



Member of the FM Global Group

Approval Standard for Firestopping

Class Number 4990

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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 and/or applications shall ensure a consistently uniform and reliable product or service. Approval Standards strive to be performance-oriented and to facilitate technological development.

For examining equipment, materials and services, Approval Standards:

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

Continuance of Approval and Listing depends on compliance with the 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 or service/application.

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

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1. INTRODUCTION

1.1 Purpose

- 1.1.1 An important technique in property loss control is the subdivision of a building into compartments and sub-compartments. This subdivision is usually accomplished by erecting physical barriers that will limit the damage caused by an event to the room of origin. The loss caused by the spread of fire damage can be minimized when effective compartmentation is incorporated into a building's design.
- 1.1.2 The damage caused by fire increases as it spreads to other areas of a building. Fire will easily spread to other areas of a building due to the collapse of a fire barrier. Fire can spread through openings in fire barriers which allow flames and/or hot gases to pass. Fire can also spread through a fire barrier by the transfer of sufficient heat through an opening that can ignite nearby combustibles on the non fire side of a wall.
- 1.1.3 One method of combating the spread of fire through openings in or around barriers is to properly design and install firestopping. Firestopping is intended for use in openings in or between fire resistant walls, floor/ceiling assemblies at head of walls and at construction joints between floors and walls.

1.2 Scope

- 1.2.1 This standard sets the performance requirements for firestopping under simulated laboratory conditions. They shall be examined for their ability to prevent the passage of flame and/or heat through or around openings in fire rated walls and floor/ceiling assemblies.
- 1.2.2 This standard sets the performance requirements for firestopping used to seal joints, voids, gaps or other discontinuities between or bounded by adjacent supporting elements such as walls, floors and at the head of walls against the spread of flame and their capability of accommodating anticipated building movements.
- 1.2.3 This standard sets the performance requirements for firestopping as it relates to their ability to resist an external force simulated by a hose stream after being subjected to a fire exposure.
- 1.2.4 This standard includes an optional water leakage test to determine the ability to resist water leakage through penetration fire stop systems in floor/ceiling assemblies when subjected to a standard water exposure.
- 1.2.5 This standard allows for an alternate fire exposure, method of test and acceptance criteria for use by jurisdictions where the ASTM fire resistance tests are not recognized by the Authority Having Jurisdiction. In those cases, the test assembly shall also be subjected to the hose stream test in order to qualify for Approval.
- 1.2.6 This standard is intended to evaluate only those hazards investigated and is not intended to determine suitability for the end use of the product.
- 1.2.7 This standard does not set the performance requirements for or a method of assessing the passage of smoke or air leakage through or around an assembly or the effects of movement of through penetrants.
 - 1.2.7.1 FM Approvals recognizes the problems caused by the non-thermal damage resulting from the migration of smoke and/or air through a fire stop. A review of the existing test methods currently in the public domain was conducted. None were incorporated into this standard at this time as they were deemed to be inadequate for some purposes of this standard. It is the intention of FM Approvals to conduct research on this topic in the future. At that time, the standard may be revised, or a new standard developed, that will incorporate other test methods and criteria deemed necessary to adequately address the non-thermal damage caused by the movement of smoke through or being emitted by the fire stop.

- 1.2.8 This standard does not address the ability of electrical penetrations to maintain their circuit integrity or to conduct electricity in fire situations.
- 1.2.9 The results of tests conducted under the controlled conditions required by this standard shall not be used to describe or appraise performance under actual fire or natural hazard conditions as actual fire and natural hazard conditions vary widely.
- 1.2.10 This standard does not address the firestopping systems along the perimeter edge of a floor slab.
- 1.2.11 Approval criteria shall include, but are not limited to, performance requirements, marking requirements, an examination of manufacturing facility(ies), an audit of quality assurance procedures, and a follow-up program.

1.3 Basis for Requirements

- 1.3.1 The requirements of this standard are based on experience, research, testing and/or the standards of other organizations. The advice of manufacturers, users, trade associations, jurisdictions and/or loss control specialists was also considered.
- 1.3.2 The requirements of this standard reflect tests and practices used to examine characteristics of fire stops for the purpose of obtaining FM Approval. Fire stops 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, fire stops 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 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 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 July 1, 2010.

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

American Society for Testing and Materials (ASTM)

ASTM E119, Standard Test Methods for Fire Tests for Building Construction and Materials

ASTM E814, Standard Test Method for Fire Tests of Through Penetration Fire Stops

ASTM E1529, Standard Test Methods for Determining Effects of Large Hydrocarbon Pool Fires on Structural Members and Assemblies

ASTM E 1966, Standard Test Method for Fire Resistive Joint Systems

ASTM E2174, Standard Practice for On-Site Inspection of Installed Fire Stops

ASTM E 2226, Practice for Application of Hose Stream

ASTM E2393, Standard Practice for On-Site Inspection of Installed Fire Resistive Joint Systems and Perimeter Fire Barriers

European Standards

EN 1363-1, Fire Resistance Tests – Part 1: General Requirements

EN 1363-2, Fire Resistance Tests – Part 2: Alternative and Additional Procedures

EN 1366-3, Fire Resistance Tests for Service Installations – Part 3: Penetration Seals

EN 1366-4, Fire Resistance Tests for Service Installations – Part 4: Linear Joint Seals

FM Approvals/ FM Global

Approval Standard 4991, Approval of Firestop Contractors (May 2001)

FM Approvals Through Penetration Water Leakage Test Procedure

Firestop Contractors International Association (FCIA)

FCIA Manual of Practice

Underwriters Laboratories of Canada

CAN/ULC -S115-05, Standard Test Method for Fire Tests of Firestop Systems

1.9 Definitions

For purposes of this standard, the following terms apply:

Authority Having Jurisdiction (AHJ) – the organization, office, official, government entity or individual responsible for approving or accepting firestopping components.

Fire Stop – fire resistant materials, systems and assemblies installed around and/or directly to through penetrating items, construction joints and at head of walls.

Joint System – an assembly or device that provides a fire separating function along continuous linear openings, including changes in direction, between adjacent fire separating elements.

Membrane Penetration System – an assembly or device that maintains the fire resistance rating when an opening is made through only one (1) side of a wall or floor.

Through Penetration – a specific construction consisting of an hourly rated wall or floor assembly, a penetrating item passing through the rated wall or floor system and the materials designed to prevent the spread of fire through the opening(s).

2. GENERAL INFORMATION

2.1 Product Information

- 2.1.1 The term fire stop is a general term for a passive fire protection system of various materials and components that are used to seal openings and joints in fire resistive wall and/or floor assemblies. The primary types of firestopping are through penetrations and joint systems.
- 2.1.2 The term through penetration is used to denote an opening in a fire rated wall or floor through which passes a mechanical, electrical, piping, structural, communication or other device. Examples of through penetrations would be fire protection piping, electrical conduits, cable trays, communication cables and other mechanical devices passing through openings in a wall.
- 2.1.3 A fire resistive joint system is used to denote the linear joint created by adjacent rated walls and or floor/ceiling assemblies. The most common joint systems are designated as wall to wall, floor to floor, floor to wall and head of wall.
- 2.1.4 Fire stops can also be used for dual purposes by also acting as a means of preventing water leakage through a floor. This type of protection is useful during the construction phase of a building when it has not yet been totally enclosed to the elements. Under such circumstances rainwater often gets into the building and causes damage to lower floors where finish work is being done by passing through openings in floors that are designed to allow the passage of piping systems. It can also be useful during a fire when a sprinkler system has been activated. In cases where the openings in floors are not made water proof, sprinkler runoff often finds it way through openings in the floor which causes water damage to lower floors that are not being exposed to fire.

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, product names and options for the products or services being submitted for Approval consideration;
- general assembly drawings, complete set of manufacturing drawings, materials list, formulation(s), sales literature and installation procedures;
- the number and location of manufacturing facilities and;
- 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 in English or with English translation.

2.3 Requirements for Samples for Examination

- 2.3.1 Following authorization of an Approval examination, the project engineer will inform the manufacturer of the number and type of samples that shall be submitted for examination and testing.
- 2.3.2 The manufacturer shall submit samples representative of production. FM Approvals, at their sole discretion, shall reserve the right to witness production of test samples and/or any components or raw materials that are deemed to be critical to the performance of the product. Any decision to use data generated using prototypes is at the discretion of FM Approvals.
- 2.3.3 Requirements for samples may vary depending on design features, results of prior or similar testing (if applicable), and results of any foregoing tests.

3. GENERAL REQUIREMENTS

3.1 General Information

- 3.1.1 This standard has been written in an attempt to provide an Approval Standard for firestopping in order to meet FM Approvals criteria and contains various options such that it can be used to satisfy Authorities Having Jurisdiction in different parts of the world. This is accomplished by establishing specific fire ratings using a base-line fire test followed by a hose stream test as the basis of the Approval. In some cases, alternate fire test methods shall be deemed equivalent to the base-line test and be allowed to be used as the basis for Approval however any alternate fire test shall be followed by the hose stream test. Additional ratings that pertain to the specific test method would also be allowed to be determined. The Approval report shall be permitted to show the ratings normally determined by the test method being used. The acceptance will be the prerogative of the AHJ based on their country and local code requirements.
- 3.1.2 The requirements of this standard shall be used to measure and describe the performance of fire stops when subjected to a fire resistance test and hose stream test. Optional ratings are available for resistance to water leakage and rapid rise fire tests.
- 3.1.3 The test methods and performance criteria used in this standard shall be in strict conformance with the referenced standards^{Note 1}. A brief description of the method will be provided elsewhere in this document. For details pertaining to a specific test method, refer to the referenced test standard.

Note 1: The only exception to the strict conformance statement shall be the location of the thermocouple used to determine the T_{FM} rating which is currently not a requirement or criteria of any existing test method. See paragraph 4.1.2.4.

3.2 Fire Tests and Ratings – Through Penetrations

- 3.2.1 All through penetrations shall be subjected to a fire resistance test followed by a hose stream test conducted in accordance with ASTM E814, “Standard Test Method for Fire Tests of Through Penetration Fire Stops”. If successful, the assembly will be assigned fire ratings based on the time period in which it successfully met the performance criteria.
- 3.2.2 Through penetration fire stops that are subjected to and meet the criteria of the ASTM E814 fire resistance and hose stream test shall be assigned three (3) separate ratings. One shall be called the *F* rating, one shall be called the T_{FM} rating and a third rating shall be called the *T* rating.

- 3.2.3 In determining the T rating, ASTM E814 specifies, and considers the performance of, a thermocouple placed directly on the penetrating item located 1 in. (25 mm) from the surface of the wall or floor. In doing this, most metal items (pipes, cables trays, etc) can not meet the criteria for a T rating due to the conductance of heat through the opening caused by the metal penetrating item.
- 3.2.4 FM Approvals does not consider the performance of the thermocouple placed directly on the penetrating item for purposes of determining the T_{FM} rating as it is not viewed as part of the firestopping materials provided in trying to protect the opening.
- 3.2.5 Other fire test methods deemed equivalent by FM Approvals shall be permitted to be used in place of the above referenced test method. When other test methods are used and the assembly successfully passes the fire resistance test and the hose stream test, the other rating designations normally determined by the other test method shall be permitted to be shown in the Approval report. See Appendix C for further explanation and examples.
- 3.2.6 Default values shall be permitted to be shown for the F and T ratings. The default rating for the F rating shall be the T_{FM} rating. The default value for the T rating shall be 0.

3.3 Fire Tests and Ratings – Joint Systems

- 3.3.1 All joint systems that are an extension of a wall shall be subjected to a fire resistance and hose stream test conducted in accordance with ASTM E1966, “Standard Test Method for Fire Resistive Joint Systems”. If successful, the assembly will be assigned an Assembly Rating based on the time period in which it successfully met the performance criteria. Floor-to-floor and floor-to-wall joint systems shall also be subjected to the same fire test but are not required to be subjected to a hose stream test.
- 3.3.2 Other test methods deemed equivalent by FM Approvals shall be permitted to be used in place of the above referenced test method. When other test methods are used and the assembly successfully passes the fire resistance test and the hose stream test, the other rating designations normally determined by the other test method shall be permitted to be shown in the Approval report. See Appendix C for further explanation and examples.

3.4 Movement And Cycling Tests – Joint Systems

- 3.4.1 All joint systems shall be subjected to a cycling test conducted in accordance with ASTM E 1966, Standard Test Method for Fire Resistive Joint Systems, prior to the fire resistance and hose stream test.
- 3.4.2 Three (3) movement ratings shall be available, Type 1, Type 2 and Type 3. A specific sample shall be permitted to be subjected to more than one (1) cycle test and qualify for more than one (1) movement category.

3.5 Water Leakage Rating

- 3.5.1 All penetration seals shall be eligible for a water leakage rating.
- 3.5.2 This rating may be useful for buildings that are under construction where the upper floor(s) are not closed in from the exterior environment while work is progressing on lower floors.
- 3.5.3 This rating may be useful in buildings where the floors are subjected to accidental standing water. This situation could arise from the discharge of sprinkler water, whether accidental or in suppressing a fire. In these cases, the chance of water leaking thorough to lower floors and causing unintended damage is minimized if not prevented.

- 3.5.4 In order to qualify for this rating, assemblies shall be installed in a simulated concrete floor, subjected to a series of environmental conditioning tests and then subjected to a water leakage test using a static column of water. For details, see FM Approvals Through Penetration Water Leakage Test Procedure.

3.6 Rapid Rise Fire Test Ratings

- 3.6.1 As an alternative to the fire resistance tests specified above in Paragraphs 3.2 and 3.3, the through penetration or joint system shall be permitted to be subjected to a rapid rise fire exposure. The rapid rise fire exposure shall simulate a hydrocarbon pool fire.
- 3.6.2 All acceptance criteria shall be as indicated above for the particular type of fire stop system and category of Approval. In such cases, the published listing shall indicate that the assembly has been subjected to an alternate, but more severe, fire exposure.
- 3.6.3 Through Penetrations and Joint Systems
- 3.6.3.1 In order to qualify as a through penetration or joint system, the assembly shall be subjected to the time/temperature requirements shown in ASTM E1529, "Standard Test Methods for Determining Effects of Large Hydrocarbon Pool Fires on Structural Members and Assemblies".
- 3.6.3.2 Other test methods deemed equivalent by FM Approvals shall be permitted to be used in place of the above referenced test method. When other test methods are used and the assembly successfully passes the fire resistance test, the other rating designations normally determined by the test method being used shall be permitted to be shown in the Approval report. See Appendix C for further explanation and examples.

3.7 Membrane Penetrations In Fire Rated Assemblies

- 3.7.1 This category addresses openings in fire rated assemblies where only one side of the fire rated barrier is penetrated and where the integrity of the wall or floor needs to be maintained. This would include items such as, but not be limited to, electrical outlet boxes and other electrical devices.
- 3.7.2 Membrane elements in wall and floor assemblies shall be tested in accordance with ASTM E119, "Standard Test Methods for Fire Tests for Building Construction and Materials". A hose stream test shall not be required.
- 3.7.3 Membrane penetrations shall be permitted to be installed on both sides of the wall (or floor). If more than one (1) membrane penetration is installed in the test assembly, the vertical and/or horizontal distance separating them shall be the minimum separating distance shown in any resulting listing.
- 3.7.4 Thermocouples shall be placed on the unexposed side of the test assembly as follows:
- a. on any toggle switches or receptacles, as applicable.
 - b. on the centerline of each faceplate no more than 1 inch (25 mm) from the top (or bottom) of the faceplate.
 - c. on the wall (or floor), 6 in. (150 mm) above the periphery of the face plate.
 - d. when the membrane penetration is on the exposed side of the test assembly, a thermocouple shall be located on the unexposed side, centered over the exposed item.
 - e. at the approximate center of the wall (or floor).

3.8 Markings

3.8.1 Marking on the product or the label accompanying the product, shall include the following information:

- name and address of the manufacturer or marking traceable to the manufacturer;
- model number or designation and applicable ratings, as appropriate;
- test method used to qualify the product if other than those referenced in this document.

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

3.8.3 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.

3.8.4 All markings shall be legible and durable.

3.9 Manufacturer's Installation Instructions

The manufacturer shall provide the user with instructions for the installation of the product.

3.10 Calibration

All examinations and tests performed in evaluation to this Standard shall use calibrated measuring instruments traceable and certified to acceptable national standards.

3.11 Installation

3.12.1 In order to ensure that the firestopping systems Approved using this standard are properly installed, they should be installed by an Approved Firestop Contractor in accordance with FM Approvals Standard 4991, Approval of Firestop Contractors and in accordance with FM Global Loss Prevention Data Sheets.

3.1.2.2 After installation, all firestopping should be inspected in accordance with ASTM E2174, "Standard Practice for On-Site Inspection of Installed Fire Stops" or ASTM E2393, "Standard Practice for On-Site Inspection of Installed Fire Resistive Joint Systems and Perimeter Fire Barriers".

4. PERFORMANCE REQUIREMENTS

4.1 Fire Resistance Test – Through Penetrations

4.1.1 Requirement

Through penetrations submitted for Approval shall be evaluated for their ability to prevent the passage of flame through or around openings in fire rated walls and floor/ceiling assemblies and for their ability to limit the transmission of heat through the assembly. In addition, no openings shall develop that permit a projection of water beyond the unexposed surface during the hose stream test.

4.1.2 Test/Verification

4.1.2.1 Through penetrations shall be subjected to a fire resistance and hose stream test conducted in accordance with ASTM E814, “Standard Test Method for Fire Tests of Through Penetration Fire Stops” followed by a hose stream test conducted in accordance with ASTM E 2226, “Practice for Application of Hose Stream”. If successful, the assembly will be assigned a fire rating based on the time period in which it successfully met the performance criteria.

4.1.2.2 Through penetrations that are subjected to and meet the criteria of the ASTM E814 fire resistance and hose stream test shall be assigned three (3) separate ratings. One shall be called the *F* rating, one shall be called the T_{FM} rating and a third rating shall be called the *T* rating.

4.1.2.3 The *F* rating shall denote the period of time which the fire stop

- withstood the fire resistance test without developing any openings through which flames can pass
- withstood the fire resistance test without the occurrence of flaming on the unexposed side of the assembly
- during the hose stream test, did not develop any opening that allows the projection of water during the hose stream test from the stream to the unexposed side.

4.1.2.4 The T_{FM} rating shall denote the period of time which the fire stop

- met all the criteria of the *F* rating
- limited the transmission of heat through the assembly, as measured by an individual thermocouple located on the unexposed side of the fire stop material, positioned 1 in. (25 mm) from the penetrating item or at the perimeter of the fire stop, from exceeding a 325°F (181°C) temperature rise above ambient temperature.

4.1.2.5 The *T* rating shall denote the period of time which the fire stop:

- met all the criteria of the *F* rating
- limited the transmission of heat through the assembly, as measured by thermocouples located on the unexposed side of the test assembly as specified in ASTM E814, from exceeding a 325°F (181°C) temperature rise above ambient temperature.

4.1.2.6 Other fire test methods deemed equivalent by FM Approvals shall be permitted to be used in place of the above referenced test method however, in order to obtain FM Approval, the assembly shall be subjected to a hose stream test conducted in accordance with ASTM E 2226, “Practice for Application of Hose Stream” regardless of whether the fire test being used requires the application of a hose stream test upon completion of the fire test. If the assembly successfully meets the criteria of the hose stream test, the assembly will be permitted to show in the ratings normally derived from the fire test method in question in the Approval report. See Appendix C for further explanation and examples.

4.2 Fire Resistance Test – Joint Systems

4.2.1 Requirement

Joint systems submitted for Approval shall be evaluated for their ability to prevent the passage of flame through or around openings in fire rated walls and floor/ceiling assemblies and for their ability to limit the transmission of heat through the assembly.

4.2.2 Test/Verification

Joint systems shall be subjected to a fire resistance and hose stream test, except as noted below, conducted in accordance with ASTM E1966, “Standard Test Method for Fire Resistive Joint Systems” and ASTM E 2226, “Practice for Application of Hose Stream”. Floor-to-floor and floor-to-wall joint systems are not required to be subjected to a hose stream test. If successful, the assembly will be assigned an Assembly Rating based on the time period in which it successfully met the performance criteria. The Assembly Rating shall denote the period of time which the joint system:

- withstood the fire resistance test without developing any openings through which flames can pass
- withstood the occurrence of flaming on the unexposed side of the assembly
- limited the transmission of heat through the assembly of any one thermocouple, as measured by thermocouples located on the unexposed side of the joint system or supporting construction, from exceeding a 325°F (181° C) temperature rise above ambient temperature
- when the joint system being tested is greater than 4 in. (100 mm) in width, limited the average temperature rise of all thermocouples on the unexposed surface of the test sample from exceeding a 250°F (139°C) temperature rise above ambient temperature
- during the hose stream test, if conducted, the joint system did not develop any opening that allowed the projection of water from the stream to the unexposed side
- successfully passed the cotton pad test

4.2.3 Other test methods deemed equivalent by FM Approvals shall be permitted to be used in place of the above referenced test method. See Appendix C for further explanation and examples.

4.3 Movement and Cycling Tests – Joint Systems

4.3.1 Requirement

Joint systems shall be subjected to a movement and cycling test prior to the fire resistance and hose stream test as shown in Paragraph 4.2.

4.3.2 Test/Verification

Joint systems shall be cycled tested in accordance with ASTM E 1966, Standard Test Method for Fire Resistive Joint Systems, prior to the fire resistance and hose stream test as shown in Paragraph 4.2.

Three (3) movement ratings shall be available as shown below. A specific sample shall be permitted to be subjected to more than one (1) cycle test and qualify for more than one (1) movement category.

Movement Type	Minimum Cycling Rate (cpm)	Minimum No. of Movement Cycles
Type 1	1	500
Type 2	10	500
Type 3	30	100

- 4.3.3 Joint systems shall be allowed to be subjected to other movement and cycling regimens that are deemed to be more critical.

4.4 Water Leakage Test (Optional rating)

4.4.1 Requirement

Through penetrations and joint systems are not required to be subjected to a water leakage test however they shall be permitted to be tested if such a rating is desired. The sample being subjected to the water leakage test is not required to be subjected to a fire or movement and cycle test.

4.4.2 Test/Verification

When a water leakage rating is desired, the test shall be conducted in accordance with the FM Approvals Through Penetration Water Leakage Test. No leakage, as evidenced by the presence of water or dye on the indicating medium or on the underside of the test sample, shall be permitted.

The minimum and maximum size of each type of through penetration for which Approval is desired (metal pipe, plastic pipe, cable, cable tray, blank, etc) shall be tested.

4.5 Rapid Rise Fire Tests (Optional rating)

4.5.1 Requirement

Through penetration and joint systems are not required to be subjected to rapid rise fire tests however they shall be permitted to be tested if such a rating is desired.

4.5.2 Test/Verification – Through Penetration or Joint Systems

- 4.5.2.1 When a rapid rise fire test rating is desired for through penetration or joint systems, the assembly shall be subjected to ASTM E1529, “Standard Test Methods for Determining Effects of Large Hydrocarbon Pool Fires on Structural Members and Assemblies.”

- 4.5.2.2 The acceptance criteria for through penetrations or joint systems subjected to ASTM E1529 shall be identical to those shown in Paragraph 4.1 for through penetrations and Paragraph 4.2 for joint systems.

- 4.5.2.3 Other test methods deemed equivalent by FM Approvals shall be permitted to be used in place of the above referenced test method

4.6 Membrane Penetration Fire Tests

4.6.1 Requirement

All membrane penetration assemblies and devices submitted for Approval shall be evaluated for their ability to prevent the passage of flame through or around openings in fire rated walls and floor/ceiling assemblies and for their ability to limit the transmission of heat through the assembly.

4.6.2 Test/Verification

Membrane elements in wall and floor assemblies shall be tested in accordance with ASTM E119, "Standard Test Methods for Fire Tests for Building Construction and Materials". The acceptance criteria shall be as follows:

- a. The temperature measured by individual thermocouples located on the unexposed side of the assembly, positioned as described in Paragraph 3.7.4, shall not exceed a 325°F (181°C) temperature rise above ambient temperature.

The average the average temperature measured by thermocouples on the unexposed surface and located as described in Paragraph 3.7.4 shall not exceed a 250°F (139°C) rise above ambient temperature.

Fire shall not propagate to the unexposed side of the test assembly nor shall any visible flaming be observed on the unexposed side of the assembly.

A hose stream test is not required to be conducted.

5. OPERATIONS REQUIREMENTS

A quality assurance program is required to assure that subsequent through penetration and joint system assemblies produced by the manufacturer shall present the same quality and reliability as the specific products 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, 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 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 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.

APPENDIX A: UNITS OF MEASUREMENT

LENGTH:	in. - "inches"; (mm - "millimeters") $\text{mm} = \text{in.} \times 25.4$ ft - "feet"; (m - "meters") $\text{m} = \text{ft} \times 0.3048$
AREA:	in^2 - "square inches"; (mm^2 - "square millimeters") $\text{mm}^2 = \text{in}^2 \times 6.4516 \times 10^2$ ft^2 - "square feet"; (m^2 - "square meters") $\text{m}^2 = \text{ft}^2 \times 0.0929$
MASS:	lb - "pounds"; (kg - "kilograms") $\text{kg} = \text{lb} \times 0.454$
PRESSURE:	psi - "pounds per square inch"; (bar - "bar") $\text{kPa} = \text{psi} \times 6.895$ bar - "bar"; (kPa - "kilopascals") $\text{bar} = \text{kPa} \times 0.01$ $\text{bar} = \text{psi} \times 0.06895$
TEMPERATURE:	$^{\circ}\text{F}$ - "degrees Fahrenheit"; ($^{\circ}\text{C}$ - "degrees Celsius") $^{\circ}\text{C} = (^{\circ}\text{F} - 32) \times 0.556$

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: FURTHER EXPLANATION AND EXAMPLES OF ALTERNATE FIRE TESTS

C-1 Introduction

- C-1.1** The purpose of this Appendix is to provide some further explanation of the intent of this standard, how it is meant to be used and interpreted and some examples of test methods that can be used.
- C-1.2** There are a number of test methods in existence that are used throughout the world to qualify firestopping. These test methods are comparable to one another in the intent of what they are trying to accomplish however the test procedures are different from one another. They use a similar fire exposure but the description of the test furnace and thermocouples used in the test do vary. Some test methods require a hose stream test, some do not and others allow it to be optional. The criteria and terminology used to assess the performance criteria can also be different.
- C-1.3** To further complicate matters, many local authorities and codes require specific test methods be used. This is normally done on a country by country basis so that what is acceptable in the US is not acceptable in Europe and vice versa. The most obvious difference in test methods is the issue of a hose stream test. Some jurisdictions require it and others do not.
- C-1.4** Because FM Global does business all over the world, it is important that our loss prevention recommendations be consistent throughout the world and not have one set of criteria in one country and another set of criteria for another country. Because of the territorial nature of fire resistance testing, this makes it particularly difficult to be consistent in each part of the world and also satisfy local code requirements at the same time.

C-2 Base-Line Test Methods and Ratings

- C-2.1** The Approval of these products will be addressed by requiring the use of ASTM test methods as the base line test methods, acceptance criteria and ratings.
- C-2.2** While this works well for areas that adopt US test methods, it does little for companies that do business in places such as Canada, Europe, Australia or Asia where different criteria are in effect.
- C-2.3** In addressing this, it was felt that the actual fire test exposures used in various parts of the world are consistent with one another and that the biggest difference was the requirement for the hose stream test, or lack of a requirement for a hose stream test. As a result, the decision was made that many of the fire exposure tests have a heating regime similar to ASTM E814 and that if a hose stream test was applied after the fire test, the results may be comparable.
- C-2.4** It was felt that as long as the test assembly could meet these criteria, it would also be acceptable to allow manufacturer's to include, as optional ratings, the actual ratings determined by the specific test method. This was done so that the test assembly could satisfy both the FM Approval requirements and also qualify for local code requirements in place in each respective country.

C-3 Examples**C-3.1 Canadian Test Standards – Through Penetration**

C-3.1.1 In order to qualify through penetrations in Canada, through penetrations are subjected to a fire resistance test conducted in accordance with CAN/ULC-S115, “Standard Test Method for Fire Tests of Firestop Systems”. The test method is essentially the same as ASTM E814 except that CAN/ULC-S115 allows the hose stream to be optional. It also has two (2) additional ratings that are not shown in ASTM E814. These two (2) additional ratings do not require the hose stream test to be conducted.

C-3.1.2 When tested per CAN/ULC-S115, “Standard Test Method for Fire Tests of Firestop Systems” fire resistance and hose stream test, the assembly is eligible to be assigned a fire rating based on the time period in which it successfully met the performance criteria. The ratings available are shown below.

- a. The FH rating in CAN/ULC-S115 denotes the period of time which the fire stop withstood the fire resistance test without developing any openings through which flames can pass or the occurrence of flaming on the unexposed side of the assembly. In addition, during the hose stream test, the fire stop shall not develop any opening that allows the projection of water from the stream to the unexposed side.
- b. The FTH rating in CAN/ULC-S115 shall denote the period of time which the fire stop met all the criteria of the FH rating and in addition, the transmission of heat through the assembly during the rating period shall not raise the temperature of any individual thermocouple on the unexposed surface of the fire stop or the penetrating item more than 325°F (181°C) above ambient temperature.

C-3.1.3 When tested in accordance with CAN/ULC-S115, the following correlation between ratings is established.

- a) The F rating in ASTM E814 = the FH rating in CAN/ULC-S115.
- b) The T rating in ASTM E814 = the FTH rating in CAN/ULC-S115.

C-3.1.4 When tested in accordance with CAN/ULC-S115, an additional thermocouple must be placed on the test assembly in order to determine the T_{FM} rating.

C-3.1.5 CAN/ULC-S115 also has ratings identified as the FNH and the FT ratings. These ratings denote the period of time which the test assembly withstood the fire resistance test without developing any openings through which flames can pass or the occurrence of flaming on the unexposed side of the assembly however the hose stream test is not required to be conducted. No Approval listing for the FNH and FT ratings will be granted, however these ratings shall be permitted to be shown in the Approval report.

C-3.2 European Test Methods – Through Penetrations

C-3.2.1 In order to qualify as a through penetration in Europe, all through penetrations are subjected to a fire resistance test conducted in accordance with EN 1363-1, “Fire Resistance Tests – Part 1: General Requirements and EN 1366-3, “Fire Resistance Tests for Service Installations – Part 3: Penetration Seals”. A hose stream test is not part of the test method. If successful, the assembly is assigned two (2) separate ratings. One shall be called the Integrity rating and the other shall be called the Insulation rating.

- a. The Integrity rating is the time the test specimen continues to maintain its separating function during the test without either:
 - causing ignition of the cotton pad
 - permitting the penetration of a gap gauge
 - resulting in sustained flaming on the unexposed face

- b. The limit for the Insulation rating shall be deemed to have occurred when the temperature recorded at any position on the unexposed face, either by a fixed thermocouple or by the roving thermocouple, is in excess of 180° C (324°F) above the initial mean exposed face temperature;
- C-3.2.2** When tested in accordance with the EN standards referenced above, the following correlation between ratings is established.
- a) The F rating in ASTM E814 is similar to the Integrity rating available in the EN standards
 - b) The T rating in ASTM E814 is similar to the Insulation rating available in the EN Standards
- C-3.2.3** When determining the F, T_{FM} and T values for the FM Approval rating, the ignition of the cotton pad and the use of the gap gauge is not required. In addition, the following the fire resistance test, a hose stream test, conducted in accordance with ASTM E2226 shall be required.
- C-3.2.4** When tested in accordance with the EN standards referenced above, an additional thermocouple must be placed on the test assembly in order to determine the T_{FM} rating.
- C-3.2.5** No Approval listing for the Integrity or the Insulation ratings will be granted, however these ratings shall be permitted to be shown in the Approval report.
- C-3.3 Canadian Test Standards – Joint Systems**
- C-3.3.1** In order to qualify joint systems in Canada, joint systems are subjected to a fire resistance conducted in accordance with CAN/ULC-S115, “Standard Test Method for Fire Tests of Firestop Systems”. The test method is essentially the same as ASTM E 1966 except that CAN/ULC-S115 allows the hose stream to be optional. It also has two (2) additional ratings that are not shown in ASTM E814. These two (2) additional ratings do not require the hose stream test to be conducted.
- C-3.3.2** When tested per CAN/ULC-S115, “Standard Test Method for Fire Tests of Firestop Systems” fire resistance and hose stream test, the assembly is eligible to be assigned a fire rating based on the time period in which it successfully met the performance criteria. The ratings available are shown below.
- a. The FH rating in CAN/ULC-S115 denotes the period of time which the joint system withstood the fire resistance test without developing any openings through which flames can pass or the occurrence of flaming on the unexposed side of the assembly. In addition, during the hose stream test, the joint system shall not develop any opening that allows the projection of water from the stream to the unexposed side.
 - c. The FTH rating in CAN/ULC-S115 shall denote the period of time which the joint system met all the criteria of the FH rating and in addition, the transmission of heat through the assembly during the rating period shall not raise the temperature of any individual thermocouple on the unexposed surface of the joint system more than 325°F (181°C) above ambient temperature.
- C-3.3.3** When tested in accordance with CAN/ULC-S115, the FTH rating shall be considered equivalent to the Assembly rating in ASTM E1996.

C-3.4 European Test Methods – Joint Systems

C-3.4.1 In order to qualify as a joint system in Europe, all joint systems shall be subjected to a fire resistance test conducted in accordance with EN 1363-1, “Fire Resistance Tests – Part 1: General Requirements and EN 1366-4, “Fire Resistance Tests for Service Installations – Part 4: Linear Joint Seals”. If successful, the assembly will be assigned two (2) separate ratings. One shall be called the Integrity rating and the other shall be called the Insulation rating.

- a. The Integrity rating shall be the time the test specimen continues to maintain its separating function during the test without either
 - causing ignition of the cotton pad
 - resulting in sustained flaming on the unexposed face
- b. The limit for the Insulation rating shall be deemed to have occurred when the temperature recorded at any position on the unexposed face, either by a fixed thermocouple or by the roving thermocouple is in excess of 180° C (324°F) above the initial mean exposed face temperature;

C-3.4.2 When tested in accordance with EN Standards, the Assembly rating shall be deemed to have occurred when any of the following criteria occurs

- withstood the fire resistance test without developing any openings through which flames can pass
- withstood the occurrence of flaming on the unexposed side of the assembly
- limited the transmission of heat through the assembly of any one thermocouple, as measured by thermocouples located on the unexposed side of the joint system or supporting construction, from exceeding a 325°F (181° C) temperature rise above ambient temperature
- when the joint system being tested is greater than 4 in. (100 mm) in width, limited the average temperature rise of all thermocouples on the unexposed surface of the test sample from exceeding a 250°F (139°C) temperature rise above ambient temperature
- during the hose stream test, if conducted, the joint system did not develop any opening that allowed the projection of water from the stream to the unexposed side
- successfully passed the cotton pad test

C-3.5 This Appendix contains guidelines on other fire test methods that can be used as the basis for obtaining FM Approval. The list of standards shown in this Appendix is not a complete list. Other fire test methods, deemed equivalent by FM Approvals, shall be permitted to be used at the discretion of FM Approvals. All such other tests shall be followed by a hose stream test conducted in accordance with ASTM E 1996.

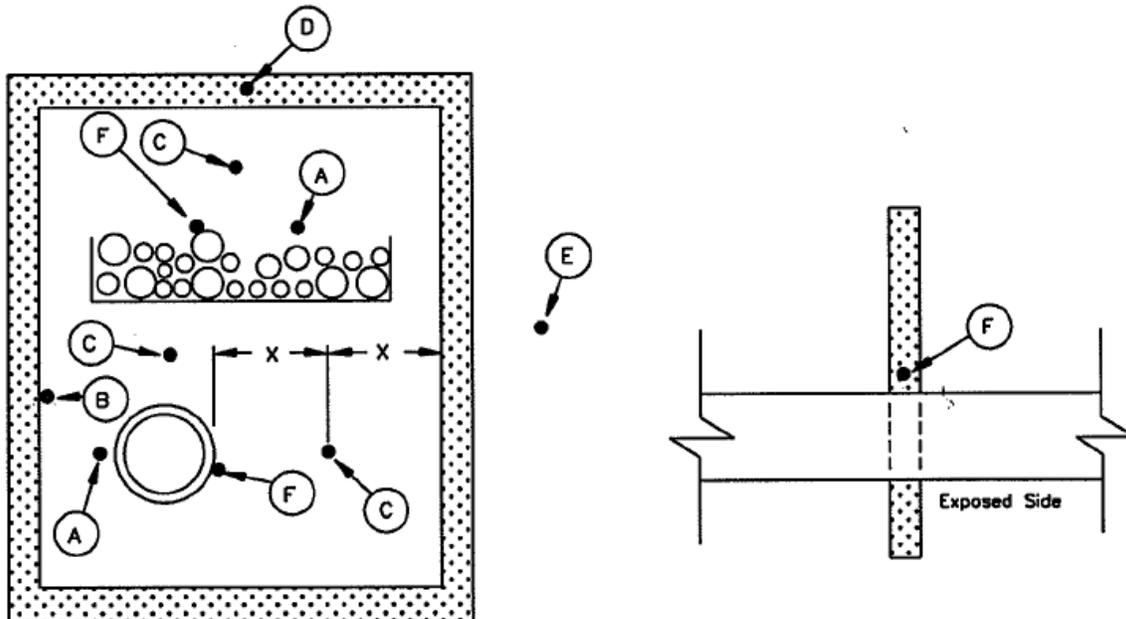
APPENDIX D: GUIDANCE ON THERMOCOUPLE PLACEMENT

D-1 INTRODUCTION

- D-1.1** This Approval Standard provides information of the baseline fire resistance test, ASTM E814, that is used as the basis for obtaining Approvals. As noted elsewhere, these other standards are similar yet different.
- D-1.2** Some of the differences in the test methods has to do with the type of thermocouples being used and their placement.
- D-1.3** Below is a general description of the thermocouple placement for those not familiar with ASTM E814. For a full description, see ASTM E814.

D-2 THERMOCOUPLES

Figure D-2
Thermocouple Measurement Locations



- D-2.1** The thermocouple placement for tests conducted in accordance shall be as shown in Figure D-2 and as described as follows:

- A** At a point on the surface of the firestop 1 in (25 mm) max from one through penetrating item for each type of penetrating item employed in the fire of the firestop. If the grouping of the penetrating items through the test sample prohibits placement of the thermocouple pad, the thermocouple shall not be required. Location A thermocouples are used to determine the T_{FM} rating.
- B** At a point on the firestop surface at the periphery of the firestop.
- C** At a minimum of three (3) points on the firestop surface approximately equidistant from a penetrating item, or group of penetrating items in the field of the firestop and the periphery.

- D At one point on any frame that is installed about the perimeter of the opening.
 - E At one point on the unexposed surface of the wall or floor that is a minimum of 12 in (300 mm) from any opening
 - F At one point on each type of through penetrating item. If the through penetrating item is insulated or coated on the unexposed side, the thermocouple shall be located on the exterior surface of the insulation or coating. If the coating or insulation does not extend the full length of the penetrating item on the unexposed side, an additional thermocouple shall be installed on the penetrating item 1 in (25 mm) beyond the termination of the insulation or coating.
- D-2.2** Measure the temperatures of each type and size of through penetrating item with at least one (1) thermocouple located 1 in (25 mm) from the unexposed surface of the firestop material. The thermocouple bead shall be held firmly against the penetrating item. The thermocouple leads shall not be heavier than No. 22 AWG [0.025 in (0.635 mm)] and shall be electrically insulated with a heat resistant and moisture resistant pad. The pads shall be held firmly against the penetrating item and shall fit closely about the thermocouple.

APPENDIX E: GUIDANCE ON THE HOSE STREAM TEST

E-1 INTRODUCTION

- E-1.1** This Approval Standard provides information of the hose stream test required to be conducted upon conclusion of the fire resistance test. As noted elsewhere, these other standards are similar yet different.
- E-1.2** Below is a general description of the hose stream test for those not familiar with ASTM E 2226. For a full description, see ASTM E 2226.

E-2 TEST EQUIPMENT

- E-2.1** The hose stream shall be delivered through a 2-1/2 in (63.5 mm) hose and discharge through a National Standard playpipe of corresponding size equipped with a 1-1/8 in discharge tip of the standard taper, smooth bore pattern without a shoulder at the orifice. The water pressure and duration of application shall be as specified in Table E-1.
- E-2.2** Position the nozzle orifice no more than 20 ft (6.1 m) from the center of the exposed surface of the test assembly so that when directed at the center, its axis is normal to the surface of the test assembly.
- E-2.2.1** When the nozzle is unable to be so located, locate it on a line deviating not more than 30° from the line normal to the center of the test assembly. When so located, its distance from the center of the test assembly is to be less than 20 ft (6.1 m) by an amount equal to 1 ± 0.02 ft (305 ± 6.4 mm) for each 10° of deviation from the normal.

E-3 CONDUCT OF TEST

- E-3.1** Immediately after the fire exposure, the test assembly shall be subjected to the impact, erosion and cooling effects of the hose stream.
- E-3.2** Adjust the hose stream to the specified pressure. During adjustment, the hose stream shall not come in contact with the test assembly.
- E-3.3** Direct the hose stream 1st at the bottom and then at all parts of the exposed surface, making changes in direction slowly. Keep the hose stream moving across the test assembly. Do not concentrate, make directional changes or stop the hose stream on any point on the test assembly. Changes in direction of the hose stream shall be made within 1 ft (305 mm) outside the perimeter edge of the test assembly. The following is a recommended pattern.
- E-3.3.1** Direct the hose stream around the periphery of the test assembly starting upward from either bottom corner.
- E-3.3.2** After the hose stream has covered the periphery, apply the hose stream in vertical paths approximately 1 ft (305 mm) apart until the entire width has been covered.
- E-3.3.3** After the hose stream has covered the width, apply the hose stream in horizontal paths approximately 1 ft (305 mm) apart until the entire height has been covered.
- E-3.3.4** Maintain the hose stream on the test assembly for the duration of the application in s/ft^2 (s/m^2) of exposed area as prescribed in Table E-1.
- E-3.3.5** If the required duration has not been reached and E-3.3.4 is complete, then repeat E-3.3 in reverse.

Pressure and Duration of the Hose Stream Test^{Note 1}

Desired F Rating (minutes)	Water Pressure at Base of Nozzle, psi (kPa)	Duration of Application, s/ft ² (s/m ²) of Exposed Area
240 ≤ F ≤ 480	45 (310)	3.0 (32)
120 ≤ F ≤ 240	30 (210)	1.5 (16)
90 ≤ F ≤ 120	30 (210)	0.9 (9.7)
F < 90	30 (210)	0.6 (6.5)

Note 1 The rectangular area of the wall or floor assembly into which the test assembly is mounted shall be considered as the exposed area since the hose stream must traverse this calculated area during its application.

E-3.4 CONDITIONS OF ACCEPTANCE

E-3.4.1 During the hose stream test, the firestop system shall not develop any opening that would permit a projection of water from the stream beyond the unexposed side.

E-4 DUPLICATE SPECIMEN

E-4.1 The intent of the standard is to subject the test assembly to the impact, erosion and cooling effects of the hose stream test where the assembly had been subjected to a fire exposure test that was one-half the resulting hourly rating but not more than 60 minutes.

E-4.2 Laboratory practice is to conduct the fire test for the full rating period and then subject the test assembly to the hose stream test.

E-4.3 In the event that the test assembly that was exposed to the full duration fire exposure does not pass the hose stream test, the hose stream test is allowed to be conducted on a duplicate specimen.

E-4.4 The duplicate specimen shall be identical to the original specimen. It shall be subjected to a fire resistance test for a period of one half the rating period but not more than 60 minutes. The hose stream test shall be conducted immediately after the duplicate specimen fire test. It shall be conducted as described above. The water pressure and duration of application shall be as specified in Table E-1.