



Member of the FM Global Group

Approval Standard for Anti-Water Hammer Check Valves

Class Number 1230

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Foreword

Approval Standards are intended to verify that the products and services described will meet stated conditions of performance, safety and quality useful to the ends of property conservation. The purpose of Approval Standards is to present the criteria for Approval of various types of products and services, as guidance for FM Approvals personnel, manufacturers, users and authorities having jurisdiction.

Products submitted for Approval shall demonstrate that they meet the intent of the Approval Standard, and that quality control in manufacturing and/or applications shall ensure a consistently uniform and reliable product or service. Approval Standards strive to be performance-oriented and to facilitate technological development.

For examining equipment, materials and services, Approval Standards:

- a) must be useful to the ends of property conservation by preventing, limiting or not causing damage under the conditions stated by the Approval listing; and
- b) must be readily identifiable.

Continuance of Approval and Listing depends on compliance with the Master Agreement, satisfactory performance in the field, on successful re-examinations of equipment, materials, and services as appropriate, and on **surveillance** audits of the manufacturing facility or service/application.

FM Approvals LLC reserves the right in its sole judgment to change or revise its standards, criteria, methods, or procedures.

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1. INTRODUCTION

1.1 Purpose

- 1.1.1 This standard states Approval criteria for anti-water hammer check valves for fire protection systems.
- 1.1.2 Approval criteria include, but are not limited to, performance requirements, marking requirements, examination of manufacturing facility(ies), audit of quality assurance procedures, and a surveillance audit program.
- 1.1.3 Approval standards are intended to verify that the product described shall meet stated conditions of performance, safety, and quality useful to the ends of property conservation.

1.2 Scope

- 1.2.1 This standard encompasses the design and performance requirements for 2, 2-1/2, 3, 3-1/2, 4, 5, 6, 8, 10, 12, 14, 16, 18, 20, and 24 inch nominal size anti-water hammer check valves. The intended application of these devices is to permit the flow of water in one direction only, preventing flow in the opposite direction, as well as to moderate the potentially destructive effects of pressure surges or water hammer due to pump starting and stopping and valve opening and closing. Sizes refer to the nominal diameter of the pipeline to which the valve will be connected. In cases where metric sized anti-water hammer check valves are to be examined for FM Approval, test criteria comparable to the equivalent or nearest nominal inch size shall be used.
- 1.2.2 This standard defines the requirements for anti-water hammer check valves with single or multiple waterways. Anti-water hammer check valves covered in this Approval standard are supplied with flanged, grooved, threaded or wafer style end connections. Other types of anti-water hammer check valves may be FM Approved if they meet the requirements and intent of this standard. Anti-water hammer check valves of unusual design may be subjected to special tests to determine their suitability.
- 1.2.3 This standard encompasses the design and performance requirements for anti-water hammer check valves for their intended installation in the discharge line of a fire pump where conditions may be expected to cause pressure surges or water hammer.

1.3 Basis for Requirements

- 1.3.1 The requirements of this standard are based on experience, research and testing, and/or the standards of other organizations. The advice of manufacturers, users, trade associations, jurisdictions and/or loss control specialists was also considered.

1.3.2 Approval Standards are intended to verify that the product described will meet stated conditions of performance, safety, and quality useful to the ends of property conservation. The requirements of this standard reflect tests and practices used to examine characteristics of anti-water hammer check valves for the purpose of obtaining Approval. Anti-water hammer check valves having characteristics not anticipated by this standard may be FM Approved if performance equal, or superior, to that required by this standard is demonstrated, or if the intent of the standard is met. Alternatively, anti-water check valves which meet all of the requirements identified in this standard may not be FM Approved if other conditions which adversely affect performance exist or if the intent of this standard is not met.

1.4 Basis for FM Approval

FM Approval is based upon satisfactory evaluation of the product and the manufacturer in the following major areas:

1.4.1 Examination and tests on production samples shall be performed to evaluate:

- The suitability of the product;
- The performance of the product as specified by the manufacturer and required by FM Approvals; and,
- As far as practical, the durability and reliability of the product.

1.4.2 A first audit shall be conducted to evaluate the manufacturer's ability to consistently produce the product that was examined and tested as part of the Approval project. The audit shall review the facility and in-place quality control procedures used in the manufacturing of the product. Typically, areas of review are incoming inspection, work in progress, production testing, final quality control, marking, calibration of equipment, shipping procedures, and document and drawing control. These examinations are repeated periodically as part of the FM Approvals' Surveillance Audit program. (Refer to Section 5.2, Surveillance Audit Program.)

1.5 Basis for Continued Approval

Continued Approval is based upon:

- Production or availability of the product as currently FM Approved;
- The continued use of acceptable quality assurance procedures;
- Satisfactory field experience;
- Compliance with the terms stipulated in the Master Agreement;
- Satisfactory re-examination of production samples for continued conformity to requirements; and
- Satisfactory Surveillance Audits conducted as part of the FM Approvals' product follow-up program.

Also, as a condition of retaining Approval, manufacturers may not change a product or service without prior written authorization by FM Approvals. (Refer to Section 5.1.3 for further details regarding changes.)

1.6 Effective Date

The effective date of an Approval standard mandates that all products tested for Approval after the effective date shall satisfy the requirements of that standard. Products FM Approved under a previous edition shall comply with the new version by the effective date or forfeit Approval.

The effective date of this standard is **12 Months from Issue Date** for compliance with all requirements.

1.7 System of Units

Units of measurement used in this standard are United States (U.S.) customary units. These are followed by their arithmetic equivalents in International System (SI) units, enclosed in parentheses. The first value stated shall be regarded as the requirement. The converted equivalent value may be approximate. Appendix A lists the selected units and conversions to SI units for measures appearing in this standard. Conversion of U.S. customary units is in accordance with the Institute of Electrical and Electronics Engineers (IEEE)/American Society for Testing and Materials (ASTM) SI 10-2010, *American National Standard for Metric Practice*.

1.8 Applicable Documents

The following standards, test methods, and practices are referenced in this standard or are beneficial in understanding this standard:

American National Standards Institute (ANSI)/American Society of Mechanical Engineers (ASME) B1.20.1-1983 (R2006), *Pipe Threads, General Purpose (inch)*.
ANSI/ASME B16.5 - 2013, *Pipe Flanges and Flanged Fittings NPS ½ through NPS 24 metric/inch Standard*
ANSI /American Water Works Association (AWWA) C606-11 (2011), *Grooved and Shouldered Type Joints*
IEEE/ASTM SI 10 - 2010, *American National Standard for Metric Practice*
ASTM D471-12a – (2012), *Standard Test Method for Rubber Property - Effect of Liquids*
ASTM D572-4 – (2010), *Standard Test Method for Rubber - Deterioration by Heat and Oxygen*
AWWA M11 - 2004, *Steel Water Pipe: A Guide for Design and Installation*
FM Global Property Loss Prevention Data Sheets

1.9 Definitions

For purposes of this standard, the following terms apply:

Accepted

Installations acceptable to the authority enforcing the applicable installation rules. When the authority is FM Global, such locations are termed “FM Global Accepted.” Acceptance is based upon an overall evaluation of the installation. Factors other than the use of FM Approved equipment impact upon the decision to accept, or not to accept. Acceptance is not a characteristic of a product. It is installation specific. A product accepted for one installation may not be acceptable elsewhere. (Contrast this definition with ***FM Approved***.)

Anti-Water Hammer Check Valve

For the purposes of this standard, a valve designed for fire protection application that suppresses water hammer as well as function as a check valve. Design of these valves typically incorporates features which enable the valve to close quickly. These features normally include short overall disc or clapper travel and springs to assist in valve closure.

Corrosion Resistant

Having resistance to corrosion equal to or exceeding that of a bronze alloy having a minimum copper content of 80 percent, or constructed of 300 or 400 Series stainless steel.

End Connections

Types of joints used to connect components of a fire protection system. Typical end connections for fire protection service include flanged, grooved, threaded and welding end.

Flanged End Valve

A valves having mating flanged ends in accordance with the dimensional values shown in ANSI/ASME B16.5. Flanges meeting other national or international standards shall be evaluated on a case-by-case basis.

FM Approvals Certification Marks

The FM Approvals Certification Marks are detailed in Appendix B. Their use is mandatory on all FM Approved anti –water hammer check valves. These registered marks cannot be used except as authorized by FM Approvals via the granting of Approval to a specific product.

FM Approved

Products FM Approved by FM Approvals. Such products are listed in the Approval Guide, an online resource of FM Approvals. All products so listed have been successfully examined by FM Approvals, and their manufacturers have signed and returned a Master Agreement to FM Approvals. The Master Agreement obligates the manufacturer to allow re-examination of the product and surveillance audits at FM Approval's discretion. It further prohibits the manufacturer from deviating from the as-FM Approved configuration of the product without review by and agreement of FM Approvals. Approval is product specific.

Grooved End Valve

A valve characterized by having grooved ends on the inlet and outlet ends of the valve body such that the valve may be installed in the sprinkler system piping using FM Approved grooved end couplings. For the purpose of this standard, grooves shall comply with the dimensional values shown in AWWA C606. Grooves meeting dimensions of other standards will be reviewed on a case-by-case basis.

Hand Hole Cover

A removable cover, which when removed, allows replacement of internal parts without having to remove the valve from the pipeline.

Rated Working Pressure

The maximum sustained pressure at or below which the valve is expected to operate trouble free. This also sets the basis for the testing described in Section 4, Performance Requirements.

Swing Check Valve

A valve with an inherent design characteristic that permits flow of water in one direction and prevents flow in the opposite direction under cyclic pressure conditions.

Threaded End Valve

A valve characterized by having threads machined into the valve body and end plate allowing for installation into a threaded pipe system. For the purposes of this standard, threaded end refers to ANSI/ASME B1.20.1 for tapered pipe threads. Other thread forms may be acceptable on a case-by-case basis.

Wafer Style Valve

A valve type where the valve is placed between two pipe flanges and held in place by the flange bolting. In this style of valve, the flange bolts surround the valve but do not connect directly to it.

2. GENERAL INFORMATION**2.1 Product Information**

2.1.1 Anti-water hammer check valves typically consist of an assembly of the following components: body, spring, disc/clapper, seat ring, seal facing, lifting lug and hinge pin.

2.1.2 In order to meet the intent of this standard, anti-water hammer check valves must be examined on a model-by-model, type-by-type, manufacturer-by manufacturer, and plant-by-plant basis. This is predicated on the basis that identical designs, fabricated using identical materials by different manufacturers or, even by different plants of the same manufacturer, have been seen to perform differently in testing. Sample valves, selected in conformance to this criterion, shall satisfy all of the requirements of this standard.

2.2 Approval Application Requirements

2.2.1 To apply for an Approval examination, the manufacturer, or its authorized representative, should submit a request to:

Fire Protection Group Manager
FM Approvals Fire Protection Building
743A Reynolds Road
West Glocester, RI 02814 USA

2.2.2 The manufacturer shall provide the following preliminary information with any request for Approval consideration:

- A complete list of all models, types, sizes, and options for the products or services being submitted for Approval consideration;
- General assembly drawings, one complete set of manufacturing drawings, materials list(s) (e.g., ASTM A48/A48A, Class 40A, Gray Iron Castings), anticipated marking format, brochures, sales literature, specification sheets and installation, operation and maintenance procedures; and,
- The number and location of manufacturing facilities.

2.2.3 All documents shall identify the manufacturer's name, document number or other form of reference, title, date of last revision, and revision level. All foreign language documents shall be provided with English translation.

2.3 Requirements for Samples for Examination

Following set-up and authorization of an Approval examination, the manufacturer shall submit samples for examination and testing. Sample requirements shall be determined by FM Approvals following review of the preliminary information. Sample requirements may vary depending on design features, results of prior testing, and results of the foregoing tests. It is the manufacturer's responsibility to submit samples representative of production. Any decision to use data generated utilizing prototypes is at the discretion of FM Approvals. The manufacturer shall provide any special test fixtures which may be required to evaluate the anti-water check valves.

3. GENERAL REQUIREMENTS

3.1 Review of Documentation

3.1.1 During the initial investigation and prior to physical testing, the manufacturer's specifications, technical data sheets, and design details shall be reviewed to assess the ease and practicality of installation and use. The product shall be capable of being used within the limits of the Approval investigation.

3.1.2 All documents pertaining to the product materials, dimensions, processing, and marking shall be controlled by the manufacturer's Quality Assurance procedures, and shall identify the manufacturer's name, document number or other form of reference, title, date of last revision, and revision level. All foreign language drawings shall be provided with an English translation.

3.2 Physical or Structural Features

3.2.1 Anti-water hammer check valves shall be designed for a minimum rated working pressure of 175 psi (1205 kPa).

- 3.2.2 Anti-water hammer check valves shall have threaded, flanged, wafer or grooved end connections. Other types of nationally or internationally recognized end connections shall be evaluated on a case-by-case basis.
- 3.2.3 Clapper parts shall be assembled in such a manner that they will not separate in reasonable cycling pressure service.
- 3.2.4 Valves that employ springs to aid in closing the valve shall be capable of withstanding 50,000 cycles of full travel without damage to, or failure of, the spring or excessive wear or damage to other components.
- 3.2.5 Valves submitted for testing shall be true production samples and shall be free of sharp edges, burrs or other imperfections liable to injure the installer or interfere with proper assembly of the unit.

3.3 Materials

All materials used in these valves shall be suitable for the intended application. Particular consideration shall be given to the corrosion resistance of the materials used as contact surfaces between rotating or moving and stationary parts. When unusual materials are used, special tests may be necessary to verify their suitability.

3.4 Markings

- 3.4.1 The following minimum information shall be clearly visible on the valve body or cover, or both:
- Manufacturer's name or trademark
 - Nominal device size
 - Year of manufacture
 - Rated working pressure
 - Model designation
 - Directional flow arrow
 - FM Approvals Certification Mark (see Appendix B)
 - Manufacturing source code where necessary.
- 3.4.2 Markings shall be cast or forged in raised characters or die stamped on the valve body.
- 3.4.3 A corrosion resistant metal nameplate bearing the same information as stated above shall be considered acceptable if permanently fastened to the valve body or cover.
- 3.4.4 Other methods of applying permanent markings will be evaluated on a case-by-case basis.
- 3.4.5 Each required marking shall be legible and durable and applied in any of, or combination of, the above methods with the exception of the directional flow arrow which must be applied as stated in Section 3.4.2 or 3.4.3.

- 3.4.6 The model or type identification shall correspond with the manufacturer's catalog designation and shall uniquely identify the product as FM Approved. The FM Approvals Certification Mark (see Appendix B) shall be displayed visibly and permanently on the product. The manufacturer shall not use this Mark on any other product unless such product is covered by separate agreement with FM Approvals. The manufacturer shall not place this model or type identification on any other product unless covered by a separate agreement.

3.5 Manufacturer's Installation and Operation Instructions

- 3.5.1 The installation instructions, including any special dimension requirements, shall be furnished by the manufacturer. Instructions shall be provided in each shipping container.
- 3.5.2 The installation instructions identified in Section 3.5.1 shall be made available in multiple languages in support of the regions where the product is intended to be sold.

3.6 Calibration

All equipment used to verify the test parameters shall be calibrated within an interval determined on the basis of stability, purpose, and usage of the equipment. A copy of the calibration certificate for each piece of test equipment is required for FM Approvals' records, indicating that the calibration was performed against working standards whose calibration is certified as traceable to the National Institute of Standards and Technology (NIST) or to other acceptable reference standards and certified by an ISO 17025 calibration laboratory. The test equipment must be clearly identified by label or sticker showing the last date of the calibration and the next due date. A copy of the service accreditation certificate as an ISO 17025, "General Requirements for the Competence of Testing and Calibration Laboratories", calibration laboratory is required for FM Approvals' records.

The calibration of recently purchased new equipment is also required. Documentation indicating either the date of purchase or date of shipment, equipment description, and model and serial number is required for identification. The period from the time the equipment was put into service to the date of testing must be within an interval that does not require the equipment to be recalibrated.

3.7 Tolerance

Tolerances on units of measure shall be as described in Appendix D, unless otherwise specified.

4. PERFORMANCE REQUIREMENTS

4.1 Examination

4.1.1 Requirement

The anti-water hammer check valves shall conform to the manufacturer's drawings and specifications and to FM Approvals' requirements.

4.1.2 Test/Verification

A sample shall be examined and compared to drawings and specifications. It shall be verified that the sample conforms to the physical and structural requirements described in Section 3, General Requirements and the manufacturer's drawings. The manufacturer's installation instructions shall be reviewed for completeness and ease of understanding.

4.2 Clapper Strength

4.2.1 Requirements

The valve clapper or disc shall withstand exposure to hydrostatic pressure of two times the rated working pressure. During and at the conclusion of the test, no fracture, permanent distortion, or functional impairment shall occur. After this test, the valve shall be fully operable and shall comply with the leakage requirements in either Section 4.3 (Resilient Seat Leakage) or Section 4.4 (Metal-To-Metal Seat Leakage), as applicable.

4.2.2 Tests/Verification

A hydrostatic pressure of two times the rated working pressure shall be applied to the outlet side of the valve with the inlet of the valve open to atmosphere. The test pressure shall be held for five minutes. During and at the conclusion of the test, no fracture, permanent distortion or functional impairment shall occur. Full compliance with Section 4.3 (Resilient Seat Leakage) or Section 4.4 (Metal-To-Metal Seat Leakage) is required after the clapper strength test.

4.3 Resilient Seat (Reverse Flow) Leakage

4.3.1 Requirement

Resilient seated valves shall be leak tight when subjected to hydrostatic test pressures applied to the outlet side of the valve ranging from 30 psi (205 kPa) to the rated working pressure.

4.3.2 Test/Verification

With the inlet side open to atmosphere, the outlet side of each size valve shall be subjected to hydrostatic pressures of 30, 100 and 175 psi (205, 690 and 1205 kPa) and at the rated working pressure if in excess of 175 psi (1205 kPa). The test pressures shall each be held for five minutes, with no leakage allowed.

4.4 Metal-To-Metal Seat (Reverse Flow) Leakage

4.4.1 Requirement

Metal-to-metal seated valve leakage shall not exceed 1 fluid ounce/hr (30 ml/hr) per inch of nominal valve size when subjected to downstream hydrostatic test pressures ranging from 30 psi (205 kPa) to the rated working pressure.

4.4.2 Test/Verification

With the inlet side open to atmosphere, the outlet side of each valve shall be subjected to hydrostatic pressures of 30, 100 and 175 psi (205, 690 and 1205 kPa) and at the rated working pressure if in excess of 175 psi (1205 kPa). The test pressures shall each be held for five minutes. Slight leakage, not in excess of 1 fluid ounce/hr (30 ml/hr) per inch of nominal valve size, is allowed.

4.5 Hydrostatic Strength

4.5.1 Requirement

Valve bodies shall withstand a hydrostatic pressure of four times the rated working pressure without rupture, cracking or permanent distortion.

4.5.2 Test/Verification

With the clapper or disc in the partially open position, valve bodies of each valve size and end connection style shall be subjected to a hydrostatic test pressure of 700 psi (4825 kPa) or four times the rated working pressure, whichever is greater, for a duration of five minutes. There shall be no visible rupture, cracking, or permanent distortion to the valve body as a result of this test.

4.6 Friction Loss Determination

4.6.1 Requirement

The construction of the valve shall be such that obstruction to the passage of water through the valve body is minimized. With the clapper or disc in the full open position, the loss in pressure through the valve shall be measured from zero water flow to a flow producing a velocity of 20 ft/sec (6.1 m/sec) in Schedule 40 steel pipe of the same nominal diameter as the valve.

4.6.2 Tests/Verification

Tests shall be conducted to determine the friction loss through each nominal size valve. A minimum of six data points shall be obtained between zero water flow and the flow rates shown in Table 4.6.2. These flows have been calculated based on a fluid velocity of 20 ft/sec (6.1 m/sec) in Schedule 40 steel sprinkler pipe. Portions of this test may be waived at the examining engineer's option if the results of drawing and calculation reviews of manufacturer's flow data are satisfactory. For valves larger than 12 in. nominal size, it shall be the responsibility of the manufacturer to submit friction loss data or calculations showing compliance.

Table 4.6.2. - Friction Loss Flow Rates

<i>Nominal Valve Size, in.</i>	<i>Flow, gal/min (L/min) at Velocity of 20 ft/sec (6.1 m/sec)</i>	
2	210	(795)
2-1/2	300	(1135)
3	460	(1740)
3-1/2	615	(2330)
4	795	(3010)
5	1245	(4715)
6	1800	(6815)
8	3120	(11 810)
10	4915	(18 605)
12	7050	(26 685)

<i>Nominal Valve Size, in.</i>	<i>Flow, gal/min (L/min) at Velocity of 20 ft/sec (6.1 m/sec)</i>	
14	8450	(31 985)
16	11,000	(41 640)
18	14,000	(52 995)
20	17,500	(66 245)
24	25,000	(94 635)

4.7 Cycle Test

4.7.1 Requirements

Anti-water hammer check valves which employ springs on the clapper shall be capable of 50,000 cycles of normal operation without excessive wear, damage or failure of any valve component.

4.7.2 Tests/Verification

A sample valve of each size shall be cycled 50,000 times, at a rate not exceeding 6 cycles per minute, through its full range of travel in a static air environment. This test shall be conducted at atmospheric (0 psi, 0 kPa) conditions. After the completion of the cycling test, the valve shall be disassembled. Parts shall be visibly examined for signs of excessive wear, damage or failure. This test, or a portion thereof, may be waived at the option of the examining engineer if the results of a design and calculation review are satisfactory.

4.8 Bonding Adequacy

4.8.1 Requirement

For resilient seated valves, rubber facings shall remain securely bonded or fastened to the base material.

4.8.2 Test/Verification

A representative size valve(s) shall be subjected to a flow rate producing a velocity of 30 ft/sec (9 m/sec) in Schedule 40 steel pipe of the same nominal diameter as the valve for 90 minutes. Following this test, there shall be no apparent separation of the rubber from the base material or substrate or any other type of failure,

such as blistering, peeling, flaking, delaminating, or evidence of loosening from the base material or of any hardware used to secure the rubber facing.

Table 4.8.2 - Bonding Adequacy Flow Rates

<i>Nominal Valve Size, in.</i>	<i>Flow, gal/min (L/min) at Velocity of 30 ft/sec (9 m/sec)</i>	
2	315	(1190)
2-1/2	450	(1695)
3	690	(2615)
3-1/2	925	(3500)
4	1190	(4505)
5	1870	(7080)
6	2700	(10 225)
8	4680	(17 705)
10	7375	(27 910)
12	10,465	(39 620)
14	12,650	(47 880)
16	16,525	(62 550)
18	20,915	(79 170)
20	25,990	(98 380)
24	37,590	(142 290)

4.9 Water Absorption

4.9.1 Requirement

For resilient seated valves, water absorption of the rubber facings shall not exceed 1.5 percent of the original thickness or weight.

4.9.2 Test/Verification

A specimen of the valve rubber facing supplied by the manufacturer shall be maintained in water at a temperature of 212 °F (100 °C) for 6 hours in accordance with ASTM D471, “Standard Test Method for Rubber Property - Effect of Liquids” to measure the comparative ability of rubber to withstand the effect of water. At the end of this period, a change in the thickness or weight of the sample shall not exceed 1.5 percent of the original thickness or weight, respectively.

4.10 Aging

4.10.1 Requirement

For resilient seated valves, aging shall not promote cracking of the rubber facings.

4.10.2 Test/Verification

Three specimens of the valve rubber facing, approximately 1 x 3 inches (25 x 75 mm) by 1/8 inch (3 mm) thick, supplied by the valve manufacturer shall be subjected to an accelerated aging test in accordance with ASTM D572, “Standard Test Method for Rubber - Deterioration by Heat and Oxygen.” The test duration shall be 96 hours. After the test, the specimen shall be examined for resilience. No cracking shall occur when the specimen is bent double, (i.e. bend radius of 180°).

4.11 Operating Characteristics

4.11.1 Requirements

Anti-water hammer check valves shall limit the energy input to a system caused by excessive reverse flow through the valve prior to closure. An examination of water pressure versus time should show a controlled pressure spike followed by rapid pressure decay. A sample valve assembly shall close during an induced water hammer event without allowing excessive reverse velocity, pressure surge or valve damage.

4.11.2 Tests/Verification

A sample 4 inch nominal size anti-water hammer check valve, considered representative of all valves submitted for Approval, shall be placed in a flow line of Schedule 40 steel piping and subjected to induced flow reversals, caused by shutting power to the supply pump against a hydro pneumatic tank at various flow rates. Valves shall be subjected to flow rates of 7.0 ft/sec (2.1 m/sec) and greater. A pressure transducer,

within 5 pipe diameters downstream of the anti-water hammer check valve under test, connected to a portable oscilloscope or similar instrument, shall permit the monitoring of the pressure response of the piping to the induced water hammers at a minimum rate of 100 Hz. When the pressure in the hydro pneumatic tank reaches 80 psi (550 kPa) the power to the supply pump shall be disconnected. The anti-water hammer check valve under test shall close rapidly without generating a measured reverse velocity of greater than 0.5 ft/sec (0.15 m/sec) for deceleration rates less than 25 ft/sec² (7.6 m/sec²).

4.12 Additional Tests

Additional tests may be required, depending on design features, results of any tests, material application, or to verify the integrity and reliability of the product, at the discretion of FM Approvals.

Unexplained failures shall not be permitted. A re-test shall only be acceptable at the discretion of FM Approvals with adequate technical justification of the conditions and reasons for failure.

5. OPERATIONS REQUIREMENTS

A quality control program is required to assure that subsequent anti-water hammer check valves produced by the manufacturer at an authorized location shall present the same quality and reliability as the specific anti-water hammer check valves examined. Design quality, conformance to design, and performance are the areas of primary concern. Design quality is determined during the Approval examination and tests, and is covered in the Approval Report. Conformance to design is verified by control of quality and is covered in the Surveillance Audit. Quality of performance is determined by field performance and by periodic re-examination and testing.

5.1 Demonstrated Quality Control Program

5.1.1 The manufacturer shall demonstrate a quality assurance program which specifies controls for at least the following areas:

- Corporate quality assurance guidelines;
- Incoming quality assurance, including testing;
- In-process quality assurance, including testing;
- Final inspection and tests;
- Handling and disposition of non-conforming materials;
- Equipment calibration;
- Drawing and change control;
- Packaging and shipping; and,
- In order to assure adequate traceability of materials and products, the manufacturer shall maintain records of all quality control tests performed, and their results, for a minimum period of two years from the date of manufacture.

5.1.2 Documentation/Manual

There shall be an authoritative collection of procedures and policies. Such documentation shall provide an accurate description of the quality management system while serving as a permanent reference for implementation and maintenance of that system. The system shall require that sufficient records are maintained to demonstrate achievement of the required quality and verify operation of the quality system.

5.1.3 Drawing and Change Control

The manufacturer shall establish a system of product configuration control that shall allow no unauthorized changes to the product. Changes to critical documents, identified in the Approval Report, must be reported to, and authorized by, FM Approvals prior to implementation for production. The manufacturer shall assign an appropriate person or group to be responsible for reporting proposed changes to FM Approved or Listed products to FM Approvals before implementation. In situations involving significant modifications to an FM Approved product, the notification shall be in the form of a formal request for an Approval examination. For modifications of a more common nature, the manufacturer shall notify FM Approvals of changes in the product or of persons responsible for keeping FM Approvals advised by means of FM Approvals Form 797, FM Approved Product Revision Report or Address/Contact Change Notice. Records of all revisions to all FM Approved products shall be maintained.

5.1.3.1 The table below has been included as a guide to manufacturers of what is considered to be a significant change to FM Approvals. As mentioned above, modifications that fit this category should be documented by means of a letter stating the change, and requesting a quotation for an Approval examination.

<i>Modification</i>	<i>Description/Example</i>
Increase in Pressure Rating	The product was originally Approved for 175 psi (1205 kPa), and now is to be evaluated to 300 psi (2070 kPa).
Addition of Product Sizes	The product was originally FM Approved for 2 – 4 inch NPS, and now FM Approval of 6 and 8 inch NPS is desired.
Addition or Relocation of the Manufacturing Location	The product was originally FM Approved as manufactured in location A, and now is desired to be made in locations A and B, or only in location B.
Major Changes to Critical Dimensions, or Components	Modifications that would depart from the national or international standards that are used in the manufacturing of the product as originally FM Approved.
	Modifications that affect the valve such as: A reduction of body wall thickness in the pressure retaining areas, change in sealing arrangement (e.g. modification to the clapper facing material), significant changes in the waterway diameter or clapper/disc thickness, and material changes to valve body, hinge pin, clapper or disc, etc.

5.1.3.2 The table below has been included as a guide to modifications which may be submitted on FM Approvals Form 797.

<i>Modification</i>	<i>Description/Example</i>
Change in Company Contact Information:	Contact Name, Phone Number, FAX Number, Office Address, Company Name
Updating of Drawings:	Minor dimensional changes, or note changes or recreation of old drawing on CAD
Change in material or marking:	Where new material is superior, or to show proposed new marking

5.1.3.3 In instances where the modification is difficult to categorize, manufacturers are encouraged to contact FM Approvals and to discuss the proposed change, and to inquire about how to send the information to FM Approvals. The examples shown in Sections 5.1.3.1 and 5.1.3.2 are based on common examples of modifications as they relate to the manufacture of anti-water hammer check valves.

5.2 Surveillance Audit Program

- 5.2.1 An audit of the manufacturing facility is part of the Approval investigation to verify implementation of the quality control program. Its purpose is to determine that the manufacturer's equipment, procedures, and quality program are maintained to insure a consistently uniform and reliable product. Initial inspections of facilities already producing similar products may be waived at the discretion of FM Approvals.
- 5.2.2 Surveillance audits shall be conducted periodically, but at least annually, by FM Approvals or its representatives or more frequently depending on jurisdictional requirements. At issue of this standard, the Occupational and Safety Health Administration (OSHA) of the United States Department of Labor requires audits of manufacturing sites producing products for use in hazardous locations during each quarter the product is manufactured.
- 5.2.3 The client shall manufacture the product or service only at the location(s) audited by FM Approvals and as specified in the Approval Report. FM Approvals does not permit manufacture of products bearing the FM Approvals Certification Mark at any other locations without prior written authorization by FM Approvals. A separate audit and product examination shall be required at each location.
- 5.2.4 In the event that all or part of the quality inspection is subcontracted, the manufacturer shall provide FM Approvals with documentation outlining the nature of the inspection, frequency, test details, and pass / fail criteria that was provided to the subcontracted company, and documentation that they have received and implemented these procedures.

5.3 Manufacturer's Responsibilities

The manufacturer shall notify FM Approvals of proposed changes in product construction, design, components, raw materials, physical characteristics, coatings, component formulation or quality assurance procedures prior to implementation of such changes.

5.4 Manufacturing and Production Tests**5.4.1 Test Requirement No. 1 - Seat Leakage**

The manufacturer shall test 100 percent of production valves for seat leakage to the rated working pressure. The pressure shall be held for a minimum of 15 seconds. If there is no visible leakage after 15 seconds, then the test may be considered acceptable. For metal seated valves only, if there is leakage visible during the 15 second test, then the test duration shall be extended to a minimum of 1 minute so that the leakage rate can be determined. If the metal seated valve is observed to have leakage in excess of 1 fluid ounce/hr (30 ml/hr) the valve is considered to have failed the test. Resilient-seated valves of any size shall have no visible leakage. Following the seat leakage test, all valves shall be opened through their full range with no evidence of sticking or binding.

5.4.2 Test Requirement No. 2 - Body Leakage

The manufacturer shall test 100 percent of production valves for body leakage to twice the rated working pressure. The pressure shall be held for a minimum of 1 minute with no evidence of body leakage or distortion.

APPENDIX A: Units of Measurement

LENGTH:	in. - “inches”; (mm - “millimeters”) mm = in. x 25.4 ft - “feet”; (m - “meters”) m = ft x 0.3048
MASS:	lb - “pounds”; (kg - “kilograms”) kg = lb x 0.454
PRESSURE:	psi - “pounds per square inch”; (kPa - “kilopascals”) kPa = psi x 6.895 bar - “bar”; (kPa - “kilopascals”) bar = kPa x 0.01 bar = psi x 0.06895
TEMPERATURE:	°F - “degrees Fahrenheit”; (°C - “degrees Celsius”) °C = (°F - 32) x 0.556
LIQUID VOLUME:	gal - “gallons”; (L - “liters”) L = gal x 3.785
FLOW RATE:	gal/min - “gallons per minute”; (L/min - “liters per minute”) L/min = gal/min x 3.785 fl. oz./hr - “fluid ounces per hour”; (ml/hr - “milliliters per hr”) ml/hr = fl. oz./hr x 29.57

APPENDIX B: FM Approvals Certification Marks

FM Approvals certification marks are to be used only in conjunction with products or services that have been FM Approved by FM Approvals and in adherence with usage guidelines.



FM APPROVED mark:

Authorized by FM Approvals as a certification mark for any product that has been FM Approved. There is no minimum size requirement for the mark, but it must be large enough to be readily identifiable. The mark should be produced in black on a light background, or in reverse on a dark background.



FM APPROVED mark with "C" only:

Authorized by FM Approvals as a certification mark for any product that has been evaluated by FM Approvals in accordance with Canadian codes and standards. There is no minimum size requirement for the mark, but it must be large enough to be readily identifiable. The mark should be produced in black on a light background, or in reverse on a dark background.



FM APPROVED mark with "C" and "US":

Authorized by FM Approvals as a certification mark for any product that has been evaluated by FM Approvals in accordance with US and Canadian codes and standards. There is no minimum size requirement for the mark, but it must be large enough to be readily identifiable. The mark should be produced in black on a light background, or in reverse on a dark background.



Cast-On FM APPROVALS marks:

Where reproduction of the FM APPROVED mark described above is impossible because of production restrictions, use these modified versions of the FM APPROVED mark. There is no minimum size requirement for the mark, but it must be large enough to be readily identifiable.



Downloadable art and other FM Approvals resources are available by visiting our Web site at www.fmapprovals.com

USAGE GUIDELINES

- All FM Approvals certification marks are the sole property of FM Approvals LLC (“FM Approvals”) and are registered or the subject of applications for registration in the United States and many other countries. They are for use only according to these guidelines.
- FM Approvals certification marks may be used only on FM Approved products and related product packaging, in advertising material, catalogs and news releases. Use of FM Approvals certification marks on such material is not a substitute for use of the complete FM Approvals certification mark on FM Approved products and/or product packaging.
- No FM Approvals certification mark or aspect thereof may be incorporated as part of a business name, Internet domain name, or brand name/trademark for products/product lines. This includes both design aspects (the FM Approvals “diamond,” etc.) and word aspects (“FM,” “Approved,” etc.). The use of any FM Approvals certification mark as a trademark is strictly prohibited.
- The Approval Standard number or class number may not be incorporated as part of a business name, Internet domain name, or brand name/trademark for products/product lines. For example, a company may not say “ABC Company’s 4100 Fire Door is FM Approved”; the proper terminology is, “ABC Company’s Fire Door is FM Approved per Approval Standard 4100.”
- FM Approvals certification marks, except for the FM Approvals Quality System Registration mark, may not be used on business stationery/cards/signage because this could mischaracterize the relationship with FM Approvals. Additionally, these items should not reference any FM Approvals certification mark.
- Products or services may not be marketed under any mark or name similar to “FM Global,” “FM Approvals” or any of the FM Approvals certification marks. Further, products or services may not be marketed to imply a relationship beyond the scope of any Approval made by FM Approvals.
- When an FM Approvals certification mark is used in advertising material or on product packaging, all material must reflect the specific circumstances under which the product was FM Approved. The material must clearly differentiate between products that are FM Approved and those that are not, and may not, in any way, imply a more substantial relationship with FM Approvals.
- A company may not reference the intent to submit a product for Approval or the expectation that a company will have a certain product FM Approved in the future. For example, a company may not state, “Approval by FM Approvals pending” or “Approval by FM Approvals applied for.”
- FM Approvals certification marks should not be preceded or followed by a qualifier that indicates a degree of certification or acceptability. For example, “exceeds,” “first” or “only” may not be used to qualify any FM Approvals certification mark.
- Only original artwork issued by FM Approvals should be used. The FM Approvals certification marks should not be altered in any way other than to resize the artwork proportionately. Unacceptable uses of the marks include, but are not limited to, adding/deleting wording or artwork, reducing the artwork to an illegible size, animation or distortion.
- The text of the FM Approvals certification marks may not be translated into any language other than English.
- FM Approvals certification marks must appear in a size and location that is readily identifiable, but less prominent than the name of the owner of the certification or the manufacturer/seller/distributor of the certified products.

APPENDIX C: Sample Listing

All new and current listings in the FM Approval Guide will be reformatted to resemble the following sample.

SRJ Inc 123 Approvals Dr, Any City, Anywhere

<i>Product Designation</i>	<i>Valve Size, in.</i>	<i>Flow Rate, gal/min (dm³/min)</i>	<i>Friction Loss, psi (kPa)</i>	<i>Rated Working Pressure, psi (kPa)</i>	<i>Remarks</i>
Series SRJ Wafer Style					
SRJ-2	2	200 (755)	21.6 (149.0)	200 (1380)	
SRJ-25	2 1/2	300 (1135)	9.5 (67.0)	200 (1380)	
SRJ-3	3	460 (1740)	10 (65.5)	200 (1380)	
SRJ-4	4	795 (3010)	10.8 (74.5)	200 (1380)	
SRJ-5	5	1245 (4715)	8.0 (55.0)	200 (1380)	
SRJ-6	6	1800 (6815)	8.6 (59.0)	200 (1380)	
SRJ-8	8	3120 (11 810)	10.3 (71.0)	200 (1380)	
SRJ-10	10	4915 (18 605)	12.3 (85.0)	200 (1380)	
SRJ-12	12	7050 (26 685)	6.5 (45.0)	200 (1380)	

APPENDIX D: Tolerances

Unless otherwise stated, the following tolerances shall apply:

Length	± 2 percent of value
Temperature	$\pm 5^{\circ}\text{F}$ ($\pm 3^{\circ}\text{C}$)
Pressure	± 5 psi (35 kPa)
Time	+ 5/-0 seconds + 0.1/-0 minutes + 0.1/-0 hours + 0.25/-0 days
Volume	± 5 percent of value

Unless stated otherwise, all tests shall be carried out at a room (ambient) temperature of $68^{\circ}\text{F} \pm 9^{\circ}\text{F}$ ($20^{\circ}\text{C} \pm 5^{\circ}\text{C}$).