



Approval Standard for Rack Storage Flue Spacers

Class Number 6917

August 2013

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

This standard states Approval requirements for rack storage flue spacers. Rack storage of combustible commodities creates a substantial hazard and potential for large fires should ignition occur in the storage area due to several issues such as large amounts of fuel that can be concentrated in racks, uninhibited airflow throughout a stable rack array, and the potential for shielding of commodity from overhead sprinklers. Solid shelves inhibit vertical fire growth, promote horizontal fire spread and can prevent sprinkler water from penetrating down through a rack to the fire area. This also limits the pre-wetting of combustibles. Lack of adequate flue spaces within rack storage arrangements can allow a fire to grow in a manner similar to a fire with solid shelves by impeding sprinkler water flow down to the seat of the fire and promoting fire spread to combustibles on adjacent shelves. The generated heat can cause excessive numbers of sprinkler heads to activate which will deplete the fire protection water supply while the fire continues to grow. Once the fire breaks out of the area of origin, it could be too large in intensity for the sprinkler systems to be effective. Presence of inadequate flue spaces within a rack storage arrangement may be considered a fire hazard and, if not properly addressed, may require special protection such as in-rack sprinklers for potential fire situations.

1.2 Scope

1.2.1 This standard sets the performance requirements of rack storage flue spacers in regards to their ability to maintain a minimum 6 in. (76 mm) wide transverse flue space within a rack structure under various anticipated storage rack loadings. All requirements in this standard shall be met in order for these products to be eligible to receive FM Approvals certification.

1.2.1.1 Two (2) different loading levels have been considered, regular duty and heavy duty.

1.2.2 This standard is intended to evaluate only those hazards investigated and is not intended to determine the suitability for all end use conditions of these products. Conditions under which these products are used vary widely. For example, these materials may be subjected to environments, storage arrangements, and fuel loadings not anticipated by this standard.

1.2.3 This standard does not address the issue of rack storage flue spacers during natural hazard events such as seismic occurrences.

1.2.4 Approval criteria shall include, but are not limited to, performance requirements, marking requirements, an examination of manufacturing facilities, 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 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 The requirements of this standard reflect tests and practices used to examine characteristics of rack storage flue spacers for the purpose of obtaining FM Approval. These requirements are intended primarily as guides and strict conformity is not always mandatory. Rack storage flue spacers

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, rack storage flue spacers 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 for its intended use;
- the proper operation and 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 to evaluate the manufacturer's ability to consistently produce the product as examined and tested, and the marking procedures used to identify the product. These examinations are repeated as part of the FM Approvals' quality control follow-up program.

1.5 Basis for Continued Approval

Continued Approval is based upon:

- production or availability of the product as 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, if deemed necessary, of production samples for continued conformity to requirements; and
- satisfactory Surveillance Audits conducted as part of FM Approvals' product follow-up program.

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

1.6 Effective Date

1.6.1 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 else forfeit Approval. The effective date shall apply to the entire Approval Standard, or, where so indicated, only to specific paragraphs of the standard.

1.6.2 The effective date for compliance with all requirements is January 1, 2014.

1.7 System of Units

Units of measurement 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 value may be the 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 10-97, "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:

FM Global Property Loss Prevention Data Sheet 8-9, *Storage of Class 1, 2, 3, 4, and Plastic Commodities*

FM Approvals Test Procedure, *Strength Test of Rack Storage Flue Spacers*

1.9 Definitions

Flue Spaces - The spaces between rows of storage are called flue spaces. In rack storage, the longitudinal flue spaces are perpendicular to the direction of loading, and transverse flue spaces are parallel to the direction of loading. The figures below illustrate this.

Rack Storage - Storage in racks that use a combination of vertical, horizontal and diagonal members to support stored material. Racks can be either open or solid shelved, and may be fixed in place.

The most commonly encountered forms of rack storage are:

- Single-row racks have no longitudinal flue spaces;
- Double-row racks are two single-row racks placed back to back separated by a longitudinal flue space;
- Multiple-row racks are racks greater than 12 ft (3.6m) wide;

Solid Shelving- Solid shelving is fixed, in-place solid, slatted (fixed or non-fixed) grated (less than 70% open), or other types of shelves located within racks that negatively impact the amount of sprinkler water that can reach the entire vertical length of the rack. Solid shelves in racks promote horizontal fire spread and obstruct sprinkler water penetration down through the racks.

Tier- Each vertical segment of storage within a rack is called a tier.

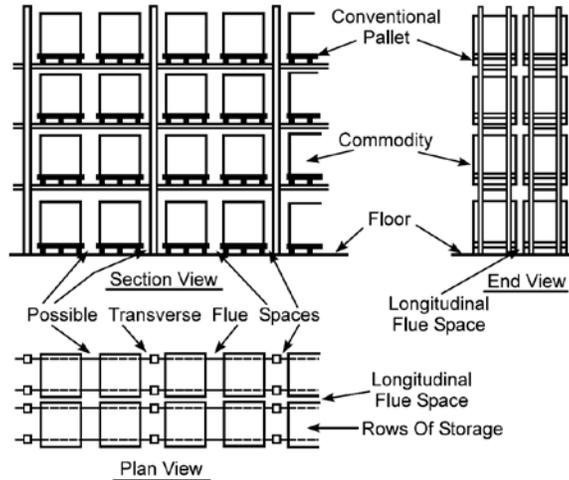


Fig. 1
Typical Double-Row (Back-To-Back) Rack Arrangement

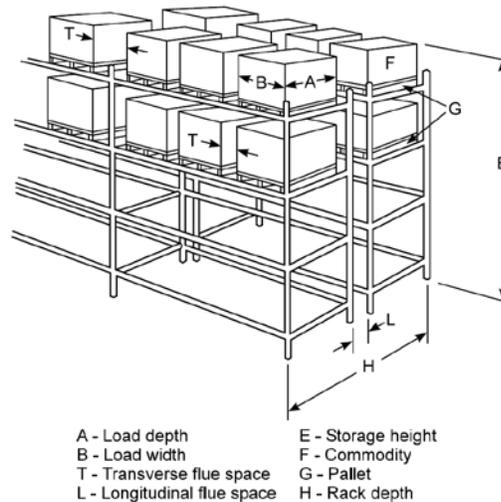


Fig. 2
Open Frame (No Shelving) Double-Row Rack

2 GENERAL INFORMATION

2.1 Product Information

2.1.1 Sprinkler system design relies on adequately maintained aisles and flue spaces. Flue spaces between pallet loads of material stored in racks allow two things to occur. First, flue spaces provide air access to the surfaces of the burning material. Second, flue spaces provide a means for sprinkler water to flow down through the storage array to the seat of the fire and pre-wet adjacent storage.

2.1.1.1 Obstructed flue spaces between pallet loads can prevent penetration of sprinkler water flow down through the rack(s). Once the fire jumps a flue space, there is little resistance to fire spread throughout the adjacent commodities within the rack. Eventually, enough

sprinklers may open to deplete the water supply to a point of ineffectiveness, resulting in an uncontrolled fire.

- 2.1.1.1.1 Often storage requirements and material handling procedures can lead to improperly maintained (blocked) flue spaces within a rack storage arrangement. Additionally, unstable loads of commodities stacked within the racks may lean into and partially block or block flue spaces.

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, brochures, sales literature, specification sheets, installation, operation, 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 Examination

- 2.3.1 Following authorization of an Approval examination, the manufacturer shall submit samples for examination and testing based on the following:
- Sample requirements to be determined by FM Approvals following review of the preliminary information.
- 2.3.2 Requirements for samples may vary depending on design features, results of prior or similar testing, and results of any foregoing tests.
- 2.3.3 The manufacturer shall submit samples representative of production. Any decision to use data generated using prototypes is at the sole discretion of FM Approvals.

2.4 Approval Categories

Approval shall be granted in two (2) categories as shown below:

- 2.4.1 Regular Duty Rack Storage Flue Spacers are intended for storage racks where the anticipated loads on the flue spacer are expected to be the result of storage that is placed in the storage rack by hand.
- 2.4.2 Heavy Duty Rack Storage Flue Spacers are intended for storage racks where the anticipated loads on the flue spacer are expected to be greater than those applied to the Regular Duty Rack Storage Flue Spacers. The greater loads are expected as the result of using a motorized or non-motorized mechanical device, such as a forklift, to place the storage in the storage rack and the mechanical device or pallet load of material impacts the flue spacer.

3 GENERAL REQUIREMENTS

3.1 Review of Documentation

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

3.2 Markings

- 3.2.1 Marking on the product shall include:
- Name and address of the manufacturer or marking traceable to the manufacturer;
 - Date of manufacture or code traceable to date of manufacture or lot identification;
 - Model number, size, rating, capacity, etc. as appropriate.
- 3.2.2 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.
- 3.2.3 The Approval Mark (see Appendix A) shall be displayed visibly and permanently on the product. The manufacturer shall not use this Mark on any other product unless such product is covered by a separate report.
- 3.2.4 All markings shall be legible and durable.

3.3 Manufacturer's Installation Instructions

The manufacturer shall supply 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.

3.4 Calibration

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

4 PERFORMANCE REQUIREMENTS

4.1 Strength Testing of Rack Storage Flue Spacers

4.1.1 All rack storage flue spacers submitted for Approval shall be made of metallic or inorganic materials which are not combustible under normal fire conditions.

4.1.1.1 For each rack flue spacer design submitted for examination, the following product information shall be provided:

- product trade name or designation,
- general description,
- limitations under which product is permitted to be used,
- intended usage and Approval category,
- complete list of all detail drawings, components, raw material suppliers, additives (if applicable), formulations (if applicable), manufacturing procedures, equipment and production requirements, and
- Material Safety Data Sheets (if applicable)

4.1.1.2 At the sole discretion of FM Approvals, production of all samples and the raw materials used to produce the samples submitted for testing shall be witnessed by a representative of FM Approvals.

4.1.1.3 Three (3) samples of each model at each critical length and thickness shall be tested. All three (samples) shall meet the acceptance criteria shown below. If any of the samples fail to meet the criteria, addition tests shall be permitted to be conducted until a total of five (5) consecutive test samples of the prescribed model meet the acceptance criteria.

4.1.2 All rack storage flue spacers submitted for Approval shall be evaluated for their ability to maintain a minimum 6 in. (152 mm) transverse flue space, within the allowances described in 4.1.3 below. The tests shall consist of installing a test specimen in a simulated rack upright and subjecting it to either a 250 lb (113.3 kg) load (for Approval as a Regular Duty Rack Storage Flue Spacer) or a 600 lb (272.5 kg) load (for Approval as a Heavy Duty Rack Storage Flue Spacer) load applied perpendicular to the flue space. Deflection measurements shall be recorded while the flue spacer is subjected to load and after the load has been removed. The tests shall be conducted on the most critical (i.e. weakest material, thinnest gauge, longest length, etc.) rack storage flue spacer for which Approval is desired. Tests shall be conducted in accordance with the FM Approvals Strength Test of Rack Storage Flue Spacers test procedure.

4.1.3 Test/Verification

4.1.3.1 Maximum deflection while the load is applied to the flue spacer shall not exceed 1/4 in. (6.4 mm).

When the permanent deflection (Δ) of a flue spacer exceeds 0.04 in. (1.0 mm), the same sample shall be subjected to nine (9) additional loadings. Upon completion of the additional loadings, the cumulative permanent deflection shall not exceed 1/4 in. (6.4 mm).

4.1.3.2 Flue spacers shall not incorporate any sharp bends or angles. The maximum angle of any bend incorporated into the flue spacer shall be 30°. This angle shall be measured parallel to the length flue spacer from the inside face of the vertical post of the storage rack to which the flue spacer is attached.

4.1.3.3 The flue spacer system shall develop the full flue width within a maximum distance of 6 in. (152 mm) from the face of the vertical post of the storage rack to which it is attached.

4.1.4 For details of the test equipment, test set-up and conduct of the test, refer to the FM Approvals *Strength Test of Rack Storage Flue Spacers* Test Procedure.

5 OPERATIONS REQUIREMENTS

A quality assurance program is required to assure that subsequent rack storage flue spacers 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 Surveillance Audit.
- 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 control guidelines
- incoming assurance, including testing
- in-process assurance, including testing
- final inspection and tests
- equipment calibration
- drawing and change control
- packaging and shipping
- handling and disposition of discrepant 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 not 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, 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 Surveillance Audit

5.2.1 An audit of the product manufacturing facility shall be 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 ensure 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 the 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”)
	mm = in. \times 25.4
	ft – “feet” (m – “meters”)
	m = ft \times 0.3048
Mass	lb = “pounds” (kg – “kilograms”)
	kg = lb \times 0.454

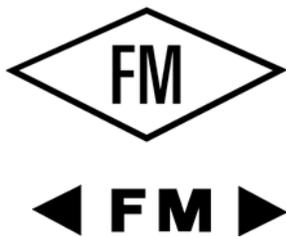
APPENDIX B: FM APPROVALS CERTIFICATION MARKS

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.