



Confined Space Awareness

By: Garrett Yates
Backflow Management Inc.
1 (800)841-7689

Identifying a Confined Space

What is a confined space?

A confined space has the following characteristics:

is large enough to get whole body inside,

is not designed for human occupation,

has limited or restricted entrance or exit.



It must have all three characteristics to be a confined space.

General Requirements

- The employer shall evaluate their workplace to determine if any spaces are permit-required confined spaces.
- If the workplace contains permit spaces the employer shall inform employees (post signs).
- If the employer determines its employees or other employees performing work will not enter the permit spaces, the employer shall take effective measures to ensure employees do not enter.
- If the employer decides that its employees will enter permit spaces, the employer shall develop and implement a written permit space program.

What is a permit required confined space?

Means a confined space that has one of the following characteristics:

Contains or has the potential to contain a hazardous atmosphere;

Contains a material which has the potential for engulfing an entrant;

Has an internal configuration such that an entrant could be trapped or asphyxiated;

Contains any other recognized serious safety or health hazard



What is a Non-permit required confined space

Means a confined space that does not contain or, with respect to atmospheric hazards, have the potential to contain any hazard capable of causing death or serious physical harm

Note: control of atmospheric hazards through forced air ventilation does not constitute elimination of the hazards

Identifying a Confined Space

What is limited or restricted entry or exit?

The ability to easily escape in an emergency is impeded by such obstacles as:

- a manhole
- a small door or opening
- a ladder
- a long tunnel



Restricted exit



Exit not restricted

Identifying Confined Spaces

Examples of confined spaces

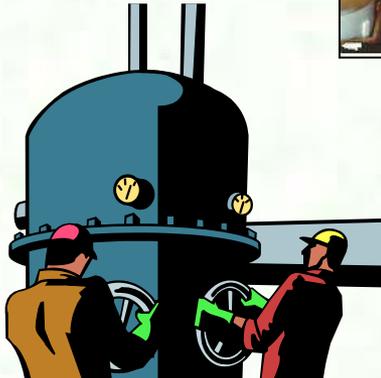
Tanks



Manholes
& Sewers



Boilers



Grain storage bins



Other examples include vaults, pipelines, tank cars, and ship holds

Controlling the Space

The hazards of a confined space can be addressed in the following ways:

- Prevent employee entry.
- Remove or reduce hazards in the space first, before a person enters.
- If hazard cannot be eliminated, you must use a **written permit system** to enter safely.



Controlling the Space

Warning employees and controlling access

Post warning signs at the entrance of confined spaces. **THIS IS REQUIRED.**

Limit employee access to confined spaces by using entry barriers or locks.

Make sure that unauthorized workers do not enter the confined space.



DANGER
PERMIT REQUIRED
CONFINED SPACE
DO NOT ENTER





A rectangular metal cover, possibly for a manhole or utility access, is shown. The cover is light-colored with some rust and has a dark rectangular border. At the top edge, there are two metal latches. In the center, there is a warning sign with a black background and white text. Below the sign, there is a circular hole in the metal. The cover is set against a grey, textured background.

DANGER
PERMIT REQUIRED
CONFINED SPACE
DO NOT ENTER

There used to be about 300
Deaths Every Year



Confined
space
entry

Annual deaths have declined

In the last 10 years there have been at least 47 incidents in the US involving confined spaces

70 employees directly affected

40 of whom died from the incident

Hazards of Confined Spaces

What are the main hazards of confined spaces?

- Hazardous atmospheres
- Engulfing materials
- Entrapment
- Moving parts
- Electricity



Hazard Identification

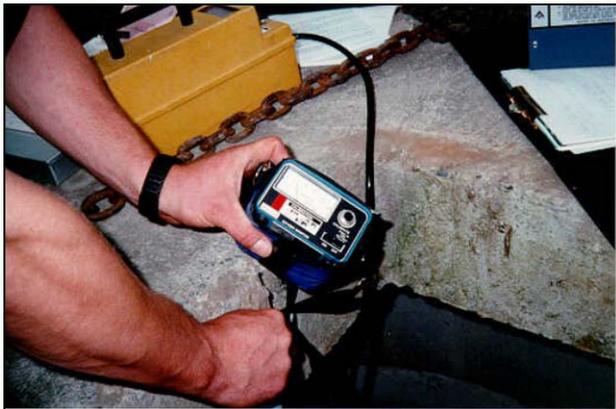
A “hazardous atmosphere” in a confined space has one or more of the following:

Flammable gas, mist or vapor

Flammable dusts

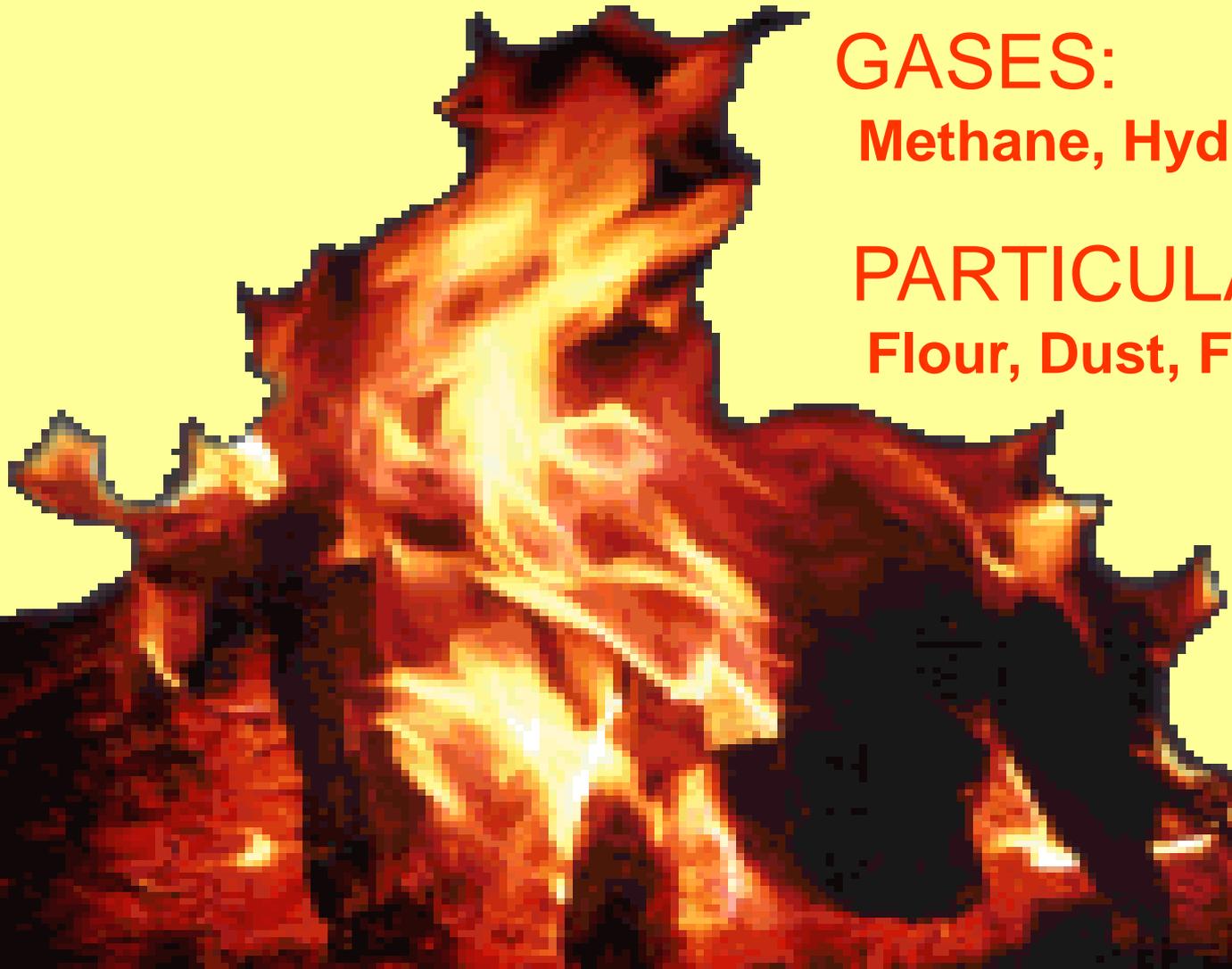
Oxygen content below 19.5% or above 23.5%

Air contaminant concentrations that would cause death, incapacitation, or permanent health problems



You must do air monitoring to determine if a hazardous atmosphere exists.

COMBUSTIBLES ATMOSPHERES



GASES:

Methane, Hydrogen, Gasoline

PARTICULATES:

Flour, Dust, Fine coal particles

Hazard Identification

Hazardous Atmospheres – Flammable Gases, Vapors and Dusts

Flammable gases, vapors or dusts will ignite from a spark or flame if above a level in the air called the “lower flammable limit” (LFL).

Gas or vapor levels higher than 10% of the LFL are considered hazardous and the confined space cannot be entered until levels are reduced.

Amounts above 10% of the LFL are usually toxic as well.

LFL is sometimes called “LEL” – “lower explosive limit”



Oxygen Deficient Atmosphere

Most common killer

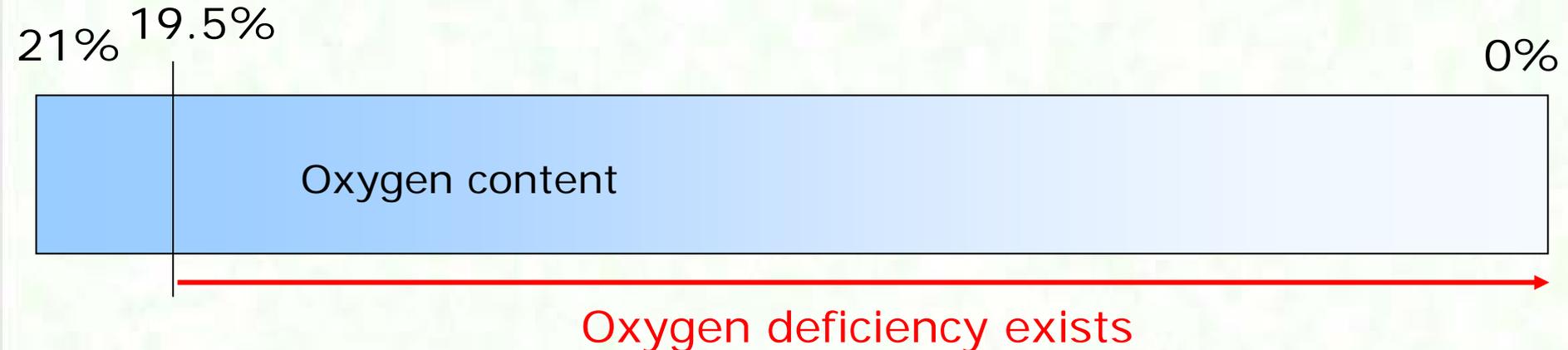
Hazard Identification

Hazardous Atmospheres – Oxygen Deficiency

A reduction in oxygen is caused by tank rusting, microbial activity, or replacement by another gas.

Lack of oxygen can cause a person to immediately collapse and die.

Normal air contains 21% oxygen. A space with oxygen content below 19.5 % is considered "oxygen deficient".



Hazard Identification

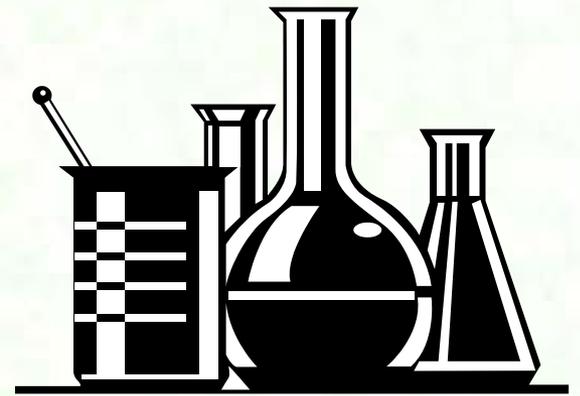
Effects of Oxygen Deficiency

<u>% Oxygen</u>	<u>Symptoms</u>
19.5% - 16%	Fatigue, mild impaired coordination
16% - 12%	Increased breathing rate and pulse; impaired coordination, perception or judgment
12% - 10%	Further increased breathing rate, blue lips, mental confusion
10% - 8%	Fainting, nausea, vomiting, mental confusion within few minutes
8% - 6%	Collapse, death within 8 minutes
6% - 0%	Coma within 40 seconds, death

Hazard Identification

Hazardous Atmospheres – Toxic Chemicals

- At very high levels, most chemicals in the air can be immediately life-threatening or cause permanent bodily harm.
- At lower levels, chemicals in the air can still cause harm.
- Most chemicals have “permissible exposure limits” (PELs) which will cause harm if exceeded.
- Even non-toxic or low-toxic chemicals can replace oxygen if levels are high enough.



PEL

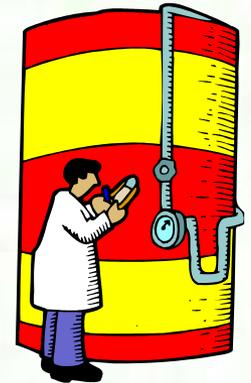
Hazard Identification

Hazardous Atmosphere – Toxic Chemicals

The most common toxic chemicals in confined spaces fatalities are **hydrogen sulfide** and **carbon monoxide**.

Other toxic chemicals can include welding fumes, vapors from liquid residues in storage tanks, or chemical products used in the confined space.

Chemicals can quickly reach toxic levels in the air of a confined space, especially gases, solvent vapors or sprayed products.



Hydrogen Sulfide
heavier than



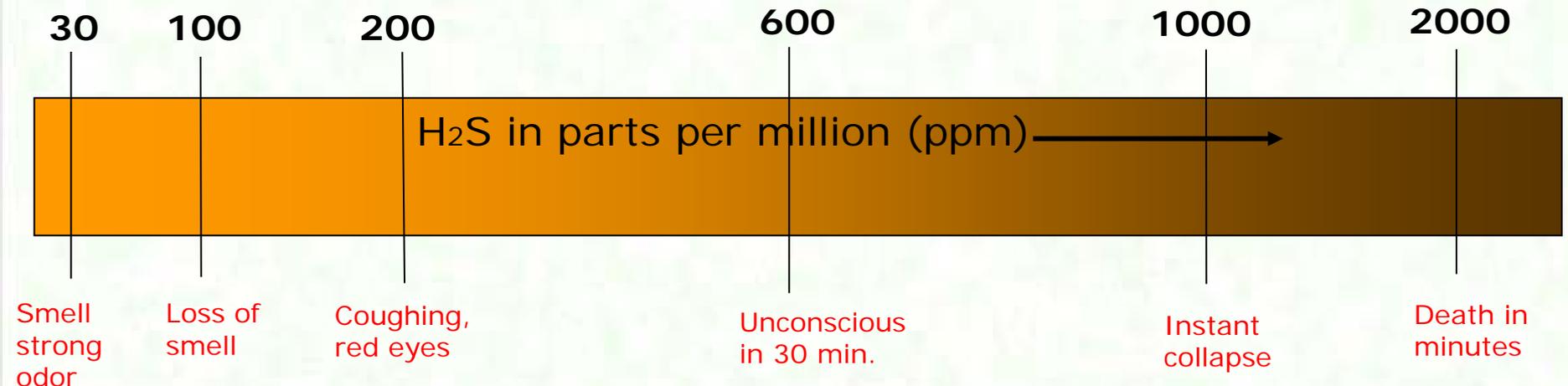
Hazard Identification

Hazardous Atmospheres—Hydrogen Sulfide (H₂S)

Hydrogen sulfide gas is commonly found in sewers.

It can be instantly fatal at higher levels in a confined space.

Disturbing sewage sludge can release more hydrogen sulfide gas.



Slightly lighter than air



DANGER!
CARBON MONOXIDE

Hazard Identification

Hazardous Atmospheres – Carbon Monoxide (CO)

Carbon monoxide comes from operating internal combustion engines in or near confined space.

Propane-powered engines also emit carbon monoxide.

Fatal levels of CO are quickly reached in confined spaces.



**Propane-powered
manlift in a large tank**

Confined Space Entry Procedures

The Importance of Air Monitoring

Air monitoring is required whenever there is a possibility of hazardous atmospheres.

Atmospheric conditions can change quickly in a confined space.

A portable gas monitor with an alarm should be used by the person entering the confined space and checked frequently.



Confined space gas monitor

Air Monitoring – Check All Levels

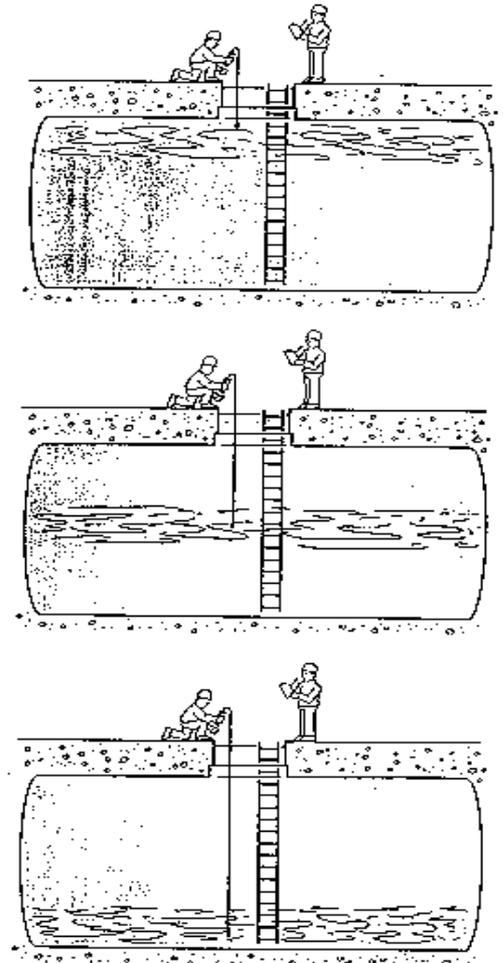
Different gases can be found at different levels

Methane:	0.55
Ammonia:	0.59
Carbon Monoxide:	0.96
Nitrogen:	0.97
Air:	1.0
Hydrogen Sulfide:	1.2
Carbon Dioxide:	1.5
Gasoline:	3- 4
Jet Fuel, JP-8:	4.7

*Lighter than
air gases*



*Heavier than
air gases*



Confined Space Entry Procedures

Ventilation of Confined Spaces

Fresh air blowers or exhaust fans are typically used.

Blower or fan should not be undersized.

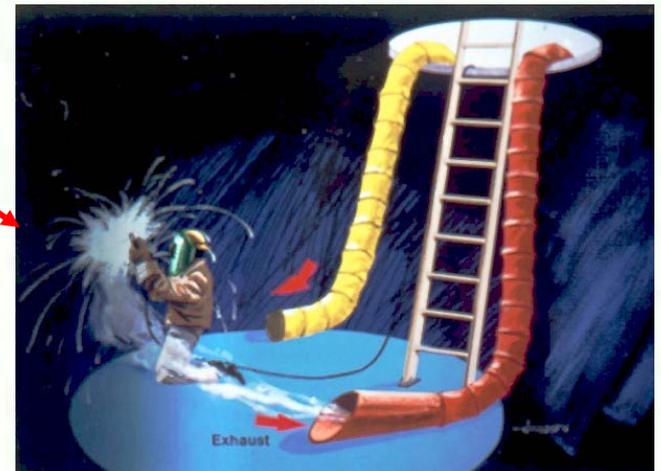
A blower intake must be placed in an area of clean air.

Exhaust ventilation must be used when welding or using chemicals in a confined space.

Watch out for pockets of unventilated contaminated air.



Don't place a blower intake near a running engine!



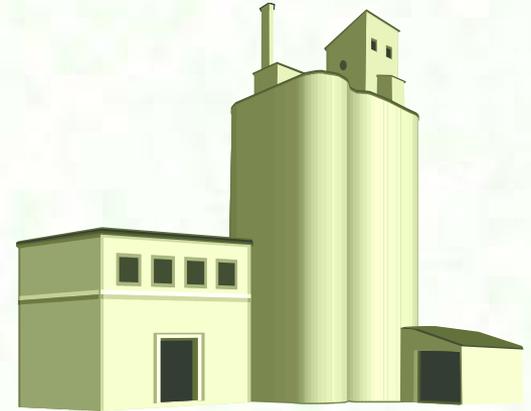
Hazard Identification

What are the Hazards of Engulfing Material?

Engulfing materials include liquids or loose solids such as grain, sand or other granular material.

People cannot escape when caught in moving loose solids and usually suffocate.

Workers often get engulfed when in-feed or out-feed lines are inadvertently opened or activated.



Hazard Identification

What is Entrapment?

The space is configured in a way that can trap a worker, for example, sides sloping towards the center



Gravel hopper



Sawdust Cyclone

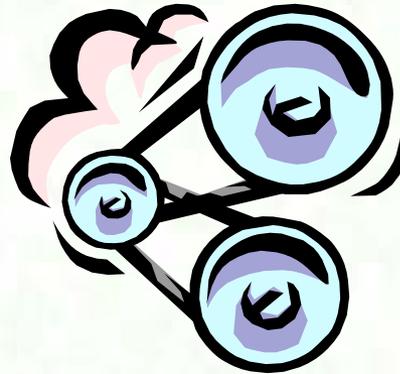
Hazard Identification

Other Recognized Hazards

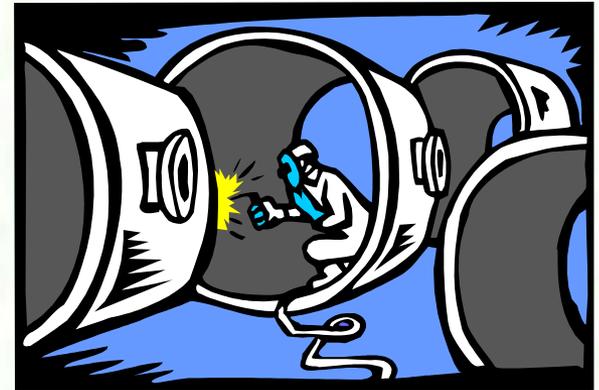
Electrical lines, steam lines
or hydraulic lines



Mechanical hazards
(moving parts)



Hazards caused by the work
(welding, painting etc.)



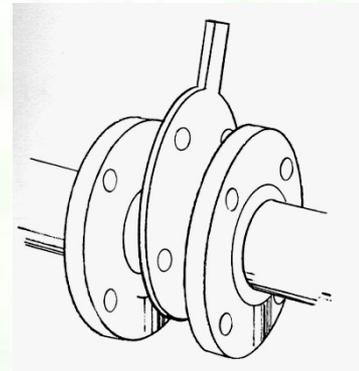
Hazard Elimination

How To Eliminate Physical Hazards

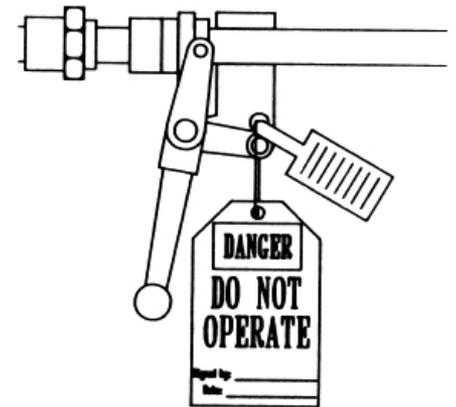
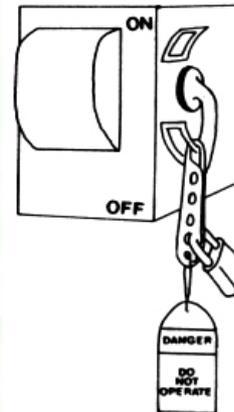
Lock-out moving parts



Blank or block steam pipes and product in-feeding pipes.



De-energize electrical parts or wiring



If Hazards Can't Be Eliminated

If hazards cannot be completely eliminated, there are only two options:

a complete written permit system, or

“alternate entry procedures.”

Both require training of employees.

Entry into a Confined Space

How is entry into a confined space classified?

Written Permit System – required when hazards can't be eliminated

Alternate Entry Procedures – allowed for controlled atmospheric hazards only

No Permit – allowed only if all hazards are eliminated

Hazards must be determined **before** entering a confined space.

Confined Space Entry Procedures

What are “alternate entry procedures”?

If the only potential hazard is atmospheric (toxic gas or oxygen deficiency) and it is controlled by ventilation, then you may use less restrictive alternate entry procedures.

These procedures have fewer requirements – no written permit system is required.

Don't assume that the only hazard is atmospheric without investigation and reliable information.

Confined Space Entry Procedures

What are alternate entry requirements?

Employees must be trained on confined space hazards,

The atmosphere in the confined space must be tested before and during entry,

Continuous ventilation must be used,

If a hazardous atmosphere is detected, or ventilation stops, the space must be promptly exited.



What does the Permit-required program consist of?

- Posting of warning signs
- Preventing unauthorized entry
- Hazard identification procedures
- Workplace evaluations procedures
- Procedures, practices, and means necessary for safe permit entry and closure operations
- An entry permit system
- Training for specific duties (entrants, attendants, entry supervisors)
- Providing PPE at no cost to employees

What does the Permit-required program consist of? Cont...

- A system for ensuring that:
 - pre-entry tests are performed
 - pre-entry preparations are completed and acceptable conditions are attained
- Monitoring the space as needed
- Developing and implementing rescue and emergency measures

The Written Permit

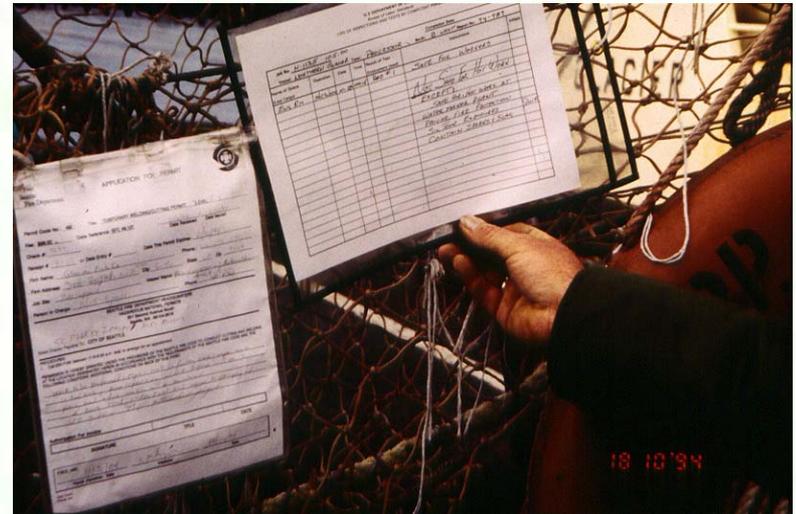
The permit states what is done and who does it:

Describes each individual's roles and responsibilities,

Specifies safety equipment and respiratory protection,

Tells how long the job will take,

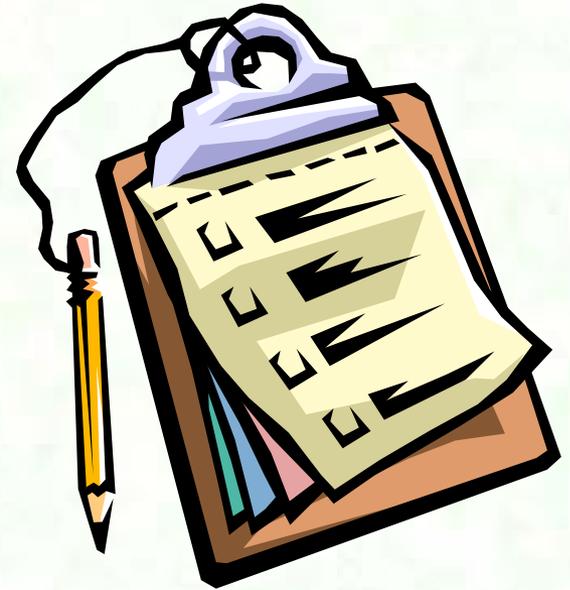
States hazards found in the space.



The Written Permit

The written permit also includes the following:

- Location of the permit space
- The purpose of entry
- The date and authorized duration
- Names of authorized entrants, attendants and entry supervisors
- Hazards of the permit space



The Written Permit

- Measures used to eliminate, isolate or control permit space hazards before entry
- Verification of acceptable entry conditions
- The results of air monitoring tests and persons performing tests
- Verified rescue and emergency services
- The communication system used
- The equipment used for entry

The Written Permit

- Any additional information necessary to ensure employee safety
- Any additional permits issued to authorize special work in the space

The employer must conduct an annual review of all cancelled permits.

Employee Training

General Requirements

Train **before** assigning duties

Train **before** changing duties

Train **whenever** operations present a new hazard



Employee Training

General Requirements

Retrain whenever there is reason to believe:

- There are deviations from the established procedures,
- There are inadequacies in the employee's knowledge of procedures.

Employee Training

General Requirements

Training must establish proficiency.

The employer must certify that this training has been done and meets the confined space regulations.



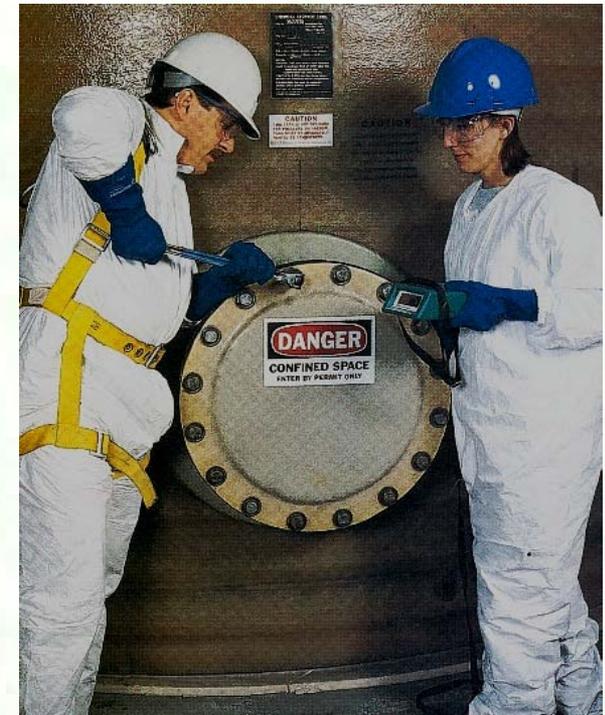
Designated Jobs

Any permit-required confined space entry has designated jobs for employees:

Entrant – person who actually goes into the confined space

Attendant – person watching the entrant

Entry Supervisor – supervises the operation



Each position requires specific training and assigned duties.

Entrant

Anyone who is authorized to enter a permit –required confined space.



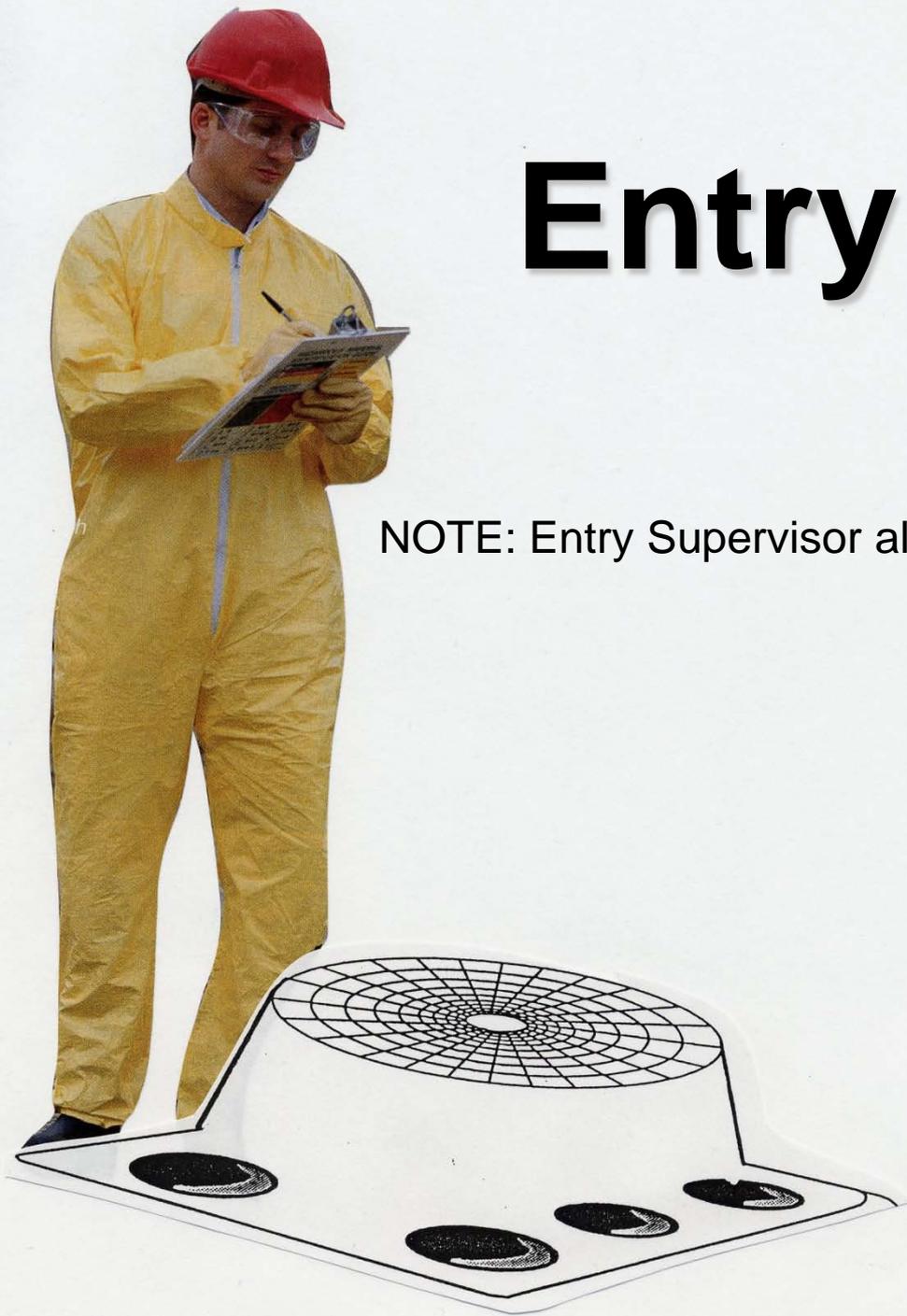
Attendant

An individual stationed outside one or more permit-required confined spaces who monitors the entrants.



Entry Supervisor

NOTE: Entry Supervisor also may serve as an entrant or attendant



Develop a rescue plan

- The type of rescue plan is dependant on space hazards
- Develop the most safe and effective rescue plan with consideration to these potential hazards
- Just relying on 911 may be unacceptable

Rescue in a Confined Space

Confined space rescue is very dangerous

60% of all confined space fatalities are would-be rescuers.

Rescuers often enter a confined space without thinking about the hazards.

Rescues cannot be done without proper equipment and training.

Not all fire departments can do confined space rescuing.





Rescue Services

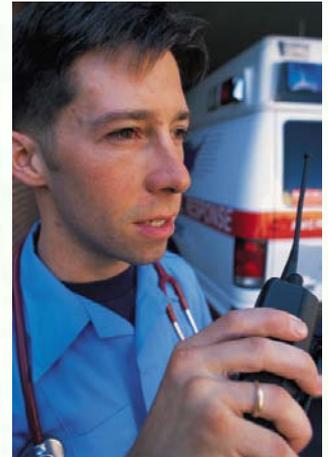
Using Outside Services

Carefully evaluate the prospective service's ability to perform as needed.

Many fire departments are not trained or not available to do confined space rescue. Check with them first.

Tell the service about the hazards inside the space.

Let the service practice mock rescues in the confined space.



Non-entry Rescue

What is a non-entry rescue?

Non-entry rescue is retrieving a person out of a confined space without going into the space.

Entrants must wear full body harnesses with a retrieval line attached.

Best suited for manholes and tanks and cannot be used in every situation.



Non-entry Rescue

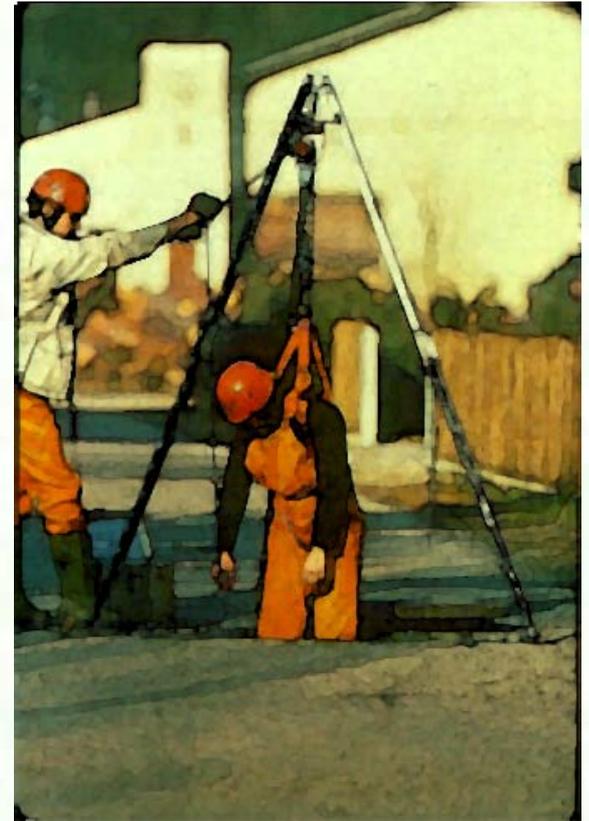
Non-Entry Rescue Equipment

It is usually impossible to pull a person out of a confined space unassisted.

A retrieval line is attached to a mechanical device or a fixed anchor point outside the space.

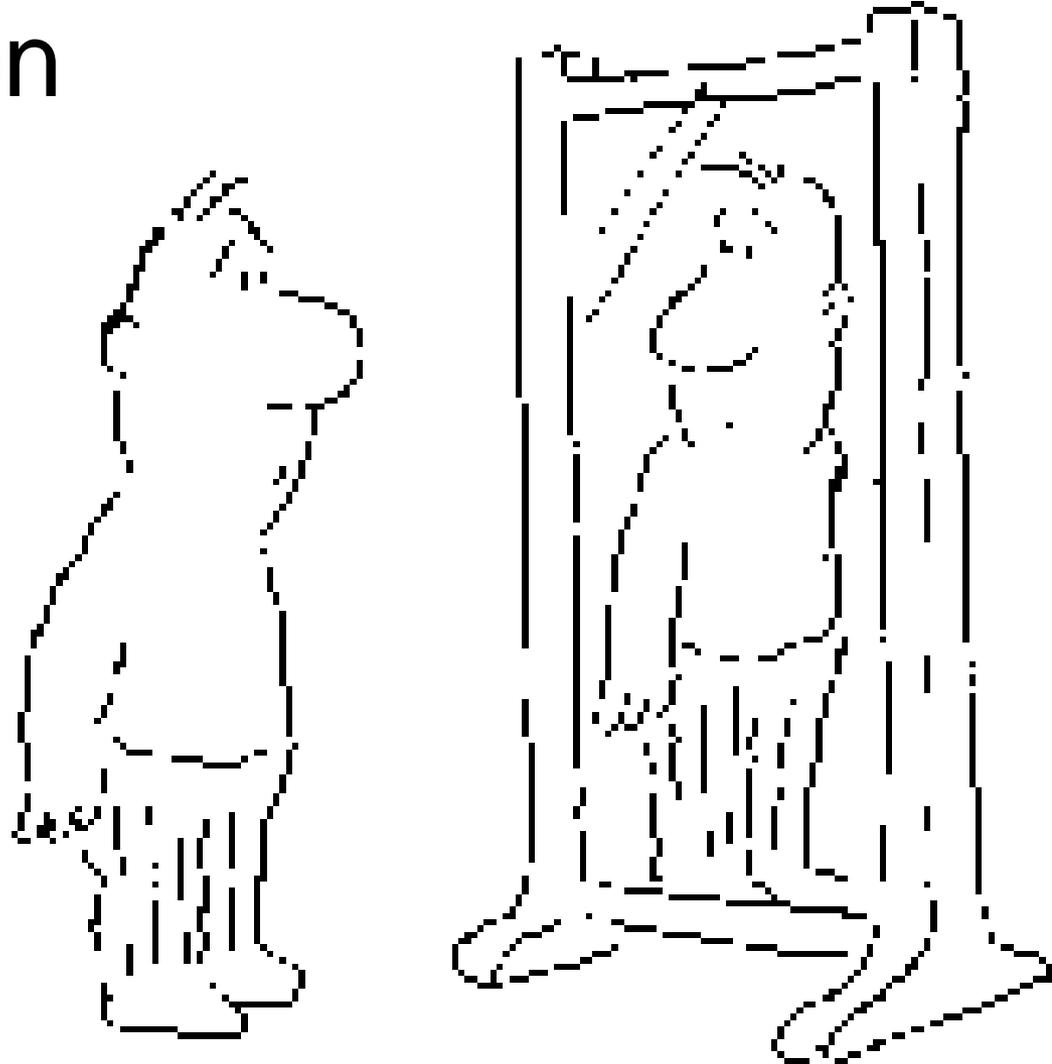
The mechanical device must be available to retrieve personnel from vertical type permit spaces more than 5-feet deep.

Special rescue tripods are available.



Remember:

This is the person
responsible for
your SAFETY



Cross Connection Control

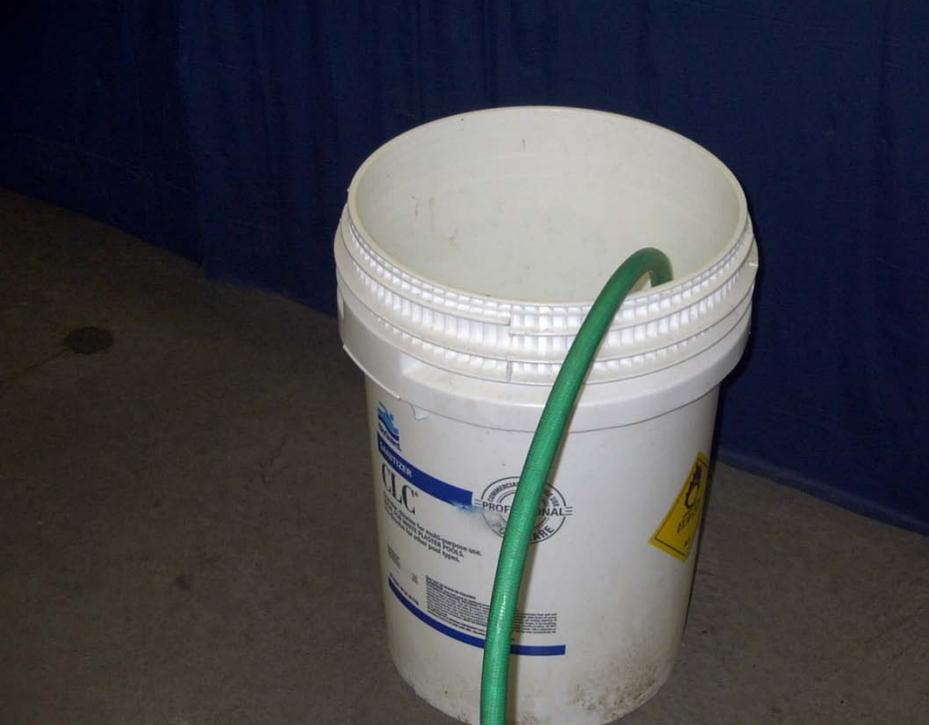


By: Mary L. Howell
Garrett Yates

Backflow Management Inc.

What is a cross connection?

A cross connection is any actual or potential link between a public water system or the consumer's water system and any source of non-potable substances.



Commercial, Industrial examples:

- Fire protection systems
- Auxiliary water supplies
- Make up lines for water using equipment
- Medical equipment i.e x-ray developers
- Film development
- Chemical dispensers for commercial kitchens

Cross Connections pose a public health risk when water changes direction in a piping system.

This reversal from the intended direction of flow is commonly referred to as:



Causes of Backflow

▶ **Backpressure**

▶ **Backsiphonage**

Backpressure

Means a pressure on the consumer's side of the service connection is greater than the pressure provided by the public water system.

◀ May cause backflow ▶

Common causes:

pumps, elevated tanks, thermal expansion

Backsiphonage

Means backflow due to a reduction in system pressure in the public water system and/or the consumer's water system

Common causes:

Main line breaks, heavy use i.e. fire hydrant use, pump failure

What are the Hazards Associated with Cross Connections?

Chemical



Physical



Biological

These three conditions are usually assigned a specific “degree of hazard”



“Non-Health or Low Hazard” (Pollution) means an impairment of the quality of the water to a degree that does not create a hazard to the public health, but does adversely and affect the aesthetic qualities of such water for potable use.

True **“Non-Health or Low Hazards”** are
not very common

“Health or High Hazard (Contamination)”

means an impairment of the quality of the water that could create an actual hazard to the public health through poisoning or through the spread of disease by sewage, industrial fluids, waste, or other substances.

This is the most common hazard

Most regulatory agencies require water suppliers to protect the public water supply from contamination via cross connections

Chapter 6 of the Uniform Plumbing Code requires property owners to protect their plumbing from cross connections

Both Regulatory authorities prohibit cross connections without backflow protection!

Methods of protection

Premises Isolation (Containment):

means the practice of protecting the public water system from contamination or pollution by installing backflow prevention assemblies at, or near, the point of delivery where the water supply enters the premise. Premise isolation does not guarantee protection to persons on the premise.

In-Premises Protection (Point of Use):

means the practice of protecting the water user within their premises that is served by the public water system by the installation of an approved air gap or backflow prevention assembly at the point of hazard or cross connection, which is generally a plumbing fixture.

The minimum type of backflow preventer required for a cross connection is dependent upon:

- Degree of Hazard

(Health/High Hazard, Non-Health/Low Hazard)

- What hydraulic conditions could occur

(Backpressure or Backsiphonage)

Recommended Publications

USC Manual of Cross Connection Control

Refer to this manual for guidance on development and implementation of cross connection control programs

Refer to this manual for installation guidelines of backflow preventers

Backflow assembly testers use the test procedures published in the most recent edition of this manual

USC Manual of Cross Connection Control 10th edition

Where do I get it?

KAP-200 University Park MC-2531

Los Angeles, CA 98089-2531

(213)740-2032

PNWS-AWWA 6th Edition CCC Manual

Refer to this manual for guidance on developing and implementing your CCC program

Refers to this manual for installation guidelines of backflow preventers

Soon to be the 7th edition!!!!!!

PNWS-AWWA Summary of Backflow Incidents

This manual makes a great public education tool for councils, boards and the public

Documented incidents support the need for CCC programs to protect public health

PNWS/AWWA Manuals

How do I get them?

PNWS/AWWA

PO BOX 872467

Vancouver, WA 98687

(503)760-6460

www.pnws-awwa.org

Guidance Document: Cross Connection Control for Small Water Systems

Published by DOH in WA, this document is intended to be used for small systems; 1,000 service connections or less

Can be a helpful reference for any size system

This document is a road atlas for getting to compliance with the CCC regulations in the WAC ...a need to have tool!

Guidance Document: Cross Connection Control for Small Water Systems

Where do I get it?

Office of Drinking Water

Department of Health

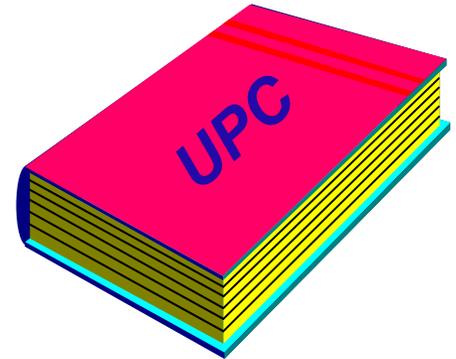
(800)521-0323

or download at

www.doh.wa.gov/ehp/dw

Uniform Plumbing Code (UPC) Background

- Adopted by States
- May be adopted with State-specific amendments
- Applies *within the property lines of consumer's premises*
- Enforced by Local Administrative Authority (Building Code Officials)



UPC Updates

- UPC adopted by States every 3 years
- Chapter 6 contains Cross Connection Control requirements



- Purpose of amendments
 - Allow innovation and new technologies in the State
 - Clarify intent of UPC
 - Conform to other Departments requirements

Uniform Plumbing Code with State Amendments

This is the Code that governs cross connection control beyond the property line (Chapter 6 is CCC requirements).

Rely on this code when conducting hazard evaluations

Helpful to have when developing coordination with the “Local Administrative Authority”

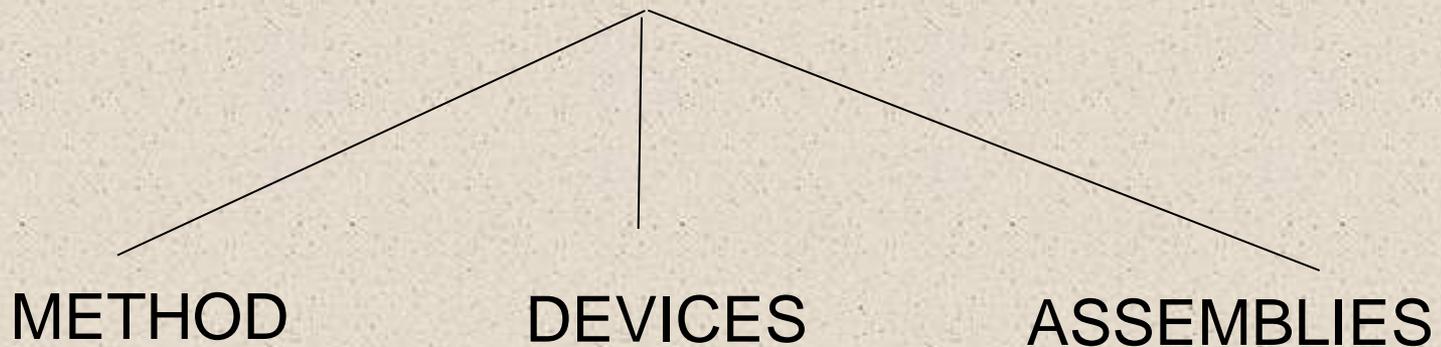
Uniform Plumbing Code edition with State Amendments

Where can I get it?

- **Most Technical Book Stores**
- **Check with State Building Codes, Labor & Industries, Plumbing Code Enforcement Departments**

What are the different types of backflow preventers available?

BACKFLOW PREVENTERS



Backflow Preventer Overview



The Method

2x Diameter of
supply line not
less than 1"

Air Gap



Backflow Devices

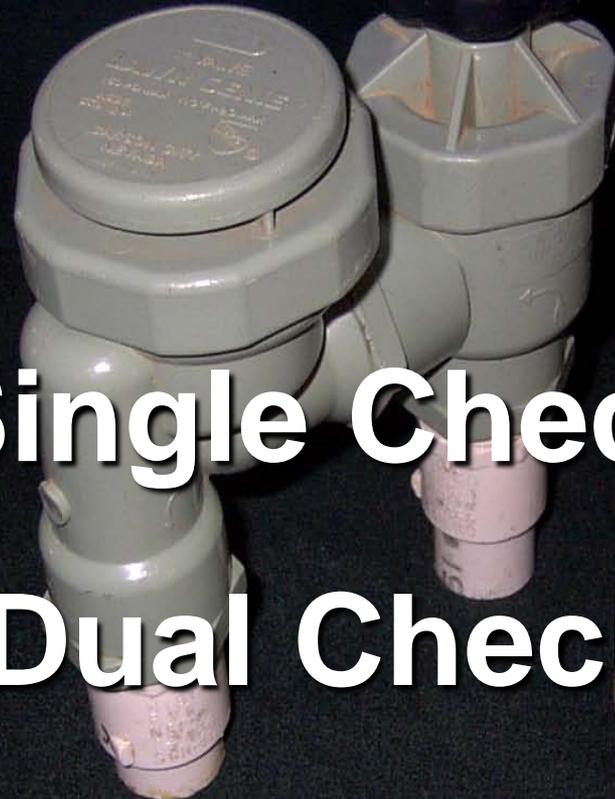
Single Checks

Dual Checks

Hose Bibb Vacuum Breakers

Atmospheric Vacuum

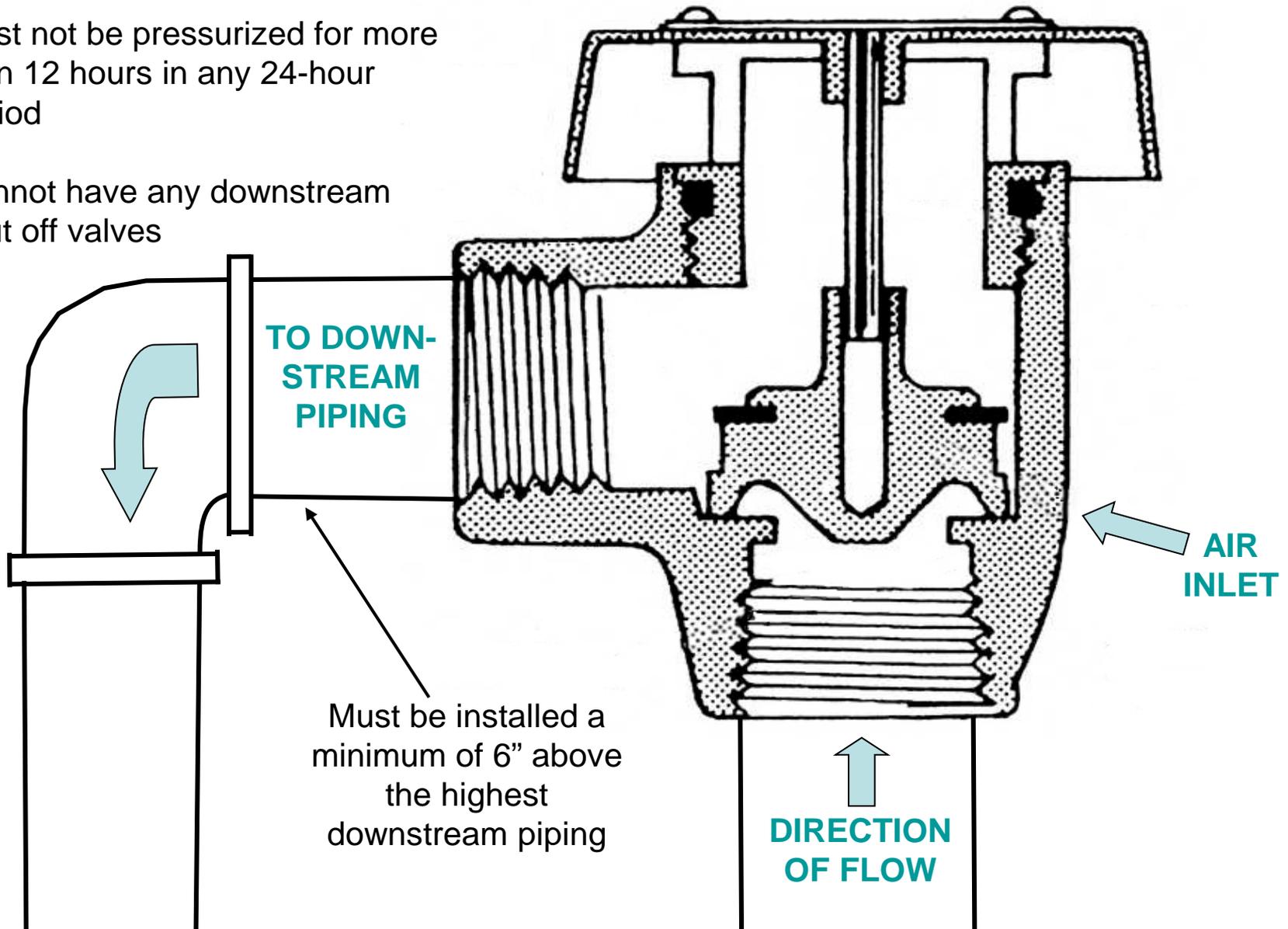
Breakers



Atmospheric Vacuum Breaker

Backsiphonage only—**HEALTH/HIGH** or **NON-HEALTH/LOW** hazards

- Must not be pressurized for more than 12 hours in any 24-hour period
- Cannot have any downstream shut off valves



Backflow Assemblies



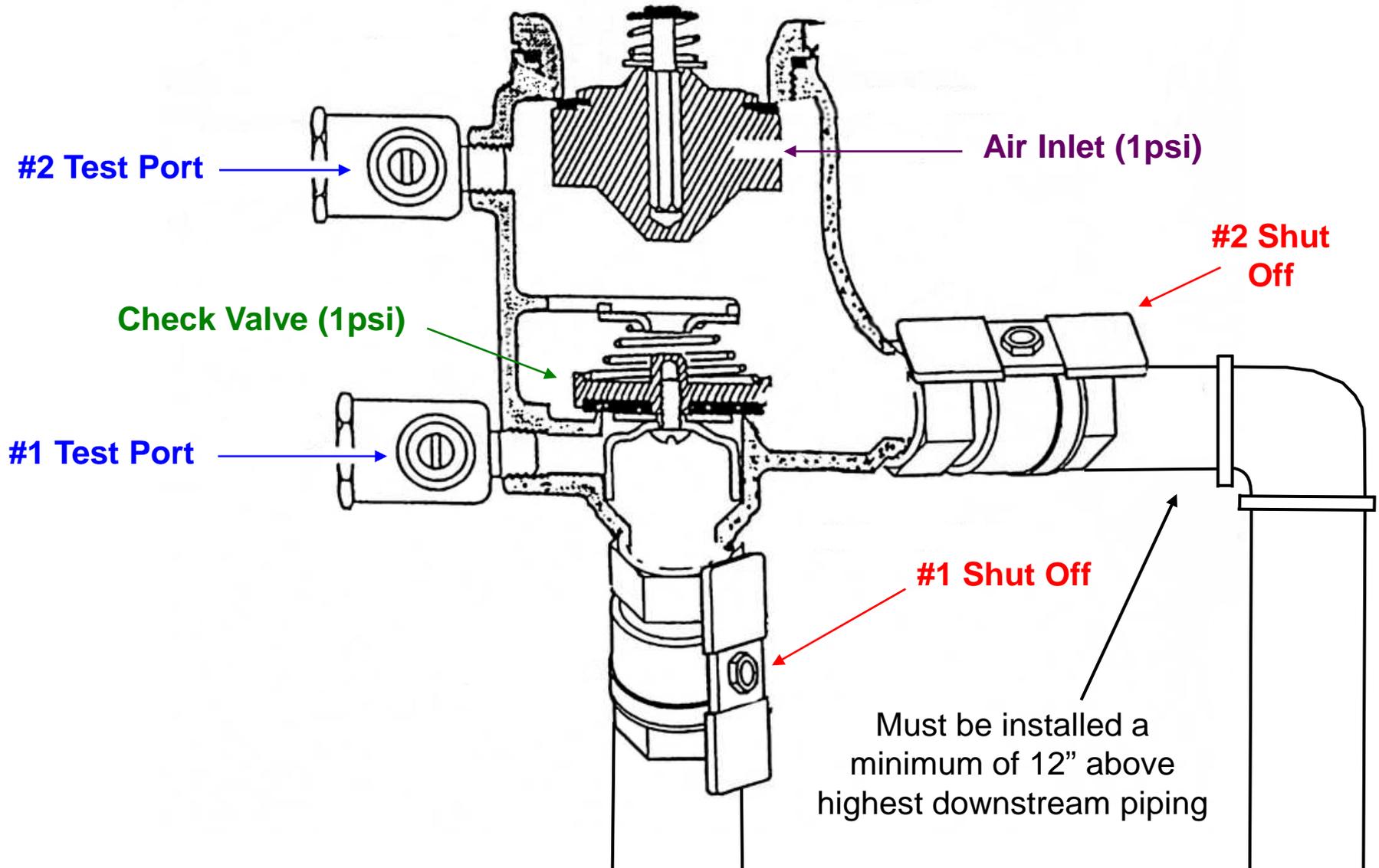
**Spill Resistant
Pressure
Vacuum
Breaker
Assembly**

Pressure Vacuum Breaker Assembly



Pressure Vacuum Breaker Assembly

Backsiphonage only—**NON-HEALTH/LOW** or **HEALTH/HIGH** hazards

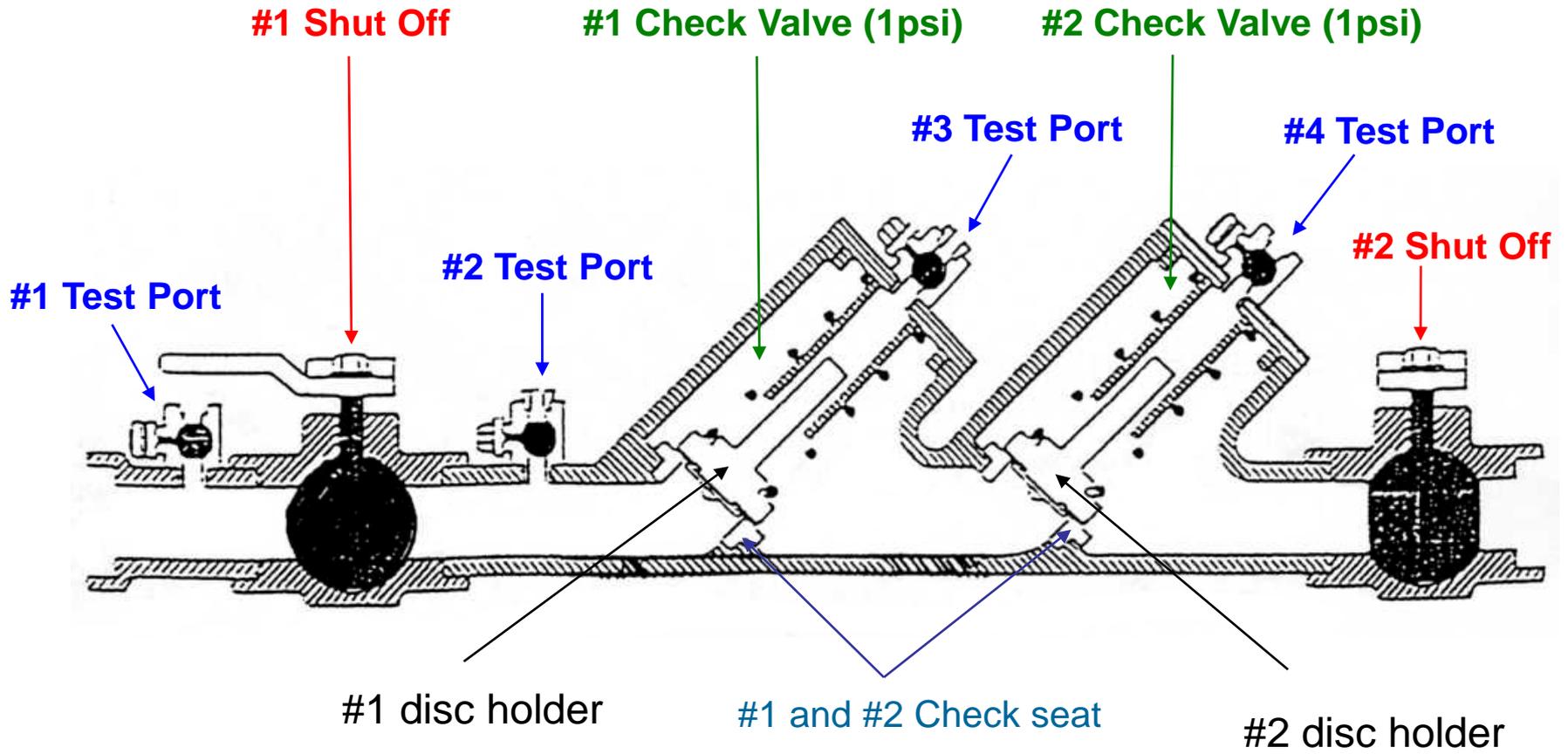


Double Check Valve Assembly



Double Check Valve Assembly

Backpressure and backsiphonage – **NON-HEALTH/LOW** hazards only



Reduced Pressure Backflow Assembly



Reduced Pressure Backflow Assembly

#1 Check Valve (5psid)

#2 Check Valve (1psid)

#1 Shut Off

#3 Test Port

#4 Test Port

#1 Test Port

#2 Test Port

#2 Shut Off

100PSI

95PSI

94PSI

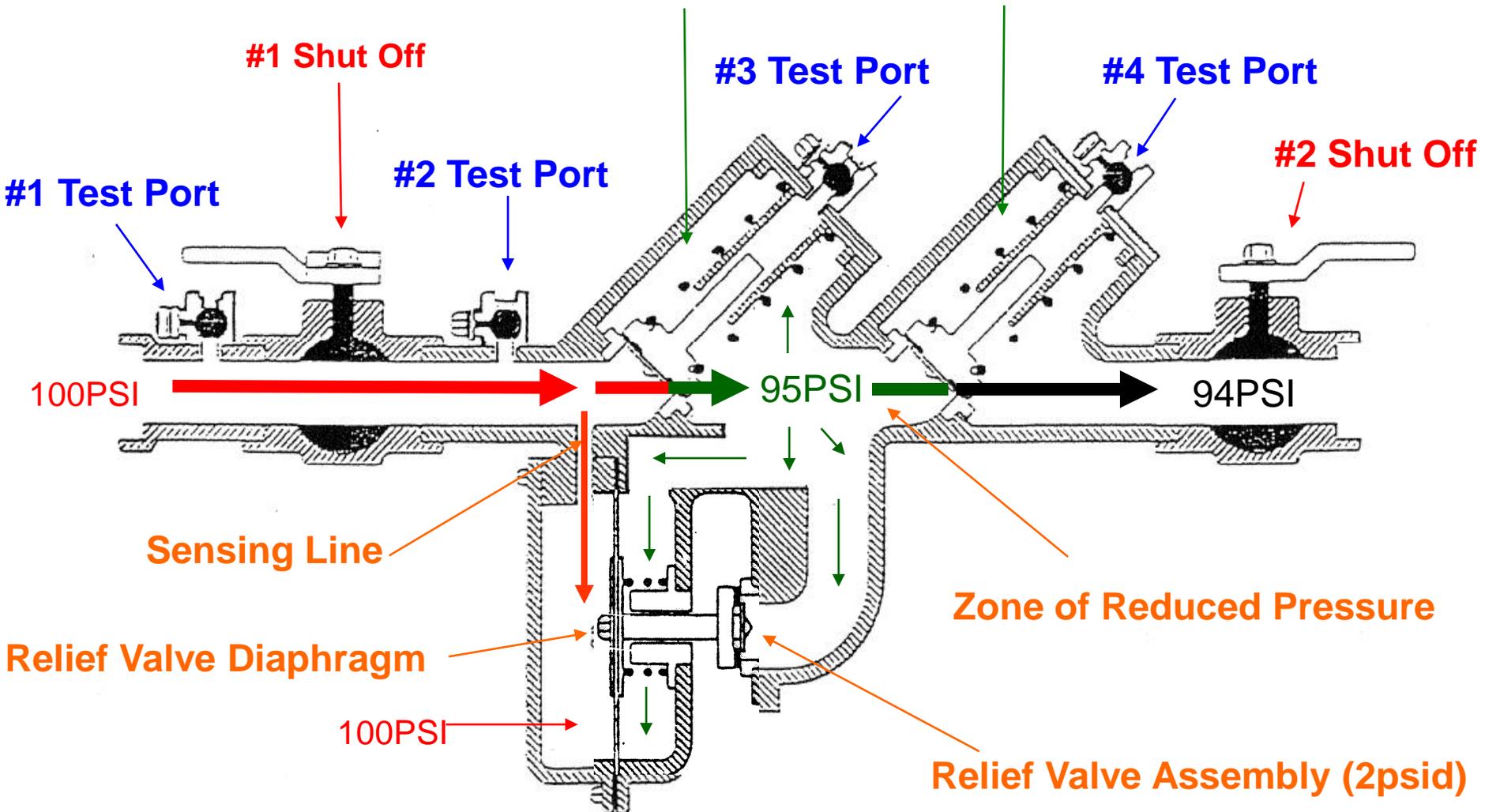
Sensing Line

Zone of Reduced Pressure

Relief Valve Diaphragm

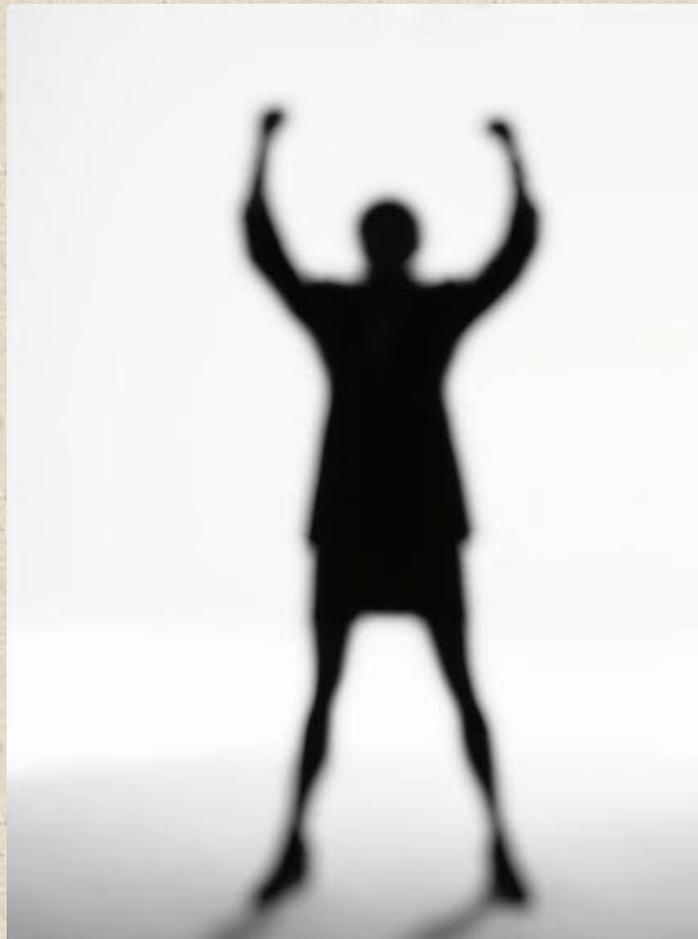
100PSI

Relief Valve Assembly (2psid)



What approvals do backflow assemblies need to carry?

- ASSE
- CSA
- UPC
- USC



Approved Assemblies List

- Available from State in OR and WA
- Can't post on State websites due to USC copyright laws
- Updates are available from State when new approvals are granted or others are deleted



General Program Requirements

1. Water suppliers establish CCC programs to protect the public water system from pollution and contamination
2. Responsibility for CCC begins at the source and ends at the point of delivery
3. Develop & implement a CCC Program that meets the minimum requirements of the State.
4. Coordinate CCC Program with Local Administrative Authority having jurisdiction

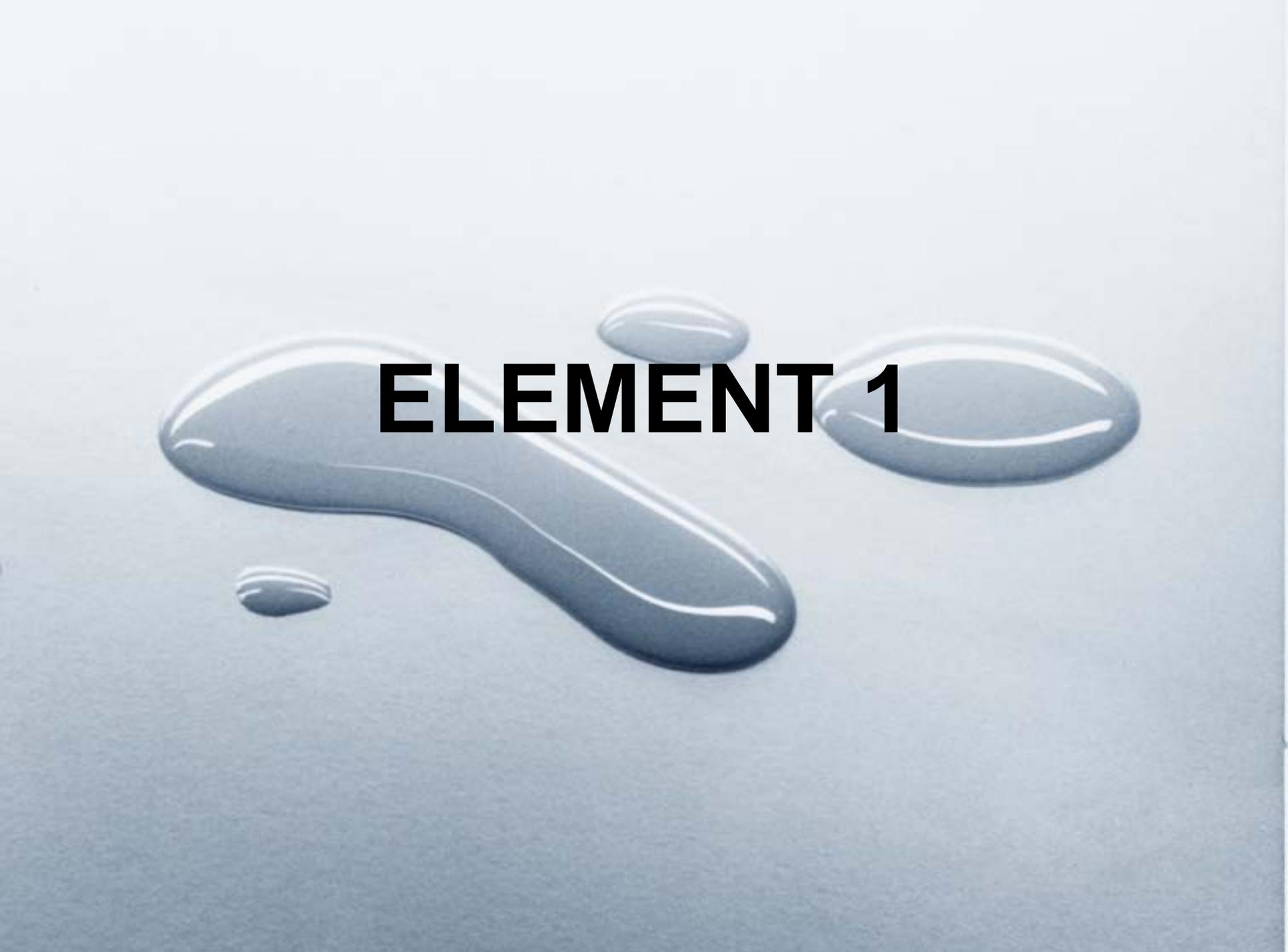
5. Ensure inspections of air gaps, devices and tests of assemblies are conducted when installed, annually, more frequently as determined by the water supplier, after an incident, after an air gap is re-plumbed
6. If not functioning, water user shall replace, repair or re-plumb as defined by the water suppliers enabling authority

7. Premise isolation is required for premises listed in the regulations or by individual hazard evaluations. Supplier may be able to accept in-premise in lieu of premise isolation
8. Water systems can implement their own CCC Program or by written agreement with another agency in OR & WA

10. Assemblies required by these rules shall be approved by USC Foundation (in Oregon, other equivalent testing laboratories as approved by DHS)
11. Assemblies once approved may remain in service provided they are not moved or altered, they are maintained, commensurate with the degree of hazard present and tested annually
12. Assembly tests performed in conformance with procedures established by USC Manual 10th Edition (or other equivalent procedures as approved by DHS in Oregon)

13. Assemblies are tested by State-certified or approved testers. Backflow testers are required to submit test reports to the water user and water supplier within a reasonable time frame and in a form acceptable to the water supplier
14. Assemblies shall be installed according to industry standards

What Are the
Elements
of a
Cross Connection
Control Program?

A large, dark blue, glossy liquid splash is centered on a light blue background. The splash has a thick, rounded shape with a prominent highlight on its upper right edge. The text "ELEMENT 1" is overlaid in the center of the splash in a bold, black, sans-serif font. There are three smaller, similar liquid droplets scattered around the main splash: one above it, one to its right, and one below and to its left.

ELEMENT 1

Create a public education program

for governing boards, staff and
water customers

ELEMENT 2

Adopt an enabling authority that allows for discontinuing water service to premises that do not:

- Eliminate an existing or potential cross connection
- Install an approved assembly
- Maintain an assembly
- Conduct the required testing of an assembly

The background of the image is a close-up view of water with fine, repetitive ripples. A bright, golden-yellow reflection, likely from the sun, is visible in the upper portion of the frame, creating a shimmering effect. The overall color palette is dominated by various shades of blue and green, with the golden reflection providing a warm contrast.

ELEMENT 3

Ensure at least one person is certified as a Specialist (except in Idaho)

(For water systems having 300 or more service connections in Oregon)

Employ or contract with a certified or qualified person to oversee the development, implementation and maintenance of your cross connection control program.

An aerial photograph of a dense forest with a large, irregularly shaped body of water in the center. The water is dark and reflects the surrounding trees. The forest is composed of various shades of green and brown, indicating different types of vegetation. The text 'ELEMENT 4' is overlaid in the center of the image.

ELEMENT 4

Establish procedures for **evaluating the degree of hazard present and for notifying the water user** of any corrective actions needed

Both new & existing services



ELEMENT 5

Maintain a **list of** appropriate and **approved backflow preventers** for the degree of hazard identified and their appropriate **installation guidelines**



ELEMENT 6

Establish procedures to ensure that backflow preventers are installed, inspected and tested (if applicable) according to standards

The image shows a close-up view of water with fine, concentric ripples. At the top of the frame, there is a bright, golden-yellow reflection, likely from the sun, which fades into a darker blue as it moves down. The overall color palette is a range of blues, from light to dark, with the golden reflection providing a focal point of light.

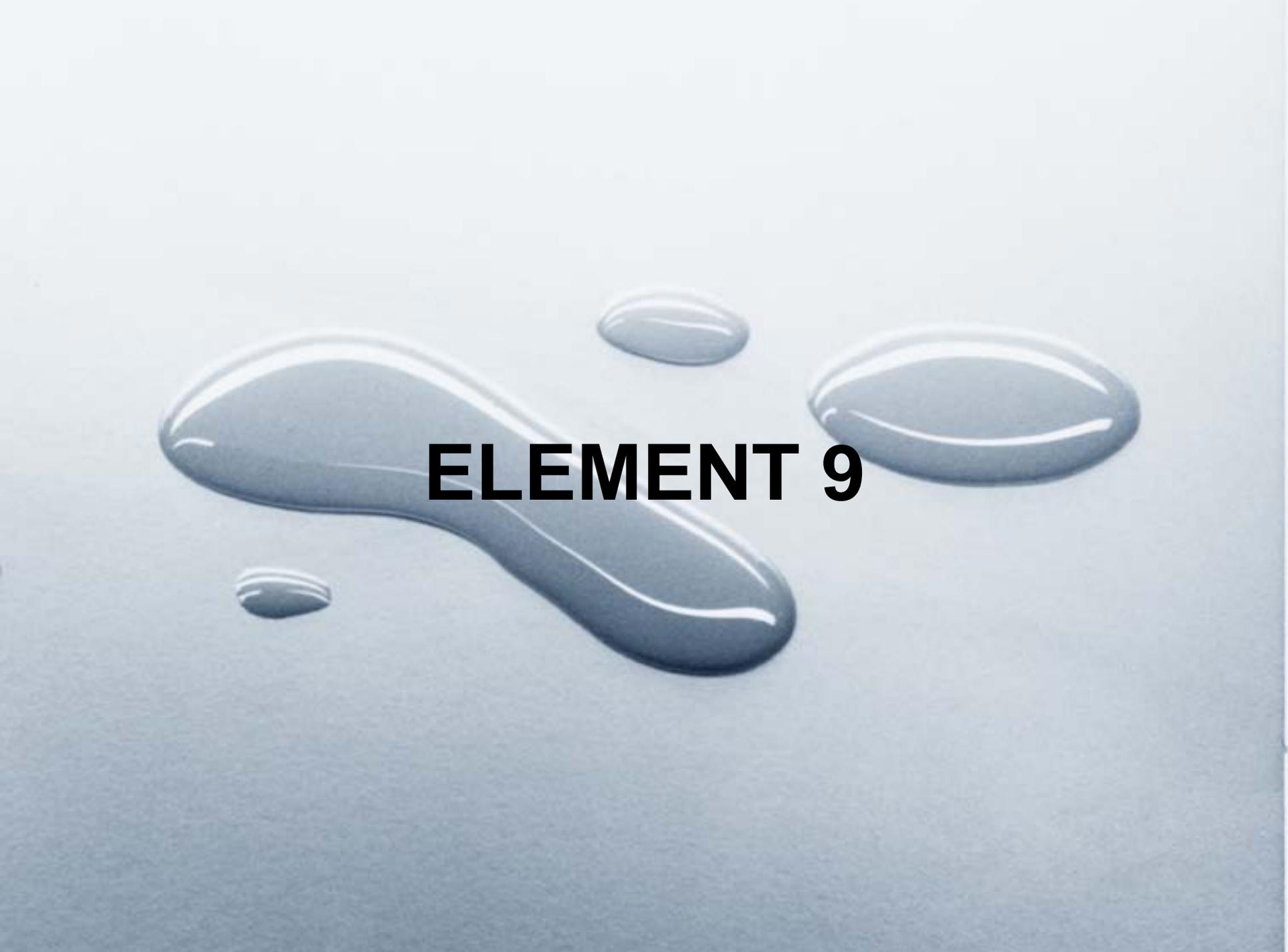
ELEMENT 7

**Establish a backflow
prevention assembly
testing Quality Control
Assurance Program**

ELEMENT 8

Establish and maintain **Cross Connection Control Records**

Includes assembly tracking, surveys completed, test report records, annual summary reporting

A blue liquid splash is centered on a light blue background. The splash consists of a large, irregular shape with a smaller, teardrop-shaped drop below it. To the right, there is a smaller, more rounded splash. Above the main splash, there is a small, oval-shaped drop. The text 'ELEMENT 9' is overlaid in the center of the main splash.

ELEMENT 9

Create procedures
for responding to
and documenting
backflow incidents