



Member of the FM Global Group

Approval Standard for Liquid and Gas Safety Shutoff Valves

Class Number 7400

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Foreword

The FM Approvals certification mark is 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 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 periodic follow-up 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 liquid and gas safety shutoff valves including those classified as fire safe valves.
- 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 sets performance requirements for liquid and gas safety shutoff valves, fire safe (class 7440) and non-fire safe (Class 7400), used in the supply lines of commercial and industrial burners as well as in ignitable liquid piping systems.
- 1.2.2 Safety shutoff valves are intended to either completely close or open in response to one or more of the following conditions: a remote safety shutdown signal, loss of actuating medium, or under the influence of heat.
- 1.2.3 Safety shutoff valves may be held open or closed electrically, pneumatically, hydraulically, mechanically or a combination of one or more of the aforementioned methods. The valve shall return to its normal position automatically in response to one or more of conditions described in Section 1.2.2. In general, automatic return is by means of a spring.
- 1.2.4 Safety shutoff valves shall reset manually, either locally or remotely.
- 1.2.5 Fire safe valves are intended to provide the same functionality as safety shutoff valves with the additional ability to minimize the total amount of internal and external valve leakage when exposed to fire conditions.
- 1.2.6 Process flow control valves are included in the scope of this standard when equipped with a safety shutoff feature that meets the standard requirements.
- 1.2.7 Valves without automatic operation are not covered in the scope of this Approval.
- 1.2.8 The requirements of this standard shall be used to measure and describe the performance of safety shutoff valves in response to exposure from heat, pressure, etc., under controlled laboratory conditions. The results of these controlled exposures shall not be used to describe or appraise actual exposure conditions since such conditions will vary widely.
- 1.2.9 This standard replaces the following Class Numbers:
 - Class 7411 Safety Shutoff Valves – Electric Opening and Holding
 - Class 7412 Safety Shutoff Valves – Electric and Pressure Opening and Holding
 - Class 7413 Safety Shutoff Valves – Manual Opening, Electric Holding
 - Class 7431 Emergency Automatic Shutoff Valves
 - Class 7432 Emergency Quick-Opening Valves
 - Class 7450 Process Flow Control Valves – Electric Opening

- Class 7451 Process Flow Control Valves – Combination Electric & Pressure Opening
- Class 7452 Process Flow Control Valves – Pressure Opening
- Class 7453 Process Flow Control Valves – Manual

1.3 Basis for Requirements

- 1.3.1 The requirements of this standard are based on experience, research and testing, and 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 safety shutoff valves for the purpose of obtaining Approval. Safety shutoff 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, safety shutoff 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 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 An examination of the manufacturing facilities and audit of quality control procedures is made to evaluate the manufacturer's ability to consistently produce the product which is examined and tested, and the marking procedures used to identify the product. These examinations may be repeated as part of FM Approvals' product follow-up 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 Approval report;
- satisfactory re-examination of production samples for continued conformity to requirements; and
- satisfactory Surveillance Audits conducted as part of FM Approvals' product follow-up program.

Also, as a condition of retaining Approval, manufacturers may not change a product or service without prior authorization by FM Approvals.

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 Approval Standard is September 1, 2018 for compliance with all requirements.

1.7 System of Units

Units of measurement used in this Standard are United States (U.S.) customary units (with the exception of heat flux). 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 American National Standards Institute (ANSI)/Institute of Electrical and Electronics Engineers (IEEE)/American Society for Testing Materials (ASTM) SI 10-2010, *American National Standard for Metric Practice*.

For the purposes of this standard, heat flux is measured in terms of International System (SI) units with the United States (U.S.) customary unit conversion provided in Appendix A.

1.8 Applicable Documents

The following standards, test methods, and practices were reviewed and considered in the development of this standard:

ASME CSD-1-2012, *Controls and Safety Devices for Automatically Fired Boilers*
API Standard 607, *Fire Test for Quarter-Turn Valves and Valves Equipped with Nonmetallic Seats*, Sixth Edition, 2010
FM Approvals, Approval Standard 2031, *Heat Responsive Links for Fire Protection*, July 2001
FM Approvals, Approval Standard 3810, *Electrical and Electronic Test, Measuring and Process Control Equipment*, January 2005
FM Global Property Loss Prevention Data Sheet 6-4, *Oil- and Gas-Fired Single-Burner Boilers*, July 2014
FM Global Property Loss Prevention Data Sheet 7-88, *Ignitable Liquid Storage Tanks*, January 2007
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 86, *Standard for Ovens and Furnaces*, 2015 Edition

1.9 Definitions

For purposes of this standard, the following terms apply:

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 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 with FM Approved.)

Actuator Pressure Range

The holding medium pressure at which the fluid controlled actuator of a safety shutoff valve holds the valve out of normal position.

Actuation Temperature

The temperature at which a heat-actuated safety shutoff valve operates and returns to normal position. (Contrast with Operating Temperature Range.)

Actuator

The component responsible for controlling the operating mechanism of a safety shutoff valve. It is operated by a source of energy, typically electric current, hydraulic fluid pressure, pneumatic pressure, or a loaded mechanical spring. This source of energy is referred to as the holding medium.

Emergency Quick Opening Valve

Deprecated term used to describe heat-actuated normally open safety shutoff valves.

Emergency Shutoff Valve

Deprecated term used to describe heat-actuated normally closed safety shutoff valves.

End Connections

Refers to the method of connecting components to a piping system. Typical end connections are flanged and threaded.

Fire Safe Valve

A safety shutoff valve with the ability to minimize the average combined internal and external valve leakage rates when exposed to fire conditions. See specific fire exposure and performance requirements in Section 4.11.

Fusible Link

A component of a heat-actuated safety shutoff valve consisting of two strips of metal soldered together with a fusible alloy that is designed to melt at a specific temperature, allowing the two pieces to separate.

FM Approvals Certification Marks

Product markings, applied by the manufacturer, that identify a product as FM Approved. 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. 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. See Appendix C for a sample Approval Guide listing.

Heat-actuated Valve

A safety shutoff valve that operates under the influence of heat. Typical heat-actuated safety shutoff valves have an external spring loaded actuator held in place by a fusible link and operate upon failure of the fusible link.

Holding Medium

Refers to the source of energy supplied to a valve actuator to maintain open or closed position against a spring return mechanism. Loss of holding medium will cause the valve to return to its normal position.

Ignitable Liquid

Any liquid or liquid mixture that will burn. A liquid will burn if it has a measurable fire point. Ignitable liquids include flammable liquids, combustible liquids, inflammable liquids, or any other term for a liquid that will burn.

Normal Position

The starting position of a safety shutoff valve prior to application of the holding medium. Safety shutoff valves can be either normally closed or normally open.

Operating Temperature Range

The specified ambient temperature range at which a safety shutoff valve will operate effectively. Consists of a minimum operating temperature and maximum operating temperature. (Contrast with Actuation Temperature.)

Process Flow Control Valve

Any valve and actuator assembly used to regulate fluid flow or pressure in a piping system.

Rated Working Pressure

Also referred to as the Maximum Allowable Working Pressure, it is the specified maximum internal pressure at which the weakest point of the safety shutoff valve can operate trouble free within the operating temperature range when the valve is in normal operation.

Safety Shutoff Valve

A normally closed or normally open valve and actuator assembly that automatically returns to normal position in response to a remote safety shutdown signal, loss of actuating medium, or under the influence of heat. Normally open safety shutoff valves are sometimes referred to as vent valves as defined in ASME CSD-1-2012, *Controls and Safety Devices for Automatically Fired Boilers*.

Specified

The value of a design parameter set by the manufacturer.

Test Medium

For the purposes of this standard, the test medium is used to apply pressure to a valve body and disc (or equivalent component) during Performance Requirement testing. The test medium is determined based on the intended fluid service of the valve. In general, water or water glycol based hydraulic fluid is the test medium utilized for testing liquid valves and compressed air or nitrogen is the test medium utilized for testing gas valves. Valves tested with compressed air or nitrogen can be Approved as both liquid and gas safety shutoff valves.

2 GENERAL INFORMATION

2.1 Approval Application Requirements

To apply for an Approval examination the manufacturer, or its authorized representative, should submit a request to information@fmaprovals.com.

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 being submitted for Approval consideration;
- Assembly drawings, component drawings, materials list, anticipated marking format, nameplate format, brochures, sales literature, specification sheets, installation, operation and maintenance procedures;
- The number and location of manufacturing facilities;
- All documents shall identify the manufacturer's name, document number or other form of reference, title, date of last revision, and revision level; and
- All documents shall be provided with English translation.

2.2 Requirements for Samples for Examination

- 2.2.1 Following authorization of an Approval examination, the manufacturer shall submit samples for examination and testing based on a determination by FM Approvals following review of the preliminary information.
- 2.2.2 Requirements for samples may vary depending on design features, results of prior or similar testing, and results of any foregoing tests.
- 2.2.3 The manufacturer shall submit samples representative of production. Any decision to use data generated using prototypes is at the discretion of FM Approvals.
- 2.2.4 It is the manufacturer's responsibility to provide any necessary test fixtures, such as those which may be required to evaluate the samples.
- 2.2.5 If there are failures encountered during the examination testing, FM Approvals will provide the manufacturer with information regarding what testing will need to be repeated and any additional sample requirements.

3 GENERAL REQUIREMENTS

3.1 Review of Documentation

- 3.1.1 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.
- 3.1.2 The manufacturer's dimensional specification and/or dimensional drawings shall fully describe the product. All critical dimensions shall be identified with the allowed upper and lower tolerance levels clearly shown.

3.2 Physical or Structural Features

- 3.2.1 A safety shutoff valve shall only be considered for Approval as a complete and identifiable assembly. It shall perform in all respects to the manufacturer's specifications.
- 3.2.2 Valves shall be provided with a means of indicating valve position (open or closed) visible from at least 5 ft (1.5 m). The valve indicator may operate either mechanically or electrically (by means of a limit switch or similar device). An electrically operated valve indicator shall be such that its failure does not imply an incorrect position. The requirement for indication may be waived for solenoid operated valves up to 3/4 inch NPT. If an electrically operated valve indicator is intended for use as an interlock in a combustion safety circuit, valve or actuator stem overtravel is required.
- 3.2.3 Loss of holding medium shall result in automatic valve operation. The operating mechanism shall not be readily bypassed nor shall the valve be capable of being blocked open or closed.
- 3.2.4 Electrical contacts, terminals, and vulnerable operating members shall be adequately protected from damage and expected atmospheric conditions.
- 3.2.5 Fusible links utilized by heat-actuated valves must satisfy the applicable Performance Requirements detailed in the Approval Standard for Heat Responsive Links for Fire Protection (Class 2031).
- 3.2.6 A safety shutoff valve that meets the requirements of the Fire Exposure Test of Fire Safe Valves in Section 4.11 can be classified as a fire safe valve. Heat-actuated valves with heat responsive component(s) cannot be FM Approved without a fire safe valve classification.
- 3.2.7 Operating temperature range shall be at least 32°F (0°C) to 140°F (60°C).
- 3.2.8 Valves designed so that upstream (inlet) pressure tends to open the valve, keep it open or in any way operate the valve cannot be FM Approved.

3.3 Markings

- 3.3.1 The following information shall be permanently marked on all FM Approved safety shutoff valves (if applicable):
- Manufacturer's name or trade name
 - Model designation
 - Type of fluid service
 - Operating temperature range
 - Direction of flow
 - Electrical ratings (for electric actuators)
 - Actuator pressure range (for pneumatic actuators)
 - Actuation temperature (for heat-actuated valves)
 - Rated working pressure
 - FM Approvals Certification Mark
- 3.3.2 For safety shutoff valves operated by an external spring, a precautionary label warning of the spring force and/or handle movement must be provided.
- 3.3.3 All markings shall be legible and durable and are typically cast into the valve body or presented on a securely attached, corrosion-resistant label or nameplate.
- 3.3.4 All products tested and Approved to this standard shall bear an FM Approvals Certification Mark. The location, material, and application method will be by mutual agreement between FM Approvals and the manufacturer.
- 3.3.5 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.
- 3.3.6 The FM Approvals Certification Mark 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 Manufacturer's Installation and Operation Instructions

The manufacturer shall provide the user with:

- instructions for the installation, maintenance, and operation of the product;
- facilities for repair of the product and/or 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 Calibration

All examinations and tests performed in evaluation to this Standard shall use calibrated measuring instruments traceable and certified to acceptable national standards. 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 a ISO 17025 calibration laboratory. The test equipment must be clearly identified by label or sticker showing the last date of 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 Approval records.

3.6 Tolerances

Tolerances on measurements shall be as described in Appendix E, unless otherwise specified.

4 PERFORMANCE REQUIREMENTS

4.1 Examination

4.1.1 Requirement

Safety shutoff valves shall conform to the manufacturer's drawings and specifications and to FM Approvals requirements.

4.1.2 Test/Verification

Sample safety shutoff valves 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 Operating Characteristics

4.2.1 Requirement

- A. Upon loss of holding medium, a safety shutoff valve shall operate, without manual action, and return to normal position within 5 seconds or less under all pressure conditions within its rating and up to 150 percent of the rated working pressure.
- B. For safety shutoff valves specified to be replaced after a single operation, this requirement may be reduced to an operation against a pressure of 150 percent of the rated working pressure and return to normal position within 5 seconds or less.

4.2.2 Test/Verification

- A. A sample valve of each size shall have an operating time measured for at least 10 operations at inlet pressures of 10, 50, 100 and 150 percent of the specified rated working pressure. The inlet pressure shall be applied with a test medium corresponding to the intended fluid service of the

sample valve. The average of the 10 measurements plus three standard deviations shall not exceed 5 seconds.

- B. For safety shutoff valves specified to be replaced after a single operation, the sample valve shall have an operating time measured for one operation against a pressure of 150 percent of the rated working pressure and it shall not exceed 5 seconds.

4.3 Seat Leakage

4.3.1 Requirement

Through-the-seat leakage of safety shutoff valves in the closed position shall not exceed the following rates:

- 24 in³/hr (400 cc/hr) air or nitrogen for gas valves
- 0.4 oz/hr (11.8 ml/hr) water or water glycol based hydraulic fluid for liquid valves

4.3.2 Test/Verification

Through-the-seat leakage shall be measured, at the valve outlet port, at 10, 50, 100 and 150 percent of the rated working pressure applied to the valve inlet for 5 minutes at each test pressure.

The inlet pressure shall be applied with a test medium corresponding to the intended fluid service of the sample valve. The average leakage rate over the 5 minute duration shall not exceed the leakage rates in Section 4.3.1 for any test pressure.

4.4 Body Leakage

4.4.1 Requirement

Safety shutoff valves shall be able to withstand an internal pressure equal to 200 percent of the rated working pressure without external leakage or damage.

4.4.2 Test/Verification

A pressure equal to 200 percent of the rated working pressure shall be applied through the valve inlet port, with the valve open, and maintained for 5 minutes with no external leakage or damage to the valve. There shall be no permanent distortion to any valve component after the pressure is released. The inlet pressure shall be applied with a test medium corresponding to the intended fluid service of the sample valve.

4.5 Durability

4.5.1 Requirement

- A. Safety shutoff valves shall operate reliably and with no significant change in operating characteristics after 20,000 operational cycles or the specified maximum allowable cycles (whichever is greater) at the rated working pressure.
- B. The total operational cycles may be reduced to 1,000 for heat actuated valves that operate mechanically via an external spring loaded actuator.

- C. This test may be waived if the valve is specified to be replaced after a single operation.

4.5.2 Test/Verification

- A. A representative valve sample shall be cycled through its full range of travel, for not less than 20,000 operations, by alternating application and removal of the holding medium.

Cycling shall be performed with pressure equal to the rated working pressure applied to the valve inlet. The inlet pressure shall be applied with a test medium corresponding to the intended fluid service of the sample valve.

There shall be no operational failure during the test. At the conclusion of the cycle test, the valve shall meet the leakage requirements in Section 4.3.1.

- B. A representative valve sample with an external spring loaded actuator shall be cycled through its full range of travel, for not less than 1,000 operations, by removing the actuator and applying an opening and subsequent closing force directly to the valve stem.

Cycling shall be performed with a pressure equal to the rated working pressure applied to the valve inlet. The inlet pressure shall be applied with a test medium corresponding to the intended fluid service of the sample valve. When operating the valve to normal position, an input torque shall be applied against the valve stop equal to that applied by the valve actuator.

There shall be no operational failure during the test. At the conclusion of the cycle test, the valve shall meet the leakage requirements in Section 4.3.1.

4.6 Electrical Insulation

4.6.1 Requirement

All electrical components of a safety shutoff valve, if so equipped, shall be capable of withstanding a high potential between input terminals and ground, for one minute without arcing or breakdown.

4.6.2 Test/Verification

For a rated voltage of less than 30 VAC or 60 VDC, a potential of 500 VAC or 710 VDC shall be applied between input terminals and the enclosure ground for one minute. For a rated voltage greater than 30 VAC or 60 VDC, the potential shall be 1000 VAC plus twice the rated voltage.

Any current leakage shall be less than 5 milliamps and there shall be no evidence of arcing or thermal breakdown of wire or component insulation.

4.7 Voltage Variation

4.7.1 Requirement

Electrically operated safety shutoff valves shall operate properly over a range of 85 to 110 percent of rated voltage.

4.7.2 Test/Verification

A pressure equal to the rated working pressure shall be applied through the valve inlet port with the valve in normal position. The inlet pressure shall be applied with a test medium corresponding to the intended fluid service of the sample valve. Input voltages of 85 and 110 percent of the actuator rated voltage shall be then be applied to the valve input terminals for a duration of 1 minute each. The valve shall operate reliably and consistently and shall not return to the normal position while the input voltages are applied.

4.8 Actuator Pressure Range

4.8.1 Requirement

Safety shutoff valves with fluid controlled actuators shall operate properly throughout the full specified actuator pressure range.

4.8.2 Test/Verification

A pressure equal to the rated working pressure shall be applied through the valve inlet port with the valve in normal position. The inlet pressure equal to the rated working pressure shall be applied with a test medium corresponding to the intended fluid service of the sample valve.

Pressures equal to the minimum and maximum of the actuator pressure range shall then be applied to the valve actuator for a duration of 1 minute each. The actuator pressure shall be applied with the specified holding medium of the sample valve. The valve shall operate reliably and consistently and shall not return to the normal position while the actuator pressures are applied.

4.9 Ambient Temperature Effects

4.9.1 Requirement

Safety shutoff valves shall be capable of operating reliably and consistently at the ambient temperature limits specified by the manufacturer. Actuator temperature operating range shall be at least 32°F (0°C) to 140°F (60°C).

4.9.2 Test/Verification

- A. A representative sample valve shall be conditioned for 4 hours at the minimum temperature of the operating temperature range for the actuator, or at 32°F (0°C), whichever is lower. For non-heat actuated valves, the sample may be conditioned in the open or closed position. Heat actuated valves shall not operate and the fusible link shall remain intact before and during conditioning.

After conditioning, while still exposed to the minimum temperature of its range, the valve shall meet the operational requirements of Section 4.2.1 and leakage requirements of Section 4.3.1. The inlet pressure shall be applied with a test medium corresponding to the intended fluid service of the sample valve. The test medium for gas valves shall be nitrogen and the test medium for liquid valves shall be a water glycol based hydraulic fluid to prevent freezing.

- B. A representative sample valve shall be conditioned for 4 hours at the maximum temperature of the operating temperature range for the actuator, or at 140°F (60°C), whichever is greater. For non-heat actuated valves, the sample may be conditioned in the open or closed position. Heat actuated valves shall not operate and the fusible link shall remain intact before and during conditioning.

After conditioning, while still exposed to the maximum temperature of its range, the valve shall meet the operational requirements of Section 4.2.1 and leakage requirements of Section 4.3.1. The inlet pressure shall be applied with a test medium corresponding to the intended fluid service of the sample valve. The test medium for gas valves shall be either nitrogen or compressed air and the test medium for liquid valves shall be water.

4.10 Actuator Control Valves

4.10.1 Requirement

Valves used to control the application of the holding medium in a fluid controlled actuator shall, when closed, withstand an inlet pressure of 150 psi or 200 percent of the maximum actuator pressure, whichever is greater, without operating the safety shutoff valve.

4.10.2 Test/Verification

With a sample safety shutoff valve in the normal position, a pressure equal to 150 psi (1030 kPa) or 200 percent of the maximum actuator pressure, whichever is greater, shall be applied to the inlet port of the closed actuator control valve for 5 minutes. The actuator pressure shall be applied with a test medium corresponding to the specified holding medium of the sample valve. The safety shutoff valve shall not operate while the pressure is applied.

4.11 Fire Exposure Test for Fire Safe Valves

4.11.1 Requirement

A safety shutoff valve classified as fire safe must not exceed an average combined internal and external valve leakage rate of 17 oz/min (500 mL/min) while at rated working pressure (+/- 10%) during a 60 minute fire exposure with a uniform heat flux of 125 kW/m² (+/- 5%). There must be no visual observations of external valve leakage in the form of a spray condition at any point during the fire exposure.

4.11.2 Test/Verification

- A. Safety shutoff valves considered for fire safe classification must meet all performance requirements discussed in Sections 4.1 to 4.10
- B. Prior to fire exposure, sample valves shall be operated per the requirements of Section 4.2.1 and seat leakage testing shall be performed per the requirements of Section 4.3.1.
- C. The sample valve, in normal position, shall be mounted in a fire exposure test apparatus similar in construction to that shown in Appendix D.
- D. With water as a test medium, the sample valve shall be pressurized to the rated working pressure. For normally closed safety shutoff valves, the pressure shall be applied to the inlet side of the closed valve and the outlet shall be piped in a manner in which internal (through-the-seat) leakage can be collected downstream. For normally open safety shutoff valves, the open valve shall have the rated working pressure applied throughout the valve body. Rated working pressure shall be maintained within +/- 10% for the duration of the fire exposure.
- E. A closed system with a known volume of water shall be utilized for the application of rated working pressure to provide a means in which to determine the total external leakage of the sample valve.

- F. The fire exposure test allows for a maximum of 10 minutes, after the initial application of fire to the sample valve, for the measured heat flux to achieve and maintain the required 125 kW/m^2 (+/- 5%). This 10 minute “ramp-up” time is included as part of the 60 minute exposure time.
- G. Visual observation of external valve leakage in the form of a spray condition shall be considered a failure and the test shall be terminated.
- H. At the conclusion of the 60 minute fire exposure, the total internal and external leakage shall be measured and the average total leakage rate calculated. The average total leakage rate shall not exceed 17 oz/min (500 mL/min).

4.12 Additional Requirements

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

A re-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 assurance program is required to assure that all subsequent safety shutoff valves(s) produced by the manufacturer shall present the same quality and reliability as the specific safety shutoff valve(s) examined. Design quality, conformance to design, and performance are the areas of primary concern.

- Design quality is determined during the examination and tests, and is documented in the Approval Report.
- Continued conformance to this standard is verified by the Surveillance Audits.
- Quality of performance is determined by field performance and as necessary 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; and
 - handling and disposition of non-conforming materials.

5.1.2 Documentation/Manual

There should be an authoritative collection of procedures/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 should 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 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, and require that, proposed changes to FM Approved or Listed products be reported to FM Approvals before implementation. The manufacturer shall notify FM Approvals of changes in the product or of persons responsible for keeping FM Approvals advised by means of an FM Approvals' Revision Request Form.
- Records of all revisions to all FM Approved products shall be maintained.

5.2 Surveillance Audit

5.2.1 An audit of the manufacturing facility is part of the Approval investigation to verify implementation of the quality assurance program. Its purpose is to determine that the manufacturer's equipment, procedures, and quality program are maintained to insure a uniform product consistent with that which was tested and FM Approved.

5.2.2 These audits shall be conducted periodically but at least annually by FM Approvals or its representatives.

5.2.3 FM Approved products or services shall be produced or provided at or from the location(s) audited by FM Approvals and as specified in the Approval Report. Manufacture of products bearing the Approval Mark is not permitted at any other location without prior written authorization by FM Approvals.

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 changes in product construction, components, raw materials, physical characteristics, coatings, component formulation or quality assurance procedures prior to implementation.

5.5 Manufacturing and Production Tests

The manufacturer shall provide documentation noting all test procedures and performance criteria related to the final inspection and testing of safety shutoff valves. Manufacturer's documentation shall be reviewed as part of the Approval process. At a minimum, the tests in Sections 5.5.1, 5.5.2 and 5.5.3 must be performed unless otherwise noted in the Approval Report.

5.5.1 *Test Requirement No. 1 – Seat Leakage Test*

The manufacturer shall test 100 percent of production safety shutoff valves at rated working pressure for seat leakage. Leakage shall not exceed the rates noted in Section 4.3.1.

5.5.2 *Test Requirement No. 2 – External Leakage Test*

The manufacturer shall test 100 percent of production safety shutoff valves at rated working pressure for external leakage. No evidence of leakage is permitted.

5.5.3 *Test Requirement No. 3 – Operation Test*

The manufacturer shall operate 100 percent of production safety shutoff valves to ensure the valve maintains proper position and opening/closing time without evidence of sticking or binding.

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 ² - "square inches"; (mm ² - "square millimeters") mm ² = in ² x 6.4516 x 10 ⁻² ft ² - "square feet"; (m ² - "square meters") m ² = ft ² 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
HEAT:	Btu - "British thermal units"; (J - "joules") J = Btu x 1.0551 x 10 ³
HEAT RELEASE RATE:	Btu/min - "British thermal units per minute"; (kW - "kilowatts") kW = Btu/min x 0.0176
HEAT FLUX:	[Btu/min]/ft ² ; (kW/m ² - "kilowatts per meter squared") kW/m ² = [Btu/min]/ft ² x 0.1895
TEMPERATURE:	°F - "degrees Fahrenheit"; (°C - "degrees Celsius") °C = (°F - 32) x 0.556
VOLUME:	gal - "gallons"; (L - "liter") L = gal x 3.785 L - "liter"; (dm ³ - "cubic decimeters") L = dm ³
FLOW RATE (LIQUID):	oz/hr - "ounces per hour"; (ml/hr - "milliliters per hour") ml/hr = oz/hr x 29.5
FLOW RATE (GAS):	in ³ /hr - "cubic inches per hour"; (cc/hr - "cubic centimeters per hour") cc/hr = in ³ /hr x 16.667

APPENDIX B: APPROVAL GUIDE CATEGORIES

FM Approved safety shutoff valves shall appear in one or more of the Approval Guide categories listed below:

Fire Protection / Safety Shutoff Valves / Liquid / Electric

Fire Protection / Safety Shutoff Valves / Liquid / Pneumatic

Fire Protection / Safety Shutoff Valves / Liquid / Mechanical

Fire Protection / Safety Shutoff Valves / Gas / Electric

Fire Protection / Safety Shutoff Valves / Gas / Pneumatic

Fire Protection / Safety Shutoff Valves / Gas / Mechanical

Fire Protection / Safety Shutoff Valves / Fire Safe

Notes:

- Safety shutoff valves classified as fire safe shall appear in the *Fire Protection / Safety Shutoff Valves / Fire Safe* Approval Guide category as well as the Approval Guide category that corresponds to the intended fluid service and actuation type.
- The Safety shutoff valves Approved for use with both liquid and gas shall appear in both the *Fire Protection / Safety Shutoff Valves / Liquid* and *Fire Protection / Safety Shutoff Valves / Gas* Approval Guide categories that correspond to the actuation type.

APPENDIX C: SAMPLE LISTING

Fire Protection / Safety Shutoff Valves / Liquid / Electric

Valve and actuator assemblies for liquid service that automatically return to normal position upon the loss of electric signal (actuator holding medium). Safety shutoff valves can be either normally closed or normally open. Normally open safety shutoff valves are sometimes referred to as vent valves.

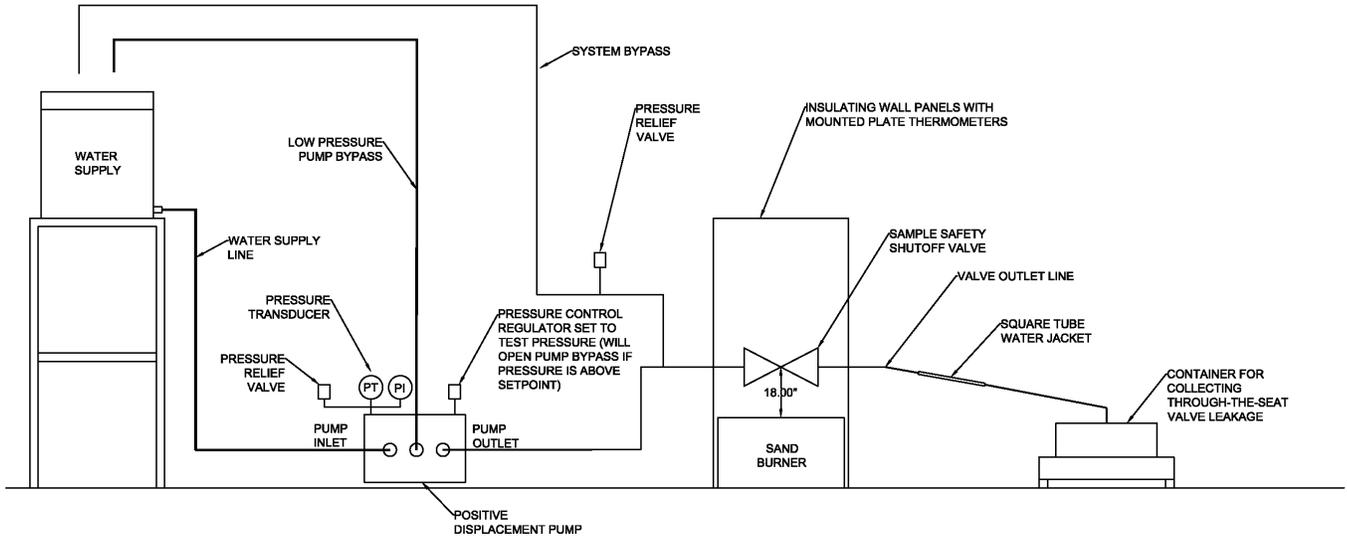
Model JML-SS and JML-V

<i>Product Designation</i>	<i>Type</i>	<i>Size, in. NPS</i>	<i>Actuator Voltage</i>	<i>End Connection</i>	<i>Rated Working Pressure, psi (kPa)</i>	<i>Remarks</i>
JML-SS	Normally Closed	1, 1-1/4, 1-1/2, 2	120 VAC	NPT	275 (1900)	a, b
JML-V	Normally Open	1, 1-1/4, 1-1/2, 2	120 VAC	NPT	275 (1900)	a, b

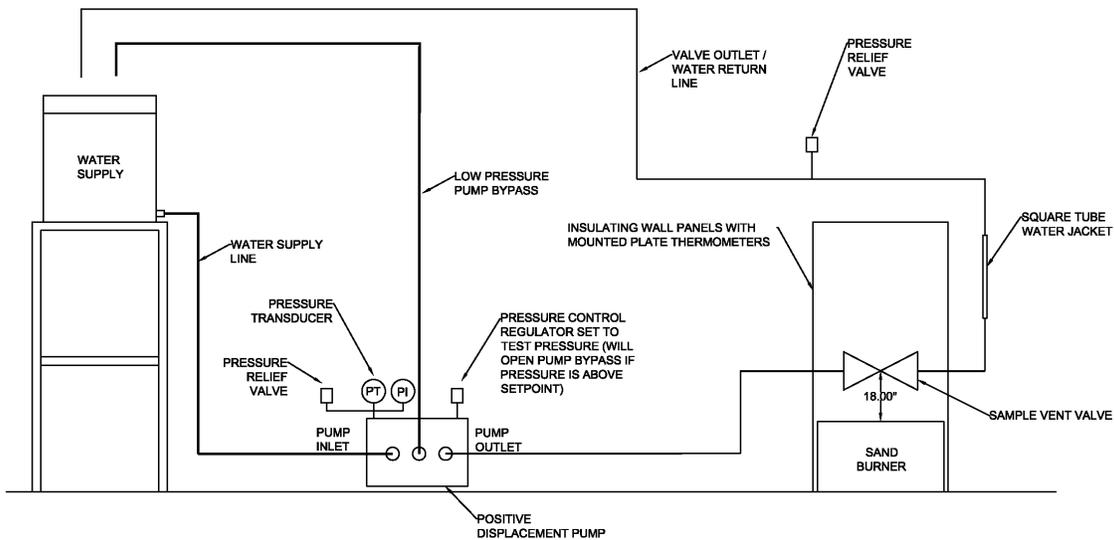
Remarks:

- a. Operating Ambient Temperature Range: 32° F (0° C) to 140° F (60° C)
- b. Considered FM Approved when supplied with an A351 CF8M valve body and Teflon valve seat

APPENDIX D: FIRE EXPOSURE TEST SETUP



D-1. Typical Fire Exposure Test Setup for Normally Closed Safety Shutoff Valves



D-2. Typical Fire Exposure Test Setup for Normally Open Safety Shutoff Valves

APPENDIX E: TOLERANCES

Unless otherwise stated, the following tolerances shall apply:

Length: ± 5 percent of value

Volume: ± 5 percent of value

Pressure: ± 5 percent of value

Flow: ± 5 percent of value

Temperature: ± 5 percent of value

Time: + 5/- 0 seconds
+ 0.1/- 0 minutes
+ 0.1/- 0 hours
+ 0.25/- 0 days

Unless stated otherwise, all tests shall be carried out at an ambient and fluid temperature of $68^{\circ}\text{F} \pm 18^{\circ}\text{F}$ ($20^{\circ}\text{C} \pm 10^{\circ}\text{C}$).