Introduction to Backflow Prevention

Safe Drinking Water | Backflow | Backflow Prevention

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INSTRUCTOR

Scott Winn

- Senior Director of Training
- International Code Council, Inc.
- Master Plumber
- Plumbing Inspector
- NCCER Authorized Instructor
- ASSE 6010, 6030, 6050, 6060
- dswinn@iccsafe.org

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The goal of this presentation is to help recognize the health impact and critical importance of clean water, and how to protect it using these key principles.

1. Define the key terms and concepts critical to backflow prevention.
2. Outline the hydraulic principles of water flow and control.
3. Prioritize the acceptable methods for preventing backflow.
4. Understand the mechanics of backflow prevention devices.

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Why Does This Matter?

- Is the water from your tap safe to drink?
- How hard is it to keep drinking water safe?
- How serious are the risks of drinking unclean water?
- What could really happen?
- What is backflow?

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Why Does This Matter?

The Clean Water Act & Safe Drinking Water Act: Legislation for Clean Water

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COURSE OUTLINE

- Backflow prevention definitions
- Hydraulic principles
- Acceptable backflow prevention methods
- Mechanics of backflow preventors

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Backflow prevention definitions

Say what?

8

Air Gap

A physical separation between the water supply and the flood-level rim of the receiving vessel (the point at which water would flow over to the surrounding ground). This separation must be at least twice the diameter of the supply line but never less than one inch.

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Backflow

The flow of water or other liquids, mixtures, or substances into the distributing pipes of a potable supply of water from sources other than its intended source.

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Backflow Prevention Assembly

A mechanical means to prevent backflow.
An Assembly has test cocks (ports/valves) for thorough field testing.

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Backflow Prevention Device

Also a mechanical means to prevent backflow, but-
Has no test cocks, preventing thorough field testing.

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Backpressure Backflow

Backflow due to an increased pressure above the supply pressure, which may be due to pumps, boilers, gravity, or other sources of pressure.
To PUSH WATER

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Backsiphonage Backflow

The flowing back of used, contaminated, or polluted water from a plumbing fixture or vessel into a water supply pipe due to a pressure less than atmospheric in such pipe.
To PULL WATER

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Continuous Pressure

More than 12 hours out of 24-hour period of continuous water pressure

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Cross-Connection

A connection or arrangement, physical or otherwise, between a potable water supply system and a plumbing fixture or a tank, receptor, equipment, or device, through which it may be possible for non-potable, used, unclean, polluted, or contaminated water, or other substances to enter into a part of such potable water system under any condition.

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Degree of Hazard

Either a pollutant (non-health hazard) or contaminant (health hazard). The distinction is derived from the assessment of materials which may come in contact with the distribution system through cross-connection.

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Principles of Hydraulics

How water moves

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Water Pressure

- Backflow & backflow prevention depend on-
  - Pressure
  - Water's reaction to pressure (hydraulic principles)
- Pressure is measured in Pounds Per Square Inch (PSI)
  - Force (in pounds)
  - Exerted over specific area (square inch)

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Water Pressure

- Elevation (height) of water generates its own pressure
  - Outside source of pressure is not necessary
  - A height of 12 inches of water (head of water column) generates 0.433 psi at the bottom of the column
  - 1 psi generated by simply raising the height of a column of water to 2.31 feet or approximately 27¾ inches
    - 1 psi/0.433 psi = 2.309 feet
    - 2.309 feet X 12 inches = 27.708 inches

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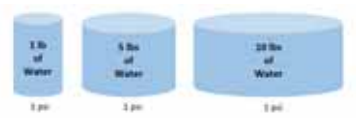
Water Pressure

Increasing the diameter of a water column (such as using a larger pipe) will not affect the pressure at the bottom of the column (**P**ounds per **S**quare **I**nch)

- Larger pipe equals more water spread over a larger area
- No matter the volume of water, the pressure at the base (psi) is the same
- To increase the pressure, you can increase the height of the water column



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Water Pressure

Three kinds of pressure to be measured-

- **Atmospheric Pressure-** the pressure exerted on the earth by the atmosphere above it. Think of this as the weight of the air pushing down on the surface of the planet.
- **Gauge Pressure-** the pressure above atmospheric pressure. Typically, the pressure read on a gauge.
- **Absolute Pressure-** the sum (or total) of Atmospheric Pressure plus Gauge Pressure.

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Water Pressure

Heat can also create (increase) pressure.

Water expands when heated.

When heated in an open pot, the water level rises.

Source: plumbingsupply.com

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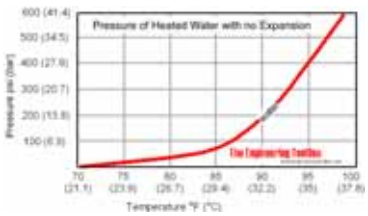
Water Pressure



Heat can also create (increase) pressure-

- Water expands when heated
  - If trapped in enclosed container or pipe, that expansion increases pressure

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Water Flow

Water pressure naturally tries to equalize.

Water within a distribution pipe is typically free to travel in either direction.

Water will generally flow away from higher pressure, toward lower pressure.

The usual goal is water flowing from a pressurized source (like a water meter), through distribution piping, to outlets, without ever reversing course.

Water reversing flow, unintentionally, creates ***backflow***

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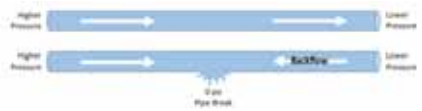
Water Flow

The simplest example of backflow is when a water distribution pipe breaks or develops a leak.

Water flows to the region of lowest pressure (the pipe break) which is zero psi because it is open to the atmosphere.

Any water flowing in a direction other than the one intended is backflow.



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Water Flow

Backflow has two primary forms

- Water is <u>pulled</u> in wrong direction by negative pressure (Backsiphonage)
- Water is <u>pushed</u> in wrong direction by positive pressure (Backpressure)

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Backsiphonage

Two common examples of Backsiphonage due to system failure:

1. A water main breaks, reversing the flow of water so it is being drawn out of a structure into the water main, toward the break where water is exiting the system.
2. Water pressure drops (for example, due to heavy use by fire fighters during a fire) while a water hose is draining into a flowerbed or tub of non-potable water. The water in the system reverses course, and water and contaminates are drawn from tubs, flowerbeds, etc., into the potable water piping.

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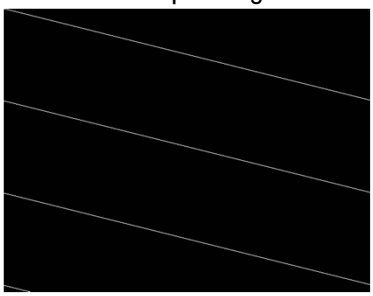
Backsiphonage



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Backsiphonage

Improper design (without failure) can also create Backsiphonage through the "Aspirator Effect". This occurs when water flows past the opening of another pipe, especially past a pipe of a smaller diameter.

Larger flow can create negative pressure, pulling contents of the smaller pipe in wrong direction, creating Backsiphonage

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Backsiphonage

Backsiphonage can be used for productive means, via a piece of equipment known as a Venturi.

A piece of pipe with a smaller diameter in the center causes the velocity of the water to increase.

With another hose or pipe connected in the same narrow section, the low-pressure region creates a vacuum, acting as a siphon.

This can be found in residential hose end sprayers or commercial mop sinks. Internal hoses pull the chemicals to be applied, moving them into the water flow and out the application nozzle or faucet.

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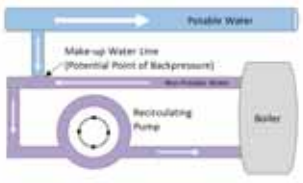
Backpressure

If water downstream has higher pressure than the supply, then water & other substances may be forced into potable water supply.
This is common in a pressurized re-circulation system



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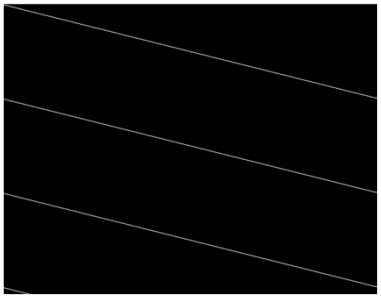
Backpressure



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Cross-Connections

Remember- a Cross Connection is any passage through which backflow may occur.

This can be an actual or potential connection between a Potable water supply and a Non-potable substance or source.

These two types of cross-connection are categorized as Indirect and Direct.

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Indirect Cross-Connections

An Indirect Cross-Connection is only subject to Backsiphonage, such as a hose with end in bucket/basin with chemicals.
If pressure drops, non-potable water or substances may be back siphoned into potable water.
There is pressure in the bucket/basin to push chemicals into the water supply.

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Direct Cross-Connections

A Direct Cross-Connection is subject to Backpressure & Backsiphonage, such as a water make-up line in boiler system with treated water recirculating throughout.

Two types of backflow could occur-

1. If the water supply loses pressure, Backsiphonage can occur.
2. If the boiler system increases pressure, backpressure can occur.

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Prioritizing Backflow Prevention Methods

What does it matter?

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Cross-Connection Hazards

The point is to identify & eliminate potential hazards to a potable water supply.

All hazards are not equal, but rather are classified into 3 different degrees of hazard or danger.

- A *Pollutant* is a non-health hazard, considered objectionable but will not cause illness or death. The objection may be to taste, smell or appearance.
- A *Contaminant* is a health hazard which could cause illness or death. The public health threat could include mild poisoning, spread of disease, etc.
- A *Lethal Hazard* is a health hazard that will likely cause major illness or death. The most common threats include radioactive material, extremely deadly poisons, and raw sewage.

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The Backflow Incident

To put backflow in context, we explored water pressure, water flow, and cross-connections

For a backflow *incident* to occur, 3 conditions are necessary:

1. A cross-connection between potable and non-potable water sources
2. A hazard in the non-potable water (contaminant, pollutant, lethal hazard)
3. A hydraulic condition (Backsiphonage or Backpressure)

This creates failure of piping system to deliver potable water as intended.

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Preventing Backflow

There are numerous ways to prevent backflow.

The method required depends on type of cross-connection (direct, indirect, etc.) and the degree of hazard (contaminant, pollutant, etc.).

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Preventing Backflow

Here are the method categories placed in general hierarchy from highest to lowest effectiveness/reliability-

1. Air Gap Separation (AG)
2. Reduced Pressure Principle Assembly (RP)
3. Double Check Valve Assembly (DC)
4. Pressure Vacuum Breaker (PVB)
5. Spill-Resistant Vacuum Breaker (SVB)
6. Atmospheric Vacuum Breaker (AVB)

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Air Gap Separation

(A Piping Arrangement)

An Air Gap is a physical separation between water supply & a flood level rim of a fixture, appliance, etc.

The flood level rim is the point where water would overflow and rise no higher.

That separation must be at least twice supply line diameter, but never less than 1 inch.

This protects against pollutants and contaminants coming in contact with the potable water system.

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Air Gap Separation
(A Piping Arrangement)

An Air Gap is not for use in area with hazardous atmosphere (fumes).

It is the referred method of protecting against lethal hazards.

It is perhaps simplest method of backflow prevention, and is at the top of prevention hierarchy, meaning the most effective.

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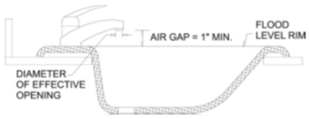
Air Gap Separation

An Air Gap is not always feasible, because all pressure is lost when water passes through.

But it is GREAT for faucets.



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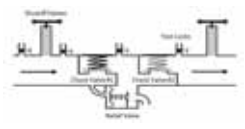
Reduced Pressure Principle Assembly (RP)

An RP consists of two internally loaded check valves in series, and a mechanically independent differential pressure relief valve located between them.

It has two resilient seated shutoff valves and four resilient seated test cocks for field testing and may be used to protect against pollutants as well as contaminants.

It is effective against both direct and indirect cross-connections

HOWEVER- It shall not be used for backflow of lethal substances or sewage, as solids may block the valves.



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Reduced Pressure Principle Assembly (RP)

The relief valve senses the difference in pressure between upstream of Check Valve #1 and downstream of Check Valve #1.

The upstream pressure must remain over 2 psi greater than downstream pressure, otherwise the relief valve opens and releases pressure to prevent contaminated water from moving upstream.

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Reduced Pressure Principle Assembly (RP)

An RP must be installed a minimum of 12" and a maximum of 36" above grade, be accessible for testing and repair, and installed horizontally unless specifically approved for vertical installation.

It should also be protected from vandalism or weather and have adequate drainage.

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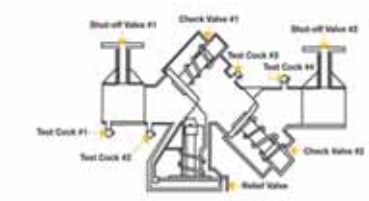
Reduced Pressure Principle Assembly (RP)



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Reduced Pressure Principle Assembly (RP)

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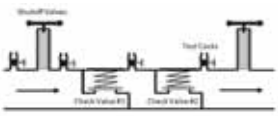
Double Check Valve Assembly (DC)

A double check consists of two internally loaded check valves in series, two resilient seated shutoff valves, and four resilient seated test cocks for field testing.
Resilient seated means the valve contact is not metal to metal.
It may be used to protect against pollutants (non-health hazards) only, but is effective against both direct and indirect cross-connections.



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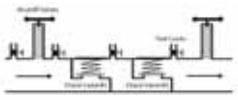
Double Check Valve Assembly (DC)

The reason for two check valves is If one check valve fails to seal properly due to debris, etc., the other check valve acts as a backup to prevent backflow from occurring.

The DC <u>should</u> be installed a minimum of 12”* and a maximum of 36” above grade, be accessible for testing and repair, and be installed horizontally unless specifically approved for vertical installation.

It should also be protected from vandalism or weather and have adequate drainage.



* Best practice, not strictly required. If submerged, the test cocks become a potential direct cross connection. AHJ's add more installation requirements if below ground level.

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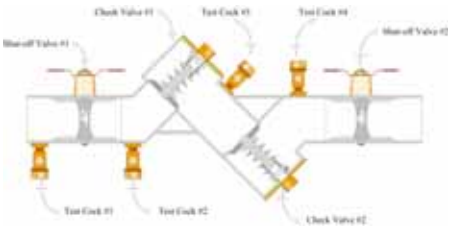
Double Check Valve Assembly (DC)



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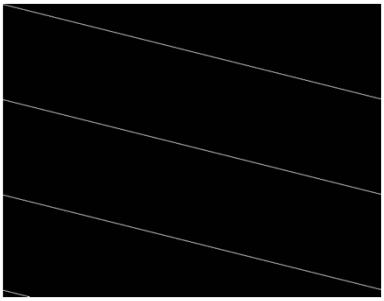
Double Check Valve Assembly (DC)



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Pressure Vacuum Breaker (PVB)

The Pressure Vacuum Breaker has and internally loaded check valve, a loaded air inlet valve, two resilient seated shutoff valves, and two resilient seated test cocks for field testing.

It may be used to protect against pollutants & contaminants but is only effective against Backsiphonage (not backpressure).

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Pressure Vacuum Breaker (PVB)

When the assembly is pressurized, the check valve opens and the air inlet valve closes, allowing water to flow through the assembly. If water attempts to flow in the opposite direction, the check valve closes, and the air inlet opens allowing air into assembly. This air breaks the vacuum (siphonage) and separates the upstream potable water from any liquid downstream.

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Pressure Vacuum Breaker (PVB)

The PVB must be installed at least 12” above all downstream piping or outlets and can be used under continuous pressure.

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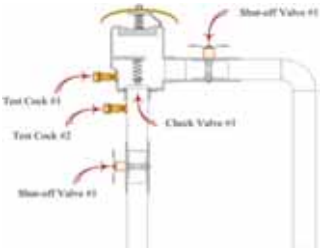
Pressure Vacuum Breaker (PVB)



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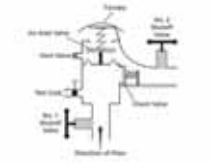
Spill-Resistant Pressure Vacuum Breaker (SVB)

The Spill-Resistant Pressure Vacuum Breaker is essentially same as the PVB application. However, when the assembly is pressurized, the air inlet closes before the check valve opens, keeping water from discharging through the air inlet.

This design variation is for situations where water discharged into an area is undesirable, such as inside a building with no floor drain below.

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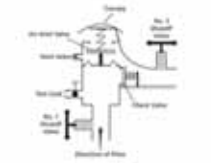
Spill-Resistant Pressure Vacuum Breaker (SVB)

The SVB may be used to protect against pollutants & contaminants but is only effective against Backsiphonage (not backpressure).

Must be installed at least 12” above all downstream piping or outlets and can be used under continuous pressure.

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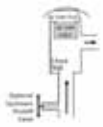
Atmospheric Vacuum Breaker (AVB)

(A Backflow Preventer Device)

The Atmospheric Vacuum Breaker consists of an air inlet valve, a check seat, and an air inlet port. Water flowing into the assembly causes the air inlet valve to close.

When water flow reverses, the air inlet valve drops down to the check seat, allowing air to into the device body, eliminating vacuum (siphonage), thus separating downstream non-potable water from upstream potable water.

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Atmospheric Vacuum Breaker (AVB)

The AVB may be used to protect against pollutants and contaminants but is effective only against Backsiphonage (not backpressure).

It must be installed at least 6" above all downstream piping or outlets, cannot have any shutoff valves or control valves downstream, and should not be subject to continuous pressure (should never be pressurized more that 12 out of every 24 hours).

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Also in the AVB class….. The Hose Bibb Vacuum Breaker

The HBVB is designed to be attached on the discharge side of a hose bibb, hydrant, or faucet, with hose threads. It consists of a check valve loaded to the close position, and an air inlet valve loaded to the open position. When water flow into the hose bibb, the vacuum breaker causes the check to open and the air inlet to close.

When incoming pressure drops, air inlet valve opens allowing air to enter.

The HBVB **cannot be** subjected to continuous pressure but may be used to protect against Pollutants and/or Contaminants.

Being a vacuum breaker, they are designed to protect against **Backsiphonage only,** and should not be subjected to backpressure.

The HBVB is typically non-testable.

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Two other specialized Vacuum Breakers

- Anti-siphon valves
  - Ballcocks

- Flushometers

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Selecting a Backflow Protection Device

3 questions must be asked to determine the appropriate backflow prevention device:

1. Is the connection a direct or indirect cross-connection (can it be exposed to backpressure)?
2. Is the cross-connection a pollutant or contaminant?
3. Is the connection under continuous use or pressure?

	Indirect (Backsiphonage Only)		Direct (Backsiphonage & Backpressure)
	Continuous Use	Non-Continuous Use	
Health Hazard	PVB, SVB, RP, Air Gap	AVB, PVB, SVB, RP, Air Gap	RP, Air Gap
Non-Health Hazard	PVB, SVB, RP, DC, Air Gap	AVB, PVB, SVB, DC, RP, Air Gap	DC, RP, Air Gap

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Inspection and Testing

Backflow prevention assemblies are critical components.

They protect the potable water systems from pollution or contamination.

IPC and IRC require annual inspections to determine whether they are operable/reliable.



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Big Ideas From This Presentation

1. Backflow and backflow prevention almost entirely depend on pressure and water's reaction to it.
2. Backflow has two primary forms depending on whether water is being pulled in the wrong direction by negative pressure (backsiphonage) or pushed in the wrong direction by positive pressure (backpressure).
3. For a backflow incident to occur, there must be a cross-connection, a hazard must be present in the non-potable water, and a hydraulic condition must exist in the piping (backsiphonage or backpressure).
4. There are numerous methods to prevent backflow with the correct one depending upon the method of cross-connection (direct or indirect), the content (pollutant or contaminant) and whether it is under continuous use or pressure.
5. IPC,IRC require that proper test procedures be followed for assemblies.

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The ICC BPAT Demo Trailer

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