

Approval Standard

for

**Flammable and Combustible
Liquid Storage Buildings**

Class Number 6049

August 1991
(Effective Date: August 1, 1992)

Foreword

FM Approvals are 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 FM 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 Approval 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. FM Approval Standards strive to be performance-oriented and to facilitate technological development.

For examining equipment, materials and services, FM 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 Global Technologies LLC reserves the right in its sole judgement to change or revise its standards, criteria, methods, or procedures.

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I INTRODUCTION

1.1 Purpose

This Standard states FM Approval requirements for buildings used to store flammable and combustible liquids. These buildings are Approved for outdoor locations only.

1.2 Scope

- 1.2.1 This Standard sets performance requirements for structures designed to provide a safe, secure storage area for flammable and combustible liquids.
- 1.2.2 These buildings are considered to be portable. Anchoring means are provided to prevent movement or upset under seismic or high wind conditions.
- 1.2.3 Storage buildings fall into two general categories; those with provisions for explosion relief and those without such provisions. Buildings without explosion relief can be Approved for storage of flammable and combustible liquids, except for storage of Class 1A and dispensing of Class 1A and 1B Flammable Liquids, as defined in NFPA 30. Explosion relief is required for buildings that will store and dispense Class 1A and dispense Class 1B liquids.

1.3 Basis for FM Approval

FM Approval is based upon satisfactory evaluation of the building and the manufacturer in the following major areas:

- 1.3.1 Examination and analysis of building construction shall be performed to evaluate:
 - the suitability of the building; and
 - the proper operation and performance of the building as specified by the manufacturer and required by FM Approvals; and, as far as practical,
 - the durability and reliability of the building.
- 1.3.2 If an assembly submitted for Approval incorporates a component for which a separate Approval Standard exists, then that component shall be examined, at minimum, to the extent required by its own Approval Standard. Components already separately Approved which are submitted as part of an assembly to be Approved need only be examined to the extent necessary to assure proper functioning as part of the assembly.
- 1.3.3 An examination of the manufacturing facilities and audit of quality control procedures shall be made to evaluate the manufacturer's ability to produce the building which is examined and tested, and the marking procedures used to identify the building. These examinations are repeated as part of FM Approvals' follow-up program.

1.4 Basis for Continued Approval

Continued Approval is based upon:

- production or availability of the building as currently Approved;
- the continued use of acceptable quality control procedures;
- satisfactory field experience;
- compliance with the terms stipulated in the Approval Agreement; and
- re-examination of production buildings for continued conformity to requirements.

1.5 Basis for Requirements

1.5.1 The requirements of this standard are based on experience, research and testing and/or the standards of other national and international organizations. The advice of manufacturers, users, trade associations and loss control specialists was also considered.

1.5.2 The requirements of this standard reflect tests and practices used to examine characteristics of storage buildings for the purpose of obtaining FM Approval. These requirements are intended primarily as guides, and strict conformity is not always mandatory. Buildings having characteristics not anticipated by this standard may be Approved if performance equal or superior to that required by this standard is demonstrated, or if the intent of the standard is met. Alternatively, buildings which do meet all the requirements identified in this standard may not be Approved if other conditions which adversely affect performance exist or if the intent of this standard is not met.

1.6 System of Units

Units of measurements are U.S. customary units. These are followed by their arithmetic equivalents in International System (SI) units, enclosed in parentheses. Appendix B lists the selected units for quantities dealt with in testing these products; conversions to SI units are included. Conversion of customary English units is in accordance with ASTM E380.

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

The effective date of this standard is August 1, 1992 for full compliance with all requirements.

II TYPES OF CONSTRUCTION

2.1 Non-Combustible Construction

Building walls, roof and doors are of all steel construction or other non-combustible materials.

2.2 Fire Rated Construction

Walls are generally of steel stud construction covered in turn by gypsum board and light gauge sheet metal. Roofs are generally constructed of plywood, insulating material and an exterior waterproof membrane; supported by steel joists, and lined with light gauge sheet metal. Doors are generally of light gauge sheet metal with a honeycomb core. Other methods of construction are not excluded by the preceding statements. All methods shall be considered on an individual basis.

III BUILDING DESIGN REQUIREMENTS

3.1 General Requirements — All Types of Construction

- 3.1.1 The structure shall be capable of withstanding, as a minimum, a 90 mph (144 km/h) wind load equivalent to a velocity pressure of 19 psf (93 kg/m²) and a downward vertical (snow) load of 40 psf (195 kg/m²), plus its own weight.
- 3.1.2 The floor support system shall be capable of supporting a load of 250 psf (1220 kg/m²) under dry conditions.
- 3.1.3 A leak-tight sump, capable of containing at least 25 percent of the liquid storage capacity of the building shall be provided.
- 3.1.4 All electrical equipment within the building shall be rated for Class I, Division 1 service as defined by the National Electrical Code, NFPA-70. Exterior mounted ventilation and/or air conditioning systems shall be rated, as a minimum,, for Class I, Division 2 service.
- 3.1.5 Gross floor area shall not exceed 1500 ft² (139m²).
- 3.1.6 Natural or mechanical ventilation at a rate not less than 1 ft³/min/ft² (0.3 m³/min/m²) of floor area shall be provided.
- 3.1.7 A suitable means of grounding the building and individual liquid containers shall be provided.

3.2 Explosion Relief — Storage of Class IA, Dispensing of Class 1A and 1B Liquids

- 3.2.1 All the requirements noted in Paragraph 3.1 above shall be met, plus the following:
 - A. The structure shall be capable of withstanding an internal pressure of 100 psf (488 kg/m²);
 - B. Explosion relief venting area shall be at least 1 ft² (0.1 m²) for each 50 ft³ (1.4 m³) of interior volume.

- C. Explosion relief panels shall be of light weight material and shall release at an explosion pressure of 20 psf (98 kg/m²) maximum. Use of FM Approved fasteners, latches, or panels is recommended.
- D. Explosion venting through the roof is not acceptable due to the possibility of snow and debris accumulation. Venting through the rear wall is the recommended practice. Vent panels shall be tethered to the building so that they do not become missiles, if deployed by explosion.

3.3 Fire Ratings

NOTE: FIRE ENDURANCE RATINGS FOR WALLS AND ROOFS ARE ACCORDING TO ASTM E119; FOR DOORS, ASTM E152; FOR FIRE DAMPERS, ANSI/UL 555; AND FIRE CHARACTERISTIC RATINGS FOR ROOFS ASTM E108.

3.3.1 Buildings located 10 ft (3m) or less from a main building or property line:

Walls	– 4 hour rating
Roof	– 3 hour Class 1A rating
Openings	– 3 hour rating for closures (doors, vent dampers)

3.3.2 Buildings located more than 10 ft (3 m) but less than 50 ft (15 m) from a main building or property line:

Walls	– 2 hour rating
Roof	– 1 hour Class 1A rating
Openings	– 1½ hour rating

3.3.3 Buildings located more than 50 ft (15 m) but less than 75 ft (23 m) from a main building or property line:

Walls	– 1 hour rating
Roof	– 1 hour Class 1A rating
Openings	– ¾ hour rating

3.3.4 Buildings located more than 75 ft (23 m) from a main building or property line:

No fire rating requirements.

3.3.5 Buildings located more than 10 ft (3 m) but less than 50 ft (15 m) from a main building or property line and equipped with an automatic sprinkler system:

Walls	– 1 hour rating
Roof	– 1 hour Class 1A rating
Openings	– ¾ hour rating

3.3.6 Buildings shall be prominently marked with fire ratings and location limits.

3.3.7 Sump walls shall be of non-combustible construction. Extending the interior walls of the building into the sump is prohibited unless the portion of the wall in the sump area is protected by a suitable liner and an exterior sump wall of heavy gauge steel, or by an interior sump wall of heavy gauge steel continuously welded to the sump floor and at the corners.

NOTE: THESE BUILDINGS MAY OR MAY NOT BE REQUIRED TO COMPLY WITH NATIONAL BUILDING CODES, SUCH AS UBC OR BOCA, SINCE THEY ARE PORTABLE, NON-PERMANENT, OUTDOOR STRUCTURES. AUTHORITIES HAVING JURISDICTION MAY REQUIRE THAT SUMP WALLS BE FIRE RATED IF THEY CHOOSE TO APPLY SUCH CODES.

IV GENERAL REQUIREMENTS

4.1 Markings

- 4.1.1 Buildings shall, as a minimum, be labeled with the manufacturer's name, address, model number and maximum liquid storage capacity. In addition, buildings of fire rated construction shall be labeled with fire ratings and location limits as defined in Section 3.3.
- 4.1.2 All Approved buildings shall be labeled with an FM Approval Mark (see Appendix A). This may be accomplished by a separate label or incorporated onto the label defined in Section 4.1.1.
- 4.1.3 Buildings without explosion relief shall be prominently marked that storage of Class IA and dispensing of Class IA and IB flammable liquids is prohibited.

4.2 Instructions

- 4.2.1 The manufacturer shall provide instructions pertaining to building location, building site preparation, and building relocation.
- 4.2.2 The manufacturer shall provide maintenance/repair instructions for the building and ancillary equipment such as lighting, ventilation systems, and fire suppression systems.

4.3 Drawings/Plans/Specifications Required

The manufacturer shall provide:

- 4.3.1 A structural analysis relative to the design of the building in accordance with accepted structural engineering practices. The analysis shall be by a registered professional engineer.
- 4.3.2 All drawings relating to the structure of the building. Drawings shall show location of structural members and their nominal sizes.
- 4.3.3 Size, location, and fastening method for explosion relief panels.
- 4.3.4 A drawing of door(s) showing construction, latching, hinging, and locking provisions.
- 4.3.5 Drawings of all data plates, warning labels and the FM Approval label, including information as to their location in the building.
- 4.3.6 Drawings and/or specification sheets pertaining to building accessories that may be standard or offered as options, i.e., lighting, ventilation, fire suppression systems, etc.
- 4.3.7 Specification sheets for doors and fire dampers, if of fire rated construction, indicating the manufacturer, model number, and that fire ratings are in accordance with applicable FM Approval standards. Fire rated doors shall be FM Approved.

4.4 Manufacturers Responsibilities

- 4.4.1 If FM Approval is granted, all drawings shall estate in bold print that any revisions require FM Approval prior to implementation.
- 4.4.2 Buildings shall be fully assembled at the manufacturer's facility and/or at other facilities so designated by the manufacturer. Other facilities are subject to the quality control program and audit requirements as designated in Section VI — Operations Requirements, of this standard.
- 4.4.3 Buildings in kit form are Approvable if assembled on site by the manufacturer's personnel, by sub-contractors under the direct supervision of the manufacturer, or by sub-contractors trained and certified by the manufacturer. Manufacturers shall establish, as a minimum, a yearly re-certification program for independent sub-contractors.

V PERFORMANCE REQUIREMENTS

5.1 Structural Analysis

- 5.1.1 The structural analysis shall be examined and reviewed in order to determine whether the building design complies with the requirements of Section III of this Standard. The examination and review shall include verification of calculations, and that valid formulas for stress and strain have been used. In general, formulas may be excerpted from Roark, "Formulas for Stress and Strain", AISC Manual of Steel Construction, or AISI Specifications for the Design of Cold Formed Steel Structural Members.
- 5.1.2 Stresses imposed upon the building structural components by external loads shall not exceed 60 percent of the yield strength of the construction material.
- 5.1.3 Stresses imposed by an internal pressure of 100 psf (489 kg/m²) shall not exceed 90 percent of the yield strength of the construction material.

5.2 Explosion Relief Panels

5.2.1 Requirement

- A. The panels shall be constructed of light weight material in order to minimize panel inertia in the event of an explosion.
- B. Effective panel area shall be at least 1 ft² (0.1 m²) for each 50 ft³ (1.4 m³) of interior volume; i.e., effective panel area shall be actual panel area less mounting surface area and less the surface area of security bars or gridwork, if provided.
- C. Panel fastener or latch release force shall not exceed the total force generated by an explosion pressure of 20 psf (98 kg/m²) multiplied by the effective area of the relief panel.

5.2.2 Test/Verification

- A. Verification of panel release force is not required if FM Approved fasteners, latches, or panels are used.
- B. Panel release force shall be verified if Approved fasteners, latches, or panels are not used. Release force shall be determined on at least 6 samples. Panels shall be tested under “as installed” conditions. Maximum measured release force shall comply with the criteria noted in Paragraph 5.2.1 above.

5.3 Sump

5.3.1 Requirement

The sump shall be constructed of heavy gauge steel with continuously welded leak-tight seams. The interior of the sump shall be coated with a corrosion-resistant material. A non-metallic liner may be provided as an option.

5.3.2 Test/Verification

Sump capacity shall be verified by calculation as being capable of containing at least 25 percent of the specified maximum liquid storage capacity of the building.

5.4 Fire Suppression

5.4.1 Requirements

- A. Sprinkler systems, if provided, shall conform to NFPA 13 standards for sprinkler quantity, orifice size, type and location. Sprinklers shall be FM Approved.
- B. Automatic fire suppression systems, if offered, shall conform to the system manufacturer’s requirements for detection, nozzle size, nozzle quantity and nozzle location. The systems shall be FM Approved.
- C. Sprinkler/nozzle location in relation to indoor lighting fixture location shall be reviewed. The relationship, in both plan and elevation, shall be such as to preclude or minimize interference with the distribution patterns of sprinklers or nozzles.

5.5 Fire Endurance Rated Walls and Roof Interiors

Materials and method of construction for fire rated walls and roof interiors shall be as illustrated in the FM Approvals Specification Tested Products Guide under the heading ASTM E119 Standard, or the equivalent thereof. In addition, gypsum board surfaces shall be covered by light gauge sheet metal panels coated with a corrosion-resistant material.

VI OPERATIONS REQUIREMENTS

6.1 Demonstrated Quality Control Program

6.1.1 A Quality Control Program is required to assure that each subsequent storage building produced by the manufacturer shall present the same quality and reliability as the specific samples examined. Design quality, conformance to design, and performance are the areas of primary concern.

Design quality is determined during the examination and tests.

Conformance to design is verified by control of quality in the following areas:

- existence of corporate quality control guidelines
- incoming assurance, including test
- in-process assurance, including test
- final inspection and test
- equipment calibration
- drawing and change control
- packaging and shipping
- handling and disposition of discrepant materials

Quality of performance is determined by field performance and by re-examination and test.

6.1.2 The manufacturer shall establish a system of product configuration control to prevent unauthorized changes, including, as appropriate:

- engineering drawings
- engineering change requests
- engineering orders
- change notices

These shall be executed in conformance with a written policy and detailed procedures. Records of all revisions to all Approved products shall be kept.

6.1.3 The manufacturer shall assign an appropriate person or group to be responsible to obtain FM Approvals authorization of all changes applicable to Approved products. FM Approvals Form 797, "Approved Product Revision Report or Address/Contact Change Notice", is provided to notify FM Approvals of pending changes.

6.2 Facilities and Procedures Audit (F&PA)

6.2.1 An inspection of the product manufacturing facility shall be part of the Approval investigation. Its purpose shall be to determine that equipment, procedures, and the manufacturer's controls are properly maintained to produce a product of the same quality as initially tested.

6.2.2 Unannounced follow-up inspections shall be conducted to assure continued quality control and product uniformity.

APPENDIX

APPROVAL MARKS

REPRODUCTION ART: FM Approval Marks

For use on nameplates, in literature, advertisements, packaging and other graphics.



- 1) The FM Approvals diamond mark is acceptable to FM Approvals as an Approval mark when used with the word "Approved."
- 2) The FM Approval logomark has no minimum size requirement, but should always be large enough to be readily identifiable.
- 3) Color should be black on a light background or a reverse may be used on a dark background.

For Cast-On Marks



- 4) Where reproduction of the mark described above is impossible because of production restrictions, a modified version of the diamond is suggested. Minimum size specifications are the same as for printed marks. Use of the word "Approved" with this mark is optional.

NOTE: These Approval marks are to be used only in conjunction with products or services that have been FM Approved. The FM Approval marks should never be used in any manner (including advertising, sales or promotional purposes) that could suggest or imply FM Approval or endorsement of a specific manufacturer or distributor. Nor should it be implied that Approval extends to a product or service not covered by written agreement with FM Approvals. The Approval marks signify that products or services have met certain requirements as reported by FM Approvals.

Additional reproduction art is available through

FM Approvals
P.O. Box 9102,
Norwood, Massachusetts 02062
U.S.A.

APPENDIX B**UNITS OF MEASUREMENT****AREA:**ft² – “square feet”(m² – “square meters”)

$$m^2 = ft^2 \times 0.0929$$

VOLUME:ft³ – “cubic feet”(m³ – “cubic meters”)

$$m^3 = ft^3 \times 0.0283$$

PRESSURE:

psf – “pounds per square foot”

kg/m² – “kilograms per square meter”

$$(kg/m^2 = psf \times 4.88926$$