ASME A112.18.3-2002
(Revision of ASME A112.18.3M-1996)

PERFORMANCE REQUIREMENTS FOR BACKFLOW PROTECTION DEVICES AND SYSTEMS IN PLUMBING FIXTURE FITTINGS

AN AMERICAN NATIONAL STANDARD

The American Society of Mechanical Engineers

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The American Society of
Mechanical Engineers

A N   A M E R I C A N   N A T I O N A L   S T A N D A R D

PERFORMANCE REQUIREMENTS FOR BACKFLOW PROTECTION DEVICES AND SYSTEMS IN PLUMBING FIXTURE FITTINGS

ASME A112.18.3-2002

(Revision of ASME A112.18.3M-1996)

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This Standard will be revised when the Society approves the issuance of a new edition. There will be no addenda issued to this edition.

ASME issues written replies to inquiries concerning interpretations of technical aspects of this Standard. Interpretations are published on the ASME Web site under the Committee Pages at http://www.asme.org/codes/ as they are issued.

The American Society of Mechanical Engineers
Three Park Avenue, New York, NY 10016-5990

In memory of, and dedicated to the life of,
our dear friend, colleague, and long-standing industry leader,
Thomas P. Konen. His contributions to the plumbing industry at large and to this committee will never be forgotten.

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FOREWORD

In November 1987, Panel 18 of the ASME Committee A112, Plumbing Materials and Equipment, initiated work to develop requirements for the protection against back pressure backflow and back siphonage in an emerging class of fittings, wherein the spout and side spray were combined for efficient use and operation. The increased concern for the protection of drinking water encouraged the Committee to look beyond traditional protection methods and develop a performance standard which excludes the contamination of potable water but gives needed freedom to manufacturers to produce fittings of complex design and construction as demanded by today's worldwide markets.

While the probability of occurrence associated with the contamination of potable water through backflow at various plumbing fixture fittings is minimal, there remains a need for a protection system. This Standard establishes performance requirements with specific criteria for acceptance, to ensure a high degree of reliability for the safety system throughout the useful life of the fitting.

Extensive testing and engineering reviews of current practice demonstrated that backflow protection is mainly a function of the check valve or check valve assembly and that reliance on vacuum breakers is dependent on the adequacy of the air vent. In achieving this, para. 6.3 of this Standard requires durability testing of multiple specimens and internationally recognized statistical methods for evaluating the results.

This Standard provides for the evaluation and approval of devices which may be combined to form a safety system being integrated into different products without further durability tests. In addition, this Standard provides for the evaluation of production fittings complete with an integrated protection system, which however does not examine the performance of the device individually. It is designed to confirm the overall reliability of the integrated safety system.

This Standard is written to give freedom to the manufacturer in design and technology to produce products with devices and system reliability consistent with good engineering practices for the protection of public health.

Suggestions for improvement of this Standard will be welcomed. They should be sent to The American Society of Mechanical Engineers; Attn: Secretary, A112 Standards Committee; Three Park Avenue; New York, NY 10016.

This Standard was approved as an American National Standard on September 6, 2002.

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Standardization of Plumbing Materials and Equipment

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Subject:	Cite the applicable paragraph number(s) and the topic of the inquiry.
Edition:	Cite the applicable edition of the Standard for which the interpretation is being requested.
Question:	Phrase the question as a request for an interpretation of a specific requirement suitable for general understanding and use, not as a request for an approval of a proprietary design or situation. The inquirer may also include any plans or drawings that are necessary to explain the question; however, they should not contain proprietary names or information.

Requests that are not in this format will be rewritten in this format by the Committee prior to being answered, which may inadvertently change the intent of the original request.

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PERFORMANCE REQUIREMENTS FOR BACKFLOW PROTECTION DEVICES AND SYSTEMS IN PLUMBING FIXTURE FITTINGS

1 PURPOSE

The purpose of this Standard is to establish performance requirements and statistically valid evaluation methods including durability tests for the manufacture of safe, efficient, and reliable backflow protection devices and systems for plumbing fixture fittings.

Alternative designs or configurations which comply with the intent of this Standard shall be permitted.

2 SCOPE

This Standard addresses functional performance and requires physical characteristics of devices and systems which provide backflow protection consistent with the level of risk associated with the plumbing fixture fitting application. The Standard establishes specific performance criteria and provides the test methods to prove compliance. It is applicable to all plumbing fixture fittings with outlets not protected by an air gap.

3 REFERENCE STANDARDS

The following documents form a part of this Standard to the extent specified herein. The latest issue shall apply.

ASTM D 1193, Specification for Reagent Water

Publisher: The American Society for Testing and Materials (ASTM), 100 Barr Harbor Drive, West Conshohocken, PA 19428

ASME A112.1.2, Air Gaps in Plumbing Systems
ASME A112.18.1, Plumbing Fixture Fittings
ASME PTC 19.2, Supplement on Instruments and Apparatus, Part 2 Pressure Measurement

Publisher:The American Society of Mechanical Engineers (ASME International), Three Park Avenue, New York, NY 10016-5990

ANSI/ASSE 1001, Pipe Applied Atmospheric Type Vacuum Breakers
ANSI/ASSE 1011, Performance Requirements for Hose Connection Vacuum Breakers
ANSI/ASSE 1014, Performance Requirements for Hand-Held Showers
ANSI/ASSE 1025, Performance Requirements for Diverters for Plumbing Faucets With Hose Spray, Anti-Siphon Type, Residential Applications
ANSI/ASSE 1052, Hose Connection Backflow Preventors
ASSE 1012, Performance Requirements for Backflow Preventers With Intermediate Atmospheric Vent
ASSE 1013, Performance Requirements for Reduced Pressure Principle Backflow Preventers
ASSE 1019, Vacuum Breaker Wall Hydrants, Frost Resistant Automatic Draining Type
ASSE 1035, Performance Requirements for Laboratory Faucet Vacuum Breakers
ASSE 1056, Performance Requirements for Back Siphonage Backflow Vacuum Breakers

Publisher: The American Society of Sanitary Engineering, 2890 Clemens Road, Suite 100, West Lake, OH 44145

AWWA C511, Reduce Pressure Principle Backflow Preventor Assembly
AWWA 10079, Standard Methods for the Examination of Water and Wastewater

Publisher: The American Water Water Works Association (AWWA), 6666 West Quincy Ave., Denver, CO 80235

CSA B 64, Backflow Preventers and Vacuum Breakers
CSA B 125, Plumbing Fittings

Publisher: CSA International, 178 Rexdale Blvd., Toronto, Ontario, Canada M9W1R3

4 DEFINITIONS

Nomenclature and definitions applicable to faucets, fixture fittings, and backflow requirements shall be as follows:

acceptance sampling plan: the correlation of sample size and allowed failure rate.

air gap: the unobstructed vertical distance through the free atmosphere between the lowest opening from any pipe or faucet and the flood-level rim of a receptor. See ASME A112.1.2.

approved: accepted by the authority having jurisdiction

backflow: the reversal of flow direction from that normally intended. Back siphonage is one type of backflow. Back pressure backflow is another type.

backflow prevention system: any mechanical system, consisting of two or more devices, designed to automatically prevent an unintentional reversal of flow in a potable water distribution system. A backflow prevention system prevents back siphonage and back pressure backflow.

back pressure: a pressure higher at the outlet of a fitting than that at the inlet or a point upstream.

back siphonage: the flowing back of water from a plumbing fixture, vessel, or other source into the fitting as the result of a vacuum at the inlet of the fitting.

bidet: a fixture and/or wall mounted fitting with transfer valves for vertical spray and rim flushing; a deck mounted fitting with hose connected outlets.

certified: indicates that testing has been conducted by an approved independent testing agency in accordance with the applicable standard and found to be in full compliance with the standard.

commercial fitting: a hose and spray assembly for food service, dispensers, and similar nonresidential applications other than those where an air gap is maintained by design, such as spring-action goosenecks.

critical level: level at which polluted water, entering through an outlet of the supply fitting, will flow back to the supply lines by gravity and/or any negative pressure in the supply line when the water control valve is fully open.

cross connection: an actual or potential connection or arrangement between two or more separate piping systems, one of which contains potable water and one of the others a source of questionable or unknown quality. The direction of flow will depend upon the pressure differential between the two systems.

deck mounted and combination fitting: residential deck mounted fitting for tubs. It often includes a hand-held or personal shower.

device: one of the constituent parts of a backflow prevention system which by itself provides a form of backflow protection.

fill valve: a water supply valve (also known as a ballcock), opened or closed by means of a float or similar device, used to supply water to a tank.

fitting with side sprays: a kitchen deck mounted fitting with integral diverter and hose connected side spray. The primary outlet is protected with an air gap.

fitting wih pull-out spout: a deck mounted fixture fitting with a primary removable spout that is connected to the body of the faucet through a flexible hose. Applications are residential kitchens, low sinks, and lavatories.

hand held shower: a product consisting of a hose and discharge piece, such as a shower head or spray; it is used in conjunction with bath and shower fittings or dedicated wall outlets.

hose bibb: a fitting terminating with a hose thread.

inspection: the process of measuring, examining, testing, gauging, or otherwise comparing the unit with the applicable requirements.

laboratory fitting: a fitting terminating with a serrated hose tip.

potable water: water which is suitable for drinking and free from impurities present in amounts which are sufficient to cause disease or harmful physiological effects.

random sample: a sample taken in a manner which gives every item in the lot, or every portion of the lot for bulk materials, an equal probability of being selected as part of the sample.

sample: the number of specimens selected from a production lot as representative of that lot.

sampling scheme, multiple: a sampling method in which, after each sample is inspected, the decision is made to accept a lot, to reject it, or to take another sample, the test result of which shall be added to that of the previous one.

shampoo fitting: a hose and spray assembly for attachment to a wall outlet or lavatory fitting.

specimen: an individual component which combined with others makes up a required sample.

upper confidence limit: the maximum probable percentage of individual safety devices subject to backflow in the field under those conditions defined in the life test.

vacuum breaker: a device or means to prevent back siphonage by allowing air to enter a fitting.

vent to air: a backflow prevention device which opens a fitting or part of a fitting to the atmosphere.

5 APPLICATION OF BACKFLOW PREVENTION DEVICES

5.1 Minimum Level of Protection

Fixture fittings which are not protected against backflow by an air gap in accordance with ASME A112.1.2 under all conditions of usage shall incorporate backflow protection by means described in paras. 6 through 16 or use a system or device in compliance with the following standards: ANSI/ASSE 1001, ANSI/ASSE 1011, ASSE 1012, ASSE 1013, ANSI/ASSE 1014, ASSE 1019, ASSE 1035, ASSE 1052, ASSE 1056, AWWA C511, CSA B64, or CSA B125 dependent on their application and code instalation requirements with no further testing to this Standard.

5.2 Application

(*a*) Backflow prevention devices or systems not covered by the standards listed in para. 5.1 shall comply with paras. 6 and 7.

(*b*) Fittings with internal backflow prevention devices or systems complying with paras. 6 and 7 shall be tested to para. 8.

(*c*) Fittings with internal backflow prevention devices or systems not complying with paras. 6 and 7 shall comply with para. 9.

Table 1 Acceptance Sampling Plan — Devices

Cumulative Sample Size (Specimens)	Failures Allowed
7	0
10	1
13	2
17	3

6 GENERAL REQUIREMENTS FOR BACKFLOW PREVENTION DEVICES

6.1 Functional

Backflow prevention devices shall be designed to prevent pollution and contamination of the potable water system.

6.2 Materials

Materials in contact with potable water shall comply with the requirements of ASME A112.18.1M.

6.3 Environment

6.3.1 Working Pressure. Backflow prevention devices shall be designed to function at water working pressures up to 125 psig (861 kPa gage).

6.3.2 Working Temperature. Backflow prevention devices shall be designed to function at water supply temperatures ranging from 40°F to 160°F (4.4°C to 71°C).

6.4 Reliability

Backflow prevention devices shall be resistant to mechanical wear, deposition of minerals, aging, and corrosion of the materials as determined by the test procedure of para. 7. The manufacturer shall establish the reliability of the individual backflow prevention device, and it shall be confirmed by durability tests in accordance with para. 7.

7 EVALUATION OF BACKFLOW PREVENTION DEVICES

7.1 Sample Size

The minimum initial sample size per set shall be seven specimens. The incremental increases and cumulative sample sizes shall be as shown in Table 1.

7.2 Test Methodology

7.2.1 Facilities. The backflow prevention devices shall be tested individually in fittings or test fixtures representing the dimensions and tolerances specified by the device manufacturer.

7.2.2 Protocol. The functional performance of the device shall be determined before and after the durability test sequence. The functional performance of a device shall be determined in accordance with para. 11. The durability test sequence for a device shall be conducted in accordance with para. 15. The process for evaluation of backflow prevention devices is illustrated in Fig. 1.

Two sample sets, each consisting of a minimum of seven specimens, shall be evaluated for durability by tests defined in para. 15. At the start of the evaluation, both sets samples shall be tested for functional performance (para. 11). Thereafter, one sample set shall be tested for mechanical wear and mineral deposition (para. 15.2), and the second sample set shall be tested for aging and corrosion (para. 15.1). When retested, there shall be a maximum of three incremental increases.

7.3 Conformance

Any physical damage to internal devices known to preclude functional performance shall be cause for rejection. The allowable failures shall not exceed the values shown in Table 1.

8 FIXTURE FITTINGS WITH INTERNAL DEVICES COMPLYING WITH PARAS. 6 AND 7

The purpose of this paragraph is to define the requirements and test procedures for the evaluation of finished products incorporating certified backflow protection devices which have been demonstrated to be in compliance with paras. 6 and 7 of this Standard.

8.1 Health and Safety

8.1.1 There shall be at least two backflow prevention devices, in series proven by tests as in compliance with para. 7 of this Standard. They shall operate independently as integral parts of the fixture fitting. At least one device shall be a check valve, called the primary check in this Standard.

Among the protection devices are

(a) check valves
(b) vents to air
(c) vacuum breakers
(d) automatic diverters

8.1.2 Contaminants shall not enter the potable water system through backflow nor shall contaminants be allowed to enter the fitting beyond the first barrier when the backflow preventer is operating properly. The test shall be in accordance with para. 12.

8.1.3 The manufacturer shall specify the type and location of the backflow protection system in the product literature or in the installation instructions.

8.2 Performance Tests

8.2.1 Selection of Test Specimens. To comply with this Standard, two specimens will be selected at random from a lot of five production fittings. Before mounting the fixture fittings in the test rig, correct installation of

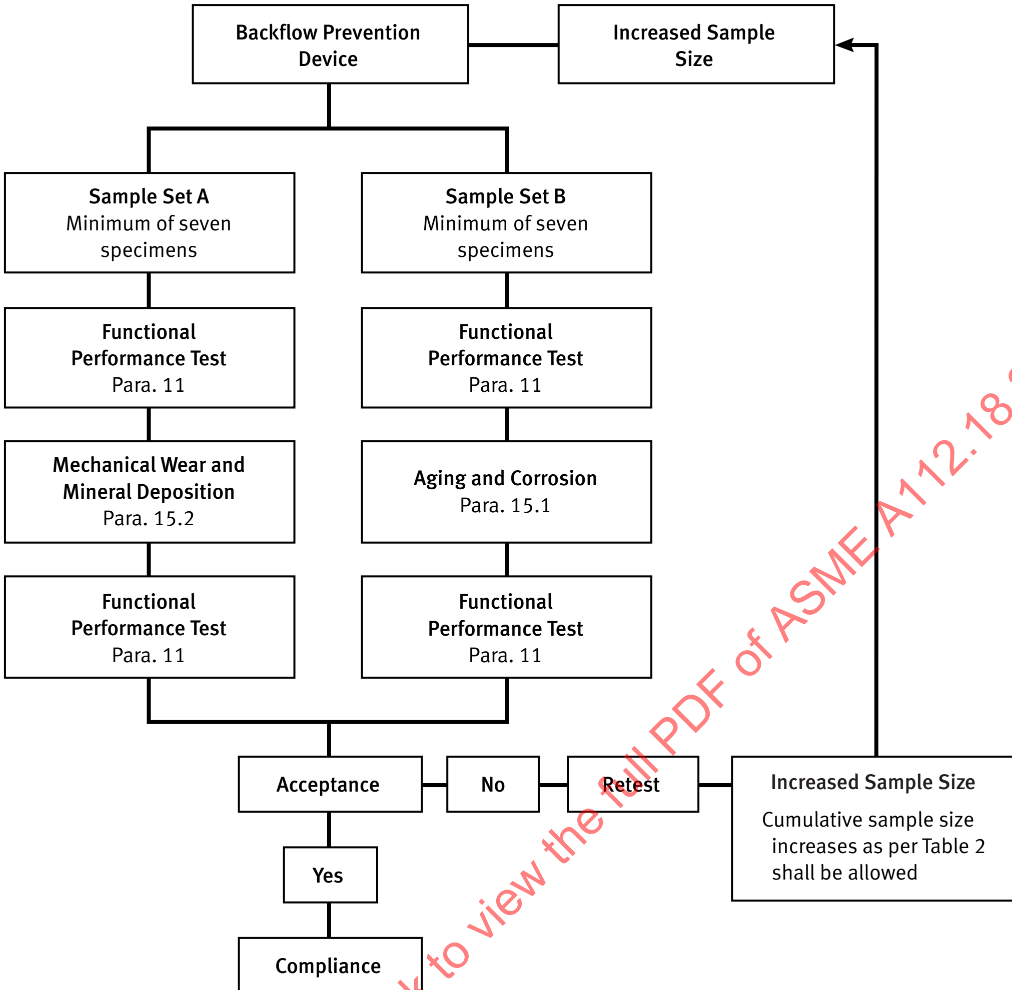

Fig. 1 Test Protocol for Devices

the protecting devices shall be verified as conforming to the manufacturer's drawings and specifications.

8.2.2 Conformance. The sample shall pass the following tests:

(*a*) back pressure, see para. 12.1;
(*b*) back siphonage, see para. 12.2;
(*c*) independence of devices, see para. 13; and
(*d*) leakage of protection systems with atmospheric vents, see para. 14.

9 FIXTURE FITTINGS WITH INTERNAL DEVICES NOT COMPLYING WITH PARA. 7

The purpose of this paragraph is to define the requirements and test procedures for the evaluation of finished products incorporating backflow protection devices that have not been demonstrated to be in compliance with para. 7 of this Standard.

This method does not examine the performance of the devices individually and therefore gives no detailed insight into their reliability. It is designed to confirm the overall minimum reliability of the integrated safety system as equal to or greater than 0.80.

9.1 Requirements

Backflow protection systems shall be designed to prevent contamination of the potable water system and shall comply with the requirements of the following paragraphs:

(*a*) 6.2 Materials
(*b*) 6.3 Environment
(*c*) 6.4 Reliability
(*d*) 8.1 Health and Safety

9.2 Sample Size

The manufacturer shall submit a minimum of 17 specimens for each of the two sample sets, plus two for the general inspection, for a total of 36 fittings. A multiple sampling scheme, as shown in Table 2, shall be used.

Table 2 Acceptance Sampling Plan — Fittings

Cumulative Sample Size (Specimens)	Failures Allowed
17	0
26	1
35	2
43	3

9.3 Test Methodology

The following tests shall be completed in the order listed in Fig. 2. Conformance to the referenced paragraphs of this Standard shall be required.

9.3.1 General. Two specimens (Sample Set C), selected at random from those submitted, shall be inspected for:

(a) independence of devices, see para. 13;

(b) leakage of protection systems with atmospheric vents, see para. 14.

9.3.2 Conformance

(a) Sample Set A. The sample shall pass the following tests:

(1) back pressure, see para. 12.1;

(2) back siphonage, see para. 12.2;

(3) aging and corrosion, see para. 15.1;

(4) back pressure, see para. 12.1;

(5) back siphonage, see para. 12.2; and

(6) leakage of protection systems with atmospheric vents, see para. 14.

(b) Sample Set B. The sample shall pass the following tests:

(1) back pressure, see para. 12.1;

(2) back siphonage, see para. 12.2;

(3) mechanical wear and mineral deposition, see para. 15.2;

(4) back pressure, see para. 12.1;

(5) back siphonage, see para. 12.2; and

(6) leakage of protection systems with atmospheric vents, see para. 14.

9.3.3 Instrumentation. Pressure and vacuum measurements shall be in accordance with ASME PTC 19.2.

10 TEST METHODS AND PERFORMANCE CRITERIA

With new products, failure of the function test (as described in para. 11 or 12) shall require discontinuation of further evaluation. Failure of the function test after the durability tests does not automatically mean the rejection of the device or the system. The testing of an additional sample shall not be conducted unless done in accordance with the multiple sampling scheme given in Table 2.

11 FUNCTIONAL TEST OF BACKFLOW PREVENTION DEVICES

When the backflow prevention devices are check valves, testing shall be conducted in accordance with para. 11.1. When the backflow prevention devices are vacuum breakers or automatic diverters and vents, testing shall be conducted in accordance with para. 11.2. Install the devices in their normal position in a test rig in accordance with the manufacturer's instructions. Where the device is intended to be installed in a housing or test fixture supplied by the manufacturer, the dimensional requirements, including tolerances, shall be accounted for in the installation.

11.1 Check Valves (New and After Durability Tests)

Check valves shall be watertight over the range of back pressures from 0.5 in. to 80 in. H_2O (0.12 kPa gage to 19.9 kPa gage) and at vacuums from 0 in. Hg to 25 in. Hg (0 kPa gage to 84 kPa gage).

Connect the inlet of the devices to a water supply capable of delivering water through each device at a flow of 1.0 gpm to 2.0 gpm (0.063 L/s to 0.126 L/s), to a vacuum system capable of maintaining a vacuum from 0 in. Hg to 25 in. Hg (0 kPa gage to 84 kPa gage) and to atmosphere. Flush the devices to purge air from the system. For basic test setup, see Fig. 3.

Connect a 0.25 in. (6.35 mm) minimum nominal inside diameter transparent sight tube in a leakproof manner to the devices or test rig outlet such that the tube is vertical upward. Apply 0.5 in. H_2O (0.12 kPa gage) back pressure and observe for leaks during a 5 min interval. Increase the back pressure up to 80 in. H_2O (19.9 kPa gage) and inspect for leakage during a 5 min interval. Reduce the back pressure to 1 in. H_2O (0.25 kPa gage) by opening the drain valve. Apply a vacuum of 5 in. Hg (17 kPa gage), increase up to 25 in. Hg (84 kPa gage), and inspect for leakage by observing the water in the sight glass.

Subject the check valve to five vacuum surges of 0 in. Hg to 25 in. Hg (0 kPa gage to 84 kPa gage) by quickly opening and closing Valves 2 and 3 sequentially.

There shall be no leakage.

11.2 Vacuum Breakers, Automatic Diverters, and Vents

The vacuum at which the vacuum breaker, the vent to air, or the automatic diverter opens to the atmosphere shall be defined by the manufacturer and tested.

Connect the inlet of each specimen to a vacuum capable of maintaining 25 in. Hg (84 kPa gage) at the inlet after the device opens. Gradually apply a vacuum until the vacuum breaker, diverter, or vent opens. Record the opening vacuum. See Fig. 4 for basic test setup. Increase the vacuum measured at the fitting to 25 in. Hg (84 kPa gage). Record the indicated air flow rate and the pressure drop. The functional performance rating shall be: the

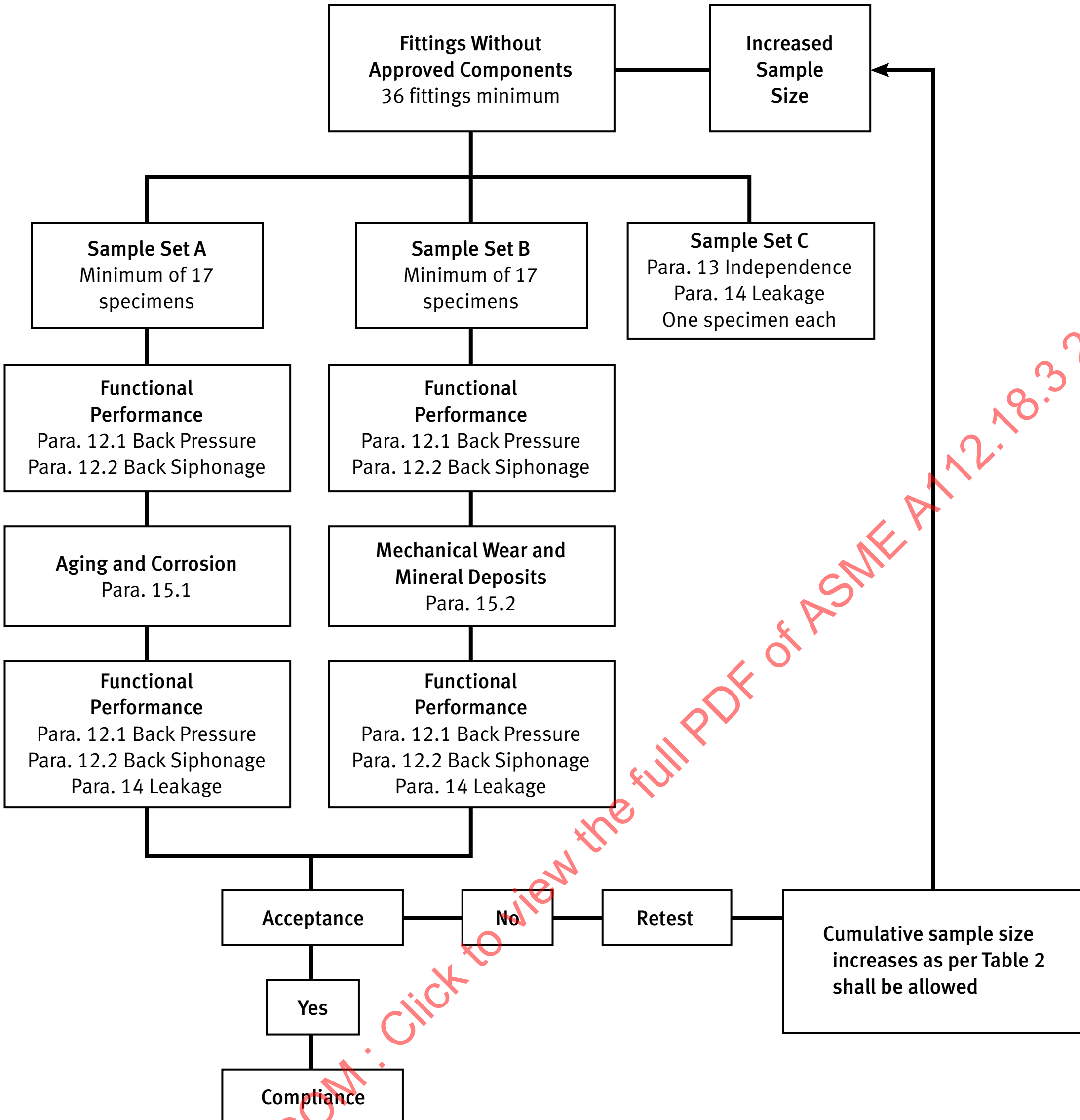

Fig. 2 Test Protocol for Fittings Without Approved Components

maximum opening pressure, the minimum flow rate at 25 in. Hg (84 kPa gage), and the corresponding pressure drop (vacuum gauge reading).

An increase in pressure drop or reduction in air flow rate larger than 20% after completion of the durability tests shall be cause for rejection.

12 FUNCTIONAL TEST OF BACKFLOW PREVENTION SYSTEMS

12.1 Back Pressure

Mount the fixture fitting as received from the manufacturer in its normal position in accordance with the installation instructions. Connect the inlet pipes collectively to a water supply capable of delivering water through each device at a flow of 1.0 gpm to 2.0 gpm (0.063 L/s to 0.126 L/s) to a vacuum system capable of maintaining a vacuum from 0 in. Hg to 25 in. Hg (0 kPa gage to 84 kPa gage). See Fig. 5.

Connect a ½ in. minimum inside diameter transparent sight glass in a leakproof manner to the hose connected outlet. Open Valve 1 with Valve 2 and Valve 3 closed and flush the fitting to purge air from it. Close Valve 1. Adjust the water level in the sight glass to be ½ in. (13 mm) above the highest level of the fitting. Open Valve 2. Observe the level of water in the sight glass for a 5 min period as an indication of leakage. Raise and hold the hose outlet for 5 min at its maximum vertical extension. Inspect for leakage.

There shall be no leakage.

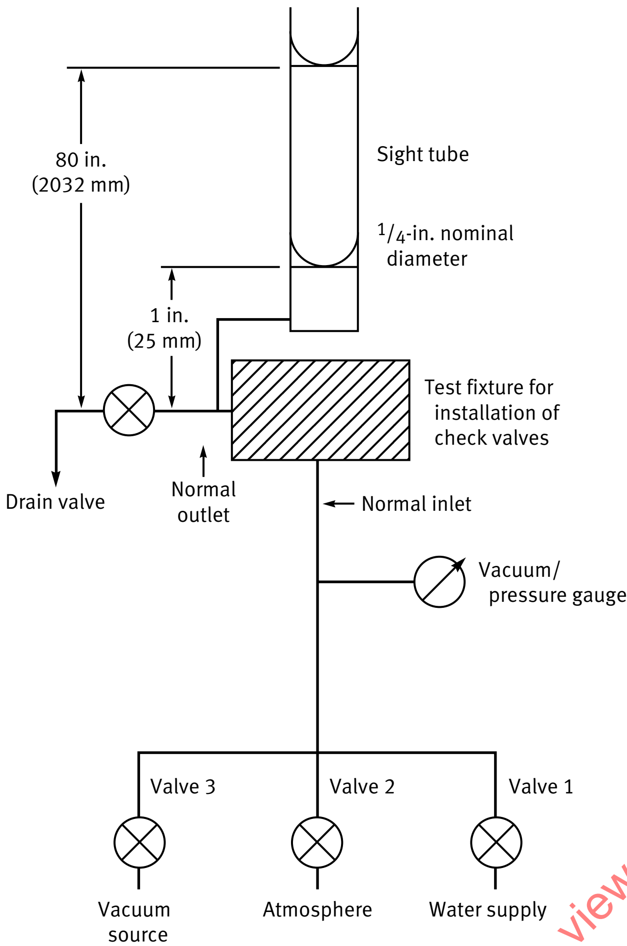

Fig. 3 Functional Performance for Check Valves

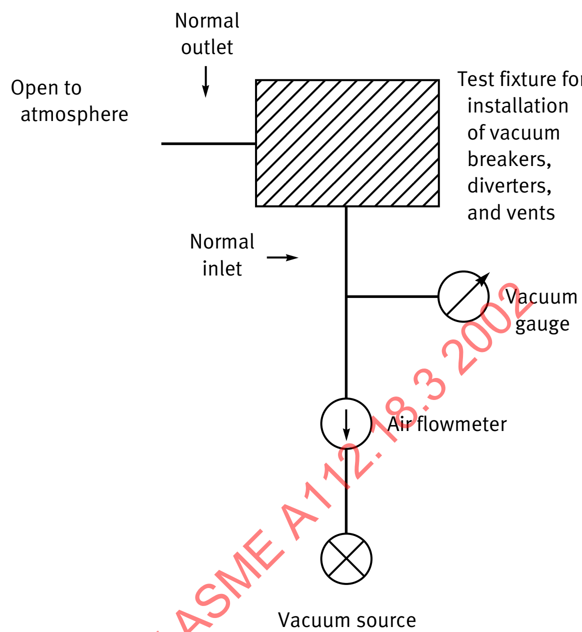

Fig. 4 Functional Performance for Vacuum Breakers, Diverters, and Vents to Air

12.2 Back Siphonage

Mount the fitting according to Fig. 6.

Adjust the fitting to deliver water at full flow with the valve or valves positioned to deliver an equal mix from each side. The entire fitting shall be free of water.

Submerge the lower end of the sight glass in a receptor providing a minimum 0.25 in. (6.35 mm) annular clearance which shall contain colored water. Position the receptor such that the surface of the water is level with the deck.

Open Valve 3. Apply and maintain a vacuum of 5 in. Hg (17 kPa gage). Observe and note any rise in the water level in the sight glass above the water level in the receptor during a 5 min interval. Increase and maintain the vacuum to a maximum of 25 in. Hg (84 kPa gage). Observe and note any rise in the water level in the sight glass above the water level in the reservoir during a 5 min interval.

Subject the fitting to five vacuum surges of from 0 in. Hg to 25 in. Hg (0 kPa gage to 84 kPa gage) by quickly opening and closing Valves 2 and 3 sequentially. Observe and note any rise in the water level in the sight glass above the water level in the receptor during a 5 min interval.

When conducted in conjunction with the durability tests of para. 15, any rise of colored water into the sight glass above the water level in the reservoir before the durability tests, for fixture fittings with backflow protection in accordance with para. 8.1.1(a), shall constitute failure of these tests.

When conducted in conjunction with the durablitiy tests of para. 15, any rise of colored water in the sight glass above the water level in the reservoir after the durability tests, for fixture fittings with backflow protection in accordance with para. 8.1.1(a), shall constitute failure of these tests.

After the durability tests, for fixture fittings with backflow protection in accordance with para. 8.1.1(b), (c), or (d), a water rise of colored water in the sight glass above the water level in the reservoir within 0.5 in. (12.7 mm) of the verified critical level (specified by the manufacturer and confirmed in para. 16) shall constitute failure of these tests.

13 INDEPENDENCE OF DEVICES

Evaluate the independence of all backflow protecting devices in a fitting by comparison of the product description received from the manufacturer with the actual product. An independent device shall share no common parts with another device except for body housing. The failure of one device in any mode shall not affect the operation of another device.

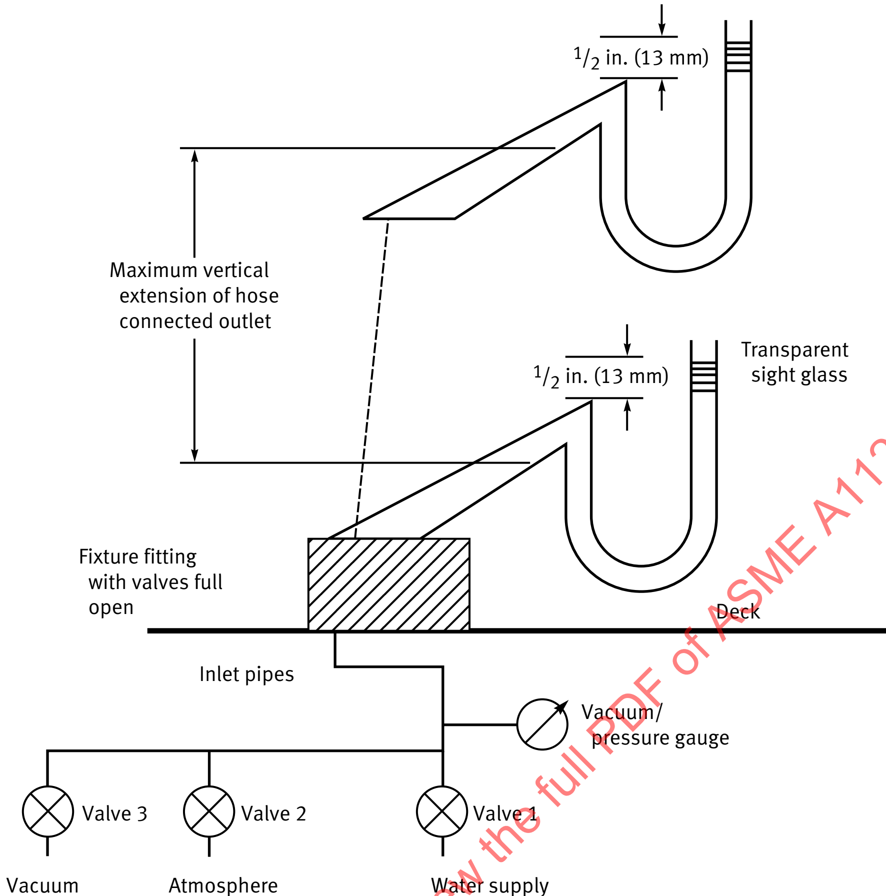

Fig. 5 Functional Performance of Backflow Prevention Systems With Regard to Back Pressure Backflow

14 LEAKAGE OF PROTECTION SYSTEMS WITH ATMOSPHERIC VENTS

The fitting shall be operated by opening and closing its valves 50 times. There shall be no visible external leakage under operating conditions of the fixture fitting at 160°F (71.1°C) and 125 psig (861 kPa gage).

15 DURABILITY TESTS

15.1 Aging and Corrosion

The tests shall be performed on one sample set of devices or systems after their functional performance has been verified as described in paras. 11, 12, 13, and 14, whichever is applicable.

Resistance to corrosion of metals and the aging of plastics and elastomers shall be tested in an endurance immersion test using Type 3 water as defined by ASTM D 1193.

The complete fitting or test body shall be preheated to 140°F (60°C) and filled with 140°F (60°C) water, purged of air and completely immersed in a constant temperature bath or oven set, and maintained at a temperature of 160°F ± 5°F (71.1°C ± 2.8°C) for 800 hr in its normal field installation position.

15.2 Mechanical Wear and Mineral Deposits

The devices or systems shall be set up in an operating fitting with the shut-off valve open or in a test fixture and connected to the water supply system. The supply valve of the test rig shall be opened and closed 200,000 times or 60,000 times if the device or fitting is solely to be used for secondary outlets. If the fixture fitting is a single lever mixer, it shall be set in the average mixed water supply position. Each cycle shall be as follows:

Opening time	0.4 ± 0.1 sec
Idle period in open position	4.0 ± 0.5 sec
Closing time	0.4 ± 0.1 sec
Idle period in closed position	1.3 ± 0.1 sec

The test shall be interrupted for a period of 1 hr after every 1,000 opening and closing cycles. After completing 25%, 50%, and 75% of the opening and closing cycles, there shall be a 48 hr idle period. There shall be a 192 hr idle period at the conclusion of the test.

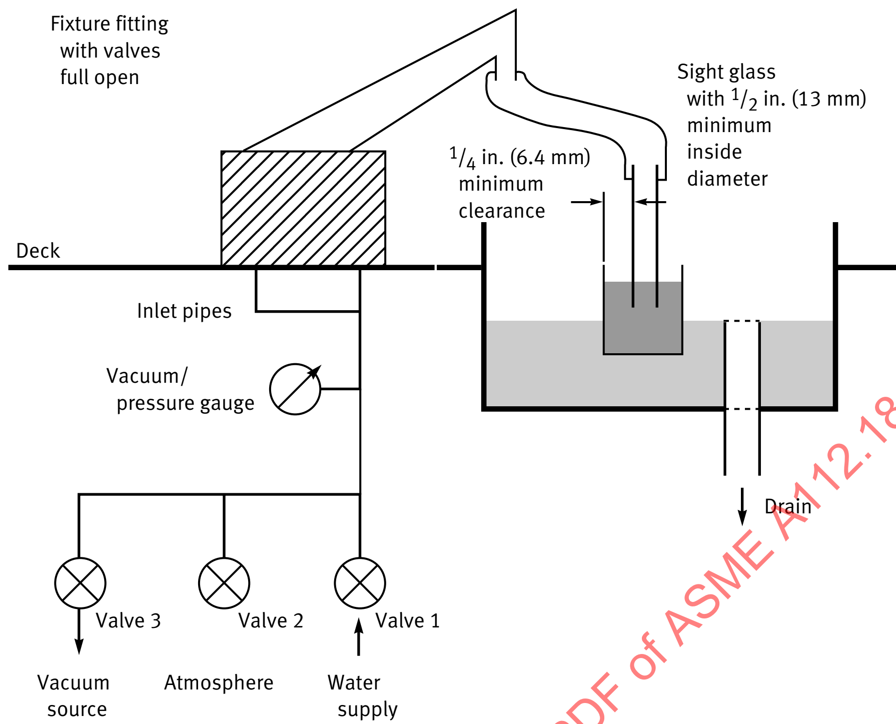

Fig. 6 Functional Performance of Backflow Prevention Systems With Regard to Back Siphonage (Hose Connected Movable Outlet Faucets)

During these periods the supply valve of the test rig or the fitting shall be closed.

Where a vacuum breaker or atmospheric vent is under test, the ambient air temperature to it shall be between 110°F and 115°F (43.3°C and 46.1°C).

Temperature changes encountered in everyday practice shall be simulated by periodically cycling the water supply from hot to cold as described below. Where complete fittings are used, their water supply inlets shall be interconnected, so that hot or cold water flows into the fitting through both inlets.

Further conditions:

Hot water temperature	140°F ± 5°F (60°C ± 3°C)
Cold water temperature	65°F ± 10°F (18.5°C ± 5.5°C)
Period of hot water flow	5 min ± 20 sec
Period of cold water flow	15 min ± 20 sec
Flow pressure	50 psig ± 5 psig (345 kPa gage ± 34 kPa gage)
Water hardness	200 ppm to 270 ppm $CaCO_3$
Saturation index (Langelier)	0.2 to 0.3

The saturation index shall be determined based on values of the parameters measured at the discharge of the water from the devices on test. The pk[1] value shall be based on calcite. The procedure shall be in accordance with Section 2330 of AWWA 10079. The index shall be determined at least once during each 10,000 cycles throughout the test.

The formulation of the test water is given in Table 3. A schematic drawing of the facility is given in Fig. 7.

[1] AWWA 10079, The Standard Methods for the Examination of Water and Wastewater, provides the method for determing the Calcium Carbonate Saturation Index. K is the solubility product constant for $CaCO_3$ at water temperature. The p designates −log10. Calcite is one of several forms of $CaCO_3$ that form in aqueous systems. A table in AWWA 10079 gives values for pK. Note that an upper case K is used in denoting pK.

Table 3 Formulation for ASME A112.18.3 Water

Chemical	Molecular Weight	Weight in DI Water g/50 gal	Weight in DI Water mg/L
$MgSO_4 \cdot 7H_2O$	246.5	28.62	151.21
$MgCl_2 \cdot 6H_2O$	203.8	5.19	27.42
$Ca(NO_3)_2 \cdot 4H_2O$	244.7	0.14	0.074
$CaCl_2 \cdot 6H_2O$	219.1	36.89	194.9
$Ca(OH)_2$	74.1	12.25	64.72
K_2SO_4	174.3	1.16	6.13
$NaHCO_3$	84.0	3.12	16.48

GENERAL NOTES:

(a) Total Hardness = 250 mg/L as $CaCO_3$.

(b) Dissolve $Ca(OH)_2$ separately in 20 gal of DI water by bubbling CO_2; if necessary add tiny amounts of 0.1N HCl. Combine this with 30 gal of DI water containing the remaining chemicals.

(c) All the chemicals are available from laboratory supply houses (e.g., Fischer Scientific).

(d) Source: Stevens Institute of Technology, May 28, 1998.

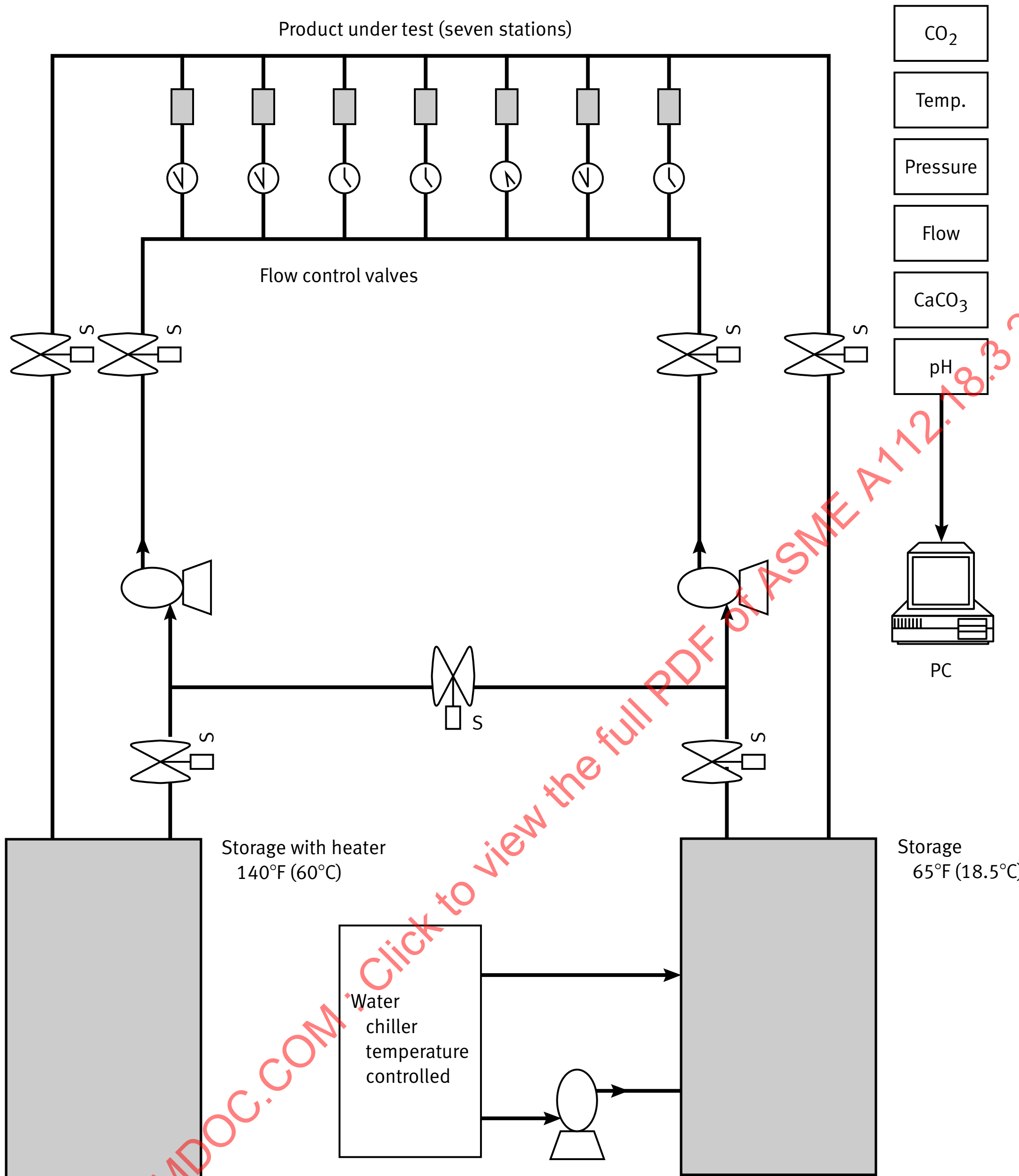

Fig. 7 Schematic Drawing of Test Facility

15.3 Inspection and Evaluation

At the conclusion of the durability tests, the device or the system shall be tested for functional performance in accordance with para. 11, 12, or 14, whichever is applicable, and against the criteria in para. 7.3.

16 VERIFICATION OF CRITICAL LEVEL [HOSE CONNECTED MOVABLE OUTLET FAUCETS WITH ATMOSPHERIC VENTS, PARAS. 8.1.1(B), (C), AND (D)]

The laboratory shall confirm the critical level.

Mount the fixture fitting in a test facility as shown in Fig. 8. Remove all check valves or block them full open. Open the fitting control valve, and place the moveable outlet in its pullout position. Connect a transparent flexible hose [1] and reservoir [2] to the fitting outlet in a leakproof manner. Adjust the fitting to deliver water at full flow with the valve or valves postioned to deliver an equal mix from each side. Flow water through the fitting until it is completely full of water and purged of any air. Fill the reservoir with water such that level [A] is below the manufacturer's specified critical level. Disconnect the inlets from the supplies and allow water

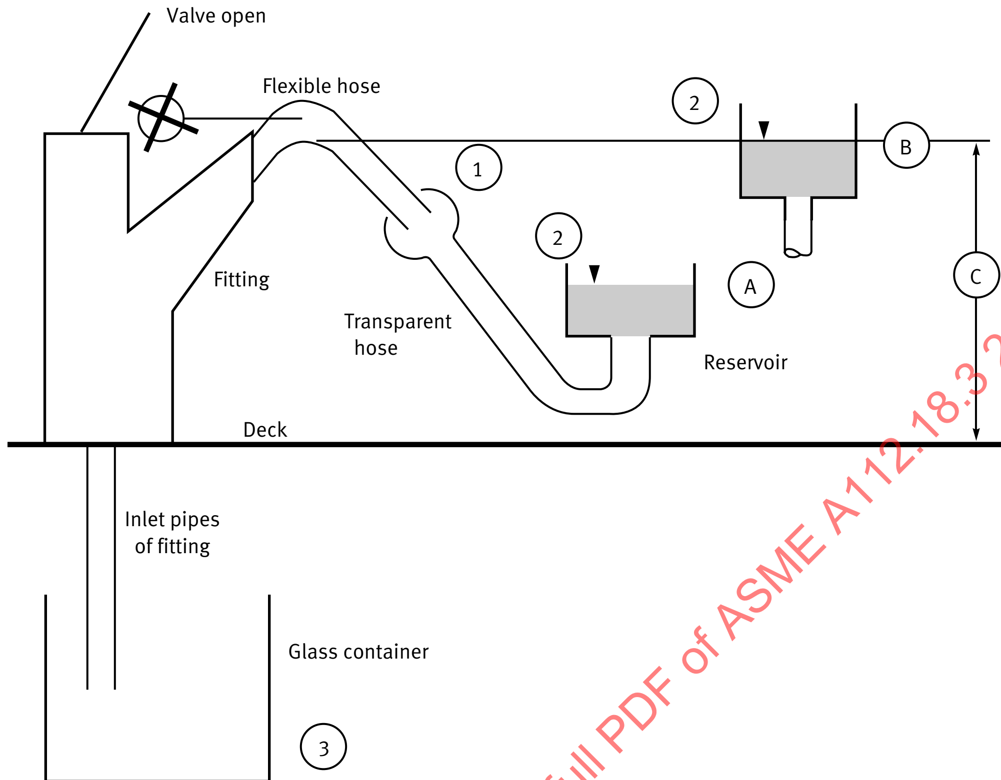

Fig. 8 Verification of the Critical Level
(Hose Connected Outlet Faucets With Atmospheric Vents)

to drain from the inlets. Place a glass container [3] under the inlet pipes of the fitting.

The determination of critical level requires that the vent to atmosphere must be open, and it shall be manually opened if required.

Slowly elevate the reservoir upwards. While monitoring the fitting inlet pipes, continue raising the reservoir until the water begins to flow from the fitting inlets. Maintain this level [B] of the reservoir until the flow ceases.

The horizontal plane located at the water surface in the reservoir [2], when the flow from the fitting ceases, is the actual critical level of the fitting.

The distance [C] from the mounting deck of the fitting to the actual critical level shall be a minimum of 1 in.

NOTE: The pullout spout (wand) may be removed from the fitting outlet flexible hose, and the transparent flexible hose connected to the end of the outlet flexible hose.

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NONMANDATORY APPENDIX A RATIONALE FOR SAMPLING SCHEME AND STATISTICAL PROCEDURES

The provisions of ASME A112.18.3-2002 have been written to provide safety systems with a minimum reliability of 80% throughout the useful life of plumbing fixture fittings. This reliability exceeds the performance of traditional plumbing fixture fittings incorporating diverters as protection systems, which have been proven adequate through many years of service (see Reference [1]).

The actual probability of backflow occurring in a faucet equipped with a safety system is calculated from the natural probability multiplied by the upper confidence limits of the individual devices featured in the safety system:

$$P = NR\ C = NR\ (P_{u1}\ P_{u2}\ P_{u3}\ \ldots)$$

where

C = upper confidence limit, i.e., maximum possible percentage of safety assemblies subject to backflow in the field under those conditions defined in the life test

NR = natural reliability, i.e., probability of backflow occurring without the use of safety systems

P = probability of backflow occurring

$P_{u1}, P_{u2} \ldots$ = upper confidence limit, i.e., maximum possible percentage of individual safety devices subject to backflow in the field under those conditions defined in the life test

A discussion of the natural reliability may be found in Reference [2].

Safety devices are

(a) check valves

(b) vacuum breakers

(c) vents to air

(d) automatic diverters

The fitting under examination must in all cases be protected by an assembly comprising at least two safety devices, of which the first barrier must be a check valve to safeguard against back pressure and back siphonage backflow.

The reliability of the safety system is defined as:

$$R_d = 1 - P = 1 - (P_{u1}\ P_{u2}\ \ldots)$$

where

R_d = reliability of the safety system based on the upper confidence limits of P_{u1}, $P_{u2} \ldots$

The upper confidence limits are based on measured failure rates for devices subjected to the durability tests defined in ASME A112.18.3-2002.

The upper confidence limits, for a P_a of 97.5% unilateral, being usual for technical products of the type under examination, are given in Table A1 for selected sample sizes and failure rates.

If, for example, 2 out of $n = 10$ specimens (= 20%) fail to meet the requirements in the life test, the upper confidence limit for all of these products in the field is 55.6%. This means the maximum probable failure rate may account for 55.6%.

For devices of the type under examination, it is proposed not to permit an upper confidence limit, i.e., the maximum probable failure rate in the field, in excess of 56%.

It shall also be mathematically possible to add the results of several tests performed to the same specification on differing numbers of specimens. This technique is referred to as a multiple sampling scheme and is widely recognized in quality control work.

Therefore, adding a second test result from 5 test specimens with 1 failure to the above described result produces an upper confidence limit for the final test result of <48.1% and means, with respect to the above assumed limit of 56%, that the product tested in this way has passed the test. It is proposed that the tested device, or the entire product in the case of integrated solutions, be certified.

The described method of computing the reliability of safety systems is mathematically exact, noninterpretable, extremely simple for test engineers and manufacturers to use, and extremely flexible in application. The latter two criteria are of particular significance to pragmatic approval testing.

The failure rate confidence limit, Table A1, is computed from the binomial distribution according to Clopper-Pearson (see Reference [3]) for the upper limit as

$$P_u' = \frac{(i+1)\ F_p\,(f1{:}\,f2)}{(n-i) + (i+1)\ F_p\,(f1{:}f2)}$$