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INTERNATIONAL ASSOCIATION OF PLUMBING
AND MECHANICAL OFFICIALS

MATERIAL AND PROPERTY STANDARD FOR BACKFLOW PREVENTION DEVICES

PS 31-77

1. PART I

GENERAL: Design and Material Specification; Laboraty Testing

1.1 General Specifications

1.1.1 Flow Characteristics and Pressure Loss Requirements

The flow characteristics and pressure loss requirements of backflow prevention devices are of prime consideration in insuring their functional operation. In all cases, flow channels should be streamlined to minimize pressure loss. The lowest possible head loss through backflow prevention devices is necessary to deal with intermittent low main pressures and high in-plant losses. Limits in columns (3) and (4) of Table 1 are commercially attainable.

1.1.2 Rated Flow and Maximum Allowable Pressure Loss

The American Water Works Association and the New England Water Works Association have adopted minimum rated flow values for displacement or compound meters in sizes 3/4 inch to 10 inches, inclusive. These flow rates are included in Table 1 for the above sizes together with those for 1/2, 1-1/4 inch and 2-1/2 inches, which have been extrapolated or interpolated. For each size of backflow prevention device, at any flows up to and including the rated flow, the maximum pressure loss shall not exceed the values given in Table 1.

1.1.3 Standard Sizes

The following standard sizes have been adopted for backflow prevention devices: 1/2, 3/4, 1, 1-1/2, 2, 2-1/2, 3, 4, 6, 8, and 10 inches. All devices designed and constructed in sizes other than those aforementioned shall be given separate consideration.

1.1.4 Markings

Size, model number and serial number markings on backflow prevention devices shall be with letters or numbers at least 1/4 inch in height. All markings shall be easily read and shall be either cast in the metal or stamped on durable name-plates permanently affixed to the assembly and on both sides of the device. The markings shall include those data specified in Table 2. In affixing name-plates with escutcheon pins or stamping data in the metal, caution should be exercised so as not to produce areas of stress concentration. Markings shall be permanent and not easily defaced.

TABLE 1

FLOW RATES AND MAXIMUM ALLOWABLE PRESSURE LOSSES OF BACKFLOW PREVENTION DEVICES

Size of Device (inches) (1)	Flow Rate (gpm) (2)	Reduced Pressure Principle Device (psi) (3)	Double Check Valve Assembly or Pressure Vacuum Breaker (psi) (4)
1/2	12*	22	10
3/4	30	20	10
1	50	18	10
1-1/4	75*	18	10
1-1/2	100	16	10
2	160	16	10
2-1/2	225*	16	10
3	320	15	10
4	500	14	10
6	1000	14	10
8	1600	14	10
10	2300	14	10

**extrapolated or interpolated.*

TABLE 2

MARKINGS FOR BACKFLOW PREVENTION DEVICES

Name or Trademark

Type of device, *i.e.*, reduced pressure principle backflow prevention device, double check valve assembly, pressure vacuum breaker, or acceptable abbreviation

Size

Model number

Direction of flow (shown by arrow)

Unit Serial Number

Maximum working water pressure (MWWP)

1.1.5 Hydrostatic Test -- Structural and Operational

a. All devices shall be pressure tested according to their designed operating pressure for use on cold water service (Maximum 110 F)* Normal test and full hydrostatic test pressure for the 150 psi range shall be as follows: working water pressure (psi): 150; full hydrostatic pressure (psi): 300. All devices shall operate satisfactorily at the maximum working water pressure.
b. The entire assembly shall be subjected to the hydrostatic test. Also, the maximum working water pressure shall be applied to the downstream side of all closed barriers with the opposite side open to the atmosphere with no leakage across the barrier. For each test, the pressure is to be maintained for at least two minutes.
c. No permanent deformation of any parts of the device shall occur under the full hydrostatic test pressure.
d. All diaphragms, bellows or other barriers to the atmosphere shall be subjected to the same hydrostatic tests as required for the body of the device.
e. All parts of the device shall be designed to withstand, without permanent distortion, the stresses developing from the specified hydrostatic test pressures as well as the combined stresses resulting from the full specified working pressures coincident with operation under a full, unbalanced pressure** condition. Such test shall be from a fully open to a fully closed position with the accompanying shock and water hammer at double the working pressure.

1.1.6 General Statement of Policy Regarding Assembled Devices

All devices which consist of independent units assembled for the purpose of preventing backflow shall comply with the material, the operational and other specifications as required for backflow prevention devices.

1.2. Design Specifications

1.2.1 Policy Regarding Design

In the design of any backflow prevention device, prime consideration shall be given to the construction of a trouble-free unit. All materials used shall be of the best quality. The waterway shall be as free as possible from obstructions and pockets which could interfere with the free flow of water or cause excessive turbulence. All moving parts shall be designed to operate up to the rated flow without chatter or vibration.

* See Section 1.2.1
** Unbalanced Pressure: Shall include variation from 0 to 150 psi wwp at intervals of no more than 20 psi.

The provisions of this Standard are not intended to prevent the use of any alternate material or method of construction provided any such alternate meets the intent of this Standard.

All moving parts shall have adequate clearances to prevent binding or galling; or to prevent the device from becoming inoperative by being thrown out of balance, by being distorted, by having one part interfere with another, or by becoming incrusted with lime, rust, or scale deposits.

All foundry and machine work shall be performed in accordance with the best modern practice for the class of work involved. All parts shall conform, within allowable tolerance, to the manufacturer's specifications and shall be free from injurious defects. All flanged joints shall be faced true and machined at right angles to their respective axes, while threaded joints must be concentric and accurately cut. All joints subjected to water pressure shall be water-tight. All ferrous parts receiving bronze mountings shall be finished to fit. Such hand work as is required in finishing shall produce a neat, workmanlike, well-fitting and smoothly operating product. All parts of a device supplied by a manufacturer of that device shall be interchangeable with the original parts.

The operation of the device shall not cause water hammer or be adversely affected by water hammer arising from an outside condition.

Devices intended for use at elevated temperatures over 110 F shall be so designed and tested as to function satisfactorily over the specified temperature range.

1.2.2 Removability of Major Parts from the Line

A backflow prevention device shall be designed so that each major part of the assembly may be installed or removed individually from the line.

1.2.3 Accessibility of Internal Parts

A backflow prevention device larger than 2" or weighing 80 pounds or more shall be provided with one or more openings through which the internal parts may be removed, repaired or inspected without having to remove the device from the line.

1.2.4 Design of Waterway

a. Area of Waterway. A backflow prevention device shall be so designed that the minimum waterway area normal to the direction of flow is at least equivalent to the corresponding pipe area for the size of device concerned.

b. Obstructions. The waterways of the device shall be so designed as to minimize cavitation and eliminate all cavities which could entrap foreign materials.

1.2.5 Clearance

a. Clearances between guide stems and guides, valve stems and guides, hinge pins and bushings, and other similar parts, shall be adequate to prevent sticking or binding.
b. Binding or clogging of parts may occur between the body of a valve and a hinge arm, clapper, counterweight, poppet valve or other similar free-moving parts. Wherever such binding or clogging of parts may occur which would prevent normal operation of the device, there shall be minimum working clearances as given in Table 3.

TABLE 3

TYPE OF DEVICE	SIZE	CLEARANCE
Iron-body	All	1/2"
Brass or Bronze	up through 1"	1/8"
Brass or Bronze	over 1"	1/4"

c. The facing ring of any size poppet-type valve shall be supported at its outer edge for at least two-thirds of its thickness and shall be held in place by a clamping member with radial bearing surface dimension determined adequate under actual operating conditions. Furthermore, the facing ring must be wide enough to overhand the seat ring at least 1/16 inch in the outside. A minimum of 1/16 inch shall be provided between the inside edge of the seat ring and the seat ring and the facing clamping member.
d. The facing ring of any size of swing-type valve shall be protected at its outer edge for at least two-thirds of its thickness and shall be held in place by a clamping member with a bearing surface determined adequate under actual operating conditions. Furthermore, the facing ring shall be wide enough to overhand the seat ring at least 1/8 inch on sizes up to 2 inches and 1/4 inch on sizes 2 inches and larger. A minimum of 1/16 inch shall be provided between the inside edge of the seat ring and the facing clamping member.
e. All bushings shall project inside the body of the device as follows: for device sizes up through 1 inch: 1/8 inch; for device sizes over 1 inch: 1/4 inch.

1.2.6 Body and Bonnet

When body and bonnet are bolted together, the bolts shall be of such design that the maximum stress at the root diameter shall not exceed a calculated 7,500 psi, based on the rated working water pressure.

1.2.7 Tapping and Threading

A valve body shall be provided with an adequate boss at each location where a tapped hole is required. The valve body shall be threaded in accordance with ANSI B2.1 or flanged in accordance with requirements for Fittings, Flanges and Valves, as mentioned in Section 1.1.3.

1.2.8 Test Cocks

a. Double check valve and reduced pressure principle backflow prevention assemblies shall be equipped with test cocks located as follows:

1. On the upstream side of the No. 1 shutoff valve.
2. Between the No. 1 shutoff valve and the No. 1 check valve.
3. Between the check valves.
4. Between the No. 2 check valve and the No. 2 shutoff valve.

b. Single check valve pressure vacuum breakers shall be equipped with test cocks located as follows:

1. Between the No. 1 shutoff valve and check valve.
2. Between the check valve and No. 2 shutoff valve.

c. Double check valve pressure vacuum breakers shall be equipped with test cocks located as follows:

1. Between the No. 1 shutoff valve and the No. 1 check valve.
2. Between the check valves.
3. Between the No. 2 check valve and the air inlet valve.

d. The sizes of these test cocks shall be as given in Table 4, Test cocks shall have female ends on the discharge sides.

TABLE 4

SIZES OF TEST COCKS

Size of Device (inches)	Minimum Size Standard Test Cock (IPS) (inches)
Up to 2, inclusive	1/4
2-1/2 to 4, inclusive	1/2
6 and larger	3/4

1.2.9 Control Piping and Diaphragms

All control piping or passageways shall be of corrosion-resistant material and in sizes sufficiently large to prevent clogging. Furthermore, the piping or passageways shall be so located as to prevent entrapment of foreign materials.

When diaphragms or bellows are used as barriers in control piping which bypasses one or more check valves in a backflow prevention assembly, such diaphragms or bellows shall be so installed that their failure shall produce visible evidence of such failure.

1.2.10 Air Release

Provision shall be made for bleeding trapped air from the highest point of a device when the normal flow of water will not displace it.

1.2.11 Valve Seats

Iron-bodied devices shall be fitted with renewable valve seats which are provided with means for insertion and removal.

1.2.12 Alignment

Check valve disc, rubber facing ring, clamping member and securing bolt of stud shall each be concentric to an axis which is normal to the face of the rubber ring. A means must be provided to prevent clamping the rubber facing ring so tight as to warp its face.
Provision shall be made to prevent a clapper or poppet from tipping and catching under the seat ring or any other faulty action which would prevent true alignment. When a clapper, poppet valve, or other barrier is in a wide open position it must bear on a definite stop or surface of contact. A stop shall be so constructed and located that it will provide a firm bearing so that the action of the water will not tend to twist or bend the valve parts or to cause the valve to chatter. All working parts shall be constructed and supported in such a manner as to preclude distortion or misalignment.

1.3 Material Specifications

Statement of Policy

The following material specifications and current ASTM (American Society for Testing and Materials) designations shall be adhered to at all times except where a manufacturer desires to use an equivalent or better material. In such cases, the substitute specifications shall be submitted for approval. In the subsequent list of materials, no attempt has been made to bar the use of alloys, rubbers, plastics, or other materials which may be adaptable and which will give at least equivalent trouble-free service.

1.3.2 Dissimilar Metals

A minimum of dissimilar metals shall be used in the construction of backflow prevention devices. In all cases where it is impossible to use similar metals, steps shall be taken, insofar as practicable, to prevent the formation of galvanic electrolytic couples. When two dissimilar metals must come close to each other, the metals chosen shall be as nearly as possible electrolytically similar and shall be insulated whenever practicable.

1.3.3 Corrosion
Ferrous metal used in backflow prevention devices shall be galvanized or otherwise protected to resist corrosion.

1.3.4 Body and Cover, Spools, and Spacers
Material used in construction of the above parts of a device shall be either valve bronze which conforms to ASTM Designation: B 61-76, gray iron which conforms to ASTM Designation: A 126-73 Class B or Schedule 40 galvanized pipe and flanges.

1.3.5 Seat Rings
Seat rings shall be constructed of valve bronze which conforms to ASTM Designation: B61-76, or stainless steel which conforms to ASTM Designations: A 296-77 Grade CF 16F or CR 20 or A 276-77, Type 304.

1.3.6 Clapper
A clapper, poppet or similar check shall be consructed of valve bronze which conforms to ASTM Designation: B 61-76.

1.3.7 Clapper, Poppet or Relief Valve Facing Ring
a. A clapper or poppet facing ring shall be composed of natural rubber or plastic of even thickness, smooth-faced, with a Shore hardness of between 35 and 45 and with good water-absorption resistance and aging properties.
b. A relief valve facing ring shall be composed of natural rubber or plastic of even thickness, smooth-faced, with a Shore hardness between 60 and 70 and with good water-absorption resistance and aging properties.

1.3.8 Swing Arm
A swing arm shall be made of valve bronze which conforms to ASTM Designation: B 61-76.

1.3.9 Swing Pin and Guide Stem
A swing pin or guide stem shall be made either of phosphor bronze which conforms to ASTM Designation: B 139-79 Grade A, C or D, or of corrosion-resisting steel, which conforms to ASTM Designation: A 276-77, Type 304.

1.3.10 Bushing
A bushing shall be made of high-leaded tin-bronze which conforms to ASTM Designation: B 584-79, Alloy Number C93700 or C93800.

1.3.11 Counterbalance
A counter balance shall be either a bronze shell filled with lead or a white metal bearing alloy which conforms with ASTM Designation: B23-73, Grade Number 19.

1.3.12 Spring

A spring shall be made either of corrosion-resisting steel which conforms to ASTM Designation: A 313-76 or of phosphor bronze which conforms to ASTM Designation: B159-77, or equal.

1.3.13 Diaphragm

Diaphragm material shall be a suitable cloth insert in natural rubber or plastic with workmanship equivalent to that shown in "Federal Specifications for Packing: Rubber, Cloth and Insertion HHP-151B.

1.3.14 Protective Coatings

Cast-iron bodies and parts that are galvanized shall be hot dipped in conformance with ASTM Designation: A 153-73, Class A or B. Synthetic protective coating of cast-iron bodies and parts shall be subject to individual approval not only of the specific use, but of the coating and process of application as well.

1.3.15 Studs, Bolts and Cap Screws

Such parts shall be made of naval brass rod which conforms to ASTM Designations: B 21-78A, Alloy Number 482 or 485, corrosion-resistant steel which conforms to ASTM Designation: A276-77, Type 304, or silicon bronze which conforms to ASTM Designations: B 97-77, Alloy B.

1.3.16 Control Piping

Control piping shall be made of copper or equally corrosion-resistant materials.

1.3.17 Test Cock

A test cock shall be made of high-leaded tin-bronze which conforms to ASTM Designation: B 584-79, Alloy Number C93700, C93800 or C94300.

1.3.18 Shutoff Valve

A shutoff valve shall be tightly closing so as not to interfere with the testing of a device.

2.2.1 Design and Operational Specifications

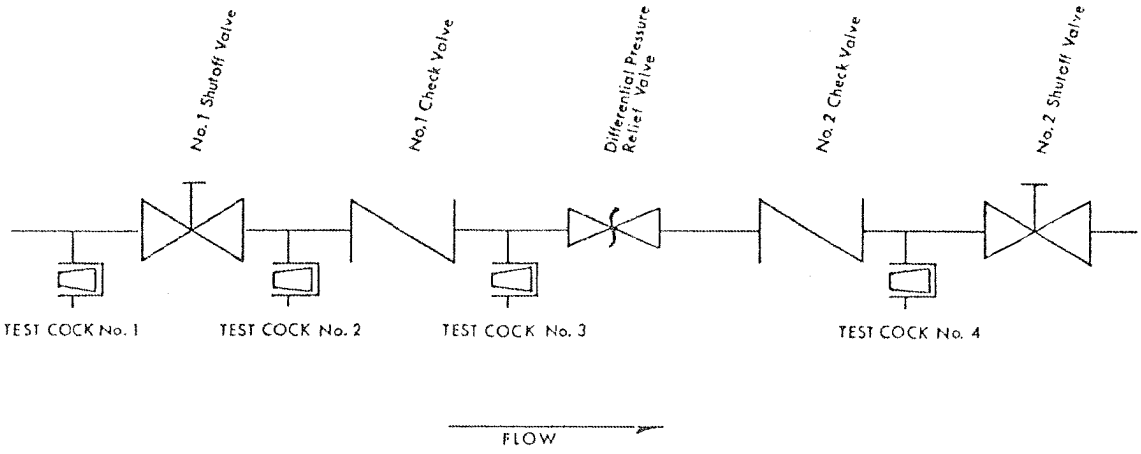
a. This device shall include two or more approved check valves with an automatically operating differential pressure relief valve located between the checks. The unit shall include a tightly closing shutoff valve on each end of the device and shall be fitted with four properly located test cocks. (See Figure 1.) During normal flow and at the cessation of normal flow, the pressure in the "zone", i.e., the zone between two checks, shall be at least 2 psi less than the upstream (or supply) pressure.

b. With no flow from the upstream side and when the pressure on the inlet side drops to 2 psi, the pressure within the "zone" shall be atmospheric. When pressure on the upstream side drops below 2 psi, the relief valve shall open further and shall be fully open when the upstream pressure reaches atmospheric or goes below atmospheric.

FIGURE 1

REDUCED PRESSURE PRINCIPLE BACKFLOW PREVENTION DEVICE

Diagrammatic sketch showing Location of Shutoff Valves, Check Valves, Differential Pressure Relief Valve and Test Cocks



c. Under a backflow condition, when the upstream pressure is 2 psi or more, the relief valve shall discharge from the "zone" to atmosphere those quantities of backflowing water given in Table 5, and the pressure in the "zone" shall be at least 1/2 psi below the upstream pressure.

d. The downstream or second check valve shall be internally loaded and shall at all times be drip tight in the normal direction of flow with the inlet pressure at 1 psi and the outlet under atmospheric pressure.

e. The differential pressure relief valve shall open and close positively and quietly and shall not discharge water under normal fluctuations of 3 psi maximum variation of inlet pressure.

f. When the upstream pressure is less than 2 psi, the differential pressure relief valve shall discharge water from the "zone" to atmosphere at the minimum flow rates shown in Table 5 with the pressure in the "zone" not exceeding 1-1/2 psi.

TABLE 5

MINIMUM FLOW RATES AND MINIMUM DIAMETERS
OF DIFFERENTIAL PRESSURE RELIEF VALVE OPENINGS

Size of Device (inches)	Minimum Flow Rate Past Relief Valve (gpm)	Minimum Diameter through Passageways of Relief Valve Openings (IPS) (inches)
1/2 and 5/8	3	3/8
3/4 and 1	5	1/2
1-1/4 and 1-1/2	10	3/4
2	20	1
2-1/2	20	1
3	30	1-1/4
4	40	1-1/2
6	40	1-1/2
8	60	2
10	60	2

f. When the upstream pressure is less than 2 psi, the differential pressure relief valve shall discharge water from the "zone" to atmosphere at the minimum flow rates shown in Table 5 with the pressure in the "zone" not exceeding 1-1/2 psi.

2.2.2 Laboratory Inspection and Tests

A device shall be inspected and tested for the following:

a. Conformance to the requirements outlined in Part I of these specifications.
b. Conformance to design and operation specifications of Section 2.2.1
c. Pressure losses for flow rates up to the rated values.
d. Conformance to working drawings.
e. Conformance to hydrostatic test -- Section 1.1.5

2. Part 2

APPROVAL PROCEDURE DESIGN AND OPERATIONAL SPECIFICATIONS AND TESTS

2.1 Approval of All Devices

All sizes and designs of backflow prevention devices shall be constructed in conformance with these specifications and must successfully pass the sequence of tests as specified under "Laboratory Tests" and "Laboratory Field Tests" as applicable to the device under test in accord with the following:

a. One unit, selected at random from a manufacturer's stock of each size and model, complete with a full set of working drawings, including material specifications, shall be submitted to an approved testing laboratory for inspection and testing as outlined under "Laboratory Tests."

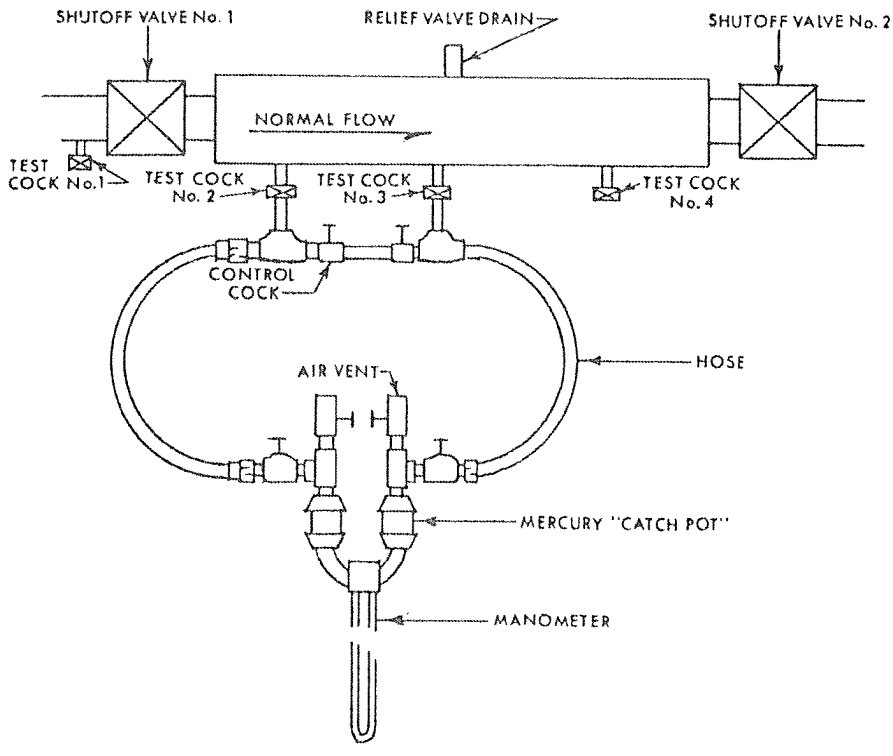
b. Subsequent to the issuance of a "Certificate of Approval", the the testing laboratory may however, for due cause, withdraw the approval of a device at anytime, after investigation and substantiation of reported malfunctions in the field for unforeseen causes and after completion of a hearing with the manufacturer.

c. The approving laboratory shall be notified of any change in design, material, or operation of an approved device which is in the field or which is offered for sale. The approving laboraory, at its own discretion, may or may not require another test. Failure to notify the approving laboratory of any changes may result in withdrawal of approval of that size and model.

d. Continuing verification of compliance with these specifications and tests shall be accomplished at least every three years to satisfaction of the approving testing laboratory. Past performance of the device under field operating conditions shall be considered before re-issuing a "Certificate of Approval". Failure to meet this requirement shall result in withdrawal of approval of that size and model of the device in question.

FIGURE 2

TEST EQUIPMENT INSTALLATION FOR REDUCED PRESSURE PRINCIPLE DEVICES



2.2.3 Laboratory Field Test Procedures

TEST No. 1

Purpose: To test operation of differential pressure relief valve.

Requirements: The differential pressure relief valve must operate to maintain the zone between the two check valves at least 2 psi less than the supply pressure.

Steps: (See Figure 2.)
a. Close No. 2 shutoff valve.
b. Install by-pass hose from test cock no. 2 through a control valve to test cock No. 3.
c. Connect one manometer lead to test cock No. 2; connect other manometer lead between control valve on by-pass line and test cock No. 3.
d. Open test cocks No. 2 and No. 3 and vent manometer.
e. Open control valve on by-pass hose slowly and ascertain that initial opening of differential relief valve is obtained at a minimum manometer differential of 2 psi.

TEST No. 2

Purpose: To test No. 1 check valve for tightness against reverse flow.

Requirement: Valve shall be tight against reverse flow under all pressure differentials.

Steps: With the differential pressure relief valve operating under reduced pressure and no drainage from it when the No. 2 shutoff valve is closed, the No. 1 check valve shall be noted as tight against reverse flow. If there is drainage from the differential pressure relief valve during this test, the No. 1 check shall be noted as leaking.

TEST No. 3

Purpose: To test No. 2 check valve for proper internal loading.

Requirements: Valve shall be drip tight in the normal direction of flow with the inlet pressure at 1 psi and the outlet under atmospheric pressure.

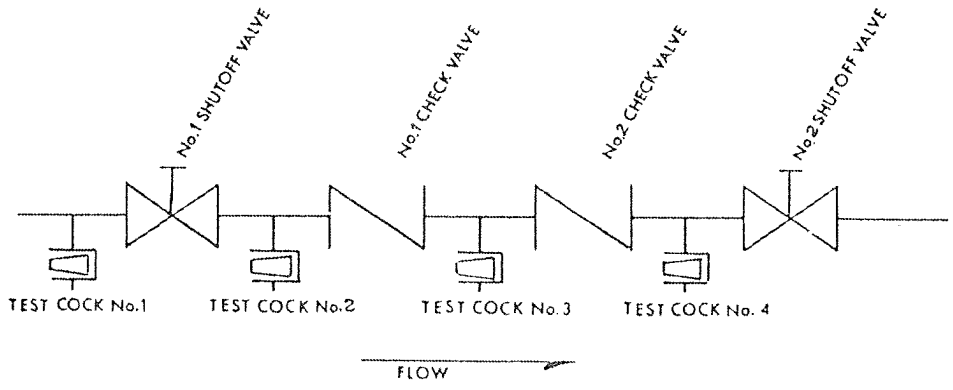
Steps:
a. Install a transparent tube at test cock No. 3.
b. Open test cock No. 3 to fill tube, then close.
b. Open test cock No. 3 to fill tube, then close.

c. Close No. 1 shutoff valve. Open test cock No. 3 fully. Then open test cock No. 4 fully.
d. The level of water in the tube must hold steady at a minimum height of 27-3/4" (1 psi) above the center line of the check valve.
e. Close all test cocks. Remove all test equipment and open No. 1 and No. 2 shutoff valves.

FIGURE 3

DOUBLE CHECK VALVE ASSEMBLY

Diagrammatic sketch showing Location of Shutoff Valves, Check Valves and Test Cocks



2.3.1 Design and Operational Specifications

a. This device shall include two independently acting approved check valves between two tightly closing shutoff valves, and four properly located test cocks. (See Figure 3).
b. Each check valve shall be internally loaded and shall at all times be drip tight in the normal direction of flow with the inlet pressure at 1 psi and the outlet under atmospheric pressure.

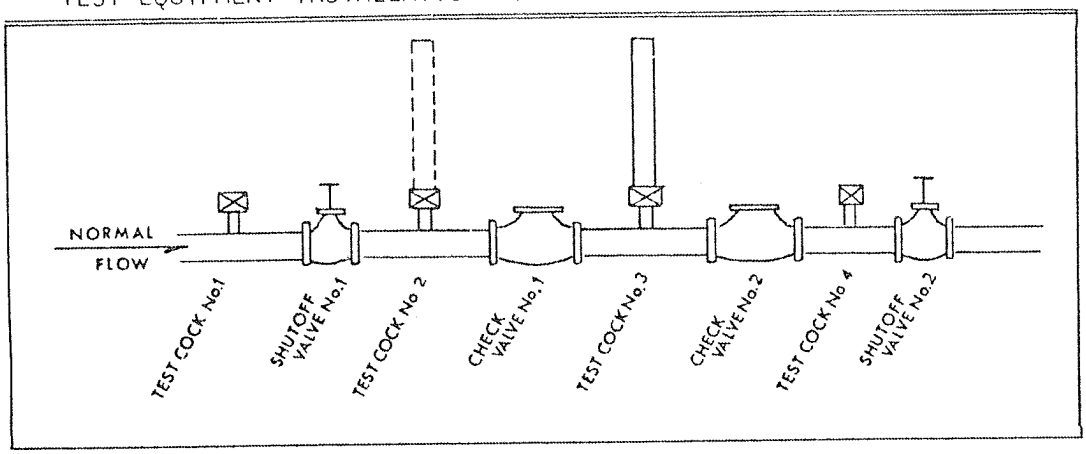
2.3.2 Laboratory Inspection and Tests

Devices shall be inspected and tested for the following;

a. Conformance to requirements outlined in Part I of these specifications.
b. Conformance to design and operational specifications of Section 2.3.1
c. Pressure loss for flow rates up to the rated values.
d. Conformance to working drawings.
e. Conformance to hydrostatic test -- Section 1.1.5

FIGURE 4

TEST EQUIPMENT INSTALLATION FOR DOUBLE CHECK VALVE ASSEMBLIES



2.3.3 Laboratory Field Test Procedures

TEST No. 1

Purpose: To test No. 2 check valve for proper internal loading.

Requirement: Valve shall be drip tight in the normal direction of flow with the inlet pressure at 1 psi and the outlet under atmospheric pressure.

Steps: (See Figure 4.)
a. Install a transparent tube at test cock No. 3. Open test cock No. 3 to fill tube, then close.
b. Close shutoff valve No. 2, then close shutoff valve No. 1.
c. Open test cock No. 3 fully. Open test cock No. 4 fully. The level of water in tube must hold steady at a minimum height of 27-3/4" (1 psi) above the center line of check valve.
d. Close test cock No. 3 and No. 4 and remove tube.

TEST No. 2

Purpose: To test No. 1 check valve for proper internal loading.

Requirement: Valve shall be drip-tight in the normal direction of flow with the inlet pressure a 1 psi and the outlet under atmospheric pressure.

Steps:

a. Install transparent tube at test cock No. 2. Open test cock No. 2.

b. Open shutoff valve No. 1 until tube is full of water, then close.

c. Open test cock No. 3. The level of water in the tube must hold steady at a minimum height of 27-3/4" (1 psi) above center line of check valve.

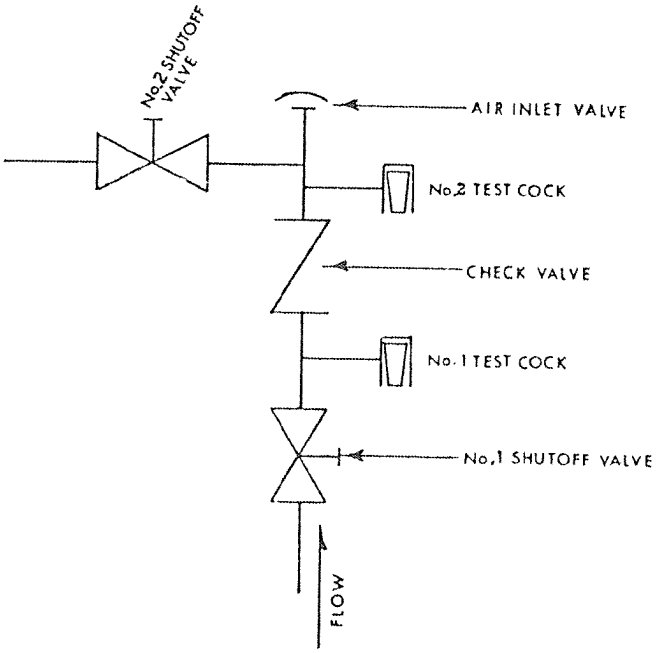
d. Close test cock No. 2 and No. 3. Remove tube and open shutoff valves No. 1 and No. 2.

2.4 DESIGN AND OPERATIONAL SPECIFICATIONS FOR AND TEST OF A PRESSURE VACUUM BREAKER WITH ONE CHECK VALVE

FIGURE 5

SINGLE CHECK VALVE PRESSURE VACUUM BREAKER

Diagrammatic sketch showing Location of Shutoff Valves, Check Valve, Air Inlet Valve and Test Cocks



2.4.1 Design and Operational Specifications

a. This device shall include an approved check valve and an opening to atmosphere on the discharge side of the check valve between two tightly closing shutoff valves, plus two properly located test cocks. (See Figure 5.)

b. The air inlet valve of the vacuum breaker shall begin to open when the internal pressure is 1 psi. It shall be fully open at atmospheric pressure within the device.
c. The device waterway rating shall be not less than the minimum gpm listed in Table 1 at the maximum allowable head loss of 10 psi.
d. The check valve shall be internally loaded and shall at all times be drip tight in the normal direction of flow with the inlet pressure at 1 psi and the outlet under atmospheric pressure.
e. The effective size of the air ports of the device shall be governed by the air flow test. If an air port shield (canopy) is used, it shall extend down around the body to the lowest portion of the air port. To prevent fouling, the minimum clearance between the air port shield (canopy) and the body shall be 3/16".

2.4.2 Laboratory Inspection and Tests

Devices shall be inspected and tested for the following:

a. Conformance to requirements outlined in Part I of these specifications.
b. Conformance to design and operational specifications.
c. Pressure losses for flow rates up to the rated values.
d. Conformance to working drawings.
e. Conformance to hydrostatic test - Section 1.1.5.
f. Air Inlet Test - When vacuums up to 25 inches of mercury are applied on the inlet side of the device with check valve fouled in accord with test procedure IV C of Appendix A, no more than a 6 inch rise of water on the discharge side shall occur.

2.4.3 Laboratory Field Test Procedures

Test No. 1

Purpose: To test operation of air inlet valve.

Requirement: The air inlet valve shall begin to open when the internal pressure is 1 psi and shall be fully open at atmospheric pressure.

Steps:
a. Remove air inlet canopy.
b. Install a transparent tube at test cock No. 2. Open test cock to fill tube, then close.
c. Close shutoff valve No. 2, then close shutoff valve No. 1.
d. Open test cock No. 2, draining water over top of tube and watching the air inlet. The air inlet valve must begin to open without aid when the level of water in the tube is at or higher that 27-3/4" (1 psi) above the horizontal center line of the air inlet valve seat. The air inlet valve must be fully open when the tube is drained.
e. Close test cock No. 2 and remove tube.

Test No. 2

Purpose: To test check valve for proper internal loading.

Requirement: Valve shall be drip tight in the normal direction of flow with the inlet pressure at 1 psi and the outlet under atmospheric pressure.

Steps:

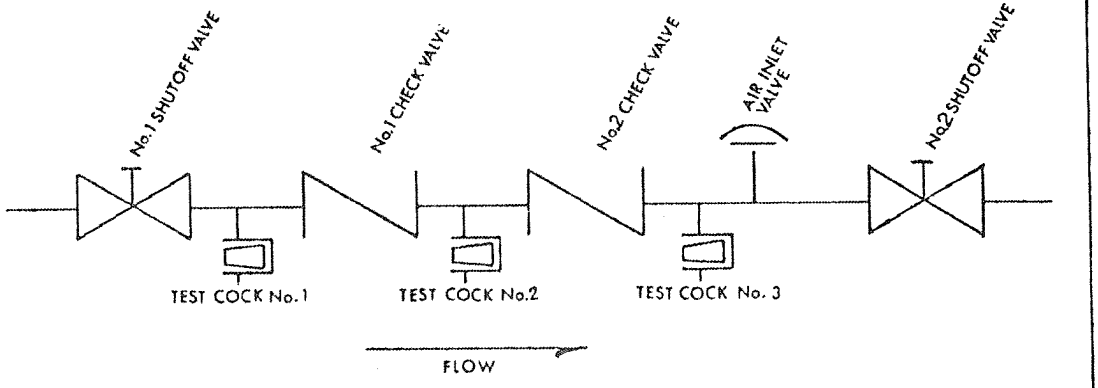
a. Install transparent tube at test cock No. 1. Open test cock No. 1.
b. Open shutoff valve No. 1 to fill tube, then close.
c. Open test cock No. 2. The level of water in tube must hold steady at a minimum height of 27-3/4" (1 psi) above center line of check valve.

2.5 Design and Operational Specifications For and Test of a Pressure Vacuum Breaker with Two Check Valves.

FIGURE 6

DOUBLE CHECK VALVE PRESSURE VACUUM BREAKER ASSEMBLY

Diagrammatic sketch showing Location of Shutoff Valves, Check Valve, Air Inlet Valve and Test Cocks



2.5.1 Design and Operational Specifications

a. The device shall include two approved check valves, an opening to atmosphere on the discharge side of the second check valve, two tightly closing shutoff valves and three properly located test cocks. (see figure 6.)
b. The air inlet valve of the vacuum breaker shall begin to open when internal pressure is 1 psi. It shall be fully open at atmospheric pressure within the device.

c. The device waterway rating shall be not less than the minimum gpm listed in Table 1 at the maximum allowable head loss of 10 psi.
d. Each check valve shall be internally loaded and shall at all times be drip tight in the normal direction of flow with the inlet pressure at 1 psi and the outlet under atmospheric pressure.

2.5.2 Laboratory Inspection and Tests

Devices shall be inspected and tested for the following:

a. Conformance to requirements outlined in Part I of these specifications.
b. Conformance to design and operational specifications.
c. Pressure losses for flow rates up to the rated values.
d. Conformance to working drawings.
e. Conformance to hydrostatic test - Section 1.1.5.
f. Air Inlet Test - When vacuums up to 25 inches of mercury are applied on the inlet side of the device with check valves fouled in accord with test procedure IV C of Appendix A, no more than a 6 inch rise of water on the discharge side shall occur.

2.5.3 Laboratory Field Test Procedures

Test No. 1

Purpose: To test operation of air inlet valve.

Requirement: The air inlet valve shall begin to open when the internal pressure is 1 psi, and shall be fully open at atmospheric pressure.

Steps:
a Remove air inlet canopy
b. Install a transparent tube at test cock No. 3. Open test cock to fill tube, then close.
c. Close shutoff valve No. 2, then close shutoff valve No. 1.
d. Open test cock No. 3, draining water over top of tube and watching the air inlet. The air inlet valve must begin to open without aid when the level of water in the tube is at or higher than 27-3/4" (1 psi) above the center line of air inlet valve seat. The air inlet valve must be fully open when the tube is drained.
e. Close test cock No. 3 and remove tube.

Test No. 2

Purpose: To test No. 2 check valve for proper internal loading.

Requirement: Valve shall be drip tight in the normal direction of flow with the inlet pressure at 1 psi and the outlet pressure at atmospheric.

Steps:

a. Install transparent tube at test cock No. 2. Open test cock No. 2.
b. Open shutoff valve No. 1 to fill tube, then close.
c. Open test cock No. 3. Level of water in tube must hold steady at a minimum height of 27-3/4" (1 psi) above center line of check valve.
d. Close test cocks No. 2 and No. 3 and remove tube.

Test No. 3

Purpose: To test No. 1 check valve for proper internal loading.

Requirement: Valve shall be drip tight in the normal direction of flow with the inlet pressure at 1 psi and the outlet under atmospheric pressure.

Steps:

a. Install transparent tube at test cock No. 1. Open test cock No. 1
b. Open shutoff valve No. 1 to fill tube, then close.
c. Open Test cock No. 2. Level of water in tube must hold steady at a minimum height of 27-3/4" (1 psi) or more above the center line of check valve.
d. Close test cocks No. 1 and No. 2. Remove tube and open shutoff valves No. 1 and No. 2.