



*Member of the FM Global Group*

# **Approval Standard for Spray Fire Shields**

**Class Number 4999**

**January 2007**

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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 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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# TABLE OF CONTENTS

<b>1. INTRODUCTION</b>	1
1.1 Purpose	1
1.2 Scope	1
1.3 Basis for Requirements	1
1.4 Basis for Approval	2
1.5 Basis for Continued Approval	2
1.6 Effective Date	2
1.7 System of Units	3
1.8 Applicable Documents	3
1.9 Definitions	3
<b>2. GENERAL INFORMATION</b>	4
2.1 Product Information	4
2.2 Approval Application Requirements	4
2.3 Requirements for Samples for Examination	4
<b>3. GENERAL REQUIREMENTS</b>	5
3.1 Review of Documentation	5
3.2 Physical or Structural Features	5
3.3 Markings	5
3.4 Manufacturer's Installation Instructions	5
3.5 Calibration	6
<b>4. PERFORMANCE REQUIREMENTS</b>	6
4.1 Spray Fire Shield Simulated Leak Test for Horizontal Piping	6
4.2 Spray Fire Shield Simulated Leak Test for Vertical Piping	6
4.3 Spray Fire Shield Fire Integrity Test	7
<b>5. OPERATIONS REQUIREMENTS</b>	7
5.1 Demonstrated Quality Control Program	8
5.2 Facilities and Procedures Audit (F&PA)	8
5.3 Installation Inspections	9
5.4 Manufacturer's Responsibilities	9
<b>APPENDIX A: Units of Measurement</b>	10
<b>APPENDIX B: FM Approvals Certification Marks, Usage Guidelines</b>	11
<b>APPENDIX C: Spray Fire Shield Simulated Leak Test for Horizontal Piping</b>	13
C-1 Introduction	13
C-2 Test Apparatus and Arrangement	13
C-3 Test Specimen	14
C-4 Test Procedure	14
C-5 Performance Requirements	15
<b>APPENDIX D: Spray Fire Shield Simulated Leak Test for Vertical Piping</b>	16
D-1 Introduction	16
D-2 Test Apparatus and Arrangement	16
D-3 Test Specimen	17
D-4 Test Procedure	17
D-5 Performance Requirements	17
<b>APPENDIX E: Spray Fire Shield Fire Integrity Test</b>	18
E-1 Introduction	18
E-2 Test Apparatus and Arrangement	18
E-3 Test Specimen	19
E-4 Test Procedure	19
E-5 Performance Requirements	20

## 1. INTRODUCTION

### 1.1 Purpose

- 1.1.1 This standard states Approval requirements for Spray Fire Shields. Spray Fire Shields are used over mechanical joints in piping systems that carry flammable liquids. Their purpose is to prevent a spray fire from developing when a mechanical joint fails and as a consequence, develops a leak in the form of a highly pressured spray.
- 1.1.2 Past experience has shown that a number of fire losses have been caused by the failure of mechanical joints such as fittings and flanges. When this happens, a pressurized release of flammable fluid occurs which often results in a pressured spray fire. Such fires create a severe challenge because they can not be extinguished or controlled with conventional sprinkler systems. The intent of this standard is to evaluate products that can be installed as a shield or guard around a fitting such that if the fitting fails, the shield will disrupt or prevent the formation of a high pressure spray. This in turn will convert any resulting fires from a spray fire scenario to a 3D spill fire scenario which can be controlled by a properly designed sprinkler system.
- 1.1.3 Products that receive Approval recognition have been evaluated to provide assurance that they will perform their intended functions under expected conditions and prevent the formation of high pressure spray fires.
- 1.1.4 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 spray fire shields under simulated laboratory conditions that model the failure of a highly pressurized mechanical joint normally found in liquid piping systems. Such liquid piping systems are found in a variety of applications including, but not limited to, turbines and generators in power generation facilities and other flammable liquid operations such as hydraulic oil lines or liquid transfer piping.
- 1.2.2 The standard assesses the ability of a shield to convert a highly pressurized spray of fluid into a low pressure, low momentum flow under both normal operating conditions as well as under fire conditions such as that typically found within power generation facilities.
- 1.2.3 This standard is not intended to determine the suitability for all end use conditions of a product. Conditions under which spray fire shields are used vary widely. It is the responsibility of the manufacturer and building owner to determine the suitability of the products for the intended location.
- 1.2.4 This standard does not examine the spray fire shields ability to: contain leakage under normal conditions as identifying and fixing leaks is preferable to an undetected build-up of leaking fluid; perform its intended function when subjected to the long term effects of the galvanic reaction that results when the shield is installed on a liquid piping system made from a dissimilar metal.

### 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 FM Approvals and other organizations. The advice of manufacturers, users, trade associations and loss control specialists was also considered.

1.3.2 Meeting these requirements qualifies a product as an FM Approved spray fire shield. Requirements prohibit component substitution without prior authorization by FM Approvals.

1.3.3 The requirements of this standard reflect tests and practices used to examine characteristics of spray fire shields for the purpose of obtaining Approval. These requirements are intended primarily as guides and strict conformity is not always mandatory. Spray fire shields 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, spray fire shields that meet all the requirements identified in this standard may not be FM Approved if other conditions that 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' 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 and Master Agreement
- satisfactory re-examination of production samples for continued conformity to requirements; and
- satisfactory Facilities and Procedures Audits (F&PAs) 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 that were 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 January 1, 2007 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 American National Standards Institute (ANSI)/Institute of Electrical and Electronics Engineers (IEEE)/American Society for Testing Materials (ASTM) SI 10-02, *Standard for Use of the International System of Units (SI): The Modern Metric System*.

## 1.8 Applicable Documents

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

American Society for Testing and Materials (ASTM) International

ASTM E 1529-00, *Standard Test Methods for Determining Effects of Large Hydrocarbon Pool Fires on Structural Members and Assemblies*

ASTM SI 10-02, *Standard for Use of the International System of Units (SI): The Modern Metric System*

American Society of Mechanical Engineers (ASME)

ASME B 16.5-2003, *Pipe Flanges and Flanged Fittings: NPS 1/2 Through 24*.

FM Approvals/FM Global

FM Global Property Loss Prevention Data Sheet 7-32, *Flammable Liquid Operations* (September 2000)

FM Global Property Loss Prevention Data Sheet 7-99, *Heat Transfer by Organic and Synthetic Fluids*

FM Global Property Loss Prevention Data Sheet 7-101, *Fire Protection for Steam Turbines and Electric Generators*

## 1.9 Definitions

For purposes of this standard, the following terms apply:

*Liquid Piping System* – a piping system that conveys pressured liquids. These systems may convey liquids such as, but not limited to, lube oil, mineral oil, hydraulic fluid and refrigerants.

*Mechanical Joint* – a method of joining lengths of pipe, valves, expansion joints, fittings or other similar items to one another by means of flanged ends that are bolted together. Placed between the flanges is a gasket such that when the fasteners joining the sections together are tightened, a pressure resistant seal is developed.

*Pool Fire* – a fire caused by the ignition of liquids. These types of fires are commonly found in open tanks or in diked areas. The heat release rate for this type of fire is dependent on the liquid being burned and the exposed surface area of the liquid pool.

*Spray Fire* – a fire caused by the ignition of liquids resulting from leaks under pressure. The spray is easily ignited and will burn nearly as fast as it is released producing heat release rates much greater than a pool fire. The duration of the fire depends on the fuel supply available and how quickly it can be shut off.

## 2. GENERAL INFORMATION

### 2.1 Product Information

- 2.1.1 The use of spray fire shields to prevent highly pressured jets of fluid is a critical component in the overall effectiveness of controlling a fire using a conventional sprinkler system. Fires resulting from highly pressured sprays of liquids can not be controlled or extinguished by conventional sprinkler systems. When a mechanical joint fails such that it results in a highly pressurized spray of liquid, the presence of the spray shield turns the pressured spray into a low pressure, low momentum flow of liquid which can be controlled or extinguished by a conventional sprinkler system.
- 2.1.2 Spray fire shields are normally fabricated from galvanized or stainless steel but can be fabricated from other materials, if these other materials successfully meet all the test criteria contained in this standard. They can be fabricated for a range of pipe diameters and operating pressures.

### 2.2 Approval Application Requirements

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

Materials Director  
FM Approvals  
1151 Boston-Providence Turnpike  
PO Box 9102  
Norwood, MA 02062  
U.S.A.

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, installation and any 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. All 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 based on the following:
- Minimum and maximum diameter pipe systems for which Approval is desired
  - Maximum design operating pressure for the liquid operating system to which it will be attached
  - Minimum thickness of materials for the various combinations of size and pressure ratings, if applicable.
- 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 At the sole discretion of FM Approvals, spray shields for pipe diameters other than the minimum and maximum noted above shall need to be tested.

### **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**

Physical and structural features, including but not limited to material type, grade and thickness, shall be shown on controlled detailed drawings.

#### **3.3 Markings**

3.3.1 The packaging and the spray shield itself shall bear the manufacturer's name, product trade name, design pressure rating for which it is Approved and the Approval mark of FM Approvals (see Appendix B).

3.3.2 Labels or markings denoting Approval shall be applied by the manufacturer only within and on the premises of manufacturing locations that are under the FM Approvals Facilities and Procedures Audit Program.

3.3.3 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.

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

3.3.5 All markings shall be legible and durable.

#### **3.4 Manufacturer's Installation 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 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.

## 4. PERFORMANCE REQUIREMENTS

### 4.1 Spray Fire Shield Simulated Leak Test for Horizontal Piping

#### 4.1.1 Requirement

In order to qualify as an FM Approved Spray Fire Shield, all systems shall be tested in accordance with the Spray Fire Shield Simulated Leak Test for Horizontal Piping (Appendix C). This test method consists of installing a special gasket between two (2) flanges such that a certain pattern of spray will result (either a 180° or a 360° spray pattern) when the system is pressurized. Prior to pressurizing the system, a spray shield shall be installed over the flanges in accordance with the manufacturer's written instructions. Tests shall be conducted using the minimum and maximum diameter pipe systems for which Approval is desired for the specific design. The pressure used during the test shall be two (2) times the pressure for which the unit will be rated. The minimum rating for Approval shall be 100 psi (0.69 MPa). Additional sizes of spray shields other than the minimum and maximum sizes shall be required to be tested at the sole discretion of FM Approvals.

#### 4.1.2 Test/Verification

One (1) sample at both the minimum and maximum diameters shall be tested per the Spray Fire Shield Simulated Leak Test for Horizontal Piping (Appendix C) for each spray pattern (180° and 360°). Additional sizes of spray shields other than the minimum and maximum sizes shall be required to be tested at the sole discretion of FM Approvals. Each sample shall be exposed for a period of forty-five (45 minutes) at two (2) times the spray shield's design pressure. These samples are not required to be subjected to any other tests as part this test program. Upon completion of the test, all samples shall maintain their structural integrity. In addition, no spray shall extend beyond a 5 ft (1.5 m) radius from the centerline of the pipe in any direction during the test.

### 4.2 Spray Fire Shield Simulated Leak Test for Vertical Piping

#### 4.2.1 Requirement

In order to qualify as an FM Approved Spray Fire Shield, all systems shall be tested in accordance with the Spray Fire Shield Simulated Leak Test for Vertical Piping (Appendix D). This test method consists of installing a special gasket between two (2) flanges such that a certain pattern of spray will result (either a 180° or a 360° spray pattern) when the system is pressurized. Prior to pressurizing the system, a spray shield shall be installed over the flanges in accordance with the manufacturer's written instructions. Tests shall be conducted using the minimum and maximum diameter pipe systems for which Approval is desired for the specific design. The pressure used during the test shall be two (2) times the pressure for which the unit will be rated. The minimum rating for Approval shall be 100 psi (0.69 MPa). Additional sizes of spray shields other than the minimum and maximum sizes shall be required to be tested at the sole discretion of FM Approvals.

#### 4.2.2 Test/Verification

One (1) sample at both the minimum and maximum diameters shall be tested per the Spray Fire Shield Simulated Leak Test for Vertical Piping (Appendix D) for each spray pattern (180° and 360°). Each sample shall be exposed for a period of forty-five (45 minutes) at two (2) times the spray shield's design pressure. These samples are not required to be subjected to any other tests as part this test program. Upon completion of the test, all samples shall maintain their structural integrity. In addition, no spray shall extend beyond a 5 ft (1.5 m) radius from the centerline of the pipe in any direction during the test. Additional sizes of spray shields other than the minimum and maximum sizes shall be required to be tested at the sole discretion of FM Approvals

### 4.3 Spray Fire Shield Fire Integrity Test

#### 4.3.1 Requirement

In order to qualify as an FM Approved Spray Fire Shield, all systems shall be tested in accordance with the Spray Fire Shield Fire Integrity Test (Appendix E). Prior to conducting the fire test, the most critical design that successfully met the criteria of the Spray Fire Shield Simulated Leak Test for Horizontal Piping or the Spray Fire Shield Simulated Leak Test for Vertical Piping (either the 180° or the 360° pattern as appropriate) shall be selected for the Spray Fire Shield Fire Integrity Test. In addition, if the most critical design (horizontal or vertical orientation) can not be determined, the fire tests shall be conducted on spray fire shields installed on both horizontally oriented piping and vertically oriented piping. Prior to the Spray Fire Shield Fire Integrity Test, a spray shield shall be installed over the flanges in accordance with the manufacturer's written instructions.

#### 4.3.2 Test/Verification

The sample shall be tested per the Spray Fire Shield Fire Test (Appendix E) followed by an abbreviated Spray Fire Shield Simulated Leak Test for Horizontal Piping (Appendix C). At the sole discretion of FM Approvals, the Spray Fire Shield Simulated Leak Test for Vertical Piping (Appendix D) shall be permitted to be conducted instead if the results of leakage tests indicate that a vertical application of the piping is more critical.

The sample shall be subjected to the fire exposure for a period of forty-five (45) minutes. Immediately following the fire test, the sample shall be subjected to the abbreviated Spray Fire Shield Simulated Leak Test for Horizontal Piping or the Spray Fire Shield Simulated Leak Test for Vertical Piping as appropriate, for a period of one (1) minute. Upon completion of the Spray Fire Shield Simulated Leak Test for Horizontal Piping or the Spray Fire Shield Simulated Leak Test for Vertical Piping, as appropriate, the sample shall maintain its structural integrity and result in having no spray extend beyond a 5 ft (1.5 m) radius from the centerline of the pipe in any direction during the test.

## 5. OPERATIONS REQUIREMENTS

A Quality Control Program is required to assure that subsequent Spray Fire Shields produced by the manufacturer shall present the same quality and reliability as the specific sample(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 Facilities and Procedures Audit (F&PA).
- 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:

- 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 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 FM Approvals' Form 797, FM Approved Product/Specification-Tested Revision Report or Address/Main Contact Change Report.
- Records of all revisions to all FM Approved products shall be maintained.

## 5.2 Facilities and Procedures Audit (F&PA)

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 at or provided 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.

## APPENDIX A

### Units of Measurement

<b>AREA:</b>	$\text{in}^2$ - “square inches”; ( $\text{mm}^2$ - “square millimeters”) $\text{mm}^2 = \text{in}^2 \times 6.4516 \times 10^2$  $\text{ft}^2$ - “square feet”; ( $\text{m}^2$ - “square meters”) $\text{m}^2 = \text{ft}^2 \times 0.0929$
<b>FORCE:</b>	lbf “pound-force”; (N - “Newtons”) $\text{N} = \text{lbf} \times 4.448$
<b>HEAT FLUX:</b>	$\text{Btu}/\text{ft}^2$ - hr - “British thermal unit per square foot hour” ( $\text{kW}/\text{m}^2$ - “kilowatts per square meter”) $\text{kW}/\text{m}^2 = \text{Btu}/\text{ft}^2$ - hr $\times 0.0032$
<b>LENGTH:</b>	$\text{in.}$ - “inches”; ( $\text{mm}$ - “millimeters”) $\text{mm} = \text{in.} \times 25.4$  $\text{ft}$ - “feet”; ( $\text{m}$ - “meters”) $\text{m} = \text{ft} \times 0.3048$
<b>MASS:</b>	$\text{lb}$ - “pounds”; ( $\text{kg}$ - “kilograms”) $\text{kg} = \text{lb} \times 0.454$
<b>PRESSURE:</b>	$\text{lbs}/\text{in}^2$ - “pounds per square inch”; ( $\text{kPa}$ - “kilopascals”) $\text{kPa} = \text{lbs}/\text{in}^2 \times 6.895$  $\text{bar}$ - “bar”; ( $\text{kPa}$ - “kilopascals”) $\text{bar} = \text{kPa} \times 0.01$ $\text{bar} = \text{lbs}/\text{in}^2 \times 0.06895$
<b>TEMPERATURE:</b>	$^{\circ}\text{F}$ - “degrees Fahrenheit”; ( $^{\circ}\text{C}$ - “degrees Celsius”) $^{\circ}\text{C} = (^{\circ}\text{F} - 32) \times 0.556$
<b>VELOCITY:</b>	$\text{ft}/\text{sec}$ - “feet per second”; ( $\text{m}/\text{sec}$ “meters per second”) $\text{m}/\text{sec} = \text{ft}/\text{sec} \times 0.3048$  $\text{mph}$ - miles per hour; ( $\text{km}/\text{hr}$ - “kilometers per hour”) $\text{km}/\text{hr} = \text{miles}/\text{hr} \times 1.61$
<b>VOLUME</b>	$\text{ft}^3$ - “cubic feet”; ( $\text{m}^3$ - “cubic meters”) $\text{m}^3 = \text{ft}^3 \times 0.028$

## APPENDIX B

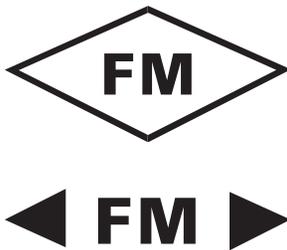
### FM Approvals Certification Marks

FM Approvals certifications marks are to be used only in conjunction with products or services that have been 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.



#### **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.



#### **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.

## 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

### Spray Fire Shield Simulated Leak Test for Horizontal Piping

#### C-1 Introduction

- C-1.1 This test method is intended to evaluate the ability of a spray fire shield to turn a highly pressurized leak into one that provides a low pressure, low momentum flow of liquid. It is also used to assess the ability of the spray fire shield to maintain its structural integrity when subjected to a simulated leak from a pressured flammable liquid piping system.
- C-1.2 The shield's design rating shall be specified by the manufacturer. The pressure used during the test shall be two (2) times the design rating of the spray shield and the systems for which it is intended to be used.

#### C-2 Test Apparatus and Arrangement

- C-2.1 The description of the apparatus is general in nature. Any equipment capable of performing the test procedure within the allowable tolerances is permitted. Only the major components are described.
- C-2.2 Test Flange Assembly shall be capable of withstanding the pressures that will be used during the test program. The flange assembly shall consist of two (2) flanged sections of threaded pipe with each section of pipe a minimum of eight (8) inches in length. All pipes, flanges and fittings that make up the assembly shall be in accordance with ASME B16.5-2003, *Pipe Flanges and Flange Fittings; 1/2 Through 24* and shall be fabricated from either steel castings or steel forgings of the grade complying with the appropriate ASTM/ASME specifications recommended for the various pressure-temperature ratings for which the system is designed. One section of pipe shall be connected to a fire hose test connection (or similar) which in turn is connected to a pump capable of providing the pressure and volume of water required during the test. The end of the other section of shall be capped (see Figure C-1 for a typical test arrangement). The entire assembly shall be oriented such that the sections of pipe are horizontal. The flange assembly shall be installed with the centerline of the flange assembly located 3 ft 6 in.  $\pm$  1/2 in. (1.07 m  $\pm$  13 mm) from the floor. All nuts and bolts mating the two flanges together shall be tightened with a torque wrench to 150 ft-lbs (0.67 kN).
- C-2.3 Specially designed test flanges shall be used. For one test, the specially designed flange shall result in a 0.0625 in (1.59 mm) thick gap between mating surfaces such that the resulting spray will form a 360° spray pattern. For the other test, the mating surfaces shall contain a gasket that results in a 180° spray pattern. When installed, the 180° spray assembly shall be oriented such that the spray pattern will be pointed downward. In order to achieve the 180° spray pattern, a metal gasket shall be used. In order to achieve the 360° spray pattern, metal washers of the appropriate diameter shall be placed between the flanges at each flange bolt hole.
- C-2.4 Pressure System - shall consist of an appropriately size pump capable of providing the necessary quantity of water at the specified pressure for the duration of the test.
- C-2.5 Pressure Measuring Apparatus - the pressure measuring apparatus used to measure the test pressure shall be capable of measuring the appropriate pressures within a tolerance of  $\pm$ 2% of the test design pressure.
- C-2.6 Spray Pattern Measuring System - shall be a measuring device (tape measure or equivalent) capable of measuring at least 5 ft (1.5 m). As an alternative, a series of concentric circles can be drawn on the floor using the center of the flange as the middle of all circles.

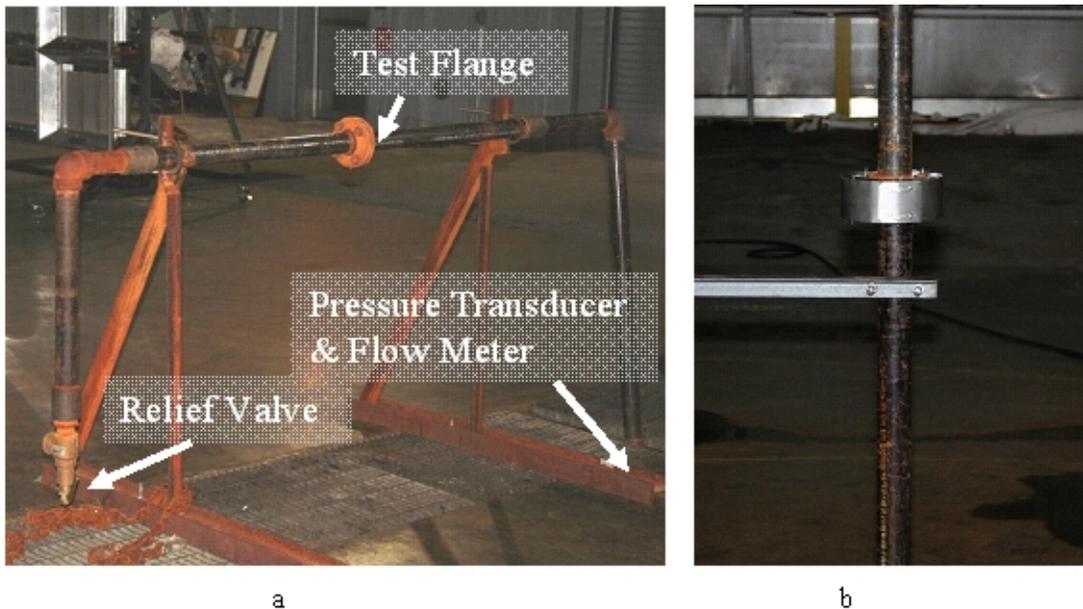


Figure C-1. Test apparatus for spray shield performance testing, a) horizontal pipe, b) vertical pipe.

### C-3 Test Specimen

- C-3.1 The test specimens shall be of sufficient size for the particular diameter pipe and flange being examined. Both the minimum and maximum diameters for the particular model (at its minimum thickness, if applicable) shall be tested at two (2) times the spray fire shield's operating pressure. The device shall be installed in accordance with the manufacturers written installation instructions.
- C-3.2 Two (2) tests shall be conducted on each model at both the minimum and maximum diameter for which Approval is desired. One sample shall incorporate a special gasket that shall result in a spray pattern of 180°. The other sample shall incorporate a special gasket such that the spray pattern is 360°.
- C-3.3 New and previously unused test specimens shall be permitted to be used for each Spray Fire Shield Simulated Leak Test for Horizontal Piping.
- C-3.4 Additional sizes of spray shields other than the minimum and maximum sizes shall be required to be tested at the sole discretion of FM Approvals.

### C-4 Test Procedure

- C-4.1 The test specimen shall be fitted onto the test apparatus in accordance with the manufacturers written installation instructions. The pump shall be started and water flow introduced into the test apparatus. The design pressure shall be attained within sixty (60) seconds of the start of the water flow. The test shall be considered to start once the test pressure is attained.
- C-4.2 The test design pressure shall be applied and maintained for a period of forty-five (45) minutes. Upon completion of the test, the pump shall be turned off and any residual pressure released.
- C-4.3 The pressure shall be maintained at two (2) times the design pressure,  $\pm 2\%$ , for the duration of the test.

C-4.4 If it can be determined at the sole discretion of FM Approvals, that subsequent spray patterns or the resulting spray pattern using other diameter pipes, spray fire shields or the results of the Spray Fire Shield Simulated Leak Test for Vertical Piping are not as critical as the initial forty-five (45) minute test, the subsequent test(s) shall be permitted to be terminated after a period of five (5) minutes.

#### **C-5 Performance Requirements**

C-5.1 Upon completion of each test, the test specimen shall be examined. The test specimen shall maintain its structural integrity with no fasteners being broken or detaching from the shield, no through openings developing in the field of the shield or any other signs of failure. Small amounts of deflection and distortion shall not be considered as a failure.

C-5.2 The resulting spray pattern shall be limited such that no spray extends beyond a 5 ft (1.5 m) radius from the centerline of the pipe in any direction.

## APPENDIX D

### Spray Fire Shield Simulated Leak Test for Vertical Piping

#### D-1 Introduction

- D-1.1 This test method is intended to evaluate the ability of a spray fire shield to turn a highly pressurized leak into one that provides a low pressure, low momentum flow of liquid. It is also used to assess the ability of the spray fire shield to maintain its structural integrity when subjected to a simulated leak from a pressured flammable liquid piping system.
- D-1.2 The shield's design rating shall be specified by the manufacturer. The pressure used during the test shall be two (2) times the design rating of the spray shield and the systems for which it is intended to be used.

#### D-2 Test Apparatus and Arrangement

- D-2.1 The description of the apparatus is general in nature. Any equipment capable of performing the test procedure within the allowable tolerances is permitted. Only the major components are described.
- D-2.2 Test Flange Assembly – shall be capable of withstanding the pressures that will be used during the test program. The flange assembly shall consist of two (2) flanged sections of threaded pipe with each section of pipe a minimum of eight (8) inches in length. All pipes, flanges and fittings that make up the assembly shall be in accordance with ASME B16.5-2003, "Pipe Flanges and Flange Fittings; ½ Through 24" and shall be fabricated from either steel castings or steel forgings of the grade complying with the appropriate ASTM/ASME specifications recommended for the various pressure-temperature ratings for which the system is designed. One section of pipe shall be connected to a fire hose test connection (or similar) which in turn is connected to a pump capable of providing the pressure and volume of water required during the test. The end of the other section of shall be capped (see Figure C-1 for a typical test arrangement). The entire assembly shall be oriented such that the sections of pipe are vertical. The flange assembly shall be installed with the center line of the flange assembly located 3 ft 6 in ± ½ in (1.07 m ± 13 mm) from the floor. All nuts and bolts mating the two flanges together shall be tightened with a torque wrench to 150 ft-lbs (0.67 kN).
- D-2.3 Specially designed test flanges shall be used. For one test, the specially designed flange shall result in a 0.0625 in (1.59 mm) thick gap between mating surfaces such that the resulting spray will form a 360° spray pattern. For the other test, the mating surfaces shall contain a gasket that results in a 180° spray pattern. In order to achieve the 180° spray pattern, a metal gasket shall be used. In order to achieve the 360° spray pattern, metal washers of the appropriate diameter shall be placed between the flanges at each flange bolt hole.
- D-2.4 Pressure System – shall consist of an appropriately size pump capable of providing the necessary quantity of water at the specified pressure for the duration of the test.
- D-2.5 Pressure Measuring Apparatus – the pressure measuring apparatus used to measure the test pressure shall be capable of measuring the appropriate pressures within a tolerance of ±2% of the test design pressure.
- D-2.6 Spray Pattern Measuring System – shall be a measuring device (tape measure or equivalent) capable of measuring at least 5 ft (1.5 m). As an alternative, a series of concentric circles can be drawn on the floor using the center of the flange as the middle of all circles.

**D-3 Test Specimen**

- D-3.1 The test specimens shall be of sufficient size for the particular diameter pipe and flange being examined. Both the minimum and maximum diameters for the particular model (at its minimum thickness, if applicable) shall be tested at two (2) times the spray fire shield's operating pressure. The device shall be installed in accordance with the manufacturers written installation instructions.
- D-3.2 Two (2) tests shall be conducted on each model at both the minimum and maximum diameter for which Approval is desired. One sample shall incorporate a special gasket that shall result in a spray pattern of 180°. The other sample shall incorporate a special gasket such that the spray pattern is 360°.
- D-3.3 New and previously unused test specimens shall be permitted to be used for each Spray Fire Shield Simulated Leak Test for Vertical Piping.
- D-3.4 Additional sizes of spray shields other than the minimum and maximum sizes shall be required to be tested at the sole discretion of FM Approvals.

**D-4 Test Procedure**

- D-4.1 The test specimen shall be fitted onto the test apparatus in accordance with the manufacturers written installation instructions. The pump shall be started and water flow introduced into the test apparatus. The design pressure shall be attained within sixty (60) seconds of the start of the water flow. The test shall be considered to start once the test pressure is attained.
- D-4.2 The test design pressure shall be applied and maintained for a period of forty-five (45) minutes. Upon completion of the test, the pump shall be turned off and any residual pressure released.
- D-4.3 The pressure shall be maintained at two (2) times the design pressure,  $\pm 2\%$ , for the duration of the test.
- D-4.4 If it can be determined, at the sole discretion of FM Approvals, that subsequent spray patterns or the resulting spray pattern using other diameter pipes, spray fire shields or the results of the Spray Fire Shield Simulated Leak Test for Horizontal Piping are not as critical as the initial forty-five (45) minute test, the subsequent test(s) shall be permitted to be terminated after a period of five (5) minutes.

**D-5 Performance Requirements**

- D-5.1 Upon completion of each test, the test specimen shall be examined. The test specimen shall maintain its structural integrity with no fasteners being broken or detaching from the shield, no through openings developing in the field of the shield or any other signs of failure. Small amounts of deflection and distortion shall not be considered as a failure.
- D-5.2 The resulting spray pattern shall be limited such that no spray extends beyond a 5 ft (1.5 m) radius from the centerline of the pipe in any direction.

## APPENDIX E

### Spray Fire Shield Fire Integrity Test

#### E-1 Introduction

- E-1.1 This test method is intended to evaluate the ability of a spray fire shield to withstand a simulated fire test and still retain the ability to withstand the simulated leak test.
- E-1.2 This test method is based on the assumption that a typical fire scenario at a turbine exposed to a flammable liquid fire caused by a highly pressurized leak at a flange in a flammable liquid piping system would last for up to forty-five (45) minutes until such time as emergency shutdown procedures could stop the flow of fuel.
- E-1.3 The test method is based on the assumption that any such fire would result in an exposure similar to that shown in ASTM E1529, *Standard Test Methods for Determining Effects of Large Hydrocarbon Pool Fires on Structural Members and Assemblies*. This test method has been selected as it will expose the spray fire shields to the most realistic and vigorous fire conditions possible from a hydrocarbon pool fire.

#### E-2 Test Apparatus and Arrangement

- E-2.1 The description of the apparatus is general in nature. Any equipment capable of performing the test procedure within the allowable tolerances is permitted. Only the major components are described.
- E-2.2 Test Apparatus – the test apparatus shall consist of a large open air room. Two (2) panels shall be installed vertically to form the two (2) sides of the apparatus. The other two (2) sides and the top shall be permitted to remain open to the room's atmosphere. Each vertical panel shall be 8 ft  $\pm$  1/2 in (2.4 m  $\pm$  13 mm) high by 2 ft  $\pm$  1/2 in (0.6 m  $\pm$  13 mm) wide. The outer layer of each panel shall be rigid plywood backing of minimum 1/2 in (13 mm) thickness. The inner layer shall be a minimum 1 in (25 mm) thick calcium silicate insulation board. The vertical panels shall be placed such that the inside surfaces are flush with the edges of the burner resulting in the inside surfaces 12 in.  $\pm$  1/2 in. (0.3 m  $\pm$  13 mm) apart from each other. The bottom edge of the vertical panels shall be level with the top surface of the heat source. To ensure that the vertical panels maintain a separation distance of 12 in.  $\pm$  1/2 in. (0.3 m  $\pm$  13 mm) throughout the test, threaded rods shall be permitted to be installed to connect the panels together at the top along each long edge of the assembly.
- E-2.3 Heat Source – the heat source for the exposure consists of a propane sand burner. The size of the burner shall be 1 ft (0.3 m) wide by 2 ft (0.6 m) in length by 1 ft (0.3 m) in height. The sand burner shall be capable of meeting the required heat output. The sand burner shall be centered between the vertical panels such that the 2 ft (0.6 m) length of the sand burner is parallel to the 2 ft (0.6 m) dimension of the vertical panel. The distance between the top surface of the sand burner and the centerline of the spray fire shield/flange assembly shall be 12 in.  $\pm$  1/2 in. (0.3 m  $\pm$  13 mm).
- E-2.4 Heat Flux Gauge – a plate thermometer shall be used to measure the heat transfer rate. The plate thermometer shall be installed on the centerline  $\pm$  1/4 in ( $\pm$ 6 mm) of the spray fire shield. Propane gas flow to the burner shall be adjusted to provide a heat flux of 50,000 Btu/ft<sup>2</sup>-hr (158 kW/m<sup>2</sup>). This heat flux shall be attained within five (5) minutes from the start of the test and shall remain at that level  $\pm$ 5% for the duration of the test. Two (2) additional heat flux gauges shall be installed on one of the panels such that they are located 3  $\pm$  1/2 in. (76  $\pm$  13 mm) above and below the centerline of the pipe.

E-2.5 Test Flange Assembly – the test flange assembly shall be capable of withstanding the pressures that will be used during the test program. The flange assembly shall consist of two (2) flanged sections of threaded pipe with each section of pipe a minimum of eight (8) inches in length. All pipes, flanges and fittings that make up the assembly shall be in accordance with ASME B16.5-2003, *Pipe Flanges and Flange Fittings; 1/2 Through 24* and shall be fabricated from either steel castings or steel forgings of the grade complying with the appropriate ASTM/ASME specifications recommended for the various pressure-temperature ratings for which the system is designed. One section of pipe shall be connected to a fire hose test connection (or similar) which in turn is connected to a pump capable of providing the pressure and volume of water required during the test. The end of the other section shall be capped. The entire assembly shall be oriented such that the sections of pipe are vertical. All nuts and bolts mating the two flanges together shall be tightened with a torque wrench to 150 ft-lbs (0.67 kN). The flange assembly shall be centered between the vertical panels of the test apparatus with the center line of the flange assembly located 12 in.  $\pm$  1/2 in. (0.3 m  $\pm$  13 mm). from the top of the sand burner.

Note: Even though the section of pipe is connected to a hose and pump during the fire test, no water is to be in the piping system during the fire test. The connection is simply to facilitate conducting the leakage portion of the procedure immediately following the fire test.

E-2.6 Test Flanges – specially designed test flanges shall be used. The specially designed flange shall result in a 0.0625 in (1.59 mm) thick gap between mating surfaces such that the resulting spray will form either a 180° or a 360° spray pattern. When used, the 180° spray assembly shall be oriented such that the spray pattern will be pointed downward. In order to achieve the 180° spray pattern, a metal gasket shall be used. In order to achieve the 360° spray pattern, metal washers of the appropriate diameter shall be placed between the flanges at each flange bolt hole.

E-2.7 Pressure System – shall consist of an appropriately size pump capable of providing the necessary quantity of water at the specified pressure for the duration of the test.

E-2.8 Pressure Measuring Apparatus – the pressure measuring apparatus used to measure the test pressure shall be capable of measuring the appropriate pressures within a tolerance of  $\pm 2\%$  of the test design pressure.

E-2.9 Spray Pattern Measuring System – shall be a measuring device (tape measure or equivalent) capable of measuring at least 5 ft (1.5 m).

### E-3 Test Specimen

E-3.1 The test specimens shall be of sufficient size for the particular diameter pipe and flange being examined. Both the minimum and maximum diameters for the particular model shall be tested. The device shall be installed in accordance with the manufacturers written installation instructions. The test specimen shall incorporate the most critical Test Flange Assembly and spray pattern (either the 180° spray pattern or the 360° spray pattern) as determined by the Spray Fire Shield Simulated Leak Test for Horizontal Piping (Appendix C) or the Spray Fire Shield Simulated Leak Test for Vertical Piping (Appendix D). If the most critical orientation can not be determined, then tests shall be conducted on both horizontally and vertically oriented piping systems. Additional sizes of spray shields other than the minimum and maximum sizes shall be required to be tested at the sole discretion of FM Approvals.

### E-4 Test Procedure

E-4.1 Once the test apparatus and test sample have been installed, the propane burner shall be ignited. This required heat release rate shall be attained within five (5) minutes from the start of the test and shall remain at that level  $\pm 5\%$  for the duration of the forty-five (45) minute test. The pipe and flange arrangement shall not be pressurized or contain any liquid during the fire test.

- E-4.2 Upon completion of the fire test, the propane burner shall be shut off. One or both of the vertical panels shall be removed as well as the sand burner. As an alternative, the test assembly shall be permitted to be moved away from the test apparatus a sufficient distance so as not to interfere with the post fire test leak test.
- E-4.3 Within five (5) minutes of the completion of the fire test, the assembly shall be subjected to a modified Spray Fire Shield Simulated Leak Test for Horizontal Piping (Appendix C) or the Spray Fire Shield Simulated Leak Test for Vertical Piping (Appendix D), as appropriate. The modified test is identical to the Spray Fire Shield Simulated Leak Test for Horizontal Piping or the Spray Fire Shield Simulated Leak Test for Vertical Piping, as appropriate, except that the test duration shall be for a period of one (1) minute. The pressure used during the modified leak test shall be two (2) times the spray shields design pressure rating  $\pm 2\%$ .
- E-4.4 **Caution:** In order to prevent cracking of the flange or piping system due to the sudden cooling effect of the introduction of water and possible pressure build-up caused by the creation of steam in the piping system, the entire exterior of the test assembly shall be sprayed lightly with a water application system. In conjunction, the water pressure system shall be slowly turned on in order to gradually introduce water into the system.

#### E-5 Performance Requirements

- E-5.1 Upon completion of each test, the test specimen shall be examined. The test specimen shall maintain its structural integrity with no fasteners being broken or detaching from the shield, no through openings developing in the field of the shield or any other signs of failure. Small amounts of deflection and distortion shall not be considered as a failure.
- E-5.2 The resulting spray pattern shall be limited such that no spray extends beyond a 5 ft (1.5 m) radius from the centerline of the pipe in any direction.

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