hose Bibb Vacuum Breaker - A device which is permanently attached to a hose bibb and which acts as an atmospheric vacuum breaker.

E.7. Pressure Vacuum Breaker - A device containing one or two independently operated spring loaded check valves and an independently operated spring loaded air inlet valve located on the discharge side of the check or checks. Device includes tightly closing shut-off valves on each side of the check valves and properly located test cocks for the testing of the check valve(s).

E.8. Reduced Pressure Principle Backflow Preventer - An assembly consisting of two (2) independently operating approved check valves with an automatically operating differential relief valve located between the two (2) check valves, tightly closing shut-off valves on each side of the check valves plus properly located test cocks for the testing of the check valves and the relief valve.

E.9. Residential Dual Check - An assembly of two (2) spring loaded, independently operating check valves without tightly closing shut-off valves and test cocks. Generally employed immediately downstream of the water meter to act as a containment device.

F. Backpressure - A condition in which the owners system pressure is greater than the supplier's system pressure.

E. Backsiphonage - The flow of water or other liquids, mixtures or substances into the distribution pipes of a potable water supply system from any source other than its intended source caused by the sudden reduction of pressure in the potable water supply system.

F. Commission - The Town of _____ Water Commission or owner or operator of a public water supply system invested with the authority and responsibility for the implementation of a cross connection control program and for the enforcement of the provisions of the Ordinance.

G. Containment - A method of backflow prevention which requires a reduced pressure backflow preventer or an air gap separation at the meter or property line

H. Contaminant - A substance that will impair the quality of the water to a degree that it creates a serious health hazard to the public leading to poisoning or the spread of disease.

I. Cross-Connection - Any actual or potential connection between the public water supply and a source of contamination or pollution.

J. Cross Connection Violation Form - A violation form designated by MassDEP, which is sent to the owner by the water supplier with copies sent to the, plumbing inspectors and Board of Health delineating cross connection violations found on the owner's premises and a procedure for corrective action.

K. Department - The Massachusetts Department of Environmental Protection (MassDEP).

L. Design Data Sheet - A report form submitted to the supplier of water along with plans for each installation of a reduced pressure backflow preventer or double check valve assembly, or for each change to any such device already installed, describing and showing the details of the specific installation.

M. Health Hazard - An actual or potential threat of contamination to the potable water in a public water system, which, in the opinion of the supplier of water would endanger health.

N. In-Plant Protection - The location of approved backflow prevention devices in a manner, which provides protection of the consumers of water and the potable water system within the premises.

O. Inspection - An on-site inspection and survey by a qualified individual to determine the existence and location of cross connections and/or the physical examination and testing of an installed backflow prevention device to verify that the backflow prevention device is functioning properly.

P. Inspection and Maintenance Report Form - A report form which is to be used by certified testers to record all pertinent testing information

Q. Owner - Any person maintaining a cross connection installation or owning or occupying premises on which cross connections can or do exist.

R. Owner's Agent - Any person or body designated by the owner to act as his or her representative.

S. Person - Any individual, corporation, company, association, trust, partnership, the Commonwealth, a municipality, district, or other subdivision or instrumentality of the United States, except that nothing herein shall be constructed to refer to or to include any American Indian tribe or the United States Secretary of the Interior in his capacity as trustee of Indian lands.

T. Pollutant - A foreign substance, that if permitted to get into the public water system, will degrade its quality so as to constitute a moderate hazard, or impair the usefulness or quality of the water to a degree which does not create an actual hazard to the public health but which does adversely and unreasonably effect such water for domestic use.

U. Potable Water - Water from any source that has been approved by MassDEP for human consumption.

V. Reviewing Authority - The supplier of water, or the local plumbing inspector, authorized by M.G.L. c. 142 and licensed by the Board of State Examiners of Plumbers and Gas Fitters, whichever is responsible for the review and approval of the installation of an approved backflow prevention device.

W. Supplier of Public Water - Any person who owns or operates a public water supply system.

X. Unapproved Source - The source or distribution system for any water or other liquid or substance which has not been approved by the MassDEP as being of safe and sanitary quality for human consumption, including but not limited to any waste pipe, soil pipe, sewer, drain, or non-acceptable potable water system material.

V. Administration

A. The Commission will operate an active cross-connection control program, to include the keeping of necessary records, which fulfills the requirements of MassDEP's Cross Connection Regulations and is approved by MassDEP.

B. The Owner shall allow his property to be inspected for possible cross-connections and shall follow the provisions of the Commission’s program and MassDEP’s Regulations.

VI. Requirements

A. Commission

1. On new installations, the Commission will provide onsite evaluation and/or inspection of plans in order to determine the type of backflow preventer, if any, that will be required, will issue permit, and perform inspection and testing.

2. For premises existing prior to the start of this program, the Commission will perform surveys of the premises and review of as-built plans and issue a cross connection violation form to the owner detailing any corrective action required, the method of achieving the correction, and the time allowed for the correction to be made. The time period allowed shall depend upon the degree of hazard involved.

3. The Commission will not allow any cross-connection to remain unless it is protected by an approved backflow preventer for which a permit has been issued and which will be regularly tested to insure satisfactory operation.

4. The Commission shall inform the Owner by letter, of any failure to comply, by the time of the first re-inspection. The Commission will allow an additional fifteen (15) days for the correction. In the event the Owner fails to comply with the necessary correction by the time of the second re-inspection, the Commission will inform the Owner by letter, that the water service to the Owner’s premises will be terminated within a period not to exceed five (5) days. In the event that the Owner informs the Commission of extenuating circumstances as

to why the correction has not been made, a time extension may be granted by the Commission but in no case will exceed an additional thirty (30) days.

5. If the Commission determines at any time that a serious threat to the public health exists, the water service will be terminated immediately.

6. The Commission will begin initial premise inspections to determine the nature of existing or potential hazards, following the approval of this program by MassDEP, during the calendar year ( ). Initial focus will be on high hazard industries and commercial premises.

B. Owner

1. The Owner shall be responsible for the elimination or protection of all cross-connections on his premises.

2. The Owner shall be responsible for applying for and obtaining all necessary approvals and permits for the maintenance of cross connections and installation of backflow prevention devices.

3. The Owner shall correct any malfunction of the backflow preventer which is revealed by periodic testing.

4. The Owner shall inform the Commission of any proposed or modified cross connections and also any existing cross connections of which the Owner is aware but has not been found by the Commission.

5. The Owner shall not install a bypass around any backflow preventer unless there is a backflow preventer of the same type on the bypass. Owners who cannot shut down operation for testing of the device(s) must supply additional devices necessary to allow

testing to take place.

6. The Owner shall install backflow preventers in a manner approved by the Commission.

7. The Owner shall install only backflow preventers approved by MassDEP.

8. Any Owner of industrial, commercial, or institutional premises having a private well or other private water source must have a permit if the well or source is cross connected to the Commission's system. Permission to cross connect may be denied by the Commission. The Owner may be required to install a backflow preventer at the service entrance if a private water source is maintained even if it is not cross connected to the Commission's system.

9. The owner of a private well or individual water source serving residential dwellings used for potable or non-potable purposes will not be allowed a physical connection with the public water supply system.

10. The Owner shall be responsible for the payment of all fees for permits, annual or semi-annual device testing, retesting in the case that the device fails to operate correctly, and second re-inspections for non-compliance with MassDEP or Commission requirements.

VII.Degree of Hazard

The Commission recognizes the threat to the public water system arising from cross-connections. All threats will be classified by degree of hazard and will require the installation of approved reduced pressure principle backflow prevention devices or double check valves. The Commission may require a containment device on the water service entrance to any customer who, as a result of unprotected cross connections, could contaminate the public water supply system.

VIII. Existing In-Use Backflow Prevention Devices

Any existing backflow preventer shall be allowed by the Commission to continue in service unless the degree of hazard is such as to supersede the effectiveness of the present backflow preventer or result in an unreasonable risk to the public health. Where the degree of hazard has increased, as in the case of a residential installation converting to a business establishment, any existing backflow preventer must be upgraded to a reduced pressure backflow preventer, or a reduced pressure backflow preventer must be installed in the event that no backflow device was present.

IX. Periodic Testing

A. Reduced pressure principle backflow devices shall be tested and inspected at least semi-annually.

B. Backflow device testing and inspection shall be performed by a MassDEP certified backflow tester.

C. The testing shall be conducted during the Commission's regular business hours. Exceptions to this, when at the request of the Owner, may require additional charges to cover the increased costs to the Commission.

D. Any backflow preventer which fails during a periodic test must be repaired or replaced by a licensed plumber. When repairs are necessary, upon completion of the repair, the device will be retested at the Owner's expense to insure proper operation. High hazard situations will not be allowed to continue unprotected if the backflow preventer fails the test and cannot be repaired immediately. In other situations, a compliance date of not more than fourteen days after the test date will be established. The Owner is responsible for spare parts, repair tools, or a replacement device. Parallel installation of two devices is an effective means of the Owner insuring that uninterrupted water service remains during testing or repair of devices and is strongly recommended when the owner desires such continuity.

E. Backflow prevention devices will be tested more frequently than specified above in "A" in cases where there is a history of test failures and the Commission feels that due to the degree of hazard involved, additional testing is warranted. Cost of the additional tests will be born by the Owner.

X. Records and Reports

Records

The Commission will initiate and maintain the following:

- Master files on customer cross-connection tests and/or inspections.
- Master files on approved cross-connection installations.
- Master files on facilities surveyed and violations found.
- Master files on correspondences, violation notices and enforcement actions.

Reports

The Commission will submit reports, such as: listing of cross connection and respective devices, summary of cross connection inspections and surveys, to the MassDEP upon request.

XI. Fees and Charges

The Commission will publish a list of fees or charges for the following services:

1. Testing fees
2. Re-testing fees
3. Fee for re-inspection
4. Charges for after-hours inspections or tests.

Addendum

1. Residential dual check

Effective the date of the acceptance of this Cross-Connection Control Program for the Town of _____ all new residential buildings will be required to install a residential dual check device immediately downstream of the water meter. Installation of this residential dual check device on a retrofit basis on existing service lines will be instituted at a time and at a potential cost to the homeowner as deemed necessary by the Commission.

The Owner must be aware that installation of a residential dual check valve results in a potential closed plumbing system within his/her residence. As such, provisions may have to be made by the owner to provide for thermal expansion within his/her closed loop system, i.e., the installation of thermal expansion devices and/or pressure relief valves.

2. Strainers

The Commission strongly recommends that all new retrofit installations of reduced pressure principle devices and double check valve backflow preventers include the installation of strainers located immediately upstream of the backflow device. The installation of strainers will preclude the fouling of backflow devices due to both foreseen and unforeseen circumstances occurring to the water supply system such as water main repairs, water main breaks, fires, periodic cleaning and flushing of mains, etc. These occurrences may “stir up” debris within the water main that will cause fouling of backflow devices installed without the benefit of strainers.

IV. Appendix:

IV.1. Inspection and Maintenance Report Form

IV.2. Standard Letters

SAMPLE OF VIOLATION NOTICE

PRINTED ON WATER DEPT. LETTERHEAD

[Date]

[Facility Owner Name]
[Facility Address]
[City/Town], [State] [Zip]

RE: Cross Connection Control Survey Violation Notice

Dear **[Facility Owner Name]**:

THIS IS AN IMPORTANT NOTICE. FAILURE TO TAKE ADEQUATE ACTION IN RESPONSE TO THIS NOTICE COULD RESULT IN SERIOUS LEGAL CONSEQUENCES.

On **[Survey Date]**, inspector **[Inspector's Name]** of the **[City/Town]** Water Department Cross-Connection Control Program conducted a survey of your property located at **[Facility Address]**. 310 CMR 22.22, Massachusetts Drinking Water Regulations requires all industrial, commercial and institutional facilities to be survey for cross-connection. This cross-connection survey was performed to determine if any cross-connection between the drinking water distribution system and any non-potable liquid or gases exists. **[Owner's Representative]** was present during the survey.

310 CMR 22.22, defines a cross-connection as "…any actual connection or arrangement between any pipe conveying potable water from a public water system and any non-potable water supply, piping arrangement or equipment including, but not limited to waste pipe, sewer, drain, other unapproved sources, or any direct or indirect connection between a plumbing fixture or device whereby contaminated water or fluids, gases, or substances may enter and flow back into the potable water piping system or the distribution system of a public water system."

The following cross-connection(s) was/were found during the cross-connection survey. **[Described in detail the cross-connection(s) found and the exact location].**

These cross-connections are in violation of 310 CMR 22.22 and must be eliminated or properly protected by **[Date].**

You are required to submit a plumbing plan or design data sheet detailing the correction for each of the cross connection found. This information must be submitted to **[PWS Name]** for review and approval.

Please note the **[City/Town]** Cross-Connection Control Program recommends the elimination of the cross connection wherever possible. In many cases, re-piping some portion of your facility may eliminate or reduce the number of backflow preventers needed which could result in significant cost savings to you and additional protection of the water supply for all consumers of this system. We encourage you to discuss this option with your plumber.

In situations of economic hardship, time extension may be granted. In order for an extension to be considered, a request must be made to the **[City/Town]** Cross-Connection Control Program in writing, indicating the reasons for the extension and the proposed schedule for elimination or protection of the cross-connection. This must be submitted with the plumbing plan or design data sheet according to the previously mentioned time frame.

The **[PWS Name]**, does not, under any circumstances, recommend or endorse any person, agent, company, contractor, etc., to engage in the correction of the violations(s) contained within this violation notification. However, this violation notification is considered to be a public record and may be obtained by any interested parties under the guidelines set forth in the Massachusetts Public Records Law.

If further information is necessary, please contact the **[City/Town]** Cross Connection Control Program at (____) ____-_____ from Monday through Friday between the hours of **[xx:xxam and yy:yypm]**. Please be advised, if you feel that any or all of the above mentioned violations are incorrect, please submit, a written statement listing the violations(s) that you feel are in error and your facility will be re-evaluated. In addition, the **[City/Town]** does have a formal appeal process. For more information, please contact Mr./Ms. at (____) ____-_____.

Thank you for your cooperation in protecting **[City/Town]** drinking water.

Sincerely,

Cross Connection Inspector

Attachment

cc: Anytown Plumbing Inspector
Anytown Building Inspector
Anytown Board of Health
Anytown Fire Marshall

IV.3. Backflow Incidents - Case Histories in Massachusetts

Listed below are some of the more dramatic backflow incidents that have occurred in the Commonwealth.

1. Chelmsford - Car Wash - 1985

Car wash process water backflowed into the city water distribution mains. A recirculating water system was used at the car wash and when a city water make-up valve was left open, the wash water entered the potable water supply through an unprotected cross connection (process system pressure exceeded city water pressure).

2. Boston - Condominium Complex - 1985

Chemically treated water from a cooling tower backflowed into the potable water system through an unprotected city water makeup line. Initial samples indicated 125 ppm hexavalent chromium in the potable water system. Six-hundred plus residents consumed bottled water for three days until appropriate devices were installed and further sampling indicated water was safe for domestic use.

3. Boston - Hospital - 1985

An estimated 500-1000 gallons of water treated with ethylene glycol and hydrazine backflowed into the domestic water system and water mains in the street. The treated water backflowed through a temporary hose connection after repairs were made to the chilled water system. Hydrants on the system and taps in the building were flushed until lab tests confirmed contamination was eliminated.

4. North Andover - Industrial Plant - 1982

Chilled water treated with hexavalent chromium backflowed into the domestic water system. The pump in the chilled water system generated a pressure which exceeded that of the city water supply and backflowed through an unprotected cross connection into the drinking water distribution system. Maintenance crews working during the plant shut down were able to eliminate the cross connection and thoroughly flush the potable water system thereby preventing a serious health hazard from occurring.

5. Boston - Regional High School 1980

Chromates pumped into the potable water system from a boiler-fortunately, the custodian noted yellow colored water in drinking fountain. School was closed for five days to flush and chlorinate water lines and install backflow preventer.

6. Chelmsford - Small Commercial Building 1975

Potable water line was contaminated with ethylene glycol due to an unprotected cross connection between the solar heating system and the potable water line. Complaint of distasteful water was registered by employees of the company.

7. Boston - Dock Connections - 1974

An unprotected cross connection between dockside potable water line and a salt water line aboard a ship caused Boston Harbor water to be pumped into the city water line. (Normal city water pressure 60-75 PSI - Salt-water Pump Press 70-80 PSI).

8. Boston - Auditorium - 1974

Potable water system in the auditorium was contaminated with chromates due to an unprotected cross connection between the recirculated water system for air conditioning and the potable water system. This condition was noticed at the luncheon of the American Water Works Association which was holding its annual meeting at the auditorium. After a thorough survey of the building, a total of 9 cross connections were identified and protected with backflow preventers.

9. Woburn - Greenhouse - 1973

Due to cross connection between a pressurized chemical application system and a potable water line and a mechanical failure of a single unapproved single check valve, an undetermined volume of a fungicide was injected into the city water distribution system. (City water pressure 60 PSI-Chemical application system 300 PSI).

Numerous complaints were received concerning odorous drinking water from residents in the area.

10. Boston - Office Building - 1972

Yellow water from drinking fountain due to an unprotected cross connection between potable water line and recirculated water line from cooling tower (sodium chromate and caustic soda added to water in cooling tower).

Several employees of U.S. Geological Survey who consumed some water from the fifth and seventh floor drinking fountains became ill.

11. Worcester - Athletic Facility - 1969

A cross connection at a practice field caused an outbreak of infectious hepatitis among members of a college football team (approximately, 90 cases including players, trainers and coaching staff).

The water to the field which had an equipment house came from a main through a meter pit. On the way to a faucet in the equipment house- a faucet used to fill water cups used by the team - the water line ran to a series of irrigation outlets located in pits below grade where they could be submerged by the flooding of the boxes.

The demand of water to fight a fire at a lower elevation caused the development of negative pressure at the field level which caused the contaminated water in the pits to enter the potable water line through a leaking connection or an open gate valve.

Subsequent tests made by flooding the boxes with dyed water and opening fire hydrants in the area below the practice field showed water could flow from the pits to the faucet in the field house.

12. Industrial Plant - 1969

River water was pumped into the potable water system at the above company through an unprotected cross connection. (River water pressure 88 to 100 PSI town Pressure 60-75 PSI.)

There were seven cases of hepatitis and approximately 130 cases of Gastrointestinal upsets.