



Member of the FM Global Group

Approval Standard for Seismic Sway Braces for Pipe, Tubing and Conduit

Class Number 1950

September 2013

Copyright © 2013 by FM Approvals LLC. All rights reserved.

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.

Table of Contents

1. INTRODUCTION	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	2
1.8 Applicable Documents	3
1.9 Definitions	3
2. GENERAL INFORMATION	5
2.1 Product Information	5
2.2 Approval Application Requirements	5
2.3 Requirements for Samples for Examination	6
3. GENERAL REQUIREMENTS	6
3.1 Review of Documentation	6
3.2 Physical or Structural Features – Rigid Brace Assemblies	6
3.3 Materials	7
3.4 Markings	7
3.5 Manufacturer's Installation Instructions	8
3.6 Calibration	8
3.7 Tolerances	8
4. PERFORMANCE REQUIREMENTS	9
4.1 Examination	9
4.2 Cyclic Testing (Component Testing)	9
Figure 4.2 Force History Plot (Component Testing)	10
4.3 Cyclic Tests (Assembly Testing)	10
Table 4.3 Limiting Horizontal Deformation for Different Brace Orientations	11
Figure 4.3.2 Test Arrangement for Assembly Testing	12
Figure 4.3.2.3 Force History Plot (Assembly Testing)	12
4.4 Test Procedure	13
4.5 Additional Tests	13
5. OPERATIONS REQUIREMENTS	13
5.1 Demonstrated Quality Control Program	13
5.2 Surveillance Audit Program	15
5.3 Manufacturer's Responsibilities	15
5.4 Manufacturing and Production Tests	15
APPENDIX A: Units of Measurement	17
APPENDIX B: FM Approvals Certification Marks	18
APPENDIX C: Sample Listing	20
APPENDIX D: Tolerances	22

1. INTRODUCTION

1.1 Purpose

- 1.1.1 This standard states Approval criteria for rigid seismic sway brace components and assemblies for pipe, tubing and conduit.
- 1.1.2 FM 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 surveillance audit program.

1.2 Scope

- 1.2.1 This standard encompasses the design and performance requirements for seismic sway bracing components used to brace pipe, tubing and conduit.
- 1.2.2 For rigid seismic sway braces, the general requirements for seismic sway bracing components apply to the components that are attached to the structural element and the components that are attached to the pipe, tube or conduit. Although used in testing, the brace member that is attached between the building-attached component and the piping-attached component is used in testing, but not included within the scope of the standard.
- 1.2.3 The evaluation of building-attached components is based on the premise that the component would either break, or deform in excess of the allowed limits, prior to either the failure of the attachment fastener, or the deflection of the structural member (e.g. beam). Therefore, the attachment fastener and structural members are not considered to be within the scope of this Approval Standard.
- 1.2.4 The evaluation of piping-attached components is based on the premise that the component would break, deform in excess of allowed limits, or lose its grip on the pipe.
- 1.2.5 Seismic sway brace components are designed to attach to pipe, tubing or conduit from Nominal Pipe Size (NPS) 1 to 12 inch (DN25 – 300).
- 1.2.6 In the case of rigid seismic sway brace assemblies, the general requirements and performance requirements apply to the entire assemblies.
- 1.2.7 Approval standards are intended to verify that the product described will meet stated conditions of performance, safety, and quality useful to the ends of property conservation.

1.3 Basis for Requirements

- 1.3.1 The requirements of this standard are based on experience, research and testing, and/or the standards of other organizations. The advice of manufacturers, users, trade associations, jurisdictions, and/or loss control specialists was also considered. The underlying details and assumptions that define the basis for the research and development of this Approval standard are contained in the Earthquake Spectra article *Test protocol for sprinkler-pipe seismic-brace components*, as listed in Section 1.8 of this standard.
- 1.3.2 The requirements of this standard reflect tests and practices used to examine characteristics of seismic sway bracing components and assemblies for the purpose of obtaining Approval. Seismic sway bracing components and assemblies 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, seismic sway bracing components and assemblies that meet all of 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 initial audit shall be conducted to evaluate the manufacturer's ability to consistently produce the product that was examined and tested as part of the Approval project. The audit shall review the facility and in-place quality control procedures used in the manufacturing of the product. Typically, areas of review are incoming inspection, work in progress, production testing, final quality control, marking, calibration of equipment, shipping procedures, and document and drawing control. These examinations are repeated periodically as part of the FM Approvals Surveillance Audit program. (Refer to Section 5.2, Surveillance Audit Program)

1.5 Basis for Continued Approval

1.5.1 Continued Approval is based upon:

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

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

1.6 Effective Date

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

The effective date of this standard is **December 31, 2013** for compliance with all requirements.

1.7 System of Units

Units of measurement used in this standard are United States (U.S.) customary units. These are followed by their arithmetic equivalents in International System (SI) units, enclosed in parentheses. The first value stated shall be regarded as the requirement. The converted equivalent value may be approximate. Appendix A lists the selected units and conversions to SI units for measures appearing in this standard. Conversion of U.S. customary units is in accordance with the Institute of Electrical and Electronics Engineers (IEEE)/American Society for Testing Materials (ASTM) SI 10-2002, *American National 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 or are beneficial in understanding this standard:

American Society of Mechanical Engineers, ASTM International, West Conshohocken, PA, 2003, DOI: 10.1520/C0033-03A, www.astm.org
ASTM A153/A153M - 09, *Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware*
ASME B36.10M-2004, *Welded and Seamless Wrought Steel Pipe*
ASTM B633-98, *Standard Specification for Electrodeposited Coatings of Zinc on Iron or Steel*
ASTM SI10 - 2002, *IEEE/ASTM SI 10 American National Standard for Use of the International System of Units (SI): The Modern Metric System*

FM Global, Corporate Offices, 270 Central Avenue, Johnston, RI 02919, www.fmglobal.com
P. K. Malhotra, Paul Senseny, Antonio Braga and Roger Allard, "Test protocol for sprinkler-pipe seismic-brace components," *Earthquake Spectra*, Volume 19, No 1, pp 87-109, February 2003.
FM Global Property Loss Prevention Data Sheets

International Organization for Standardization (ISO), 1, ch. de la Voie-Creuse, Case postale 56, CH-1211 Geneva 20, Switzerland, www.iso.org
ISO 17025 (2005), *General Requirements for the Competence of Testing and Calibration Laboratories*

Occupational Safety & Health Administration (OSHA), 200 Constitution Avenue, NW, Washington, DC 20210, www.osha.gov
OSHA Code of Federal Regulations 29 CFR part 1910, *Occupational Safety and Health Standards*
OSHA Directive Number CPL1-03 titled: NRTL Program Policies, Procedures and Guidelines

1.9 Definitions

For purposes of this standard, the following terms apply:

Accepted

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

Attachment Fastener

The fastener used to connect the building-attached component to the structural member.

Brace Member

This is the component between the structural attached component and the piping attached component. This is usually made from steel pipe, strip steel, angle steel, strut, etc. For the purposes of this standard, the brace member is considered rigid.

Conduit

For the purposes of this standard conduit refers to the product being braced; that is, pipe, tubing or conduit.

Connection Components

For rigid style seismic sway braces, this term refers to a rigid member, usually a length of pipe, angle iron, or strut that connects the building-attached component to the piping-attached component.

Corrosion Resistant

Having resistance to corrosion equal to or exceeding that of carbon steel coated per electro-deposit process with zinc coating thickness of a minimum of 5 μm .

FM Approvals Certification Mark

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

FM Approved

This term refers to products FM Approved by FM Approvals. Such products are listed in the Approval Guide, an on-line resource of FM Approvals. All products so listed have been successfully examined by FM Approvals, and their manufacturers have signed and returned a Master Agreement to FM Approvals. These forms obligate the manufacturer to allow re-examination of the product and surveillance audit at FM Approval's discretion. It further requires the manufacturer not to deviate from the FM Approved configuration of the product without review by and agreement of FM Approvals.

Lightwall Pipe

Lightwall pipe is characterized by having a combination of outside diameter and wall thickness not suitable for cut grooving or threading. Lightwall pipe shares the same outside diameter dimensions as Schedule 40 pipe, however the wall thickness of Lightwall pipe ranges between that of Schedule 5 and 10 and can vary from manufacturer to manufacturer. The normal end connections for Lightwall pipe are: welded, roll grooved, and plain end. This pipe is also commonly referred to in industry as "Flow" pipe or "Schedule 7" pipe. There is no national or international standard for this product at this time.

Pipe

For the purposes of this standard Pipe and/or Piping refers to the product being braced; that is pipe, tubing or conduit.

Rod Stiffener

This term refers to a product that is attached directly to the all-thread hanger rod in order to provide an increased measure of resistance to buckling when subjected to axial compressive loading.

Schedule 40 Pipe

Schedule 40 pipe refers to a historically accepted combination of outside diameter and wall thickness that has been subsequently published in national standard ASME B36.10M-2004. Other national and international standards also make reference to Schedule 40 pipe but may or may not reflect the same dimensions for a given nominal pipe size. Approved end connections are threaded, welded, rolled or cut groove, or plain end.

Schedule 30 Pipe

Schedule 30 pipe refers to a historically accepted combination of outside diameter and wall thickness that has been subsequently published in national standard ASME B36.10M-2004. Other national and international standards also make reference to Schedule 30 pipe but may or may not reflect the same dimensions for a given nominal pipe size. Approved end connections are welded, rolled groove, or plain end.

Schedule 10 Pipe

Schedule 10 pipe refers to a historically accepted combination of outside diameter and wall thickness that has been subsequently published in national standard ASME B36.10M-2004. Other national and international standards also make reference to Schedule 10 pipe but may or may not reflect the same dimensions for a given nominal pipe size. Approved end connections are welded, rolled groove, or plain end.

Schedule 5 Pipe

Schedule 5 pipe refers to a historically accepted combination of outside diameter and wall thickness that has been subsequently published in national standard ASME B36.10M-2004. Other national and international standards also make reference to Schedule 5 pipe but may or may not reflect the same dimensions for a given nominal pipe size. Approved end connections are welded, roll grooved, mechanically swaged fittings.

Seismic Sway Brace – Rigid Brace Style

An assembly consisting of three components (as described below) intended to minimize the differential movement between the sprinkler system piping and the structure, to which it is attached, during an earthquake.

Building-Attached Component

A component of a seismic sway brace intended to provide a means of attachment to a structural element of a building.

Piping-Attached Component

A component of a seismic sway brace intended to provide a means of attachment to the pipe, tube or conduit.

Seismic Sway Brace – Two-Way Brace and Four-Way Brace

For risers and overhead sprinkler piping, there are two sway bracing designs; two-way and four-way. Two-way braces are designed to resist either longitudinal or lateral movement with respect to the axis of the pipe. Lateral movement is normal to longitudinal movement and is generally regarded as horizontal. Four-way sway bracing resists differential movement in all horizontal directions.

Tubing

For the purposes of this standard tubing refers to the product being braced; that is pipe, tubing or conduit.

2. GENERAL INFORMATION

2.1 Product Information

- 2.1.1 Seismic sway bracing is used to minimize the differential movement between the product being braced (pipe, tubing or conduit) and the structure to which it is attached during an earthquake. For risers and overhead piping, there are two sway bracing designs; two-way and four-way. Two-way braces are designed to resist either longitudinal or lateral movement with respect to the axis of the pipe. Lateral movement is normal to longitudinal movement and is generally regarded as horizontal. Four-way sway bracing resists differential movement in all horizontal directions.
- 2.1.2 In order to meet the intent of this standard, seismic sway brace components must be examined on a model-by-model, type-by-type, manufacturer-by-manufacturer, and plant-by-plant basis. This is predicated on the basis that identical designs, fabricated in identical materials by different manufacturers or, even by different plants of the same manufacturer, have been observed to perform differently in testing. Sample seismic sway brace components, selected in conformance to this criterion, shall satisfy all of the requirements of this standard.

2.2 Approval Application Requirements

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

Fire Protection Group Manager
FM Approvals Hydraulics Laboratory
743A Reynolds Road
West Glocester, RI 02814 U.S.A.

- 2.2.2 The manufacturer shall provide the following preliminary information with any request for Approval consideration:
- A complete list of all models, and sizes, for the products or services being submitted for Approval consideration;
 - Products and sizes to be braced, including reference to the industry standard to which the product is to be manufactured, – For example, Schedule 10 pipe in sizes 4, 6, 8 inch NPS, or Lightwall pipe and tubing in 4 inch (DN100) nominal sizes;
 - Brace member types and thicknesses, (i.e. Schd 40 pipe, strut, angle, flats, etc.);