



*Member of the FM Global Group*

# **Approval Standard for Expansion Chambers**

**Class Number 1364**

**February 2013**

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# Foreword

The FM Approvals certification mark is intended to verify that the products and services described will meet FM Approvals' 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 FM Approval of various types of products and services, as guidance for FM Approvals personnel, manufacturers, users and authorities having jurisdiction.

Products submitted for certification by FM Approvals shall demonstrate that they meet the intent of the Approval Standard, and that quality control in manufacturing shall ensure a consistently uniform and reliable product. Approval Standards strive to be performance-oriented. They are intended 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 Approval 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.

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 requirements for expansion chambers for use in wet pipe sprinkler systems that utilize water or antifreeze solutions.
- 1.1.2 Approval criteria may include, but are not limited to, performance requirements, marking requirements, examination of manufacturing facility(ies), audit of quality assurance procedures, and a follow-up program.

### 1.2 Scope

- 1.2.1 This standard applies to any component intended for use in sprinkler system piping to reduce pressure changes from temperature cycling in sprinkler systems, or to account for thermal expansion or pressure changes in anti-freeze systems. These expansion chambers are referred to as thermal expansion chambers.
- 1.2.2 The standard applies to any component (with the exception of anti-waterhammer check valves) intended for use in sprinkler system piping to reduce pressure surges from fire pump start-ups. These expansion chambers are sometimes referred to as surge suppressors or surge arrestors.

### 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 The requirements of this standard reflect tests and practices used to examine characteristics of expansion chambers for the purpose of obtaining Approval. Expansion chambers 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, expansion chambers 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 Approval

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 audits are repeated periodically for as long as the product remains FM Approved, as part of FM Approvals' Surveillance Audit program. (Refer to Section 5.2, Surveillance Audit Program.)

## 1.5 Basis for Continued Approval

1.5.1 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 FM Approval's product surveillance audit program.

1.5.2 Also, as a condition of retaining Approval, manufacturers may not change an FM Approved product or service without prior authorization by FM Approvals. (Refer to section 5.1.4 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 else forfeit Approval.

The effective date of this Standard is **One Year 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 Materials (ASTM) SI 10-2010, *American National Standard for Metric Practice*.

Two units (liter and bar), outside of but recognized by SI, are commonly used in international fire protection and are used in this Standard.

## 1.8 Applicable Documents

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

American National Standards Institute (ANSI) B16.5 - 1996, *Pipe Flanges & Flanged Fittings*  
ANSI/American Water Works Association (AWWA) C-606- 2011, *Grooved and Shouldered Joints*  
American Society of Mechanical Engineers (ASME) B1.20.1 - 1983 (R2006), *Pipe Threads, General Purpose, (Inch)*  
ASME Boiler & Pressure Vessel Code - 2010, Section VIII Division 1 – *Rules for Construction of Pressure Vessels*  
FM Global Property Loss Prevention Data Sheet 2-0 - April 2011, *Installation Guidelines for Automatic Sprinklers*  
IEEE/ASTM SI 10-2010, *American National Standard for Metric Practice*  
ISO 17025 - 2005, *General Requirements for the Competence of Testing and Calibration Laboratories*  
NFPA 13, 2010 edition, *Standard for the Installation of Sprinkler Systems*  
U.S. Department of Transportation (DOT) Title 49, Code of Federal Regulations (CFR), *Hazardous Materials Regulations of the Department of Transportation*

## 1.9 Definitions

### ***Accepted***

This term refers to 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 whether to accept the product. Acceptance is not a characteristic of a product. It is installation specific. A product accepted for one installation may not be acceptable elsewhere. (Contrast with FM Approved.)

### ***Bladder***

This term is used to describe the rubber chamber located inside an expansion chamber that is pre-charged with gas to act as a shock absorber to liquid expanding or surging within a closed loop sprinkler system.

### ***Expansion Chamber***

This is a generic term used throughout this Approval Standard to describe either thermal expansion chambers or surge suppressors. See below detailed definitions of *Thermal Expansion Chambers* and *Surge Suppressors*.

### ***End Connections***

The term “End Connections” refers to the method of connecting components of a fire protection system. Typical end connections in fire protection service are flanged, grooved, threaded and welded end.

### ***FM Approvals Certification Marks***

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

### ***FM Approved***

This term refers to products FM Approved by FM Approvals. Such products are listed in the Approval Guide, an on-line resource of FM Approvals, see Appendix C. All products so listed have been successfully examined by FM Approvals, and their manufacturers have signed and returned a Master Agreement to FM Approvals. This form obligates the manufacturer to allow re-examination of the product and surveillance audits at FM Approvals discretion. It further requires the manufacturer not to deviate from the as-FM Approved configuration of the product without review by and agreement of FM Approvals. Approval is product specific.

### ***Pre-Charge Pressure***

This term is used to describe the initial gas charge of the bladder before the fluid system pressure is introduced. The pre-charge pressure supplied by the manufacturer and contained in the expansion chamber bladder of a newly constructed expansion chamber is referred to as the “factory” pre-charge pressure.

### ***Rated Working Pressure***

This is the maximum sustained pressure at or below which the device shall operate trouble free for its entire design life. This value sets the basis for the testing described in Section 4.

### ***Surge Suppressor***

Surge suppressors (also referred to as surge arresters or dampers), similar in construction to thermal expansion chambers, are used to moderate the potentially destructive effects of pressure surges or water hammer due to pump starting and stopping and valve opening and closing. They are employed when an anti-waterhammer check valve, alone, proves inadequate to control the problem, but should always be used in conjunction with such a valve.

### ***Thermal Expansion Chamber***

Thermal expansion chambers are used in automatic sprinkler systems to control the effects of thermal expansion on system pressure that can occur due to fluid temperature changes. These hydropneumatic pressure vessels provide additional space in the system to accommodate the expanded volume of solution when temperature increases. They contain a pre-charged bladder (containing nitrogen or dry air, typically) that is compressed as the system pressure increases creating the space for the increased volume of fluid.

## 2. GENERAL INFORMATION

### 2.1 Product Information

- 2.1.1 Expansion chambers are typically composed of two major parts: a steel pressure vessel shell and an internal rubber bladder that is pre-charged by the manufacturer typically with either dry air or nitrogen.
- 2.1.2 Expansion chambers for use in anti-freeze systems shall be tested for compatibility with both pure ethylene glycol and water, and pure propylene glycol and water only. Any other anti-freeze mixture will be the subject of a special evaluation.

### 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 Hydraulics Laboratory  
743A Reynolds Road  
West Glocester, RI 02814  
U.S.A.

- 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, complete set of manufacturing drawings, materials list, anticipated marking format, piping and electrical schematics, nameplate format, brochures, sales literature, spec. sheets, installation, operation and maintenance procedures, and
  - The number and location of manufacturing facilities.
- 2.2.3 All the above referenced documents shall be controlled by the manufacture's Quality Assurance procedures, and shall identify the manufacturer's name, document number or other form of reference, title, date of last revision, and/or revision level. All foreign language documents shall be provided with English translation.

### 2.3 Requirements for Samples for Examination

- 2.3.1 Following authorization of an Approval examination, the manufacturer shall submit samples for examination and testing. Sample requirements to be determined by FM Approvals following review of the preliminary information.
- 2.3.2 Requirements for samples may vary depending on design features, results of prior or similar testing, and results of any foregoing tests.
- 2.3.3 The manufacturer shall submit samples representative of production. Any decision to use data generated using prototypes is at the discretion of FM Approvals.
- 2.3.4 It is the manufacturer's responsibility to provide any necessary test fixtures, such as those which may be required to evaluate the expansion chambers discussed in this standard.

### 3. GENERAL REQUIREMENTS

#### 3.1 Review of Documentation

During the initial investigation and prior to physical testing, the manufacturer's specifications and details shall be reviewed to assess the ease and practicality of installation and use. The Approval investigation shall define the limits of the Approval.

#### 3.2 Physical or Structural Features

3.2.1 Assemblies shall be rated for a minimum rated working pressure of 175 psi (1205 kPa). Standard installation is limited to wet pipe sprinkler systems only. Expansion chambers with higher rated working pressures will be evaluated on a case-by-case basis.

3.2.2 Typical expansion chambers are sized by end connection size and gallons of capacity. Other sizing shall be evaluated on a case-by-case basis.

3.2.3 Typical end connections are cut grooved per ANSI/AWWA C-606, threaded per ANSI B1.20.1, or flanged per ANSI B16.5, or other national or international recognized Standard. Other types of end connection will be evaluated on a case by case basis, provided such ends are compatible with the requirements of FM Global Property Loss Prevention Data Sheet 2-0, "Installation Guidelines for Automatic Sprinklers".

##### 3.2.4 Pressure Vessels

3.2.4.1 Pressure vessels utilized in expansion chambers shall conform to the appropriate regulations and design standards for the installation location. In the U.S.A., pressure vessels must conform to the following regulations:

- ASME Boiler & Pressure Vessel Code, Section VIII, Division 1 – "Rules for Construction of Pressure Vessels".
- Vessels that are shipped pressurized within the U.S.A. must also conform to DOT Title 49, CFR, Parts 171 through 180.

3.2.4.2 The following documents shall be submitted for each size of each pressure vessel design, to demonstrate compliance with the relevant design standard:

- Calculation of wall thicknesses per the method specified in the design standard, with appropriate supporting references, as necessary
- Certificate of chemical analysis of materials
- Certificate of physical properties of materials

3.2.5 Assemblies submitted for testing shall be true production samples and shall be free of sharp edges, burrs, or other imperfections likely to injure the installer or interfere with proper assembly and test of the unit.

#### 3.3 Materials

All materials used in these assemblies shall be suitable for the intended application. Parts exposed to water shall be constructed of corrosion-resistant materials. Alternative materials may be considered, provided they meet the intended performance requirements. All components shall withstand the normal abuse of shipping, handling, and installation.

### 3.4 Markings

3.4.1 The product shall be marked by a securely attached, corrosion-resistant label or nameplate that includes the following information:

- Manufacturer's name or trademark;
- Chamber size;
- Year of manufacture;
- Rated working pressure;
- Model designation
- FM Approvals' Approval Mark (see Appendix B)

When hazard warnings are needed, the markings should be universally recognizable.

3.4.2 The model or type identification shall correspond with the manufacturer's catalog designation and shall uniquely identify the product as FM Approved. The manufacturer shall not place this model or type identification on any other product unless covered by a separate agreement.

3.4.3 The Approval Mark (see Appendix B) shall be displayed visibly and permanently on the product and packaging as appropriate. The manufacturer shall not use this Mark on any other product unless such product is covered by a separate report.

3.4.4 All markings shall be legible and durable.

### 3.5 Manufacturer's Installation and Operation Instructions

3.5.1 The manufacturer shall provide the user with

- Instructions for the installation, maintenance, and operation of the product;
- Facilities for repair of the product and supply replacement parts; and
- Services to ensure proper installation, inspection, or maintenance for products of such nature that it would not be reasonable to expect the average user to be able to provide such installation, inspection, or maintenance.

3.5.2 The instruction manual that is supplied with each unit shall outline in detail the field procedures for installing and repairing the units. The manual shall be reviewed by FM Approvals for completeness and ease of comprehension prior to testing.

### 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 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 a ISO/IEC 17025 calibration laboratory. The test equipment shall 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, model and serial number is required for identification. The period from the time the equipment was put into service to the date of the testing must be within an interval that does not require the equipment to be recalibrated.

### 3.7 Tolerances

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

## 4. PERFORMANCE REQUIREMENTS

### 4.1 Examination

#### 4.1.1 Requirement

The expansion chamber(s) shall conform to the manufacturer's drawings and specifications and to FM Approvals requirements.

#### 4.1.2 Test/Verification

Sample expansion chambers shall be examined and compared to drawings and specifications. It shall be verified that the samples conform to the physical and structural requirements described in Section 3, General Requirements.

### 4.2 Hydrostatic Strength Test

#### 4.2.1 Requirement

Expansion chambers shall withstand a hydrostatic pressure equal to four times the rated working pressure without rupture, cracking or permanent distortion.

#### 4.2.2 Tests/Verification

Sample expansion chambers of each chamber size shall be subjected to a hydrostatic test of 700 psi (4825 kPa) or four times the rated working pressure, whichever is greater, for a duration of 5 minutes. If necessary, the bladder assembly may be removed during this test. There shall be no visible rupture, cracking, or permanent distortion to the expansion chamber body as a result of this test.

### 4.3 Bladder Strength Test

#### 4.3.1 Requirement

Rubber bladders shall withstand a hydrostatic pressure equal to 350 psi (2415 kPa) or two times the rated working pressure, whichever is greater, for 5 minutes. No cracking, rupture or functional impairment shall result.

#### 4.3.2 Tests/Verification

The internal rubber bladder of sample expansion chambers of each chamber size shall be subjected to a hydrostatic test of 350 psi (2415 kPa) or two times the rated working pressure, whichever is greater, for a duration of 5 minutes. This test may be conducted with the bladder contained within the expansion chamber shell or outside of the shell, at the convenience of the test facility. There shall be no visible rupture or functional impairment to the expansion chamber bladder as a result of this test.

### 4.4 Pressure Cycling Test

#### 4.4.1 Requirement

Expansion chambers shall be subjected to pressure cycling, where hydrostatic pressure introduced into the shell fluctuates between zero and 125 psi (860 kPa), for 20,000 cycles, at a rate of approximately 6 cycles per minute. At the conclusion of the 20,000 cycles, there shall be no signs of leakage, excessive component wear, damage or failure of any component.

#### 4.4.2 Tests/Verification

A sample expansion chamber shall be subjected to a pressure cycling test, where the hydrostatic pressure introduced into the shell fluctuates between zero and 125 psi (860 kPa), for 20,000 cycles, at a rate of approximately 6 cycles per minute. The bladder will contain no more than 5 psi (35 kPa) prior to this test to allow the bladder to collapse during each cycle. At the conclusion of the 20,000 cycles and without removing the bladder from the expansion chamber shell, the bladder shall be pneumatically pressurized to the manufacturer's maximum pre-charge pressure of the expansion chamber for a duration of 5 minutes. There shall be no signs of leakage or functional impairment to the expansion chamber bladder or shell as a result of this test.

### 4.5 Operational Test

#### 4.5.1 Requirement

Expansion chambers for use as surge suppressors shall limit the energy input in a system caused by pressure surges or water hammer due to pump starting and stopping and valve opening and closing. The expansion chamber shall sustain induced water hammer shocks without damage, and shall minimize the chance of those shocks being transmitted or amplified throughout the balance of the piping system in which they are installed.

#### 4.5.2 Tests/Verification

A sample surge suppressor type expansion chamber shall be installed in a 4 or 6 inch flow line (the exact flow line to be utilized for this test shall be determined based on the capacity of the expansion chamber(s) being examined). The expansion chamber size and bladder pre-charge shall be determined using the manufacturer's installation instructions. Installation of the expansion chamber in the flow line shall include the following additional components: two pressure transducers, an equal tee, a gate valve, an FM Approved anti-waterhammer check valve and a quick-closing butterfly valve. The figure in Appendix C illustrates the required test configuration.

A pressure transducer shall be installed upstream and downstream of the anti-waterhammer check valve. Downstream of the check valve an equal tee shall be installed with a quick-closing butterfly valve installed downstream of the tee. The gate valve shall be installed at the tee outlet with the expansion chamber installed downstream of the gate valve.

While water circulates at flows between 2 ft./sec. and 20 ft./sec. velocity, the butterfly valve shall be closed as quickly as possible, and pressure surges noted with and without the expansion chamber (with the gate valve open and closed), to note the relative effect. Oscilloscope readings or strip chart reading would be typical acceptable methods of obtaining the comparison information.

### 4.6 Material Compatibility

#### 4.6.1 Requirement

For thermal expansion chambers, the bladder material shall be compatible with anti-freeze solutions used in wet pipe sprinkler systems.

#### 4.6.2 Tests/Verification

A sample strip of bladder elastomer in sheet form shall be exposed to both pure ethylene glycol and water and to pure propylene glycol and water at room temperature for 30 days. During each working day, the solution shall be stirred around the rubber sample to ensure complete liquid coverage and the absence of air bubbles on the elastomer surfaces. At the conclusion of the test, the elastomer sample shall be rinsed in lukewarm tap water and dried. The sample shall then be, first, bent double on itself, and second, twisted 360 degrees longitudinally, to determine if the sample shows indication of crazing, cracking, or other defect due to deterioration of the

rubber. Other anti-freeze compounds will be subject to a special evaluation. Tests will be conducted with the worst-case ratio of anti-freeze to water for the given bladder material.

#### 4.7 Temperature Tests

##### 4.7.1 Requirement

An expansion chamber assembly shall be able to withstand exposure to hot and cold temperatures without failure. There shall be no degradation of the elastomer at the conclusion of the test period.

##### 4.7.2 Tests/Verification

4.7.2.1 Pre-charge the bladder of a sample expansion chamber to 50 psi (345 kPa) pneumatically at room temperature. Place in an oven at 150° F (65° C) for 45 days. At the conclusion of the test period, remove from the oven and allow the sample to cool to room temperature. The measured pressure shall be within 5 psi (35kPa) of the original set pressure on the same gauge. There shall be no sign of degradation of the bladder, or damage to the relief valve assembly.

4.7.2.2 Pre-charge the bladder of a sample expansion chamber to 50 psi (345 kPa) pneumatically at room temperature. Place in a freezer at -40° F (-40° C) for 4 days. At the conclusion of the test period, remove from the freezer and allow to warm to room temperature. The measured pressure shall be within 5 psi (35kPa) of the original set pressure on the same gauge. There shall be no sign of degradation of the bladder, or damage to the relief valve assembly.

#### 4.8 Additional Tests

Additional tests may be required, at the discretion of FM Approvals, depending on design features and results of any foregoing tests.

Any test following a failure shall be acceptable only at the discretion of FM Approvals and with a technical justification of the conditions or reasons for failure.

## 5. OPERATIONS REQUIREMENTS

A quality control program shall be required to assure that subsequent fire service meters produced by the manufacturer at an authorized location, shall demonstrate the same quality and reliability as the specific fire service meters 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 Program. Quality of performance is determined by field performances 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:

- Existence of corporate quality assurance guidelines;
- Incoming quality assurance, including testing;
- In-process quality assurance, including testing;
- Final inspection and tests;
- Equipment calibration;
- Drawing and change control;
- Packaging and shipping;
- Handling and disposition of non-conforming materials
- 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 of the expansion chambers.

5.1.2 Documentation/Manual

There should be an authoritative collection of procedures and policies. It should 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 Records

To assure adequate traceability of materials and products, the manufacturer shall maintain a record of all quality assurance tests performed, for a minimum period of two years from the date of manufacture.

5.1.4 Drawing and Change Control

The manufacturer shall establish a system of product configuration control that shall not allow unauthorized changes to the product. Revisions 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 revisions to FM Approved products to FM Approvals before implementation. In situations involving significant modifications to an 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 provide notification to FM Approvals by means of FM Approvals Form 797, *FM Approved Product/Specification-Tested Revision Request Form*. Records of all revisions to all FM Approved products shall be maintained.

- 5.1.4.1 The table below has been included as a guide to manufacturers of what is considered to be a significant change to FM Approvals. The table is not all-inclusive. 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 of Pressure Rating	The product was originally FM 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 4 and 6 inch NPS, and now Approval of 8 and 10 inch NPS sizes is desired.
Additional 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 may affect the results of earlier satisfactory testing of the expansion chambers such as: A reduction of body wall thickness in the pressure retaining areas or a change to the bladder material.

- 5.1.4.2 The listing below has been included as a guide to manufacturers of modifications that are commonly submitted on FM Approvals Form 797.

<i>Modification</i>	<i>Description / Example</i>
Change in Company Contact Information:	Company Name, Company Contact and Title, Phone Number, Fax Number, Email Address, Company Office Address
Updating of Drawings:	The Form 797 is used to notify FM Approvals in the event of: minor dimensional changes to non-critical features, minor changes in notes, location of title block, re-creation of the same drawing on CAD, etc.
Changes in Markings:	Please describe what changes are to be made and include a drawing of the proposed marking.
Changes in Materials:	Where new material is either superior, or comparable to material used in original Approval
Updating of Documentation:	Creation of New or Revisions to Sales literature, Installation Instructions, Grooving Dimensions, Quality Manual, etc.

- 5.1.4.3 In instances where the modification is difficult to categorize, manufacturers are encouraged to contact FM Approvals to discuss the nature of the change, and to inquire about how to send the information to FM Approvals. The examples shown in Sections 5.1.4.1 and 5.1.4.2 are based on common examples of modifications as they relate to the manufacture of fire service meters.

## 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 ensure that the manufacturer's equipment, procedures, and quality program are maintained to produce 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 FM Approved product or service only at the location(s) audited by FM Approvals and as specified in the Approval Report. Manufacture of products bearing the FM Approvals Certification Mark is not permitted at any other locations without prior written authorization by FM Approvals.
- 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 Installation Inspections**

Field inspections may be conducted to review an installation. The inspections are conducted to assess ease of application, and conformance to written specifications. When more than one application technique is used, one or all may be inspected at the discretion of FM Approvals.

### **5.4 Manufacturer's Responsibilities**

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

### **5.5 Manufacturing and Production Tests**

#### **5.5.1 Test Requirement No. 1 – Bladder Leakage Test**

The manufacturer shall test all completed expansion chambers for leakage at factory pre-charge pressure before leaving the factory. The pneumatic pressure shall be applied to the bladder connection for a minimum of 1 minute with no leakage allowed.

#### **5.5.2 Test Requirement No. 2 – Body Hydrostatic**

The manufacturer shall test all completed expansion chambers for body integrity before leaving the factory. They shall be hydraulically pressurized per ASME Boiler & Pressure Vessel Code - 2010, Section VIII Division 1. No leakage, cracking, or evidence of distortion of the shell allowed.

**APPENDIX A: Units of Measurement**

**LENGTH:** in. - “inches”; (mm - “millimeters”)  
mm = in. x 25.4

ft - “feet”; (m - “meters”)  
m = ft x 0.3048

**AREA:** in<sup>2</sup> - “square inches”; (mm<sup>2</sup> - “square millimeters”)  
mm<sup>2</sup> = in<sup>2</sup> x 6.4516 x 10<sup>2</sup>

ft<sup>2</sup> - “square feet”; (m<sup>2</sup> - “square meters”)  
m<sup>2</sup> = ft<sup>2</sup> x 0.0929

**MASS:** lb - “pounds”; (kg - “kilograms”)  
kg = lb x 0.454

**PRESSURE:** psi - “pounds per square inch”; (bar - “bar”)  
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:** gal. - “gallons”; (L - “liter”)  
L = gal. x 3.785

L - “liter”; (dm<sup>3</sup> - “cubic decimeters”)  
L = dm<sup>3</sup>

**FLOW RATE:** gal./min. - “gallon per minute”; (L/min - “liters per minute”)  
L/min. = gal./min. x 3.785

**FLOW VELOCITY:** ft./s - “feet per second”; (m/s - “meters per second”)  
m/s = ft./s x 0.3048

**APPENDIX B: FM Approvals Certification Marks**

FM Approvals certifications 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.



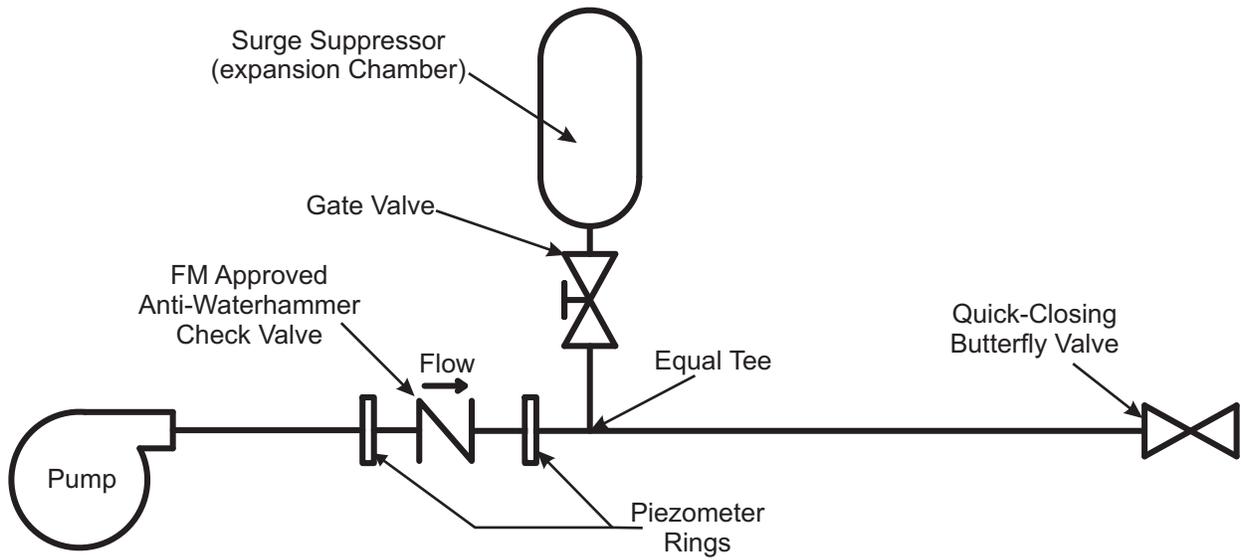
*Downloadable art and other FM Approvals resources are available by visiting our Web site at [www.fmapprovals.com](http://www.fmapprovals.com)*

## FM Approvals Certification Marks

### 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: Operational Test Setup Diagram



## APPENDIX D: Sample Listings

### Thermal Expansion Chambers

#### *Fire Protection / Automatic Sprinkler Systems / Expansion Chambers*

Thermal expansion chambers are used in automatic sprinkler systems to control the effects of thermal expansion on system pressure that can occur due to fluid temperature changes. They are installed in wet pipe systems that utilize water or antifreeze solutions.

These hydropneumatic pressure vessels provide additional space in the system to accommodate the expanded volume of solution when temperature increases. They contain a pre-charged cushion (containing nitrogen or dry air, typically) that is compressed as the system pressure increases creating the space for the increased volume of fluid. Thermal expansion chambers are designed to maintain maximum system pressures within the working pressure limitations of the system equipment. Because of the complex effects of system variables on satisfactory performance, each expansion chamber installation should be engineered by the manufacturer for best results.

Thermal expansion chambers are not intended for use as surge suppressors. Those devices can be found under Fire Protection / Automatic Sprinkler Systems / Surge and Waterhammer Arresters.

<i>Product Designation</i>	<i>Tank Volume, gal (L)</i>	<i>Max Working Pressure, psi (kPa)</i>	<i>Remarks</i>
JL-1.5-TE	1.5 gal (5.7 L)	175 psi (1205 kPa)	a, b
JL-2-TE	2.0 gal (8 L)	175 psi (1205 kPa)	a, b
JL-8-TE	8 gal (30 L)	175 psi (1205 kPa)	a, b
JL-25-TE	25 gal (95 L)	175 psi (1205 kPa)	a, b

Remarks:

- a. Due to the complex effects of system variables on satisfactory performance, each thermal expansion chamber installation should be engineered by the manufacturer for best results.
- b. Operating Temperature Range: -20° F (-29° C) to 200° F (93° C)

## Surge Suppressors

### *Fire Protection / Automatic Sprinkler Systems / Surge and Waterhammer Arresters*

Surge suppressors are used to moderate the potentially destructive effects of pressure surges or water hammer due to pump starting and stopping and valve opening and closing. They are employed when an anti-waterhammer check valve, alone, proves inadequate to control the problem, but should always be used in conjunction with such a valve.

These hydropneumatic devices absorb pressure surges into a precalculated volume of captive gas and return the absorbed water volume to the system in a controlled fashion. Surge suppressors are installed on the system side of the fire pump discharge check valve and as close to the valve as possible. Because of the complex effects of system variables on satisfactory performance, each surge arrester installation should be engineered by the manufacturer for best results.

Surge suppressors are not intended for use as thermal expansion chambers. Those devices can be found under Fire Protection / Automatic Sprinkler Systems / Expansion Chambers.

<i>Product Designation</i>	<i>Tank Volume, gal (L)</i>	<i>Max Working Pressure, psi (kPa)</i>	<i>Remarks</i>
JL-1.5-SS	1.5 gal (5.7 L)	175 psi (1205 kPa)	a
JL-2-SS	2.0 gal (8 L)	175 psi (1205 kPa)	a
JL-8-SS	8 gal (30 L)	175 psi (1205 kPa)	a
JL-25-SS	25 gal (95 L)	175 psi (1205 kPa)	a

Remarks:

- a. Due to the complex effects of system variables on satisfactory performance, each surge suppressor installation should be engineered by the manufacturer for best results.

**APPENDIX E: Tolerance**

Unless otherwise stated, the following tolerances shall apply:

*Angle:*  $\pm 2^\circ$

*Frequency (Hz):*  $\pm 5$  percent of value

*Length:*  $\pm 2$  percent of value

*Volume:*  $\pm 5$  percent of value

*Volume Per Unit Area:*  $\pm 5$  percent of value

*Pressure:* + 5 percent of value  
- 0 percent of value

*Temperature:*  $\pm 4^\circ\text{F}$  ( $2^\circ\text{C}$ )

*Flow*  $\pm 2$  percent of value

*Time:* + 5/-0 seconds  
+0.1/-0 minutes

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