State of Ohio Class A Drinking Water Operator Certification Program

Session Three: Supplemental Materials

This course includes content developed by the Ohio Environmental Protection Agency, the Pennsylvania Department of Environmental Protection, the Indiana Department of Environmental Management, the California State University at Sacramento, and 360water, Inc.

Project funded by the USEPA.

CONTENTS

1. Minimum Pressures

The water system should be designed to operate at minimum of 20 pounds per square inch under normal conditions. This pressure is usually enough to supply an adequate quantity of water to the consumer to operate plumbing fixtures. The higher pressures in the distribution system will minimize the possibility of backflow thereby reducing the possibility of contamination.

OhioEPA

The Ohio Administrative Code describes the rules for minimum pressures.

3745-83-01 Operational requirements.

A. Except as otherwise noted, the definitions in rule 3745-81-01 of the Administrative Code shall apply to this chapter.

B. Disinfection.

   1. For purposes of this rule of the Administrative Code, "major noncommunity public water system" means a noncommunity public water system designated by the director for which he deems it advisable, because of the relatively large number of people who drink or may drink water from the system, that the water be disinfected in the same manner as for a community public water system.

   2. Unless exempted under other provisions of this rule, each community public water system and each major noncommunity public water system shall maintain a minimum chlorine residual of at least two-tenths milligram per liter free chlorine, or one milligram per liter combined chlorine measured at representative points throughout the distribution system. The director may by order require higher residuals as necessary to compensate for pH, temperature, or other characteristics of the delivered water. Chlorine concentrations shall be analyzed in accordance with paragraph (C) of rule 3745-81-27 of the Administrative Code.

   3. A system is exempt from paragraph (B)(2) of this rule if it meets all the following conditions:

      a. The system obtains all its water from a ground water source which has, in the judgment of the director, been properly developed, constructed, and adequately protected; or from a system to which paragraph (B)(2) of this rule applies;

      b. The distribution system serving the water system, in the judgment of the director, has been properly constructed and maintained and is protected by an effective cross-connection program;

      c. The system, in the judgment of the director, has a satisfactory history of bacteriological monitoring indicating no contamination;

      d. The director has certified in writing that conditions of paragraphs (B)(3)(a), (B)(3)(b), and (B)(3)(c) of this rule have been met.

4. A system is exempt from paragraph (B)(2) of this rule if, with written approval of the director, it uses chlorine dioxide as a primary or supplementary disinfectant in accordance with the terms of the approval.
5. Each water system subject to paragraph (B)(2) of this rule and not exempt under paragraph (B)(3) of this rule shall install and place in operation equipment capable of meeting disinfection requirements of this rule.
6. Notwithstanding the MRDL for total residual chlorine in paragraph (C) of rule 3745-81-10 of the Administrative Code, at times of actual or threatened outbreak of waterborne disease, each system subject to paragraph (B)(2) of this rule that may be affected by such outbreak shall maintain a minimum chlorine residual of at least one milligram per liter free chlorine, or six milligrams per liter combined chlorine measured at representative points throughout the distribution system, despite possible resulting tastes or odors in the delivered water.
7. Finished water storage facilities, as defined in paragraph (E)(1) of this rule, serving community water systems or major non-community water systems shall be adequately disinfected in accordance with "American Water Works Association Standard C652-02 Disinfection of Water-Storage Facilities (2002)" before being placed in service and before being returned to service after repairs. A reservoir shall be considered adequately disinfected when analyses of at least two consecutive samples taken at twenty-four hour intervals are total coliform-negative. The consecutive samples taken in order to determine compliance with this paragraph shall be analyzed in accordance with paragraph (D) of rule 3745-81-27 of the Administrative Code. The standard sample used shall contain one hundred milliliters.
8. All new, cleaned, or repaired water mains serving community water systems or major noncommunity water systems shall be disinfected in accordance with "American Water Works Association Standard C651-99 Disinfecting Water Mains (1999)." Samples taken in order to determine compliance with this paragraph shall each contain one hundred milliliters and shall be analyzed in accordance with paragraph (D) of rule 3745-8127 of the Administrative Code.
    a. A new or cleaned water main shall be considered adequately disinfected when analyses of at least two consecutive samples taken at twenty-four hour intervals are total coliform-negative.
    b. Repaired water mains shall be considered adequately disinfected when analyses of samples taken in accordance with "American Water Works Association Standard C651-99 Disinfecting Water Mains (1999), Section 4.7.5" are total coliform-negative.

C. Approval of chemicals. All chemicals, substances, and materials added to or brought in contact with water in or intended to be used in a public water system or used for the purpose of treating, conditioning, altering, or modifying the characteristics of such water shall be shown by either the manufacturer, distributor, or purveyor to be non-toxic and harmless to humans when used in accordance with the formulation and concentration as specified by the manufacturer, and shall conform with the "American National Standards Institute/National Sanitation Foundation" (ANSI/NSF) standard 60 Drinking Water Treatment Chemicals - Health Effects (2001 and previous), or standard 61 Drinking Water System Components - Health Effects (2003 and previous). Any organization certified by the "American National Standards Institute" may certify in writing that a product conforms with these standards.

D. Minimum pressure. Community water systems shall maintain a minimum pressure of twenty pounds per square inch gage at ground level at all points in the distribution system under all conditions of flow other than conditions caused by line breaks, extreme fire flows, or other extraordinary circumstances.

E. Finished water storage facilities

1. "Finished water storage facility" means a tank, reservoir, or other facility used to store water that will undergo no further treatment except residual disinfection.
2. A public water system shall provide a cover on all finished storage facilities so they are not open to the atmosphere.

F. Reports.

1. Community water systems.
   a. In addition to any other reporting requirement of Chapter 3745-81 of the Administrative Code, the operator of a community water system shall prepare an operation report for each month of operation on forms provided by the director. The director may require that the report include the following:
      1) General operation data;
      2) A summary of samples analyzed, including distribution system sampling and chlorine residual sampling;
      3) Information on daily water treatment and system pumpage;
      4) Information on chemical application;
      5) Analysis of general parameters relating to the quality of the treated drinking water;
      6) Source water levels;
      7) Changes in personnel in responsible charge;
      8) Such other information as may be necessary or desirable for the director to carry out his duties under Chapter 6109 of the Revised Code.
   b. The operation report shall be submitted to the district office with jurisdiction no later than the tenth of the month following the month for which the report was prepared.
   c. The operator shall report significant interruptions of service or of chlorination immediately by telephone to the district office with jurisdiction.
2. Noncommunity water systems.
   a. The operator of a public water system other than a community public water system shall prepare and file an operation report at a frequency determined in writing by the director. The reports shall be on forms provided by the director and shall contain such information as may be necessary for the director to carry out his duties under Chapter 6109 of the Revised Code.
   a. The operation report shall be submitted to the district office with jurisdiction no later than the tenth of the month following the end of the period for which the report was prepared.

[Comment: This rule incorporates the American water works association standards C651-99 and C652-02 by reference. Copies may be obtained from the "AWWA Bookstore, 6666 West Quincy Avenue, Denver, CO, 80235, 1-800-9267337, www.awwa.org." These standards are available for review at "Ohio EPA, Lazarus Government Center, 122 South Front Street, Columbus, OH, 43215-3425."]

[Comment: This rule incorporates the ANSI/NSF standards 60 and 61 by reference. Copies may be obtained from "NSF International, 789 North Dixboro Road, P.O. Box 130140, Ann Arbor, MI, 48113-0140, (734)769-8010, www.nsf.org." These standards are available for review at "Ohio EPA, Lazarus Government Center, 122 South Front Street, Columbus, OH, 43215-3425."]

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Promulgated Under: 119.03
Statutory Authority: RC Section 6109.01, 6109.03, 6109.04 Rule
Amplifies: RC Section 6109.01, 6109.03, 6109.04
Prior Effective Dates: 11/26/80, 09/13/93, 01/01/99, 04/21/01

2. Security

Public water system security is a major concern for all communities. The USEPA has published guidelines for security for small community systems. Briefly, well heads should be locked and all chemicals should be stored in locked facilities. Small community budget constraints may affect the security procedures employed by drinking water operators.

Selections in the Appendix are taken from the USEPA publication, Drinking Water Security for Small Systems Serving 3,300 or Fewer Persons, from the Office of Water, EPA 817-R-05-001. The complete document can be found at www.epa.gov/safewater.

3. Pump Terms and Definitions

Flow—the volume of water per unit of time that passes through a pump. Typical units of measure for flow include gallons per minute (gpm), cubic feet per second (cfs), and gallons per day (gpd).

Pump Head—the amount of energy input to the water by the pump. Pump head is typically measured in units of feet of water (ft).

Water Horsepower—the amount of power supplied to the water which is needed to pump water to a certain elevation. Water Horsepower is typically measured in units of horsepower (hp).

Brake Horsepower—the amount of power that must be applied to the pump shaft to operate the pump. This is higher than the water horsepower since there are inefficiencies in the pump and motor, where energy is lost to friction and heat. Brake Horsepower is typically measured in units of horsepower (hp).

Pump Efficiency—the percentage of the power input to the shaft, that is actually transferred to the water.

Pumps provide lift to move water from the plant to elevated storage areas.

The majority of the line pressure is not provided by pumps but by storage elevation of the water which creates “head” that provides the pressure. However, many systems use booster pumps to provide additional pressure in areas that need it.

Components

The main components of a Water Distribution System include:

- Pumps
- Storage facilities
- Transmission mains
- Valves and hydrants
- Meters

Storage Facilities can consist of the following:

- Clear wells
- Stand pipes
- Elevated storage tanks.
- Hydro-pneumatic tanks.

Clear wells are large concrete basins for storing treated water at the treatment facility or in the distribution system. A clear well allows the treatment plant to operate at a constant rate, building up reserves during low-use hours and maintaining supply during peak-use hours. It also can allow for additional contact time with disinfectants.

Elevated Storage Tanks have supporting structures to elevate the tank to provide additional head (pressure). They use gravity to pressurize water through the distribution system.

Storage tanks are typically filled in off-peak hours and monitored to maintain sufficient water pressure during high-use periods. An example of a high use period is early morning and mid-evening.

There are different ways that transmission main systems can be designed.

- Branching systems have dead-end lines that can cause taste and odor problems due to stale water in the ends of the lines.

- Branching systems must be flushed out periodically. This is usually completed by releasing water in a systematic way from fire hydrants

- Loop or grid systems eliminate dead ends and provide more water in high-demand situations, such as fire fighting.

Different materials can be used for transmission mains. The following are the most common:

Ductile iron:

- Stronger, more ductile (flexible) and lighter than cast iron
- Often coated with cement mortar to reduce internal corrosion

Plastic (polyvinylchloride or PVC):

- Low initial cost
- Lightweight
- Resistant to corrosion
- Low resistance to flow
- More susceptible to crushing
- Cannot be thawed electrically

Meters are placed throughout the distribution system to measure the flow to main supply lines, pumping stations, connections to other utility systems and individual users.

Meters are used for billing purposes and to identify areas of water loss.

Metered billing will promote lower customer use and encourage conservation.

4. Valves

Purpose of Valves

- The primary purpose of valves is to allow for isolation of mains or sections of main within the network.

- Another important function of valves is to control flow or pressure.

Valve Applications

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- **Isolation Valves** are used to isolate mains or sections of mains.
    - Isolation may be necessary when repairing main breaks or leaks or performing other distribution network maintenance activities.
    - The most commonly used isolation valve is the gate valve.

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Gate Valve

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5. Distribution Networks

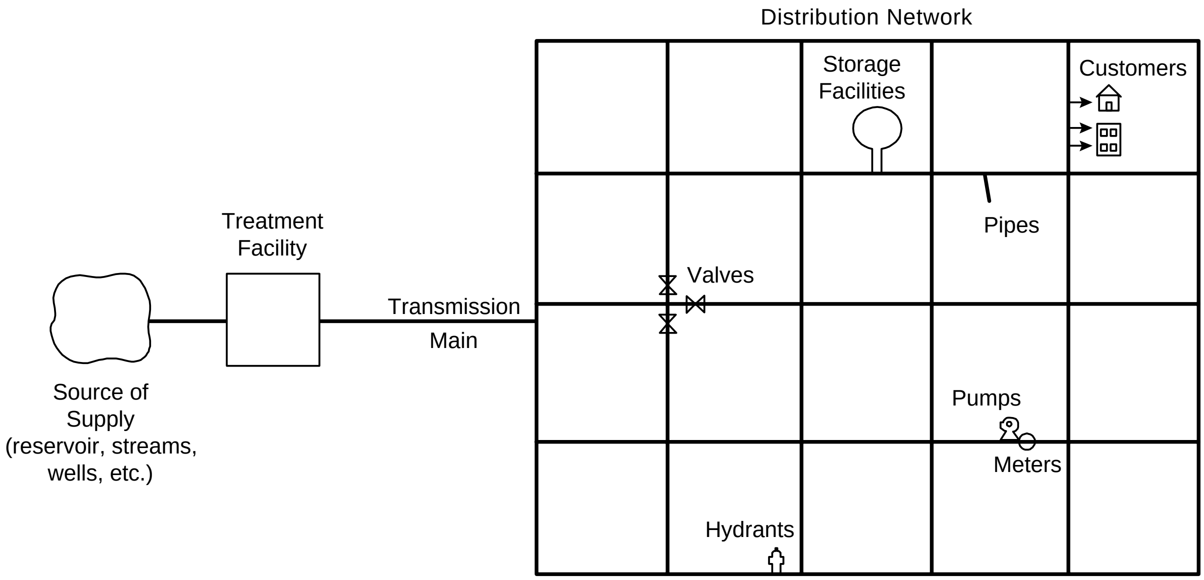
Purposes of Distribution Networks

- The primary purpose of a distribution network is to deliver adequate volumes of safe drinking water to system customers at adequate pressures.

- Another important purpose of a distribution network is to provide adequate fire flows to areas of the system.

Components of Distribution Networks

- Pipes
- Storage Facilities
- Pumps
- Valves
- Hydrants
- Meters



Distribution System Layout

6. Ohio Regulations

The Ohio Administrative Code, at section 3745-85-01, described the requirements for a drinking water supply emergency contingency plan.

Below is the text of contingency plan requirements.

3745-85-01 Contingency plans.

A. Except as otherwise noted, the definitions in rule 3745-81-01 of the Administrative Code shall apply to this chapter.

B. Contingency plan required. Each community water system shall prepare and maintain a written contingency plan for providing safe drinking water to its service area under emergency conditions.

C. Location of copies.

   1. One copy of the contingency plan shall be kept at the water treatment plant, if there is a plant, and another shall be kept in the water system administrator's office.

   2. Public water systems serving a population of more than two hundred fifty shall keep three additional copies of the plan at various accessible, secure locations in the service area.

   3. A copy of the contingency plan shall be available for inspection by representatives of the director.

   4. A copy of the contingency plan for community water systems shall be made available to the county emergency management agency (EMA) upon its request.

D. Contents of contingency plan.

   The contingency plan shall contain:

   1. A map of the distribution system, detailed locations for each valve in the system, including references that will aid in location of valves, and a map of the well field and surface water intakes as applicable.

   2. A statement of amounts budgeted for emergency use, along with a statement showing who can authorize expenditures for such purpose, and under what conditions such authorization and expenditure can occur.

   3. A determination of not less than ten of the most likely emergencies that will affect the water system and a description of the procedures to be followed and actions necessary to

provide service during the emergencies. For systems serving fewer than one thousand five hundred people, the following emergency circumstances shall be included in such outline.

(a) Short term power failure (time of interruption less than two hours);

(b) Extended power failure (two hours or more);

(c) Pump or motor failure;

(d) Loss of water from a well or other water source;

(e) Major water main break;

(f) Unplanned absence of operator; and

(g) Contamination of source water including, but not limited to, releases of oil and hazardous substances.

4. A description of the method that will be used to obtain and transport water from an alternate source should such procedure become necessary (including connecting to another water system), and a description of at least three possible alternate sources of water and the method of disinfection that will be used for each source.

5. A list of water users having critical needs for a continuous supply of water.

6. The methods of notification of users that an emergency exists.

7. If depressurization of the water system has occurred, the procedure that will be used to return the system to normal service.

8. Twenty-four hour telephone numbers for:

   (a) The Ohio environmental protection agency, division of drinking and ground water;

   (b) Police;

   (c) Fire;

   (d) The county EMA director;

   (e) All water supply personnel;

   (f) Municipal administrative personnel;

   (g) Contractors for line breaks, "first call" and "second call";

(h) Electric power supplier;

(i) Electricians, "first call" and "second call";

(j) Well drilling and pump service contractors, "first call" and "second call";

(k) Plant mechanical contractors, "first call" and "second call";

(l) All suppliers of equipment and chemicals normally used;

(m) Hospital, emergency squad, medical assistance; and

(n) Critical water users who have requested notification.

E. Revision required.

1. The contingency plan required by this chapter of the administrative code shall be revised and updated as necessary, but at least annually;

2. Copies of the revised pages of the plan shall be promptly distributed to holders of the plan, as described in paragraph (C) of this rule.

3. Community water systems that have identified hazardous chemical contamination as one of their most likely emergencies under paragraph (D) (3) of this rule shall consult with the county EMA regarding participation in a hazardous spill exercise.

Replaces: Part of 3745-85-01, former 3745-85-02, former 3745-85-03, Part of 3745-85-04, former 3745-85-05

Effective: April 21, 2001

RC 119.032 review dates: 03/14/2006 and 03/14/2011

Promulgated under: RC Chapter 119
Rule authorized by: RC Section 6109.01, 6109.03, 6109.04 Rule amplifies: RC Section 6109.01, 6109.03, 6109.04 Prior effective dates: 11/26/80

7. Sample Contingency Planned Approved by OEPA

Below is a sample Contingency Plan approved by the OEPA for use by a mobile home park. This sample plan will show how this small community followed the requirements under OAC 3745-85-01.

SAMPLE PLAN

DRINKING WATER SUPPLY EMERGENCY CONTINGENCY PLAN
MOBILE HOME PARK
FRANKLIN COUNTY, OHIO
PWS NUMBER XXXXXXX

REVISED SEPTEMBER, 2005

Copies of this plan are at the following locations:

1. WATER TREATMENT PLANT
2. MIKE SMITH (HOME)
3. JOE JONES (HOME)

The following persons are thoroughly familiar with the emergency plan and are authorized to implement all or part of the plan as necessary:

1. JOE JONES	CELL	________	HOME	________
2. MIKE SMITH		________		________

Contingency plans must be updated at least yearly and a copy of the revised plan submitted to the:

Ohio EPA, Central District Office
3232 Alum Creek Drive
Columbus, OH 43207-3417

MOBILE HOME PARK FRANKLIN COUNTY

DRINKING WATER SUPPLY
EMERGENCY CONTINGENCY PLAN
(PWS ID NUMBER xxxxxxxx)

REVISED SEPTEMBER, 2005

[Site specific telephone numbers have been omitted]

THE OHIO ENVIRONMENTAL PROTECTION AGENCY		
Division of Public Drinking Water Central Office		614-644-3020
Central District Office	1-800-282-9378	614-728-3776

FIRE DEPARTMENT AND AMBULANCE SERVICES
Hamilton Township 911

POLICE DEPATTMENT
Columbus Police Department 911
Franklin County Sheriff
Ohio State Highway Patrol

DISASTER SERVICES
Emergency Management Agency of Franklin Co.

WATER COMPANY PERSONNEL
Joe Jones, Water Plant Operator
Mike Smith

MOBILE HOME PARK OWNER
Pioneer, OH 43554

CONTRACTORS FOR MAIN BREAKS
First Call - Excavating- Gerard
Second Call - Excavating

ELECTRIC POWER SUPPLIER
The American Electric Power Co.

GAS COMPANY
Columbia Gas

ELECTRICIAN
First Call - Electric
Second Call - Electric
Third Call - Electric

[Site specific telephone numbers have been omitted]

PUMP SERVICES
HD Water Services
Dublin Pump Company

PLANT MECHANICAL CONTRACTORS
First Call- Kel-Par Company
Second Call- J.R. Mason Inc

CHEMICAL SUPPLIERS
KOK Chemical Products Inc.
Bonded Chemical Co.

DISTRIBUTIION SYSTEM SUPPLIES
National Waterworks Co.,Inc.
Midwest Pipe and Supply

WATER HAULERS
H20 on the Go

WATER SOURCES
City of Columbus

LEAK DETECTION SERVICES
Underground Utility Services Gene Rigby
Ohio Leak Locators

LOCAL RADIO STATIONS

WTVN 610 Newsroom	614-481-6397
WBNS AM/FM	614-460-3850

LOCAL TV STATIONS

WBNS Columbus OH	Channel 10	614-460-6950
WTVN Columbus OH	Channel 6	614-461-6666
WCMH Columbus OH	Channel 4	614-263-1512

LOCAL NEWSPAPER

Columbus Dispatch	Newsroom	614-461-5000

APPENDIX B

CRITICAL USERS LIST

WATER USERS HAVING A NEED FOR CONTINUOUS WATER SUPPLY

This system has only residential customers with no one being identified as a critical user having a need for a continuous supply of water.

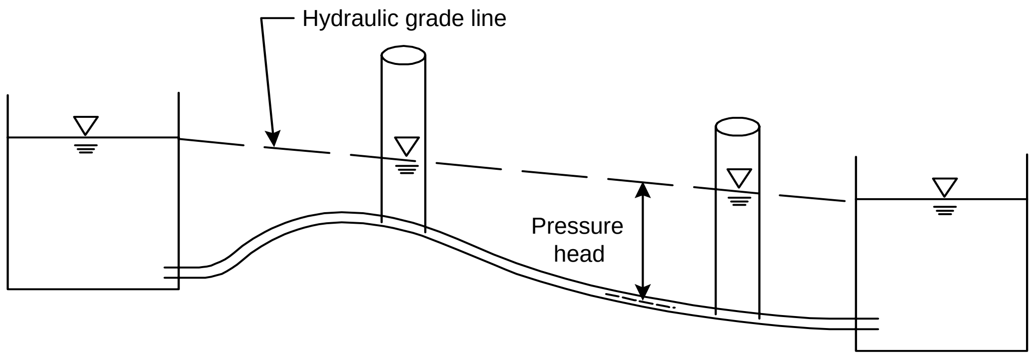
APPENDIX I

SUPPLIERS LIST

National Waterworks	Distribution Repair Parts
KOK Products	Chlorine
Cargill Salt	Softener Salt
Artesian of Pioneer	

PARTS LIST

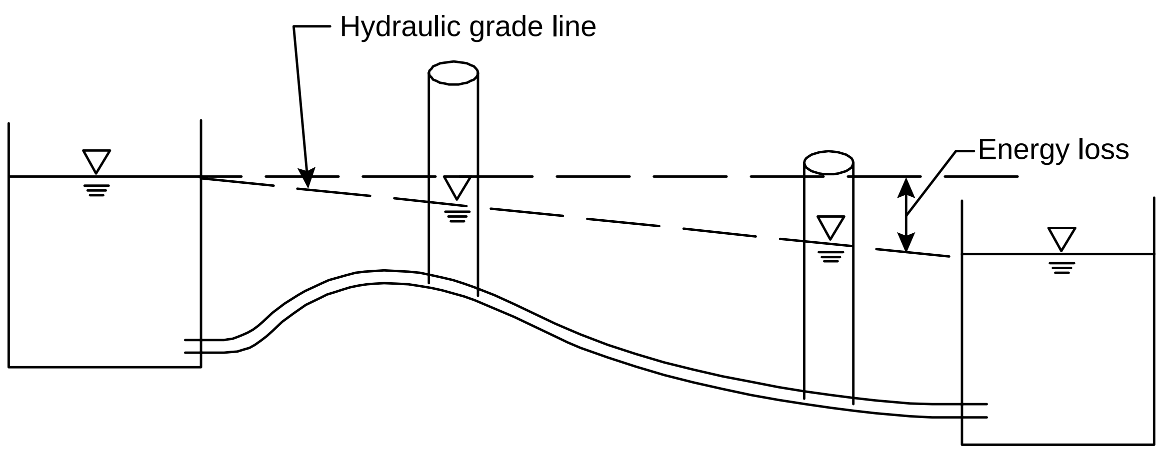
No distribution parts are kept on hand at the treatment plant. Parts are purchased locally as needed, when needed, primarily from National Waterworks.



Hydraulic Grade Line

8. Energy Loss

The difference between the Hydraulic grade line at two different points, one up stream the other downstream, equals energy loss. Energy Loss, or headloss, can have a negative impact on system pressures and flows.



Energy Loss

Friction Losses

- As water travels through a pipeline, the energy or head of the water is reduced due to friction created by the roughness of the pipe walls. This loss in head will reduce the available pressure in the pipeline. Friction loss is represented by the letter C in hydraulic equations. The lower C values represent smoother inside surfaces of the pipe.

- The pipeline roughness varies based on the age, material, size of the pipeline, and the quality of the water that flows through the pipeline.

- A general rule of thumb to estimate headloss is that it is approximately equal to the flow in a pipeline, squared. Therefore, if the flow in a pipeline is doubled, the headloss will increase by a factor of about 4.

Minor Losses

- Headloss caused by rapid changes in velocity due to:
  - Changes in pipe diameter, shape, or direction, or
  - Meters and valves.

9. Backflow Prevention

Backflow prevention is put in place to prevent an outside source of potential contamination from being introduced into the distribution system. An example of a typical cross connection may be an interconnection between your distribution system and an untreated well which could cause contamination in your system.

OhioEPA

The Ohio Administrative Code describes the rules for backflow prevention.

3745-95-04 Where protection is required.

A. An approved backflow prevention device shall be installed on each service line to a consumer's water system serving premises, where in the judgment of the supplier of water or the director, a pollution system, health or severe health hazard to the public water system exists.

B. An approved backflow prevention device shall be installed on each service line to a consumer's water system serving premises where any of the following conditions exist:

   1. Premises having an auxiliary water system on the premises, unless such auxiliary system is accepted as an additional source by the supplier of water and the source is approved by the director;

2. Premises on which any substance is handled in such a fashion as to create an actual or potential hazard to a public water system. This shall include premises having sources or systems containing process fluids;
3. Premises having internal cross-connections that, in the judgment of the supplier of water, are not correctable, or intricate plumbing arrangements which make it impracticable to determine whether or not cross-connections exist;
4. Premises where, because of security requirements or other prohibitions or restrictions, it is impossible or impractical to make a complete cross-connection survey;
5. Premises having a repeated history of cross-connections being established or re-established; or
6. Others specified by the director.

C. The following requirements apply to premises that have an auxiliary water system on the real property that is owned or under control of the consumer and adjacent to the premises.

1. A physical separation shall be maintained between the public water system or a consumer's water system and the auxiliary water system as required by paragraph (B) of rule 3745-95-02 of the Administrative Code; and
2. An approved backflow prevention device shall be installed on each service connection serving the consumer's water system, unless the supplier of water does all of the following:
    a. Determines, on a case-by-case basis, that the installation of an approved backflow prevention device on a service connection is not required in consideration of factors including, but not limited to, the past history of cross connections being established or re-established on the premises, the ease or difficulty of connecting the auxiliary water system with the public water system on the premises, the presence or absence of contaminants on the property or other risk factors;
    b. Requires the consumer to sign an agreement which specifies the penalties, including those set forth in rule 3745-95-08 of the Administrative Code, for creating a connection between the public water system and the auxiliary water system;
    c. Conducts or causes to be conducted an inspection at least every twelve months to certify that no connection or means of connection has been created between the public water system and the auxiliary water system;
    d. Maintains an inventory of each consumer's premises where an auxiliary water system is on or available to the premises, or on the real property adjacent to the premises; and
    e. Develops and implements an education program to inform all consumers served by the public water system about the dangers of cross-connections and how to eliminate cross-connections.

D. An approved backflow prevention device shall be installed on each service line to a consumer's water system serving, but not necessarily limited to, the following types of facilities unless the director determines that no severe health, health, system or pollutional hazard to the public water system exists:

1. Hospitals, mortuaries, clinics, nursing homes;
2. Laboratories;
3. Piers, docks, waterfront facilities;

4. Sewage treatment plants, sewage pumping stations, or storm water pumping stations;
5. Food or beverage processing plants;
6. Chemical plants;
7. Metal plating industries;
8. Petroleum processing or storage plants;
9. Radioactive material processing plants or nuclear reactors;
10. Car washes; and
11. Others specified by the director.

E. An approved backflow prevention device shall be installed at any point of connection that is approved in accordance with paragraph (B) of rule 3745-95-02 of the Administrative Code between a public water system or a consumer's water system and an auxiliary water system, unless such auxiliary system is accepted as an additional source by the supplier of water and the source is approved by the director.

Effective: 05/01/2003
R.C. 119.032 review dates: 12/06/2002 and 05/01/2008
Promulgated Under: 119.03
Statutory Authority: 6109.04
Rule Amplifies: 6109.01, 6109.03, 6109.04, 6109.13 Prior Effective Dates: 7/1/72, 11/26/80

Definitions

Backflow

Backflow is a flow condition, induced by a differential pressure, which causes the flow of water, or mixtures of water and other substances, into the distribution pipes of a potable water supply system from a source other than its intended source.

- Backflow can result from backsiphonage or backpressure. Backsiphonage and backpressure are discussed in more detail later in this unit.

Cross-Connection

A **cross-connection** is an arrangement allowing either a direct or indirect connection through which backflow, including backsiphonage, can occur between a system containing a source or potential source of contamination and the drinking water in a public water system. Simply put, a cross-connection links a source of pollution with a potable water supply.

- Cross-connections allow treated water to be removed from any public water system, used for any purpose or routed through any device or pipes outside the public water system, and returned to the public water system.
- Cross-connections do not include connections to devices totally within the control of one or more public water systems and connections between water mains.
- There are two basic types of cross-connections: direct and indirect.
  - ➢ A direct cross-connection is subject to backflow by backpressure. A potable water makeup water line that supplies a boiler is one example of a direct cross-connection.

Direct Cross-Connection

- An indirect cross-connection is not subject to backflow by backpressure. Consequently, backflow can only occur due to backsiphonage. An over- the-rim type inlet, used to fill an open vessel, is an example of an indirect cross-connection.

Common Cross-Connections

Cross-connections can be difficult to identify. Many common situations that appear harmless can be actual or potential cross-connections. Because of the dynamic nature of water systems, with constant expansions and modifications occurring, the ability to identify cross-connections is very important. A connection between a drinking water system and a non-potable water system, such as a fire protection system or process water system is an obvious cross-connection, but others are not so obvious. Cross-connections can occur in complex piping arrangements within buildings and equipment or at a simple connection like a wash sink with a hose attached.

Backsiphonage

Backsiphonage is the backflow of water (or a mixture of water and other substances) from a plumbing fixture or other customer source, into a public water supply system due to a temporary negative or sub-atmospheric pressure within the public water supply system.

- Backsiphonage occurs when atmospheric pressure exerted on a pollutant forces it toward a potable water system that is under vacuum.

- The water system main does not have to be under a true vacuum (i.e., zero psi absolute pressure or –14.7 psi gage pressure) for backsiphonage to occur. Only a negative difference in pressure and a full pipe or tube is required to produce backsiphonage.

Potential Causes of Backsiphonage

Negative or sub-atmospheric pressures in the water system, which can lead to backsiphonage, are often caused by high demands or high flow rates. System headloss caused by friction losses and minor losses, as well as demand for flow beyond the supply capacity, can result in negative or sub-atmospheric pressure in the system. The following are several common occurrences that can result in negative or sub-atmospheric pressure and can potentially cause backsiphonage:

- Hydrant Operation

  Flowing hydrants for fire fighting, hydraulic testing, system flushing and other reasons can result in high flow rates and low systems pressures.

- Main Break

  Main breaks can result in the discharge of large volumes of water at very high flow rates, causing low system pressures.

- High Demands
  High demands can result in negative or sub-atmospheric pressures when the hydraulic capacity of the system is exceeded, causing low pressure due to friction and minor losses. Also, when water demands exceed supply capacity, low pressure can develop

- Booster Pumps

  Operation of booster pumps without a low pressure cutoff switch can result in negative pressures on the suction side of the pumps, causing a potential for backsiphonage.

Backpressure

Backpressure is the backflow of water, or a mixture of water and other substances, from a plumbing fixture or other customer source, into a public water supply system due to a pressure in the fixture or customer source that exceeds the system pressure.

Backpressure can occur for two reasons:

- An increase in pressure in the customer system.

- A decrease in pressure, to below the customer system pressure, in the public water system.

Potential Causes of Backpressure

- Pumps, boilers, and air/steam pressure in the customer system increase pressure and can cause backflow to the water supply system.

- If pressure decreases in the water supply system, the weight of water in high-rise building piping can provide enough pressure to cause backflow.

Purpose of Backflow Prevention

To prevent potential contaminants from being introduced to the distribution network by the reverse flow of water from a source of questionable water quality.

Types of Backflow Prevention Devices

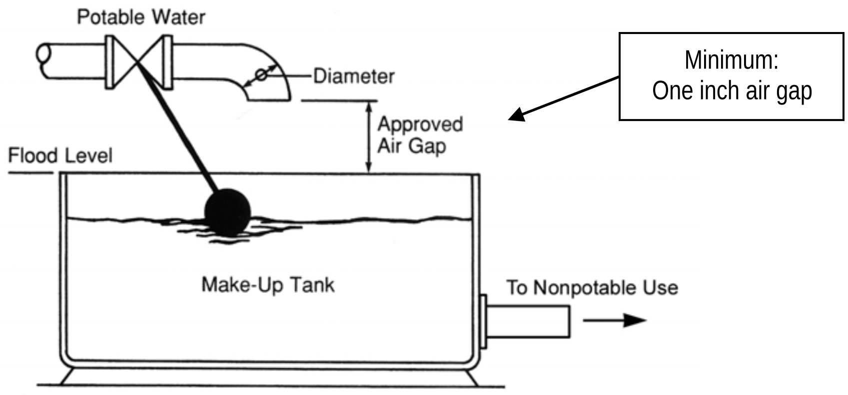
- A physical air gap or separation between the backflow source and the distribution network.

- A reduced pressure device (double-check valve with relief valve as added redundancy).

- A double-check valve assembly.

Types of Backflow Prevention Devices

Air Gap

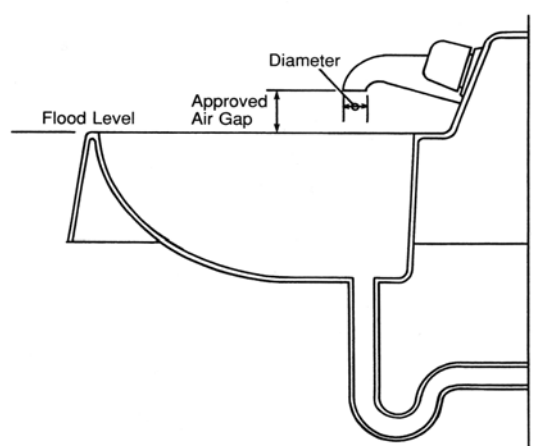


Schematic of Air Gap on a Tank

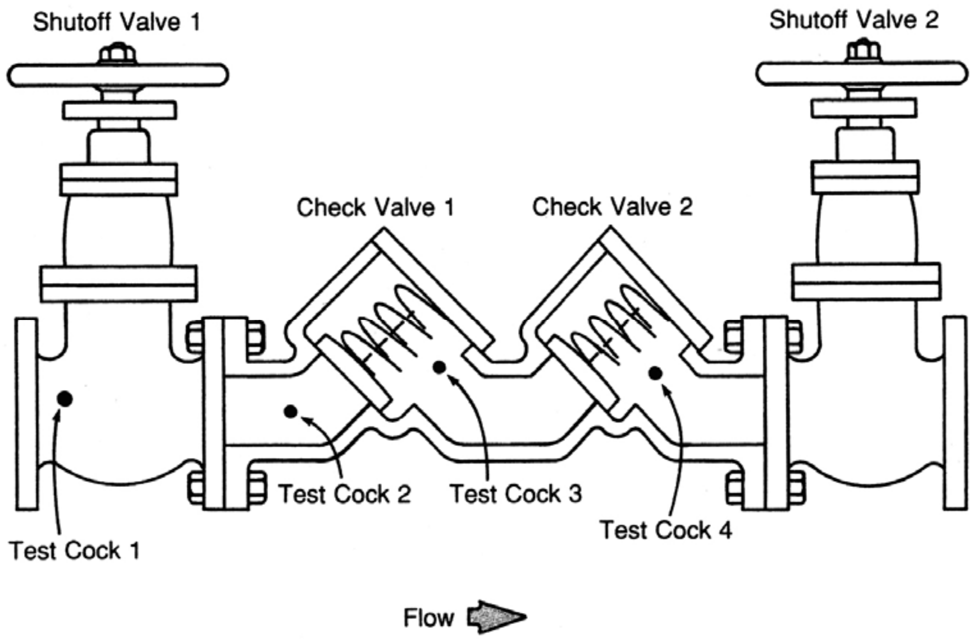
Operation of an Air Gap

An **air gap** provides a physical separation between the end of a potable water supply line, faucet, plumbing fixture or other device, and the flood level rim of an open or non-pressurized receiving vessel. A minimum of one inch separation is required.

- The air gap is a non-mechanical backflow preventer consisting of an unobstructed vertical distance through free atmosphere between the lowest point of a water supply outlet and the flood level of the fixture being discharged to.
- See diagram on right for air gap on a lavatory.



Double Check Valve Assembly (DCVA)



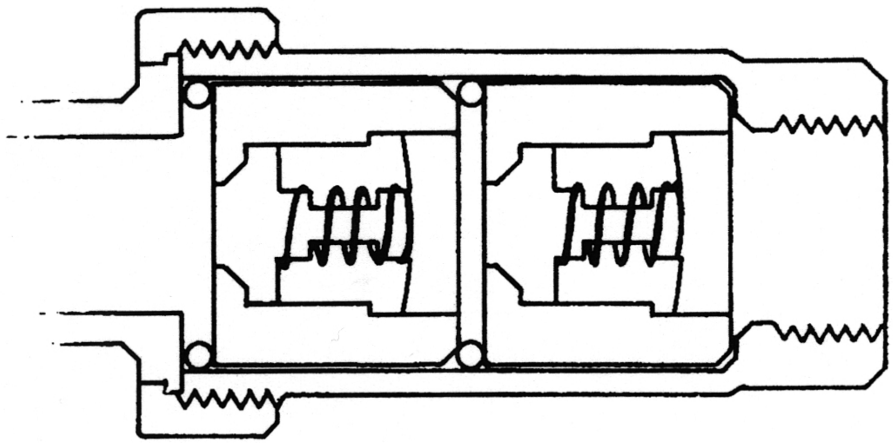
Schematic of Double Check Valve Assembly

Operation of a Double Check Valve Assembly

The **Double Check Valve Assembly** (DCVA) consists of two ***independently acting***, soft seated, spring-loaded check valves in series within one body, with two tightly closing shutoff valves and four test cocks.

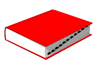
- During normal operation, the check valves open and permit flow from the potable water system to the customer. If backflow conditions occur due to either backpressure or backsiphonage, the check valves will close tightly and prevent potential pollution of the potable water system.

Residential Dual Check Valve (RDCV)



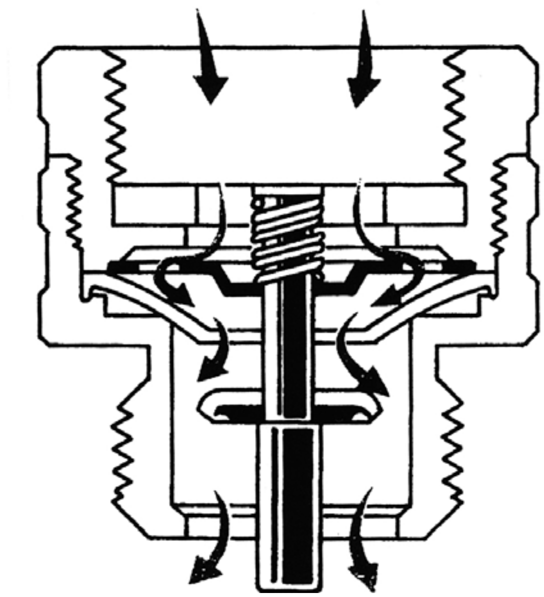
Residential Dual Check Valve Schematic [9]

Operation of a Residential Dual Check Valve



The **Residential Dual Check Valve** (RDCV), consists of two spring-loaded, independently acting check valves in a single valve body. The check valves close to prevent backflow by backpressure and/or backsiphonage.

Hose-Bibb Vacuum Breaker (HBVB)



Schematic of Hose-Bibb Vacuum Breaker

Operation of a Hose-Bibb Vacuum Breaker

A Hose-Bibb Vacuum Breaker (HBVB) consists of a spring-loaded check valve that seals against an atmospheric outlet when the supply pressure is turned on. When the supply is turned off, the device vents to the atmosphere, providing protection against backsiphonage.