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Section 1
Introduction

1.1 Purpose of the Manual

This manual describes the DC Water and Sewer Authority (WASA) Cross-Connection Control Program and the responsibilities for individual consumers, WASA, the DC Department of Consumer Regulatory Affairs (DCRA), the DC Department of Health (DOH), and the EPA Region III (the enforcement agency for DC). The degree of hazard, methods of backflow control, and guidance for selecting appropriate devices are defined in the manual. Procedures for facility inspections and backflow-prevention assembly field tests are presented in detail to provide clear guidance for complying with WASA's policies. Standard forms and letters are included in appendices to assist WASA in tracking all facilities implementing cross-connection control.

1.2 WASA's Cross-Connection Control Policy

WASA is responsible for providing safe water to every customer. In performing this responsibility, WASA must take necessary actions to protect the potable water distribution system from contamination or pollution due to the backflow of contaminants at the water service connection. To provide the maximum protection to all water users, WASA's policy is to require "**containment**", or premise isolation of all **high hazard** facilities. The consumer is responsible for isolating contamination within a facility and installing backflow prevention assemblies at service connections in existing high hazard facilities and new buildings considered high hazards. This approach essentially prevents the consumer from contaminating the water supply, but does not protect the consumer within the building. The DOH will be working closely with WASA to educate consumers on how to protect against contamination at internal cross-connections within their own facilities.

WASA's policy is described in the following actions:

A. WASA's cross-connection control surveyors will inspect drinking water supply piping within existing buildings. They will begin with facilities that are known or suspected to be high hazards (see Section 4.1.3) and then inspect all other commercial and industrial buildings in the District. A letter will be sent to the consumer notifying them of upcoming inspections.

B. Existing high hazard facilities will be required to be equipped with an appropriate backflow prevention assembly at the service connection. WASA may allow portions of buildings considered to be high hazard or individual high hazard cross-connections to be isolated instead of the building as a whole at WASA's discretion. WASA shall inform the consumer in writing of the need to install an approved backflow prevention assembly based on the results of the cross-connection survey. The consumer shall immediately install such approved assemblies at his/her expense.

C. New buildings constructed in the District which are considered high hazards will be required to have an approved backflow prevention assembly at the service connection. Hazard determination will be made by WASA as a part of the initial permit process through a review of the plumbing plans and the applicant's description of the activities at the building. WASA and the plumbing official (DCRA) may allow high hazards to be isolated within the building plumbing system at their discretion.

D. Fire protection systems, regardless of class or type, shall be isolated from the potable water system with a double check valve assembly at a minimum.

E. The consumer will provide for regular testing and maintenance of backflow devices by a certified backflow prevention assembly tester. The certified backflow prevention assembly tester shall also provide a record of testing, repairing, and replacement of backflow prevention devices to WASA.

F. After due notification, any non-compliance with preceding requirements may result in discontinuing water service to the premises. WASA may terminate the water service to a facility until cross-connection control requirements have been satisfactorily met.

1.3 Program Responsibilities

Implementing a successful cross-connection control program requires the full cooperation of the water purveyor (DC WASA), the health agency (DOH), the plumbing official (DCRA), the consumer (DC building owners and occupants), and the certified backflow prevention technician. Each has its responsibilities and must carry their share of a coordinated cross-connection control program in order to prevent contamination of the potable water supply. The responsibilities of each are outlined in **Table 1-1**.

As shown in the table, the **consumer** will be held responsible for installing, testing, and maintaining backflow prevention assemblies in existing high hazard facilities as directed by DC WASA. This includes purchasing devices and contracting with certified technicians for testing and maintenance or training and certifying in –house staff.

The division of cross-connection control responsibilities between WASA and the consumer for a typical facility is shown in **Figure 1-1**.

Figure 1-2 illustrates a more complex facility situation, where water is distributed to a number of buildings within the complex by branches from the main service line. It may be impractical to install one backflow prevention device on the main service line, but the service line branches feeding individual buildings should contain the appropriate backflow prevention assembly based on the degree of hazard associated with the building uses. WASA will assess responsibilities and backflow prevention requirements for these complex facilities on a case by case basis.

To assist the consumer and ensure consistency, WASA will do the following:

- Establish requirements for approved backflow prevention assemblies

Table 1-1
Primary Responsibilities for the DC WASA Cross-Connection Control Program

Program Component	Primary Responsibility
1. Administer Program	
a. Coordinate public information initiative/consumer education program for residential, commercial, and industrial users.	WASA, assistance from DOH, DCRA
b. Develop and maintain cross-connection database.	WASA
c. Develop certification procedures for surveyors and testers. Maintain records of certified surveyors, testers, and approved backflow prevention devices. Establish fees.	WASA, coordination with DCRA requirements
d. Correspond with consumers.	WASA
e. Investigate potential backflow events.	WASA, assistance from DOH, DCRA
2. Enforce Plumbing Code During Construction, Renovations, and Changes in Occupancy	DCRA with WASA input
3. Conduct Cross-Connection Surveys of Commercial and Industrial Buildings (*for Containment Only*)	
a. Prioritize existing buildings for surveys.	WASA
b. Conduct surveys to determine the level of protection required.	WASA
c. Conduct surveys of non-federal consecutive systems for containment of individual buildings or entire system.	WASA
d. Coordinate with federal facilities and military installations for cross-connection control.	EPA Region III Water Protection Division, George S. Rizzo, and WASA
4. Install and Test Backflow Prevention Assemblies (*for Containment Only*)	
a. Review and approve engineering plans.	WASA and DCRA
b. Install and initially test devices.	Consumer (tracked by WASA)
c. Perform routine tests of existing devices.	Consumer (tracked by WASA)
5. Consumer Education Program	DOH & WASA

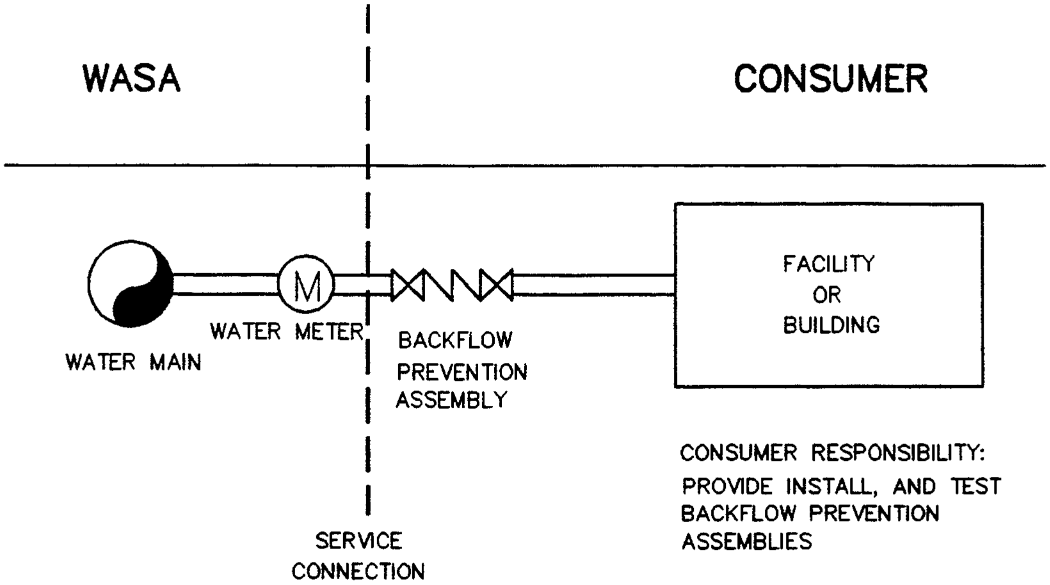


Figure 1-1 Cross-Connection Responsibility (Typical)

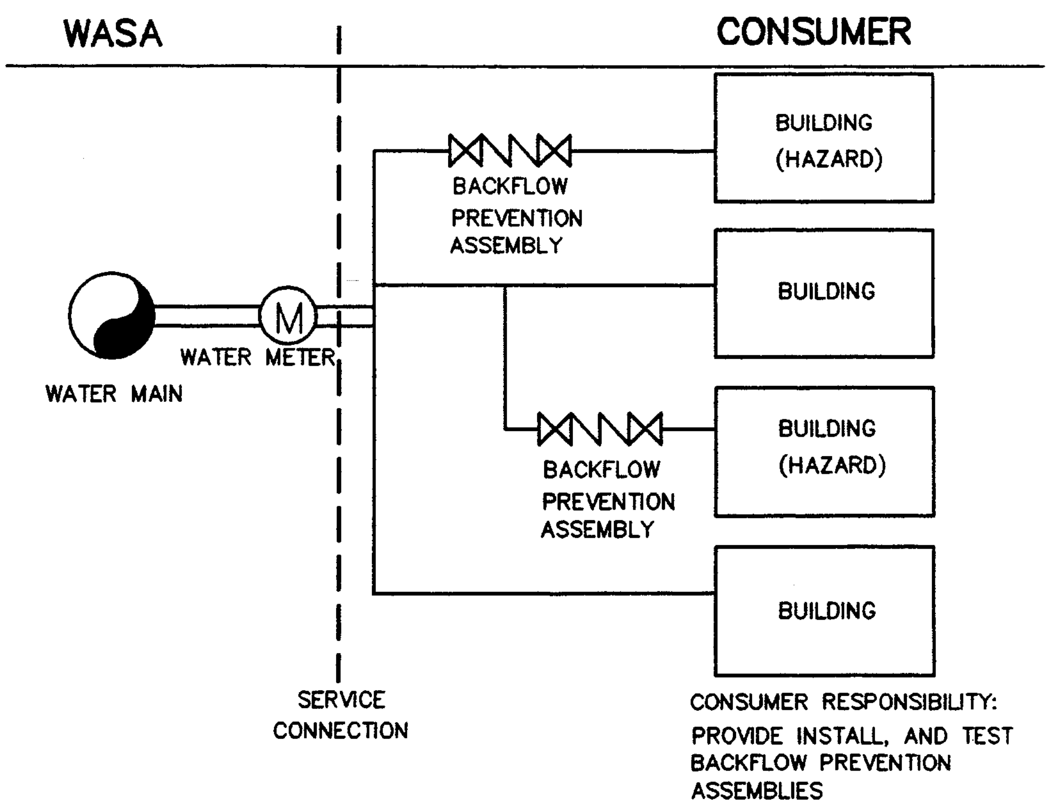


Figure 1-2 Cross-Connection Responsibility (Special Case for Complex Facility)

- Provide guidelines for backflow preventer installations and standard procedures for reviewing installation plans and obtaining permits from the plumbing official (DCRA)
- Set requirements for and maintain a list of certified backflow prevention technicians
- Conduct inspections of facilities
- Maintain a database of customer accounts, backflow prevention devices, inspections, etc. to track continuing compliance requirements

These items are contained in various sections of this manual.

1.4 Consumer Education Program

WASA and DOH will be jointly implementing an aggressive consumer education program for cross-connection control in the District of Columbia. The program will consist of three components:

- Regular water bill inserts
- Local school/community education programs
- Personal education during cross-connection surveys and regular health inspections

WASA and DOH employees will also receive updates on the cross-connection control program through internal newsletters and seminars, so that they may be able to effectively answer questions on the program.

Regular Utility Bill Inserts

WASA will distribute information on the cross-connection control program through regular utility bill inserts. The first several inserts will be general, explaining cross-connection control principles and letting the consumer know that WASA is beginning their program. Subsequent bill inserts will be used to update the public on the status of the program.

Local School Programs

Studies have shown that while people may have a tendency to overlook printed material that comes in the mail, many will show interest in materials that are sent home with their children. To effectively tap into this resource, DOH with assistance from EPA Region III, will work with the DC public school system to develop educational programs and/or distribute materials on cross-connection control. DOH will also investigate additional opportunities to educate District residents on the importance of cross-connection control.

Personal Education During Routine Surveys and Inspections

WASA cross-connection control surveyors and DOH health inspectors have the best opportunity to educate consumers. They come into direct contact with those that will be most impacted by the District's cross-connection control program. It is important that WASA and DOH representatives be able to simply define cross-connections and backflow and provide the consumer with examples of contamination of the public supply at cross-connections (see **Figure 3-1**). WASA and DOH inspectors will be trained to educate the public and will carry informational brochures and/or question and answer sheets to distribute to consumers during inspections.

Section 3
Cross-Connection Principles

This section answers the question: "What is a cross-connection?" Section 3.2 describes the causes of backflow at cross-connections, and Section 3.3 provides a detailed description of backflow prevention methods.

3.1 Definition of Cross-Connection

Cross-connections are physical links through which it is possible for contaminating materials to enter a potable water supply. Contaminating materials may be gases, liquids, or solids, such as chemicals, waste products, steam, water from other sources (potable or nonpotable), or any matter that may change the color or add odor to the water. Bypass arrangements, jumper connections, removable sections, swivel or changeover assemblies, or any other temporary or permanent connecting arrangement through which backflow may occur are considered to be cross-connections.

The term "cross-connection" applies to unprotected links as well as links that are protected by air gaps or mechanical backflow prevention devices. Protected links are still considered cross-connection because:

- Backflow can still occur at cross-connections equipped with backflow preventers in the event of equipment failure

- Inspection and maintenance of backflow prevention assemblies at protected cross-connections is an important part of WASA's cross-connection control program

The **Figure 3-1** shows examples of typical cross-connections:

3.2 Causes of Backflow

Backflow of contaminants from a non-potable source into the distribution system can occur at a cross-connection by one of two ways:

Backsiphonage, when there is a negative or reduced pressure in the supply piping, which could be caused by:

- undersized pipes
- water line breaks at locations lower than the point of service
- reduced system pressure due to high water use (e.g. fire demands)

Back-pressure, in which an induced higher pressure occurs on the non-potable water side, such as:

- potable system connections to pressurized industrial fluid systems
- submerged to non-potable water reservoirs

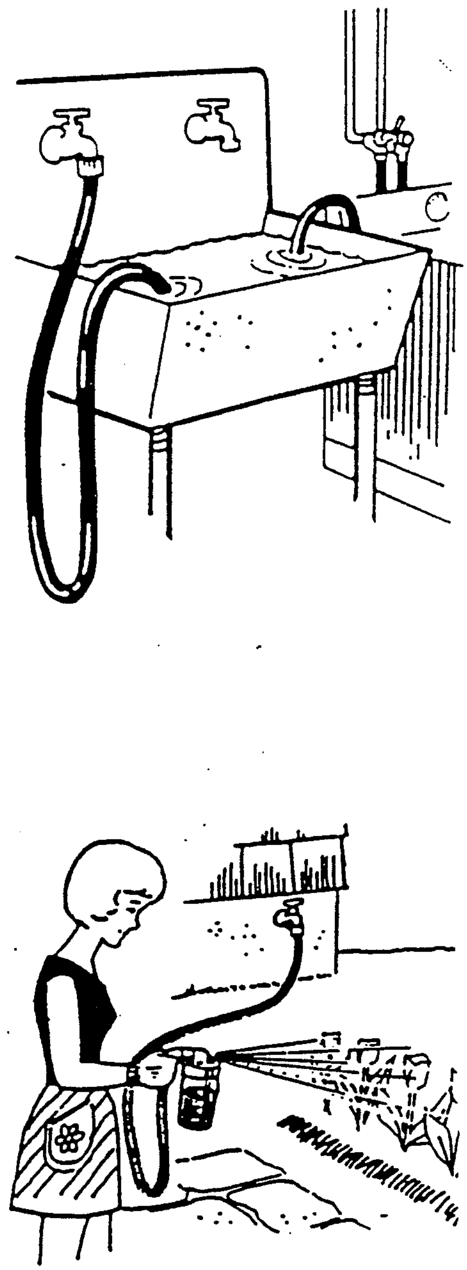


Figure 3-1 Typical Cross-Connection

(Source: USC/FCCHR Cross-Connection Training course)

Figure 3-2 shows how contamination could occur due to backsiphonage during a water main break.

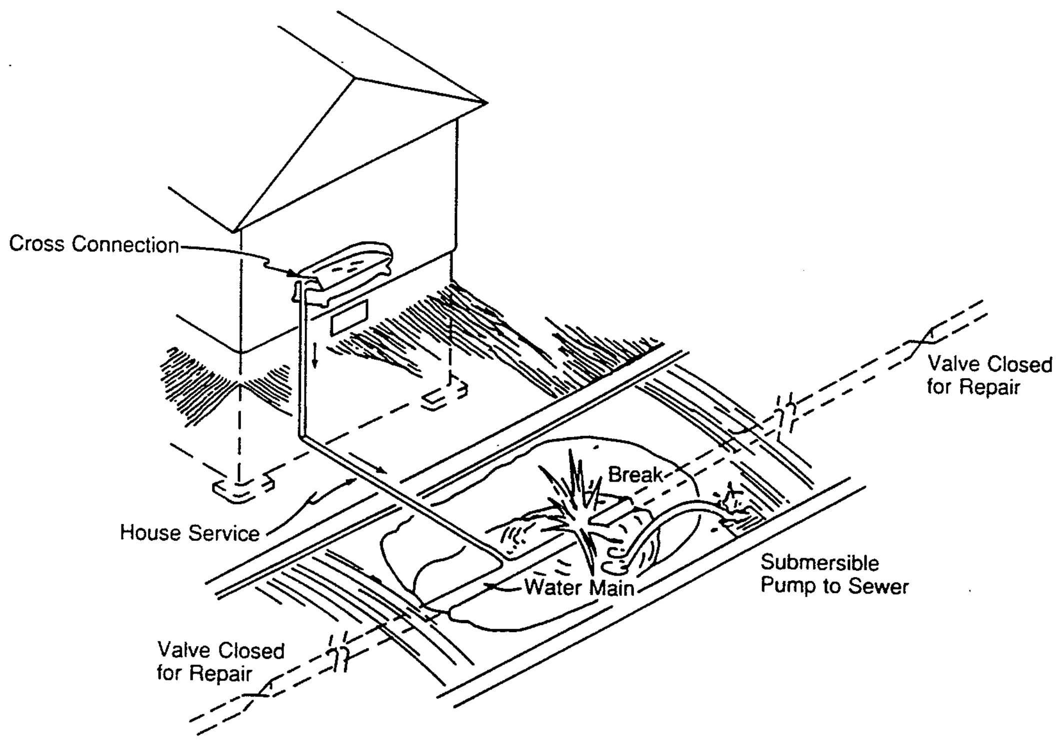


Figure 3-2 Backflow Due To Main Break

(Source: American Water Works Association Manual, 1990)

3.3 Cross-Connection Control Methods

To protect against backflow at cross-connections, an air gap or a mechanical backflow-prevention assembly must be installed. The proper device should be selected according to the type of connection and degree of hazard. (This is discussed in Section 4 of this manual) There are four general methods or types of assemblies that can be used to control cross-connection.

1. Air gap (AG)

2. Reduced-pressure principle backflow prevention assembly (RPBA)

3. Double check valve assembly (DCVA)

4. Vacuum breakers

   - Pressure vacuum breaker (PVB)
   - Atmospheric vacuum breaker (AVB)
   - Hose-connection vacuum breaker (HCVB)

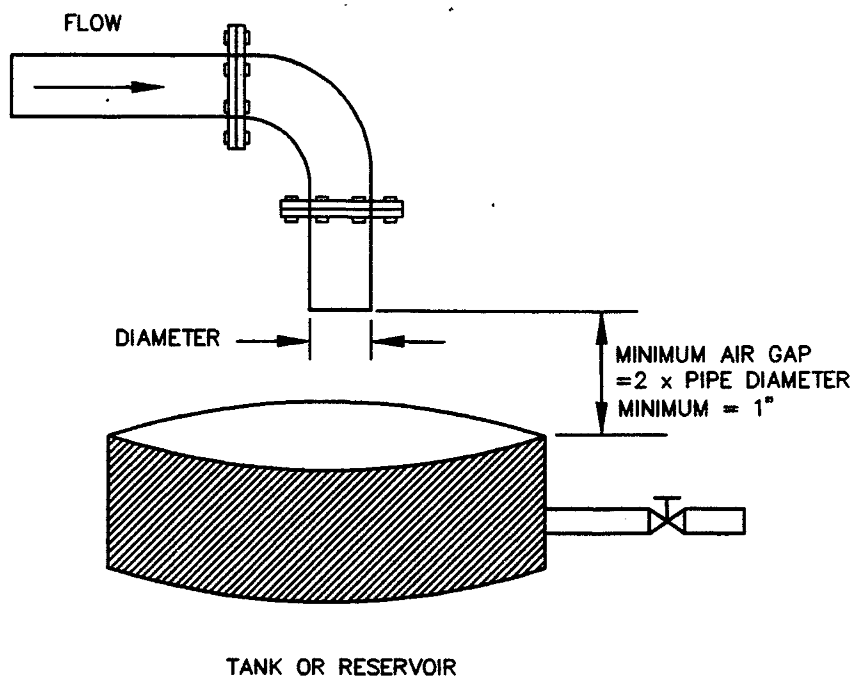
Each of these methods is described in detail on the next several pages.

Air Gap (AG)

An air gap is the unobstructed vertical distance between the lowest opening from any pipe or faucet conveying water or waste and the flood level rim of the receptacle. This vertical physical separation must be at least twice the diameter of the water supply outlet, and never less than 1 inch (25 millimeters [mm]). **Figure 3-3** shows an air gap.

A well-designed and properly maintained air gap is one of the best methods for protection against backflow. Because they can be easily bypassed, air gaps must be regularly inspected.

An air gap can be used to control backflow caused by backsiphonage or backpressure. In the case of extremely hazardous installations, an approved air gap separation is recommended.



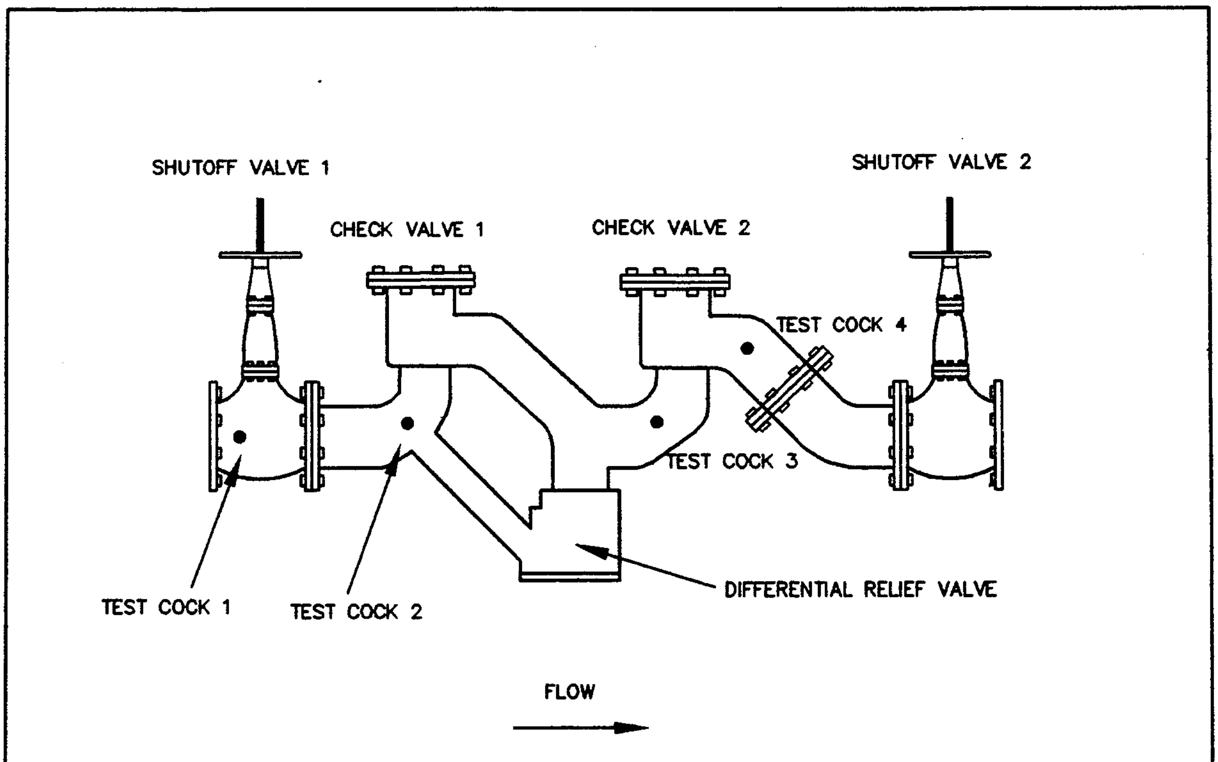
CDM/M&M Team	D.C. WASA Cross-Connection Control Program	Figure No.
	AIR GAP (AG)	3-3

Reduced-Pressure Principle Backflow Prevention Assembly (RPBA)

An approved reduced-pressure principle backflow prevention assembly consists of two independently acting check valves together with a hydraulically operating, mechanically independent pressure differential relief valve located between the two check valves and lower in elevation to the first check valve. **Figure 3-4** shows a typical RPBA.

An RPBA creates a reduced pressure zone between the two check valves. In flow conditions both check valves are open and the relief valve is held closed by supply pressure, allowing water to flow to the downstream piping. In a no-flow or static pressure condition, both check valves will close and the supply pressure will hold the relief valve shut, protecting against backflow.

An RPBA can be used for protection against backpressure and backsiphonage. The RPBA can protect against backflow of both health and non-health related contaminants. One of the advantages of this device is that there is visible flow through the relief valve if one of the check valves fails. It is important to remember that RPBA's are mechanical assemblies that must be regularly tested and maintained to ensure backflow protection.



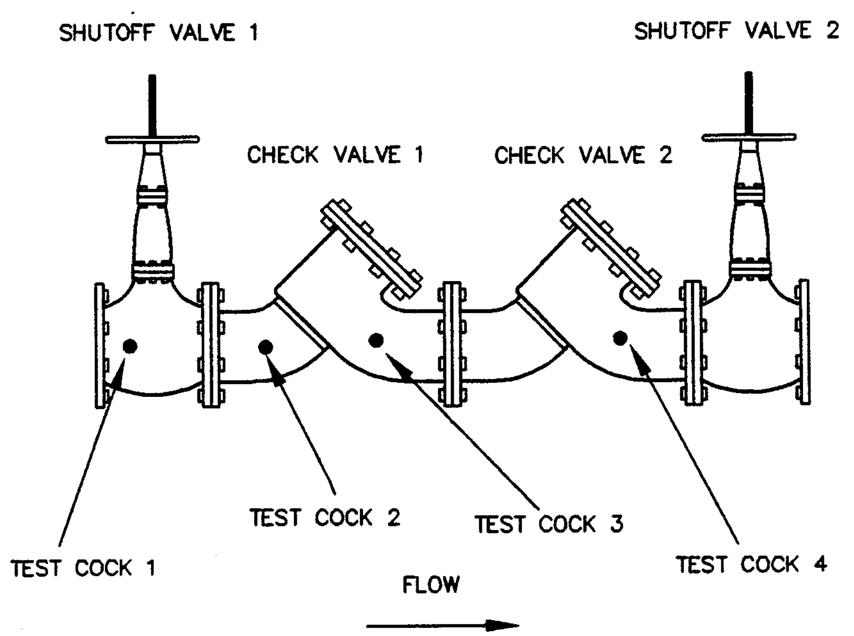
CDM/M&M Team	D.C. WASA Cross-Connection Control Program	Figure No.
	REDUCED-PRESSURE PRINCIPLE BACKFLOW PREVENTION ASSEMBLY (RPBA)	3-4

Double Check Valve Assembly (DCVA)

An approved double check valve assembly consists of two independently acting check valves. Tightly closed, resilient seat shutoff valves are attached at each end, and the assembly is fitted with properly located resilient seated test cocks. The DCVA permits flow during normal operation with the check valves open. If backflow occurs, the check valves will close tightly preventing contamination. **Figure 3-5** shows a typical DCVA.

A DCVA can be used to control backflow caused by back-pressure or backsiphonage. This device should only be used to protect against backflow of non-health related contaminants. It is important to remember that DCVA's are mechanical assemblies that must be regularly tested and maintained to ensure backflow protection.

An approved double check detector assembly (DCDA) is a specially designed DCVA composed of a line-size approved double check valve assembly with a bypass containing a specific water meter and an approved double check valve assembly. This assembly is primarily used on fire sprinkler systems.

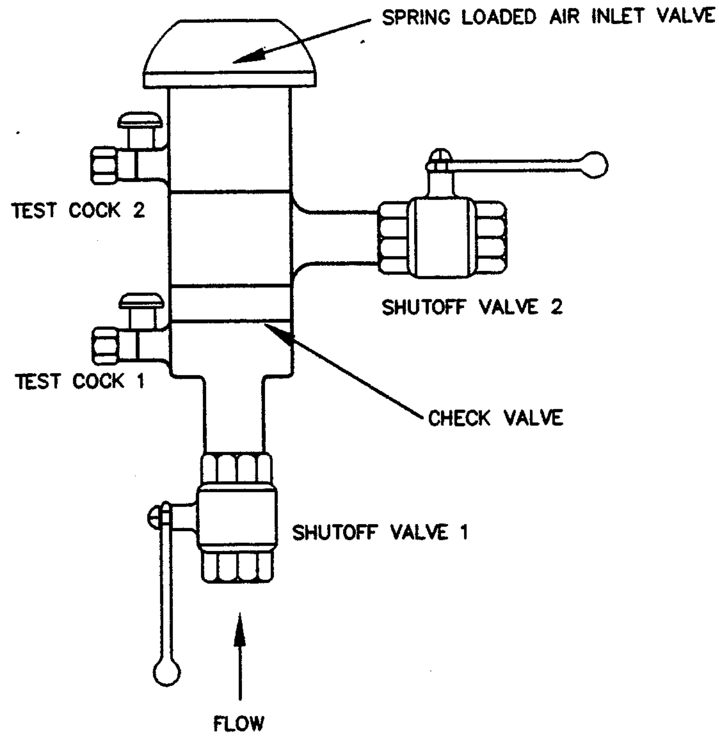


CDM/M&M Team	D.C. WASA Cross–Connection Control Program	Figure No.
	DOUBLE CHECK VALVE ASSEMBLY (DCVA)	3–5

Pressure Vacuum Breaker (PVB)

A pressure vacuum breaker assembly consists of an independently operating, internally loaded check valve and an independently operating loaded air inlet valve located on the discharge side of the check valve, with properly located resiliently-seated test cocks and tightly closing resiliently-seated shutoff valves attached at each end of the assembly. PVB's are designed to operate under pressure for prolonged periods of time to prevent backsiphonage. In a normal flow situation, the internally loaded check valve remains open and the air inlet valve is closed. When a backsiphonage occurs, the internally loaded check valve closes. **Figure 3-6** shows a typical PVB.

A PVB can be used to protect against both health and non-health related contaminants. This device can be only used during backsiphonage and not backpressure in the downstream piping. This assembly is not for use at a meter.

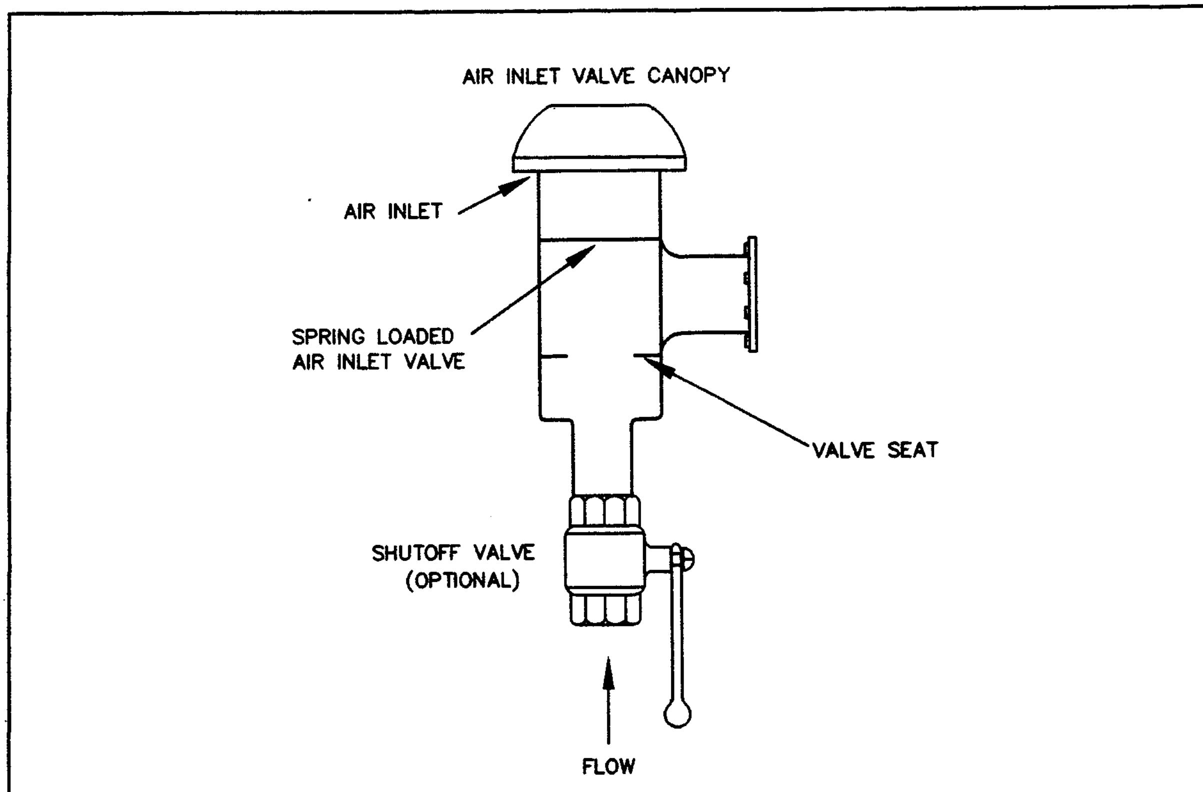


CDM/M&M Team	D.C. WASA Cross–Connection Control Program	Figure No.
	PRESSURE VACUUM BREAKER (PVB)	3–6

Atmospheric Vacuum Breaker (AVB)

The AVB consists of a float check, a check seat, and an air inlet port. A shutoff valve immediately upstream may be an integral part of the assembly. The AVB is designed to allow air to enter the downstream water line to prevent backsiphonage. The flow of water into the body causes the air inlet valve to close the air inlet port(s). When the flow of water stops the air inlet valve falls and forms a check valve against backsiphonage. At the same time it opens the air inlet port(s) allowing air to enter and satisfy the vacuum. **Figure 3-7** shows a typical AVB.

The AVB is used to protect against non-health hazards only and should not be used in situations with continuous operating pressure. This device can be used during backsiphonage and not backpressure in the downstream piping.

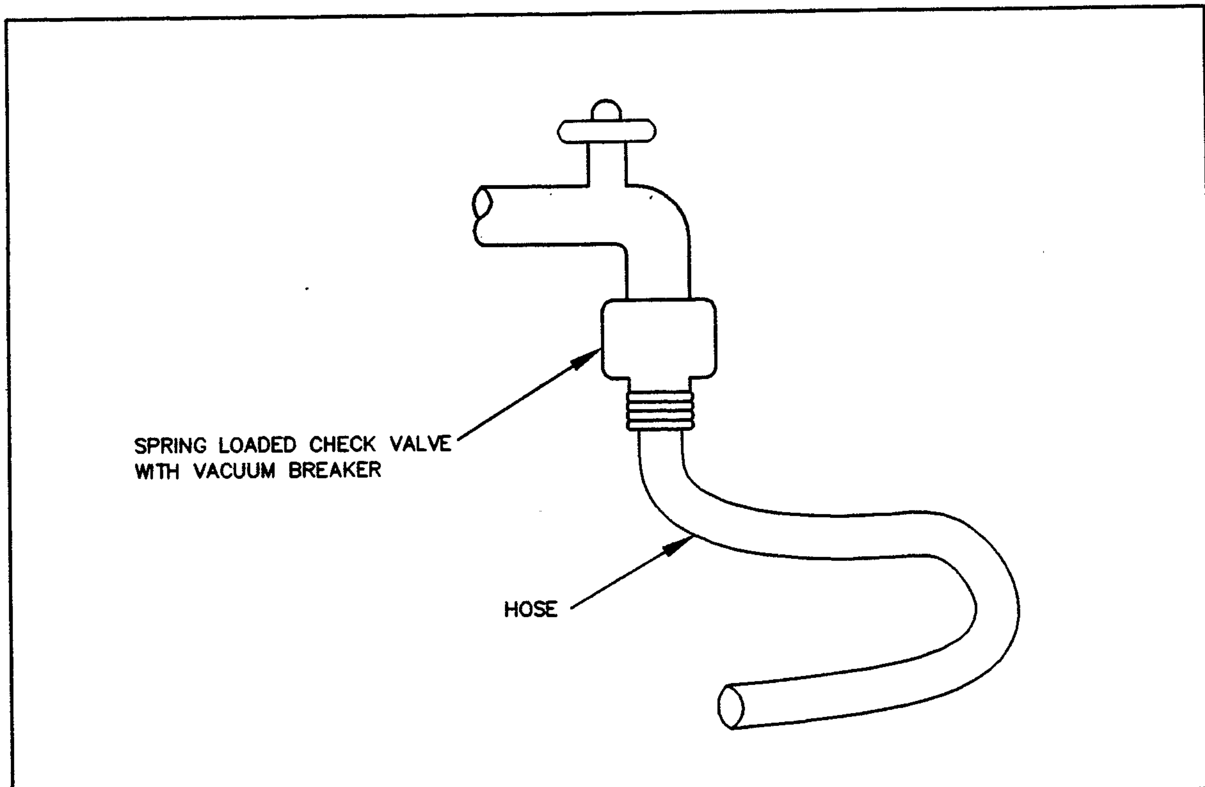


CDM/M&M Team	D.C. WASA Cross–Connection Control Program	Figure No.
	ATMOSPHERIC VACUUM BREAKER (AVB)	3–7

Hose-Connection Vacuum Breaker (HCVB)

A HCVB is an atmospheric vacuum breaker designed to be attached to an outlet having a hose connection thread. The HCVB consists of a spring-loaded check valve that seals against an atmospheric outlet when water supply pressure is turned on.

A HCVB can be used to protect against backsiphonage, but not against backpressure and should not be subject to constant operating pressure. **Figure 3-8** shows a typical HCVB.



CDM/M&M Team	D.C. WASA Cross–Connection Control Program	Figure No.
	HOSE–CONNECTION VACUUM BREAKER (HCVB)	3–8

Section 4
Application of Backflow Prevention Assemblies

This section provides guidelines for selecting approved backflow prevention assemblies for specific situations. A description of the criteria for selecting assemblies is provided first, following by specific recommendation for the different assembly types. Guidelines for selecting backflow preventers for different types of fire protection systems are at the end of this section.

4.1 Criteria for Selecting Assemblies

The following evaluation criteria should be used to select the appropriate backflow preventer at a given location:

- Backflow type
- Operating condition
- Degree of hazard

These are described below.

4.1.1 Backflow Type

The type of backflow that could occur at a cross-connection affects the selection of an appropriate assembly. In general, backflow can be divided into two categories:

- Backsiphonage – Caused by reduced pressure in the supply piping.

- Backpressure – Caused by an induced higher pressure on the non-potable side.

4.1.2 Operating Condition

The selection of backflow preventers depends on whether the supply line operates under continuous pressure or intermittent pressure conditions.

4.1.3 Degree of Hazard

The selection of backflow preventers is most dependent on the degree of perceived hazard associated with the cross-connection.

HIGH HAZARD is a cross-connection involving any substance (contaminant) that, if introduced into the potable water supply, could cause death, illness, spread disease, or has a high probability of causing such effects.

LOW HAZARD is a cross-connection involving any pollutant that generally would not be a health hazard, but that would, if introduced into the potable water supply, constitute a nuisance or be aesthetically objectionable.

Degree of Hazard increases with toxicity of the substance and probability that contamination will occur. The risk associated with the substance's toxicity, however, always governs the final hazard classification.

4.2 Selecting Assemblies for Specific Situations

Table 4-1 provides a listing of backflow prevention assembly types and their suitability under different situations. The situations include the degree of hazard for contamination, what type of backflow is likely to be encountered, and the operating pressure conditions.

This table includes devices that are typically used for facility containment (RPBA's and DCVA's) as well as devices that are typically used for internal and fixture outlet protection. WASA will specify the type of containment device required based on survey results and evaluation criteria established in section 4-1.

WASA will not, however, typically perform detailed internal inspections to isolate high hazards within existing buildings. The consumer is encouraged to work with health and plumbing code officials to ensure that persons living or working within facilities are protected from internal cross-connections. The current plumbing code sets forth guidelines for internal and fixture outlet protection. The consumer can contact DCRA to obtain information on applicable sections of the code and to make sure that their internal plumbing is up to DC standards.

Table 4-1
Criteria for Selecting Assemblies

Assembly Type	Degree of Hazard	Type of Backflow	Operating Condition
Air gap (AG)	High or Low	Backsiphonage or Backpressure	N/A
Reduced-pressure principle backflow prevention assembly (RPBA)	High or Low	Backsiphonage or Backpressure	Can operate under continuous pressure
Double check valve assembly (DCVA)	Low	Backsiphonage or Backpressure	Can operate under continuous pressure
Pressure vacuum breaker (1) (PVB)	High or Low	Backsiphonage	Can operate under continuous pressure
Atmospheric vacuum breaker (AVB)	Low	Backsiphonage	Not be subjected to operating pressure for more than twelve (12) hours in any twenty-four (24) hour period. It is preferable not to have shutoff valve downstream.
Hose-connection vacuum breaker (1) (HCVB)	High or Low	Low head pressure or Backsiphonage	Not be subjected to operating pressure for more than twelve (12) hours in any twenty-four (24) hour period. It is preferable not to have shutoff valve downstream.

(1) In some cases, these devices may not be suitable for high hazard applications depending on toxicity and potential for contamination.

4.3 Selecting Assemblies for Fire Protection Systems

The level of backflow protection for fire protection system depends on the type of system and the potential or actual connections to non-potable water sources. Some fire systems are equipped with pumping connection to allow the fire department to supplement the building sprinkler system in the event of a fire. Other fire protection systems incorporate the use of chemical additives or antifreeze. Simple, or "limited" fire protection systems are typically used in smaller buildings or residences and contain a minimum of sprinkler heads and no pumper connections or chemical additives.

All fire protection systems can be considered potentially hazards due to stagnation of water in the sprinkler piping. As potable water remains unused in pipes, the disinfectant residual will volatilize, a buildup of sediment and corrosion products may occur, microbial growth may increase, and the dissolved oxygen level may fall. In some cases, this water may no longer meet the definition of potable water – safe for human consumption.

Acceptable backflow protection for fire systems can be achieved using a regular double check valve assembly (DCVA), a double check detector assembly (DCDA), a reduced-pressure principle backflow prevention assembly (RPBA), or a reduced pressure-principle detector assembly (RPDA). An older version of the Building Officials and Code Administrators (BOCA) code allowed single check valves on limited systems, but this is no longer allowed in the current code and is not acceptable in the District of Columbia. Metered assemblies (RPDA's and DCDA's) may be required at the direction of the DC Fire Department.

Table 4-2 shows the guideline backflow protection for the different kinds of fire protection systems in DC

Table 4-2
Backflow Protection for Different Type of Fire Protection System

Type of fire protection system	Required protection
System does not incorporate chemical additives, but has one or more fire pumper connections (Siamese connection).	System should be protected using DCVA, DCDA, RPBA, or RPDA.
System is equipped with chemical additives or antifreeze or potential for other high hazard cross-connections exist.	System should be protected by a RPBA or RPDA.
"Limited" system with no chemical additives and no pumper connections. Considered low hazard.	System should be protected by a DCVA or DCDA at minimum.

Section 6
Backflow Prevention Assembly Installation Requirements

All backflow preventers installed in the District of Columbia for facility containment must conform to the installation requirements outlined in this section. Air gaps are addressed first, followed by mechanical devices. Instructions to the consumer for obtaining the necessary installation approval from WASA and the plumbing permit from DCRA are provided in Section 6.3.

6.1 Air Gap Separation Using Receiving Tanks

The receiving tank must be installed inside the building near the service connection.
For the purpose of inspection, the water supply pipe between the meter and the tank must to be exposed. The distance between the free flowing discharge end of supply line and the overflow rim of the tank must be at least twice the diameter of the water supply outlet, and never less than 1 inch. The pipe between the meter and the discharge point can not contain any outlet, tee, tap or any other connection.

6.2 Mechanical Devices

6.2.1 General Requirement of Installation

Backflow prevention assemblies must be installed by a **licensed plumber** (see Section 9 of this manual for certification requirements). Backflow preventers must also be initially tested by a **certified backflow prevention assembly tester** (this person must also be a licensed plumber) using the procedures outlined in Section 8. The consumer is responsible for contracting with a certified backflow prevention assembly tester for this work. WASA will maintain a current list of certified persons in the District.

Mechanical backflow prevention devices must be located to permit easy access and adequate and convenient space for maintenance, inspection, and testing.

Whenever possible, an approved backflow prevention assembly should be installed within a building on the service connection after, but close, to the meter. In certain cases as approved by WASA's cross-connection control office, backflow prevention assemblies may be installed at an alternative location such as outdoors. Installation of DCVA's in pits shall be approved only as provided in item 6.2.4 of this section. Installation of RPBA's in pits is prohibited due to flooding concerns. Regardless of its location, assemblies must be protected from freezing, flooding, and mechanical damage.

In some facilities, backflow prevention assemblies installed in parallel may be necessary to meet the needs of the facility:

1) If the facility requires uninterrupted service and where it is not possible to shut down the water lines to permit necessary testing and maintenance

2) If the service line to be protected is considered greater than 10 inches

If a bypass line is required, both lines shall be equipped with approved backflow prevention assemblies. The combined hydraulic capacity of the parallel lines/backflow preventers shall be equal to or greater than the line that is being subdivided.

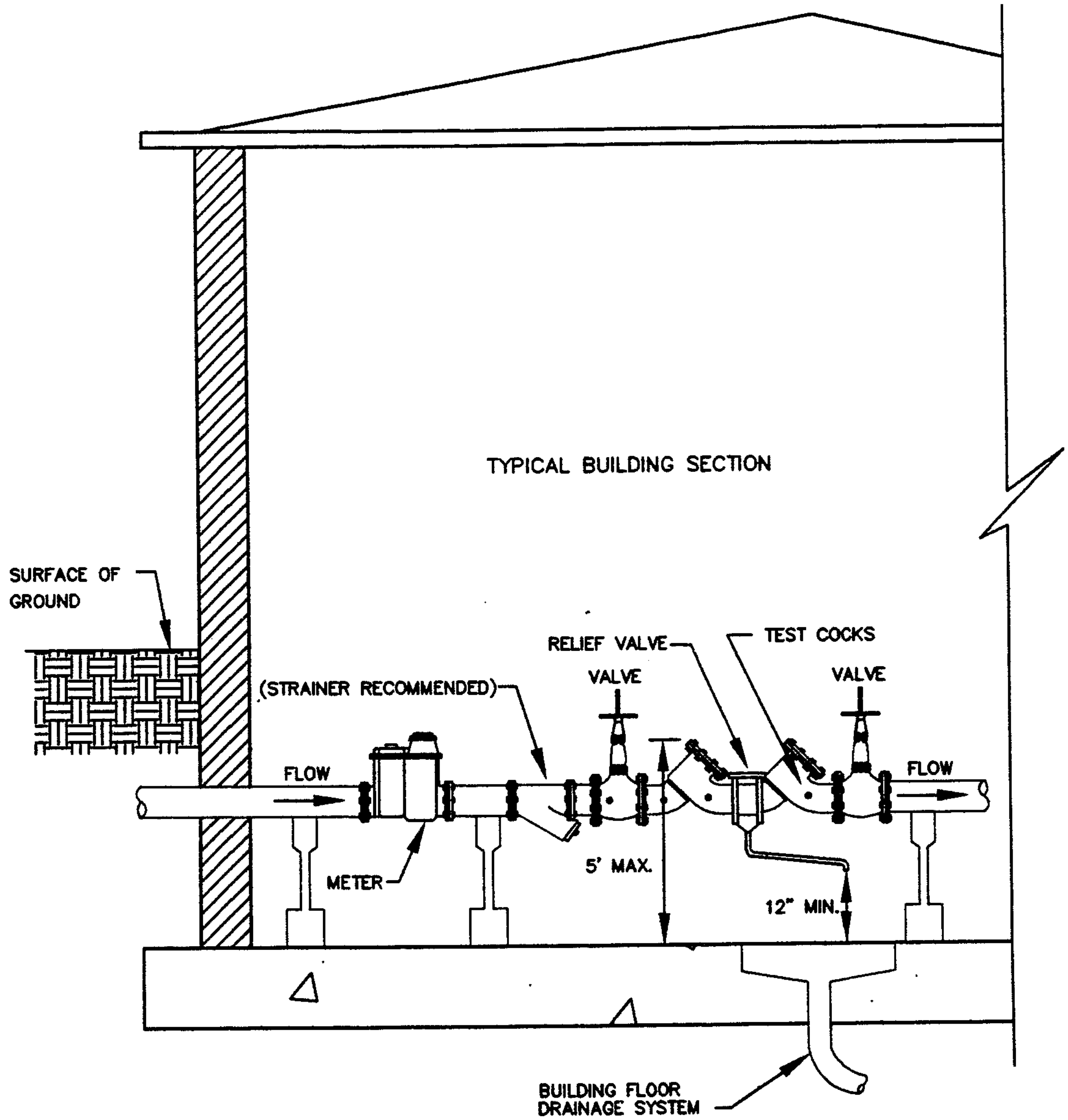
The backflow unit must be maintained as an assembly. The device must be equipped with proper shutoff valves, attached to the assembly, for maintenance and testing. For fire protection systems, shutoff valves must be UL or FM approved. Approved assemblies should be shipped from the manufacturer with shutoff valves and test cocks. The installation of a strainer before the device is recommended to prevent mechanical damage.

6.2.2 Installation of Approved RPBA and RPDA

Reduced pressure principle assemblies must be installed a minimum of 12-inches and a maximum of 5 feet from the floor to the bottom of the device. The device must be a minimum of 12 inches from any wall. Devices must be installed in horizontal alignment unless the device is approved by WASA for vertical installation. Drainage must be provided for the relief valve port and must meet minimum air gap requirements. See **Figure 6-1** for indoor installation of an RPBA.

6.2.3 Installation of Approved DCVA and DCDA

Double check valve assemblies must be installed a minimum of 12-inches and maximum of 5 feet from the floor to the bottom of the device. The device must be minimum of 12 inches from any wall. Devices must be installed in horizontal alignment unless the device is approved by WASA for vertical installation. See **Figure 6-2** for indoor installation of a DCVA. Protection against freezing and vandalism must be provided for outdoor installations. See Section 6.2.4 for requirements for pit installations.



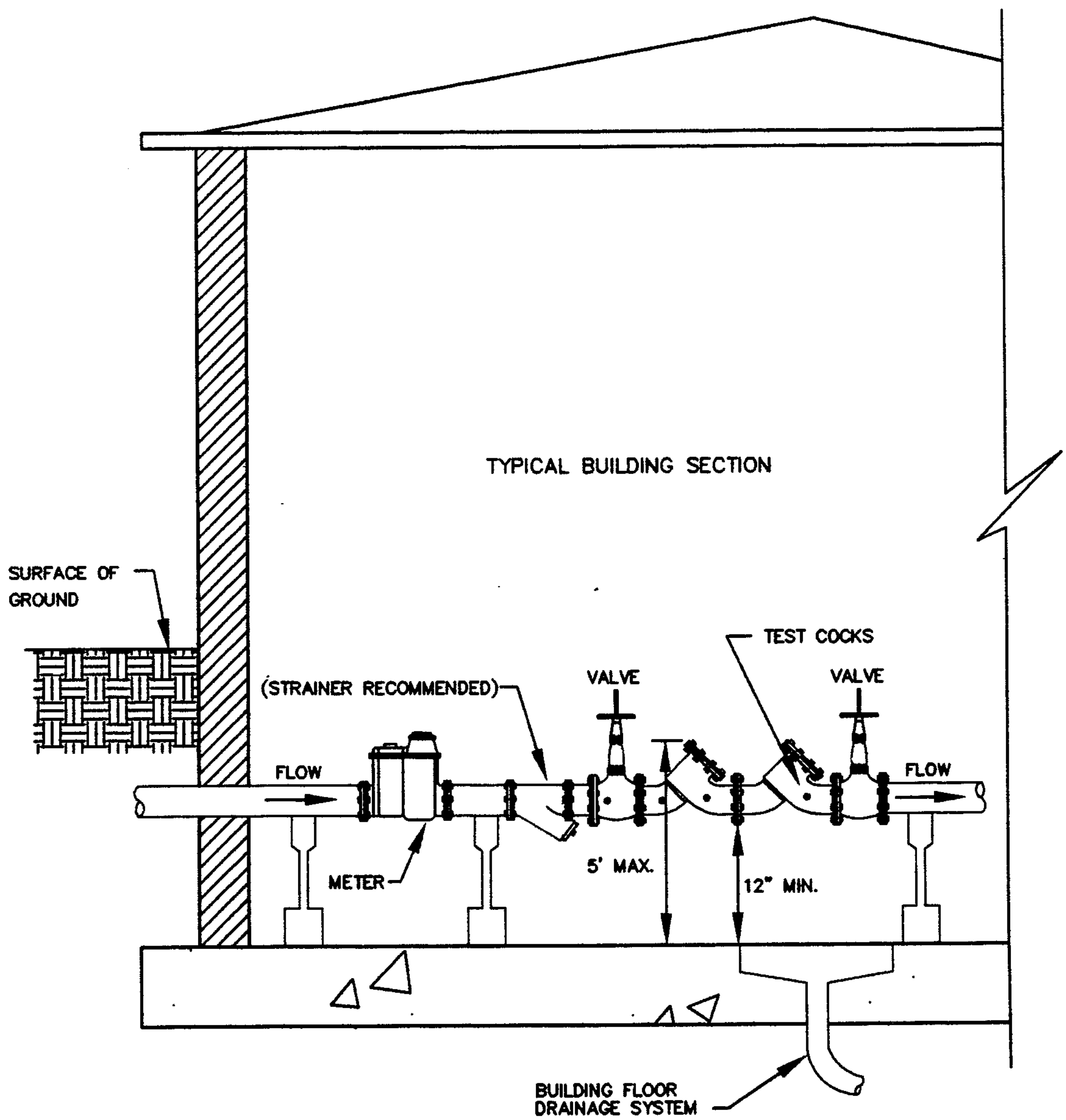
NOTES:

(1) BACKFLOW PREVENTERS TO BE SET A MINIMUM OF 12 IN. FROM FLOOR TO THE LOWEST PART OF DEVICE AND A MAXIMUM OF 5 FT. FROM THE FLOOR TO THE TOP OF DEVICE AND 12 IN. FROM ANY WALL.

(2) THE BUILDING FLOOR DRAINAGE SYSTEM MUST BE CAPABLE OF ACCEPTING THE MAXIMUM FLOW FROM THE UNIT'S RELIEF VALVE.

CDM/M&M Team	D.C. WASA Cross–Connection Control Program	Figure No.
	RPBA INSTALLATION	6–1

Figure Adapted from Information Contained in Reference 4



NOTE:
BACKFLOW PREVENTERS TO BE SET A MINIMUM OF 12 IN. FROM FLOOR TO THE LOWEST PART OF DEVICE AND A MAXIMUM OF 5 FT. FROM THE FLOOR TO THE TOP OF DEVICE AND 12 IN. FROM ANY WALL.

CDM/M&M Team	D.C. WASA Cross–Connection Control Program	Figure No.
	DCVA INSTALLATION	6–2

Figure Adapted from Information Contained in Reference 4

6.2.4 Installation of DCVA's and DCDA's in Below-Ground Pits:

1) **Installation of RPBAs and RPDAs in below ground pits is prohibited.** Installation of DCVAs and DCDAs in below ground pits is allowed in certain circumstances if approved by the WASA Water Quality Office. Installations must comply with OSHA standards where applicable for work in confined spaces.

2) The pit interior must be a minimum of 10 feet long, 6 feet wide, and must have a clear height 6 ½ feet high.

3) The pit must be watertight. Adequate drainage must be provided. The drain line must not be connected to a sewer.

4) The pit opening and manhole cover must be at least 30 inches in diameter.

See **Figure 6-3** for installation requirements for DCVA's and DCDA's in below-ground pits.

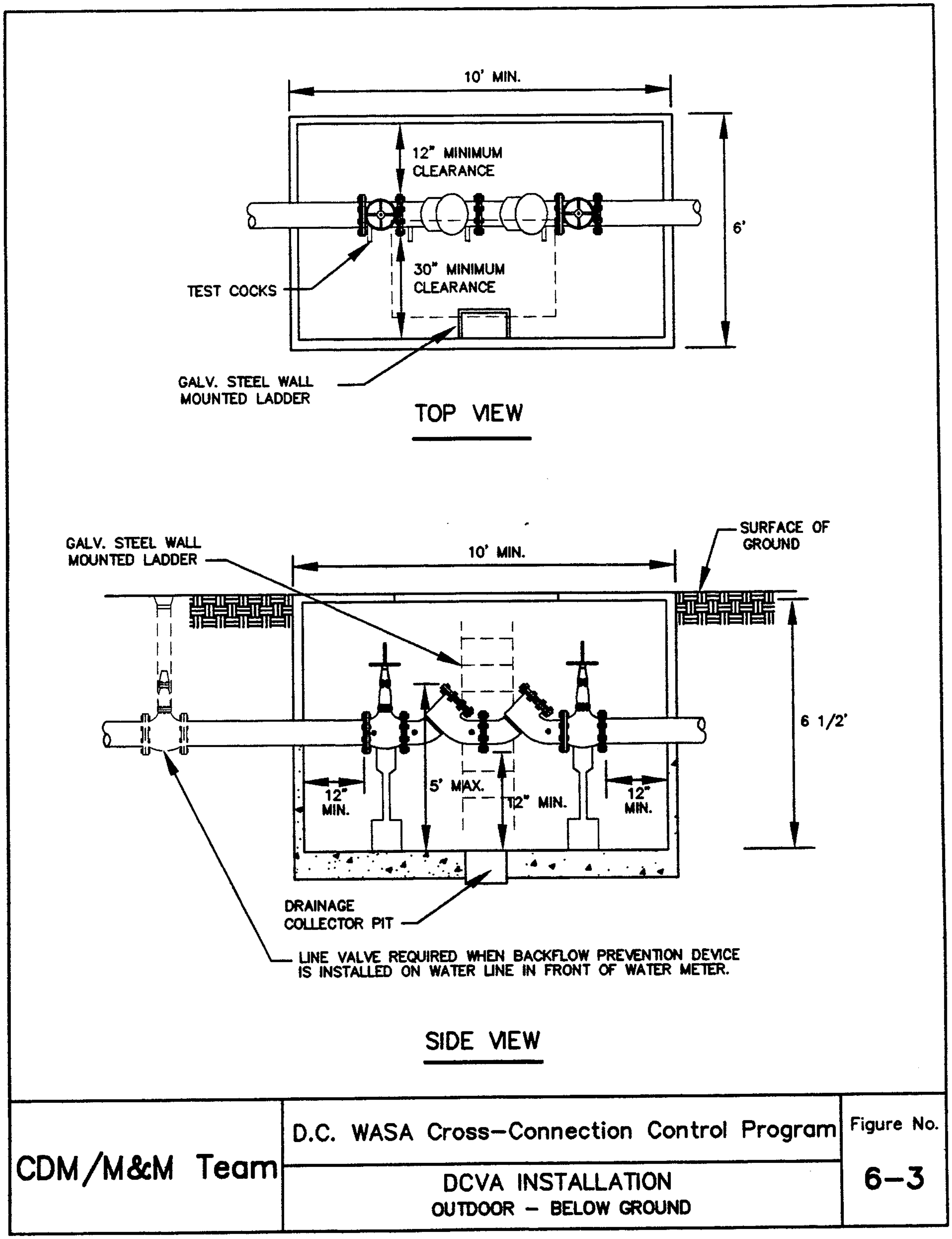


Figure Adapted from Information Contained in Reference 4

6.3 Backflow Preventer Installation Plan Approval

Plans for installation of backflow prevention assemblies in existing buildings must be submitted to the WASA Water Quality Division for review and approval. (See Directory in front of manual). The submittal must include the following:

1) Facility Information

- Facility Name
- Address
- Contact Person/Agency
- Telephone number of facility contact person
- Indicate whether facility is new or existing
- Describe generally the type of business or activities carried out at this facility

2) Device Data (for each device)

- Type of Backflow Prevention Assembly
- Manufacturer
- Model No.
- Size
- Location of Device
- Bypass Arrangement
- Type of Gate Valve (Gate Valve if are used for fire protection systems must be UL-or FM-approved.)

3) Plumbing Plan

a. Completed title block (name of facility, address, date, preparer, scale, etc.)
b. Schematic plumbing system (at least 8 ½" x 11") using accepted symbols and nomenclature, detailing:
   - Clearances in device installation
   - Location of upstream and downstream shutoff valves
   - Make, model, size and alignment of device
   - Location of potable water lines
   - System, source, or equipment downstream of device, complete with information on the secondary system (operating pressure, chemical treatment, etc.)

Where installation will involve large or complex plumbing systems, formal prints must be submitted with a Professional Engineers stamp.

Mechanical backflow prevention assemblies should be sized hydraulically, taking into account both volume requirements of the service and head loss of the assembly. Installation plans must address thermal expansion.

After approval from WASA, the consumer must obtain the proper approval from the plumbing official (DCRA). Installation plans for fire protection systems must also be approved by the DC fire department.

8.2.1 Basic Steps Prior To Field Testing

The technician must observe the condition of the test gauge equipment during all steps of the following field test procedures. The gauge should zero out when not pressurized, needle valves and fittings must be drip tight, and the gauge should be drained after testing to protect against freezing. Gauge calibration procedures are provided in Section 8.3. The technician must observe general safety procedures during all aspects of the field test and maintenance procedures, such as personal safety, elevated platforms, electrical hazards, and tools.

In addition to the above, there are five (5) important basic steps that need to be followed before each of the field test procedures:

1. **Notification** – Notify the facility contact or onsite personnel that water service will be shut off during the test procedure. Special arrangements may need to be made so that interruption of service will not create a hardship on the user. Also, notify the fire department if you are shutting down a fire protection system for longer than one hour. It is advisable to point out to the consumer, or his representative, that while the water is shut off during the test period, any inadvertent use of water within the building will reduce the water pressure to zero. Backsiphonage could result, if unprotected cross-connections exist, which would contaminate the building water supply system. In order to address this situation, it is recommended that the consumer caution the inhabitants of the building not to use the water until the backflow test is completed and the water pressure restored.

2. **Inspection** - Inspect the assembly for the required components for the field test procedure, such as upstream and downstream shutoff valves and properly placed test cocks.

3. **Identification** – Make sure the proper assembly is being tested by checking the identification tag for make (manufacturer), model, and serial number. Number the test cocks, starting at the water inlet.

4. **Observation** – Observe area around the assembly carefully for telltale signs of leakage, such as moss or algae growth, plant life, or soil erosion. This should supply the tester with additional information regarding the condition of the assembly before the test is performed. For example, wet spots under relief valve port of reduced pressure principle backflow prevention assembly is an indication of relief valve activity, possibly from pressure fluctuations or fouling of the assembly. Proper testing will define the problem.

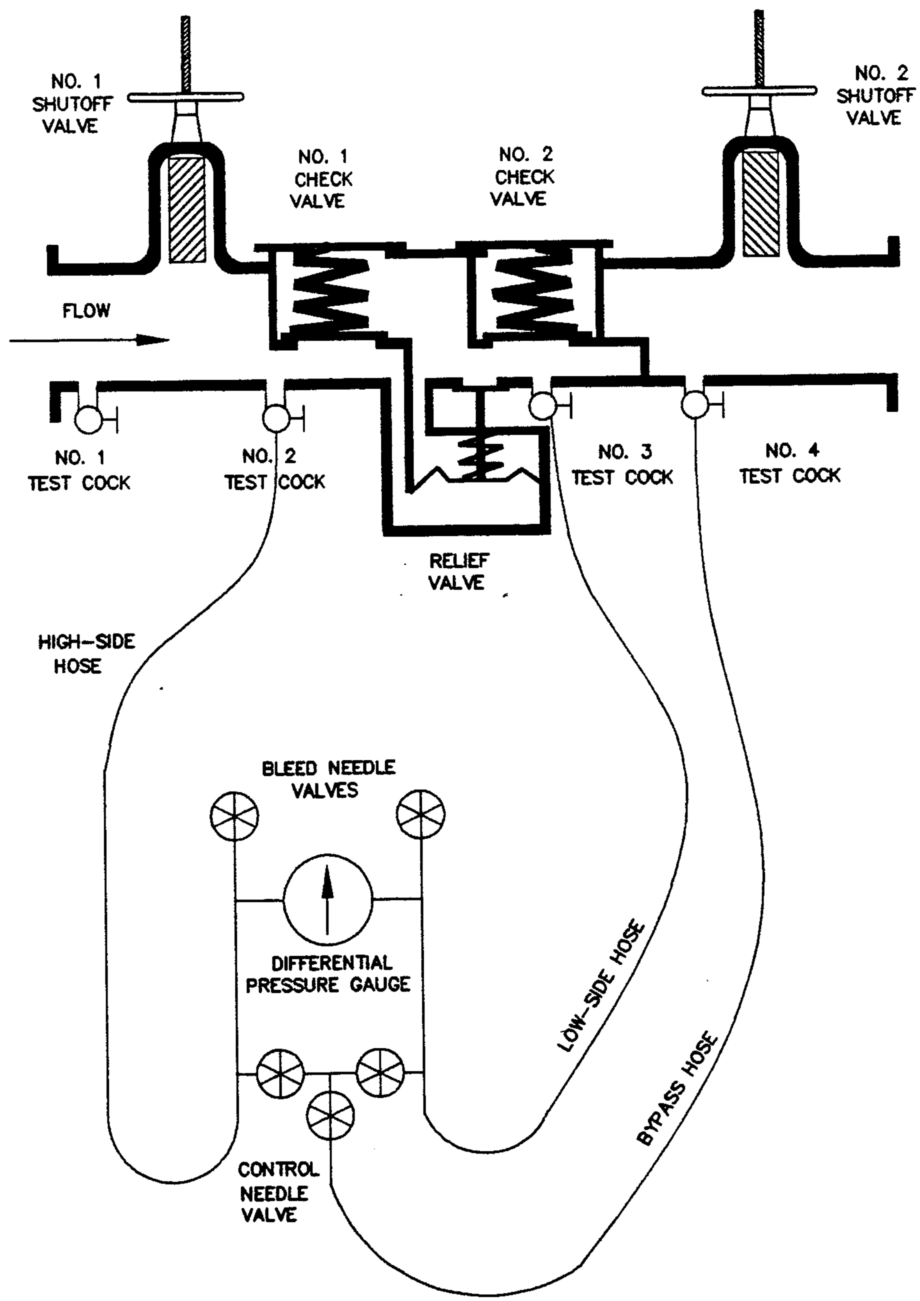
5. **Documentation** – Record all information on the Backflow Preventer Test Report (blank reports are in Appendix B) and submit the completed certified form to WASA's Water Quality Office after each test.

8.2.2 Reduced Pressure Principle Assembly Test Procedure

8.2.2.1 Equipment required

The following equipment is required as shown in **Figure 8-1**:

1. Differential pressure gauge – minimum range 0-15 PSID (0.1 or 0.2 PSID graduations) with a working pressure of 500 psi.
2. Three 6-feet lengths high pressure hose – minimum ¼ inch diameter
3. ¼-inch needle valves for fine control of flows
4. Three ¼-inch IPS x 45 degree SAE flare connectors – brass
5. Adapter fittings for each test cock size – brass, i.e. 1/8 inch x ¼ inch, ¼ inch x ½ inch, ¼ inch x ¾ inch



CDM/M&M Team	D.C. WASA Cross–Connection Control Program	Figure No.
	HOOK–UP OF EQUIPMENT FOR TESTING RPBA	8–1

Figure Adapted from Information Contained in References 2 & 3

8.2.2.2 Test Procedure

Test No 1: Relief Valve Opening Point

Purpose: To test the operation of the differential pressure relief valve.

Requirement: The differential pressure relief valve must operate to maintain the zone between the two checks valves at least 2 PSI less than the supply pressure.

Note: It is important that during this test the tester does not cause the relief valve to discharge before step 10 below.

Steps:

1. Open No. 4 Test Cock to establish flow through the unit, then flush water through No. 1, No. 2 (open No. 2 Test Cock slowly), and No. 3 Test Cocks, by opening and closing each test cock one at a time. This will eliminate foreign material. Be careful not to activate the relief valve during this process. Close No. 4 Test Cock.

2. Install appropriate fittings to test cocks.

3. Install hose from the high side of the differential pressure gage to the No. 2 Test Cock.

4. Install hose from the low side of the differential pressure gauge to the No. 3 Test Cock.

5. Open No. 3 Test Cock slowly and then bleed all air from the hose and gauge by opening the low side bleed needle valve.

6. Maintain the low side bleed needle valve in the open position and slowly open No. 2 Test Cock.

7. Open the high side bleed needle valve to bleed all air from the hose and gauge.

8. Close the high side bleed needle valve, then close the low side bleed needle valve after the gauge reading has reached the upper end of the scale.

9. Close No. 2 Shutoff Valve. Should the gauge reading drop to the low end of the gauge scale and the differential pressure relief valve discharge continuously, then the No. 1 Check Valve is leaking. Test No.1, No. 2 and No. 3 may not be completed.

10. Observe the apparent pressure drop across No. 1 Check Valve. During all subsequent steps of this procedure the differential gauge is "on line", showing the pressure drop across No. 1 Check Valve.

11. Open the high-side control needle valve, then open the low-side control needle valve no more than one-quarter (1/4) turn to bypass water from No. 2 Test Cock to No. 3 Test Cock. If the

low-side control needle valve must be opened more than one-quarter (1/4) turn, then see Instructions for a Leaking Shutoff Valve.

12. Watch the pressure differential drop slowly to the relief valve opening point. Record this opening point pressure value.

13. Close the needle valves.

Test No. 2 – Tightness of No. 2 Check Valve

Purpose: To test the No. 2 Check Valve for tightness against reverse flow.

Requirement: The No. 2 Check Valve shall be tight to prevent reverse flow under all pressure differentials.

Steps:

1. Maintain the No. 2 Shutoff Valve in a closed position (from Test No. 1)

2. Vent all of the air through the bypass hose by opening both the high side control needle valve and the bypass needle valve. Close the bypass needle valve only, leaving the high side control needle valve open.

3. Attach the bypass hose to the No. 4 Test Cock, and then open the No. 4 Test Cock.

4. Bleed water from the zone by opening the low side bleed needle valve on the gauge in order to reestablish the normal reduced pressure within the zone. Once the gauge reading reaches a value above the apparent No. 1 Check Valve pressure drop, close the low side bleed needle valve.

5. Open the bypass needle valve.

   - If the indicated differential pressure reading remains steady, then the No.2 Check Valve is reported as "closed tight." Go to Test No. 3.

   - If the differential pressure reading falls to the relief valve opening point, bleed water through the low side bleed needle valve until the gauge reading reaches a value above the apparent No. 1 Check Valve pressure drop. If the gauge reading settles above the relief valve opening point, record the No. 2 Check Valve as "closed tight," and proceed to Test No. 3. If the differential pressure reading falls to the relief valve opening point again, then the No. 2 Check Valve is noted as "leaking," and Test No. 3 below cannot be completed.

   - If the differential pressure reading drops, but stabilizes above the relief valve opening point, the No. 2 Check Valve can still be reported as "closed tight".

- If the reading on the gauge increases to the high end of the scale, see the USC/FCCHR Manual of Cross-Connection Control 9th edition, Section 9.2.3.5-Backpressure Condition.

Test No. 3 – Tightness of No. 1 Check Valve

Purpose: To determine the tightness of No. 1 Check Valve, and to record the static pressure drop across No. 1 Check Valve.

Requirement: The static pressure drop across No. 1 Check Valve should be at least 3.0 psi greater than the relief valve opening point (Test No. 1). This 3.0 psi buffer will prevent the relief valve from discharging during small fluctuations in line pressure. A buffer of less than 3.0 psi does not imply a leaking No. 1 Check Valve, but rather is an indication of how well No. 1 Check Valve is sealing.

Steps:

1. With the bypass hose connected to No. 4 Test Cock as in step 5 of Test No. 2 (above), bleed water from the zone through the low side bleed needle valve on the gauge until the gauge reaches the high end of the scale. Close the low side bleed needle valve. After the gauge reading settles, the steady state differential pressure reading indicated (reading is not falling on the gauge) is the actual static (that is no flow) pressure drop across No.1 Check Valve and is recorded as such.

2. Close all test cocks, slowly open No. 2 Shutoff Valve, and remove all test equipment.

8.2.2.3 Troubleshooting

Table 8-1 summarizes possible causes of problems encountered during the RPBA test. Instructions for leaking No. 2 Shutoff Valve are provided below.

Instructions for Leaking No. 2 Shutoff Valve

If the differential pressure reading on the gauge during Test No. 1, step 11, does not change, or the low side control needle valve must be opened more than one quarter (1/4) turn, it is likely that the No. 2 Shutoff Valve is leaking. The No. 2 Shutoff Valve should be re-opened and closed in an effort to get a better seal. This may particularly occur when testing units, which do not have resilient seated shutoff valves. Also make sure that test hose fittings are drip-tight.

In Tests No. 1, No. 2, and No. 3 above, a leaking No. 2 Shutoff Valve may affect the accuracy of the recorded values. A small leak in the No. 2 Shutoff Valve can be tolerated as long as the hose capacity is enough to satisfy the leak of the No. 2 Shutoff Valve. If the hose capacity is not enough, see the USC/FCCHR Manual of Cross-Connection Control 9th edition, Section 9.2.3.3 for instructions on installing a temporary bypass hose.

Table 8-1
RPBA Troubleshooting

Problem	**Possible Causes** (1)
Relief valve discharges continuously	1. Faulty No. 1 check valve 2. Faulty No. 2 check valve with backpressure condition 3. Faulty relief valve 4. Plugged relief valve connection line
Relief valve discharges intermittently	1. Fluctuating supply pressure 2. No. 1 check buffer is too small (that is less than 3.0 psi), with line pressure fluctuation
Relief valve discharges after No. 2 shutoff valve is closed (Test No. 1, step 9)	Normally indicates faulty No. 1 check valve Dirty or damaged disc or seat
Relief valve would not open, low side control needle valve must be operated more than ¼ turn (Test No. 1, step 11)	Leaking No. 2 shutoff valve with flow through the assembly (see instruction for leaking shutoff valve under troubleshooting)
Relief valve would not open, differential drops to zero (Test No. 1, step 11)	1. Relief valve stuck, closed due to corrosion or scale 2. Relief valve connection line plugged
Relief valve opens at too high pressure (with sufficiently high No. 1 check valve reading)	1. Faulty relief valve a. Dirty or damaged disc b. Dirty or damaged seat
No. 1 check valve reading too low (less than 3.0 psi buffer) (Tests No. 1 and No. 3)	1. Dirty or damaged disc 2. Dirty or damaged seat 3. Valve guide members hanging up
Leaky No. 2 check valve (Test No. 2)	1. Dirty or damaged disc 2. Dirty or damaged seat 3. Valve guide members hanging up

(1) Many problems can be corrected by cleaning the internal components of the backflow prevention assemblies. Carefully observe condition of the components.

Repair note: Lubricants shall only be used to assist with the reassemble of components, and shall be non-toxic.

8.2.3 Double Check Valve Assembly Test Procedure

8.2.3.1 Equipment Required:

The following equipment is needed:

1. Differential pressure gauge – minimum range 0-15 PSID (0.1 0r 0.2 PSID graduations)
2. One 6-feet length high pressure hose – minimum ¼-inch diameter
3. ¼-inch needle valves, for fine control of flows
4. One ¼-inch IPS x 45 degree SEA flare connector – brass
5. Adapter fittings for each test cock size – brass, i.e. 1/8 inch x ¼ inch, ¼ inch x ½ inch, ¼ inch x ¾ inch
6. Street ell, pipe nipple, or tube
7. Bleed-off valve

8.2.3.2 Test Procedures

Test No. 1 – Tightness of No. 1 Check Valve

Purpose: To determine the static pressure drop across No. 1 Check Valve.

Requirement: The static pressure drop across No. 1 Check Valve shall be at least 1.0 PSID.

Note: For both Test No.1 and No.2, the differential pressure gauge must be held at the same level as the assembly being tested. Be sure that hoses not being used are also kept at this level.

Steps: (See **Figure 8-2**)

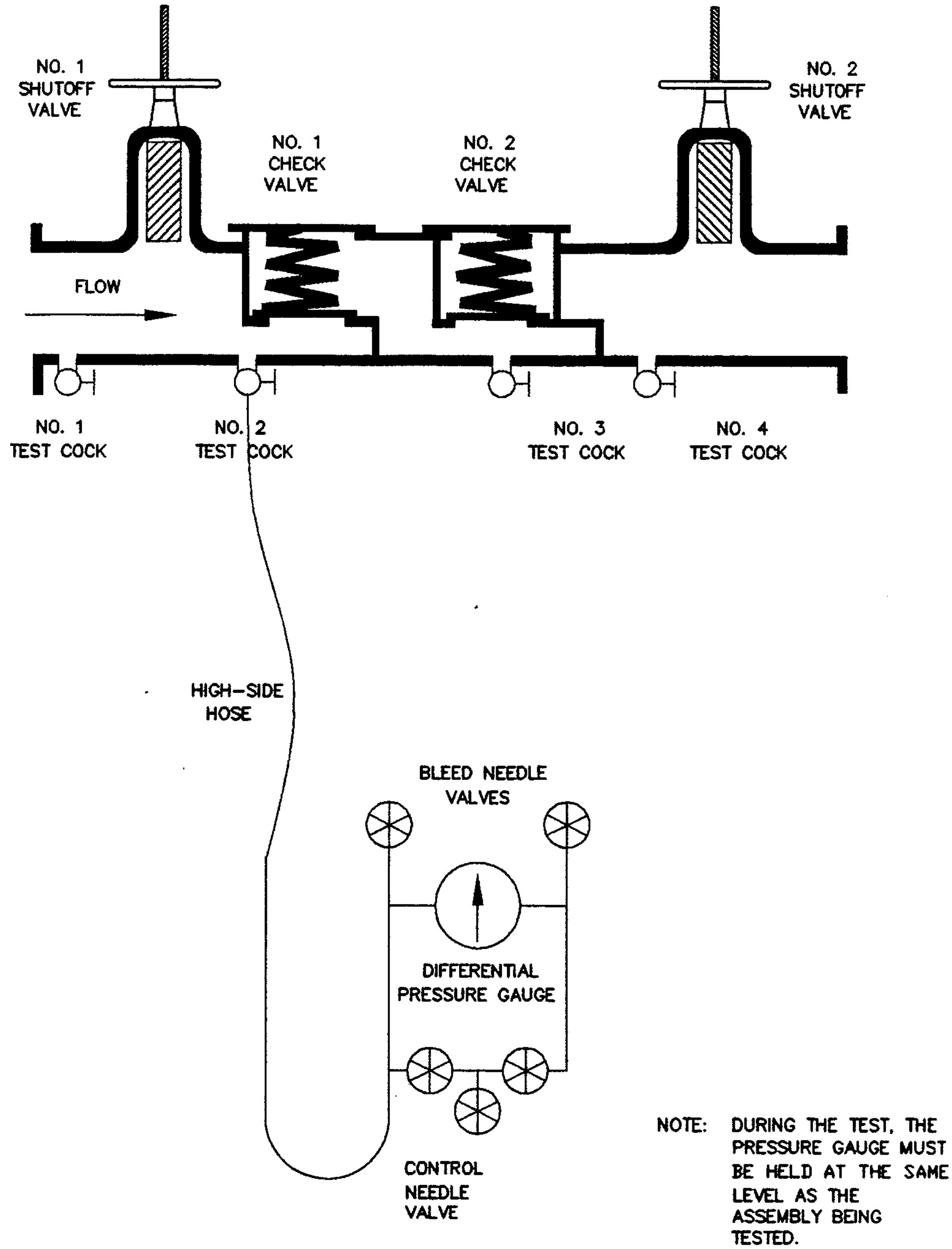
1. Bleed water through all four test cocks, one at a time, to eliminate foreign material.

2. Install appropriate fittings.

3. If No. 3 Test Cock is not at the highest point of the check valve body, then a vertical tube or pipe must be installed on No. 3 Test Cock so that it rises to the top of the check valve body. (Note: If a vertical tube or pipe is attached, the gauge must be held at the same height as the water in the tube during the test)

4. Install bleed valve arrangement and hose from the high side of the differential pressure gauge to the No. 2 Test Cock.

5. Open No. 2 Test Cock and bleed all air from the hose and gauge by opening the high side bleed needle valve, then close the high side bleed needle valve. If a tube is attached to No. 3 Test Cock, open No. 3 Test Cock to fill the tube, then close No. 3 Test Cock.



CDM/M&M Team	D.C. WASA Cross–Connection Control Program	Figure No.
	HOOK–UP OF EQUIPMENT FOR TESTING DCVA – TEST NO. 1	8–2

Figure Adapted from information Contained in References 2 & 3

6. Close No. 2 Shutoff Valve, then close No. 1 Shutoff Valve.

7. Slowly open No. 3 Test Cock. After the gauge reading stabilizes and water stops running out of No. 3 Test Cock, the steady state differential pressure reading indicated on the gauge is the static pressure drop across No. 1 Check Valve and is to be recorded as such. Proceed to step 8. Should there be a continuous discharge of water from No. 3 Test Cock or, if the water level at No. 3 Test Cock recedes, see Troubleshooting Section 8.2.3.3.

8. Close all test cocks, open No. 1 Shutoff Valve, and remove all test equipment.

Test No. 2 – Tightness of No. 2 Check Valve

Purpose: To determine the static pressure drop across No. 2 Check Valve.

Requirement: The static pressure drop across No. 2 Check Valve shall be at least 1.0 PSID.

Steps: (See **Figure 8-3**)

1. Install bleed-off valve arrangement and hose from the high side of the differential pressure gauge to the No. 3 Test Cock. If No. 4 Test Cock is not at the highest point of the check valve body, then a vertical tube or pipe must be installed on No. 4 Test Cock so that it rises to the top of the check valve body.

2. Open No. 3 Test Cock, and bleed all air from the hose and gauge by opening the high side bleed needle valve, and then closing the high side bleed needle valve. If a tube is attached to No. 4 Test Cock, open No. 4 Test Cock to fill the tube, then close No. 4 Test Cock.

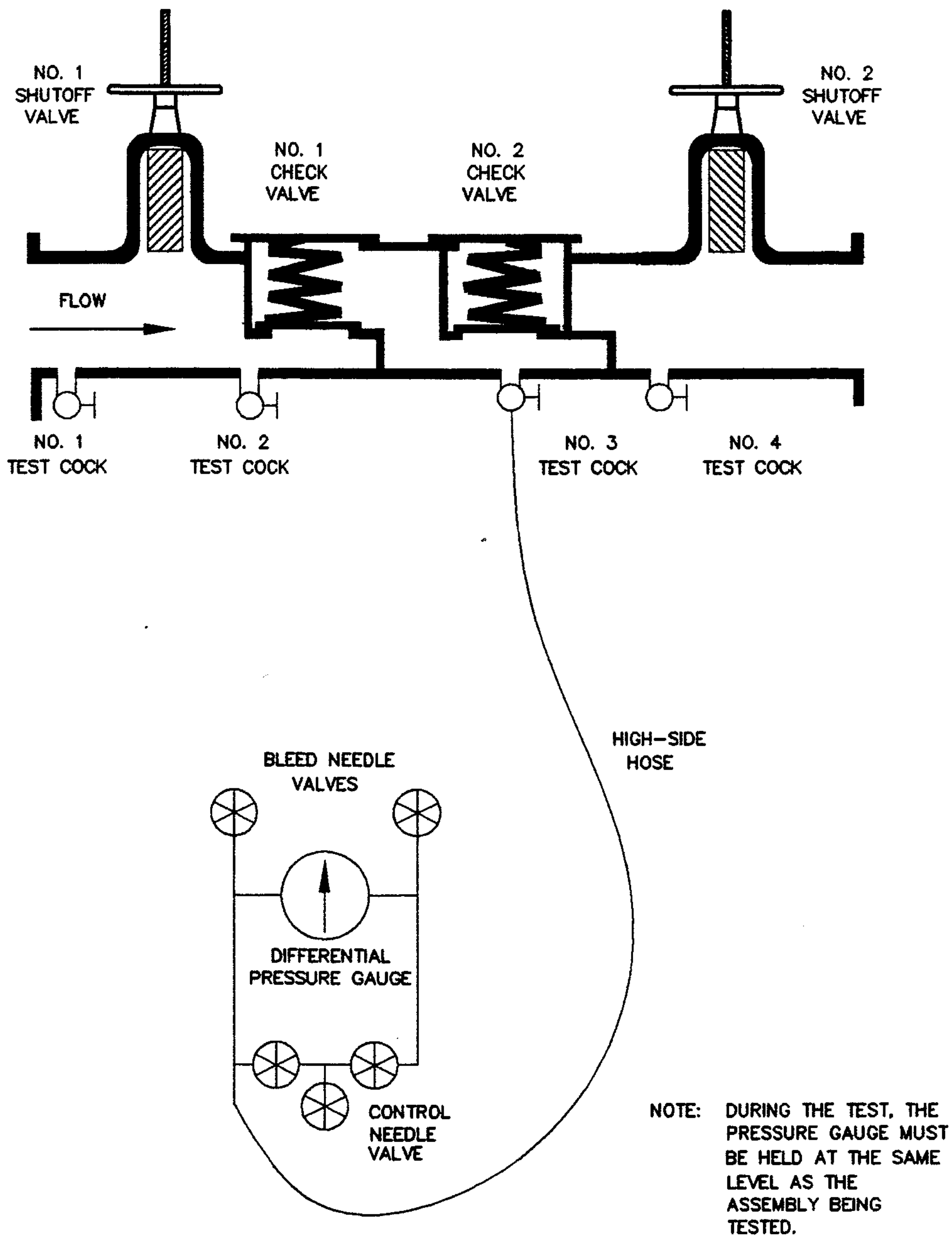
3. Close No. 1 Shutoff Valve.

4. Slowly open No. 4 Test Cock. After the gauge reading stabilizes and water stops running out of No. 4 Test Cock, the steady state differential pressure reading indicated is the static pressure drop across No. 2 Check Valve and is to be recorded as such. Go to Step 6. Should there be a continuous flow of water from No. 4 Test Cock, see Troubleshooting section 8.2.3.3. If the water recedes from the No. 4 Test Cock proceed to step 5.

5. Should the water at No. 4 Test Cock recede, there is a leaking No. 2 Shutoff Valve. Move the gauge to the centerline of the assembly and record the gauge reading as the pressure differential across the No. 2 Check Valve.

6. Close all test cocks and remove all test equipment.

7. Remove fittings. Open No. 1 Shutoff Valve, then slowly open No. 2 Shutoff Valve.



CDM/M&M Team	D.C. WASA Cross–Connection Control Program	Figure No.
	HOOK OF EQUIPMENT FOR TESTING DCVA – TEST NO.2	8–3

Figure Adapted from Information Contained in References 2 & 3

8.2.3.3 Troubleshooting

Many problems can be corrected by cleaning the internal components of the backflow prevention assemblies. The following Section describes additional testing required if leaking shutoff valves are found during the tests. These steps in this section are numbered as T (Trouble Shooting) for ease of identification.

Leaking Shutoff Valves – Water Discharges from No. 3 Test Cock (Test No. 1)

T1. If water continues to flow from No. 3 Test Cock, then a shutoff valve may be leaking. Observe the reading on the gauge, but do not record at this time. Open the bleed-off valve.

- If the water continues to flow the bleed-off valve, and the bleed-off valve can be adjusted so there is a slight drip from the No. 3 Test Cock. Go to step **T2** below; or,
- If it is not possible to adjust the bleed-off valve to allow a slight drip at the No. 3. Test cock, the No. 1 shutoff valve is leaking and must be repaired before the test may be completed.
- If the water does not continue to flow from the bleed-off valve go to step **T3** in this section.

T2. After adjusting the bleed-off valve so that there is a slight drip at the No. 3 Test Cock, record the reading on the gauge as the static pressure drop across the No. 1 Check Valve. This reading should be greater than or equal to 1.0 psi. Return to Test No. 1 step 8. If the reading is less than 1.0 psi, the No. 1 Check Valve must be repaired and retested before proceeding to Test No. 2.

T3. If water does not continue to flow from the bleed-off valve with water still flowing from the No. 3 Test Cock, record the observed reading at step **T1** as the static pressure drop across the No. 1 Check Valve. Also record the No. 2 Check Valve as leaking, and the No. 2 Shutoff Valve is leaking with backpressure. This concludes the test, proceed to Test No. 2 Step 6; appropriate repairs must be made.

Leaking Shutoff Valves-Water Recedes from No. 3 Test Cock (Test No. 1)

T4. If water recedes from No. 3 Test Cock, the level of the gauge should be moved to the centerline of the assembly. Record the gauge reading as the static pressure drop across the No. 1 Check Valve. The No. 2 Check Valve should be recorded as leaking and the No. 2 Shutoff Valve as leaking. Proceed to Test No. 2 Step 6.

Leaking Shutoff Valves (Test No. 2)

T5. If at Test No. 2 Step 4 water continues to flow from the No. 4 Test Cock, one of the shutoff valves is leaking. Observe the reading on the gauge, but do not record it at this time. Open the bleed-off valve.

- If the water does not continue to flow from the bleed-off valve go to step **T6** below.

- If the water continue to flow from the bleed-off valve, and the bleed-off valve can be adjusted so there is slight drip from the No. 4 Test Cock. Go to step **T7** in this section; or,
- If it is not possible to adjust the bleed-off valve to allow a slight drip at the No. 4 Test Cock, the No. 1 Shutoff Valve should be checked to make sure it is closed tight. Then proceed to step **T 8**.

T6. If water does not continue to flow from the bleed-off needle valve with water still flowing from the No. 4 Test Cock, record the observed reading at step **T5** as the static pressure drop across the No. 2 Check Valve. Also the No. 2 Shutoff Valve is leaking with backpressure. This concludes the test, proceed to Test No. 2 Step 6; appropriate repairs must be made.

T7. After adjusting the bleed-off valve so that there is a slight drip at the No. 4 Test Cock record the reading on the gauge as the static pressure drop across the No. 2 Check Valve. This reading should be greater than or equal to 1.0 psi. Return to Test No. 2 Step 6.

T8. If, after checking the tightness of the No. 1 Shutoff Valve, it is possible to adjust the bleed-off valve so there is a slight drip from the No. 4 Test Cock, record the reading on the gauge as the static pressure drop across the No. 2 Check Valve and return to Test No. 2 Step 6. If it is not possible to adjust the bleed-off valve so that the water flowing at the No. 4 Test Cock is a slight drip, proceed to step **T9**.

T9. If it is not possible to adjust the bleed-off valve so that the water flowing from the No. 4 Test Cock is a slight drip, and if No. 1 Check Valve was holding less than 1.0 psi in Test No. 1, then the No. 1 Check Valve must be repaired before testing the No. 2 Check Valve. Then return to Test No. 1 step 1. Otherwise go to step **T10**.

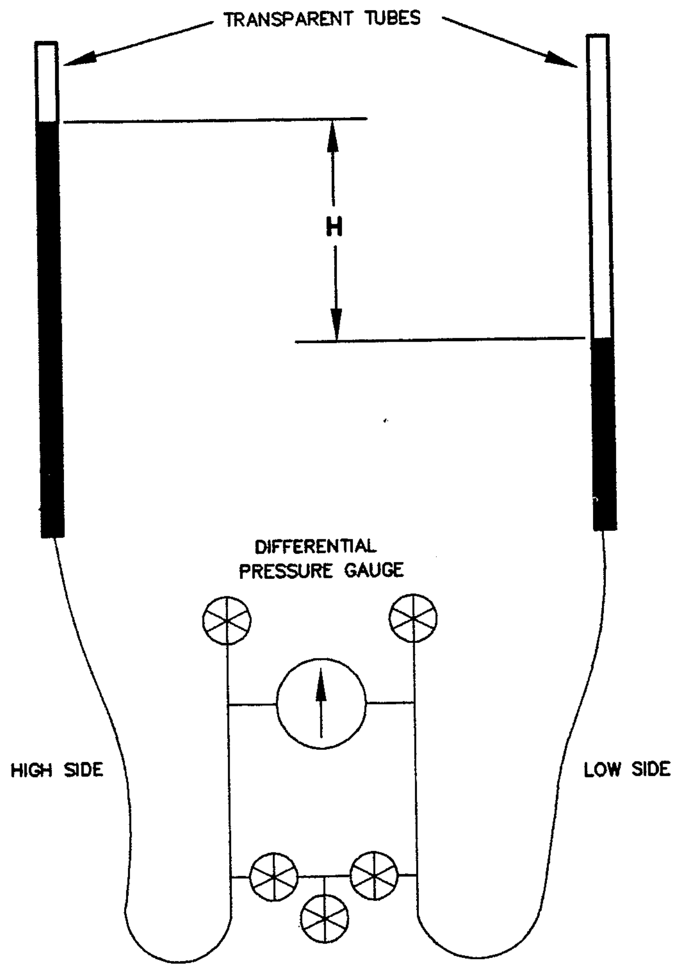
T10. If No. 1 Check Valve was holding 1.0 psi or more in Test No. 1, close the bleed-off valve and open the No.2 Test Cock. Record the reading on the gauge as the static pressure drop across the No. 2 Check Valve and return to Test No. 2 Step 6.

8.3 Gauge Calibration

Properly calibrated gauge equipment is essential to insure accurate data acquisition. Therefore, methods to inspect the accuracy of the gauges used in the above test procedures are provided below. Gauging equipment should be checked for accuracy at least once a year, and calibrated when necessary. The water column method for checking differential accuracy is described in below:

<u>Materials</u>

The following materials are needed (See **Figure 8-4**):



CDM/M&M Team	D.C. WASA Cross-Connection Control Program	Figure No.
	DIFFERENTIAL GAUGE CALIBRATION CHECK WATER COLUMN	8-4

Figure Adapted from Information Contained in References 2 & 3

Two transparent tubes (approximately 1 inch diameter), minimum length – 8 feet.

1. Adapters from transparent tube to gauge – rubber stoppers, nipples, ells, and hoses.

Procedure

1. Attach high side hose to base of one transparent tube.

2. Attach low side hose to base of second transparent tube.

3. Fill transparent tubes with water.

4. Bleed air from gauge by opening high side bleed valve, then close; open low side bleed needle valve and close.

5. Fill or drain transparent tubes to desired height (h).

   27 3/4 inch Water = 1.0 PSI
   55 1/2 inch Water = 2.0 PSI
   83 1/4 inch Water = 3.0 PSI
   etc.

6. Compare gauge reading to water column height (h); the two values should be the same within +/- 0.2 psi.

7. If gauge requires adjustment, contact the gauge manufacturer or a qualified gauge calibration facility.