FM Approvals®

Member of the FM Global Group

Approval Standard for Flexible Hose Assemblies for Flammable Gases and / or Ignitable Liquids

Class Number 6036

December 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 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, successful re-examinations of equipment, materials, and services as appropriate, and 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 Purpose

1.1.1 This standard states Approval requirements for flexible hoses used to carry flammable gases and / or ignitable liquids. Flexible hoses used to carry flammable gases and / or ignitable liquids may be used with, but not limited to, appliances or machinery.

1.1.2 Approval criteria may include, but are not limited to, performance requirements, marking requirements, examination of manufacturing facility(ies), audit of quality assurance procedures, and a follow-up program.

1.2 Scope

1.2.1 This standard encompasses the design and performance requirements for flexible hoses with threaded end fittings used to carry flammable gases and / or ignitable liquids, such as, but not limited to, propane and natural gas, which may be used in appliances or machinery.

1.2.2 Flexible hoses used to carry flammable gases and / or ignitable liquids are used in many residential and commercial applications. Some commercial markets are laundromats, restaurants and food service, retail, and healthcare. Flexible hoses may be connected to stoves, ovens, furnaces, boilers, gas-fired fireplaces, etc.

1.2.3 Flexible hoses for flammable gases and / or ignitable liquids are made with corrugated stainless steel tubing with an optional non-metallic covering. The stainless steel is austenitic stainless steel alloy of the 300 series. Threaded end fittings are applied for connection to an ignitable liquid or gas source and appliance or machinery.

1.2.4 The intent of the design and performance requirements is for the flexible hoses to withstand stresses imposed by shifting or tipping appliances and machinery and/or by damage to structural framing caused by earthquakes, without fracture or leakage.

1.2.5 This standard is not applicable to hoses intended for direct burial underground.

1.2.6 This standard is not applicable to hoses intended for use with propane in its liquid state.

1.2.7 Other applications shall be evaluated on a case-by-case basis. In cases where International System (SI) sized flexible hoses for flammable gases and / or ignitable liquids are to be examined for Approval, test criteria comparable to the equivalent or nearest United States (U.S.) customary units shall be used.

1.2.8 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.

1.3.2 The requirements of this standard reflect tests and practices used to examine characteristics of flexible hoses for flammable gases and / or ignitable liquids for the purpose of obtaining Approval. Flexible hoses for flammable gases and / or ignitable liquids 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, flexible hoses for flammable gases and / or ignitable liquids 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
- the durability and reliability of the product, as far as practical

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' Surveillance Audit program.

1.4.3 Installation guidelines require the installation of striker plates at all penetration points through framing members.

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 Surveillance Audits

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 for compliance with all requirements is the publication date.

1.7 System of Units

Units of measurement used in this Standard are U.S. customary units. These are followed by their arithmetic equivalents in 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 10-97, "Standard for Use of the International System of Units (SI): The Modern Metric System." Two units (liter and bar), outside of but recognized by SI, are commonly used in international fire protection and are used in this Standard.

1.8 Applicable Documents

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

ASTM SI10 - 10 IEEE/ASTM SI 10, *American National Standard for Metric Practice*

FM Global Property Loss Prevention Data Sheet 7-32, *Ignitable Liquid Operations*

International Organization for Standardization (ISO) 10380 - 1994, *Corrugated flexible metallic hose and hose assemblies*

International Organization for Standardization (ISO) 7369 – 2004, *Pipework – Metal hoses and hose assemblies – Vocabulary*

ANSI/CSA LC 1-2005 CSA 6.26-M2005, *Fuel Gas Piping Systems Corrugated Stainless Steel Tubing (CSST)*

FM Approvals Standard 1637—2010, *Approval Standard for Flexible Sprinkler Hose with Threaded End Fittings*

Ditch, B., *Development of a Fire Performance Test for Corrugated Stainless-Steel Tubes, FM Approval Class Number 6036*

1.9 Definitions

For purposes of this standard, the following terms apply:

Appliance (Machinery)
Any device that uses gas or liquid as a fuel to produce light, heat, power, refrigeration, air conditioning, etc.

Corrosion Resistant
Flexible hoses for flammable gases and / or ignitable liquids shall be termed corrosion resistant if its interior surface exhibits equivalent resistance to aqueous corrosion as steel pipe which is internally coated with zinc by the hot-dip process to a weight of no less than 1.8 oz/ft^2 (0.55 kg/m^2).

Corrugated Hose
Pressure-tight hose with corrugations, helicoidal (formed or arranged in a spiral) or annular (formed in a ring) to the axis of the hose. Made by deforming the metal and flexibility is obtained by bending the corrugations.

Dynamic Bend Radius
The minimum acceptable bending radius of the hose, bent in relation to the hose axis, as specified by the manufacturer.

End Connections
The method of connecting components of an appliance, machinery, or flammable gases and / or ignitable liquid supply to the flexible hose.

End Fitting
Permanently attached item which allows metal hose to be connected to other components.

Flexibility
The capability of a metal hose to be repeatedly bent during operation.

Flexible Hose Assembly
Assembly of a metal hose with its end fittings.

FM Approvals Certification Mark
The FM Approvals Certification Marks are detailed in Appendix B. Their use is mandatory on all units of FM Approved flexible hoses for flammable gases and / or ignitable liquids. 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 online 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. This agreement obligates the manufacturer to allow re-examination of the product and audit of facilities and procedures at the discretion of FM Approvals. It further requires the manufacturer not to deviate from the as - FM Approved configuration of the product without review by and agreement of FM Approvals. Approval is product or assembly specific.

Minimum Bend Radius
The minimum radius [expressed in inches (mm)] at which a hose is designed to operate that the flexible hose is safely allowed to bend, as specified by the manufacturer.

Rated Working Pressure
The maximum sustained pressure at, or below, which the flexible hose for flammable gases and / or ignitable liquids shall operate trouble free.

2 GENERAL INFORMATION

2.1 Approval Application Requirements

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

Materials Group 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
- The minimum bend radius of the flexible hose(s) for flammable gases and / or ignitable liquids
- General assembly drawings, complete set of manufacturing drawings, materials list, anticipated marking format, brochures, sales literature, specification sheets, installation, operation and maintenance procedures, etc.
- 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.

2.2 Requirements for Samples for Examination

Following generation and authorization of an Approval examination, the manufacturer shall submit samples for examination and testing. Sample requirements are to be determined by FM Approvals following review of the preliminary information. Sample requirements may vary depending on design features, results of prior testing, and results of the foregoing tests. It is the manufacturer’s responsibility to submit samples representative of production. Any decision to use data generated utilizing prototypes is at the discretion of FM Approvals. The manufacturer shall provide any special test fixtures which may be required to evaluate the flexible hose for flammable gases and / or ignitable liquids.

3 GENERAL REQUIREMENTS

3.1 Review of Documentation

During the initial investigation and prior to physical testing, the manufacturer's specifications, technical data sheets, installation/assembly instructions, and design details shall be reviewed to assess the ease and practicality of installation and use. The product shall be capable of being used within the limits of the Approval investigation.

3.2 Physical or Structural Features

3.2.1 Flexible hoses for flammable gases and / or ignitable liquids shall only be made of austenitic stainless steel alloy with a nickel content of >6% by weight.

3.2.2 Flexible hoses for flammable gases and / or ignitable liquids which include a non-metallic coating or covering shall comply with the international color designation of yellow for the coating/covering color.

3.2.3 Flexible hoses for flammable gases and / or ignitable liquids submitted for testing shall be true production samples and shall be free of sharp edges, burrs, or other imperfections which might injure the installer or interfere with proper assembly of the unit.

3.2.4 Threaded end fittings on flexible hoses for flammable gases and / or ignitable liquids shall be metal.

3.2.5 All end fittings shall be suitable for use with end connections having tapered pipe threads which conform to a national or internationally recognized standard.

3.2.6 Unless otherwise noted, each specific diameter flexible hose and end fitting(s) combination is considered a unique sample and must be examined individually. For flexible hoses manufactured with identical materials with a range of diameters, examination covered by this standard shall occur at least on the minimum and maximum inside diameter, based on the nominal inside diameter of the hose, requested for Approval recognition.

3.3 Materials

All materials used in these hoses shall be suitable for the intended application.

3.4 Markings

3.4.1 Each flexible hose for flammable gases and / or ignitable liquids shall be permanently marked on its external surface with the following information:

- Manufacturer’s name or trademark
- Nominal size
- Rated working pressure
- Model designation
- The FM Approvals Certification Mark

3.4.2 Markings shall be cast or forged in raised characters, etched or die stamped on the fitting assembly.

3.4.3 A metal nameplate aluminum sticker or a corrosion resistant aluminum sticker bearing the same information as stated above shall be considered an acceptable alternative to 3.4.1 if permanently fastened to the flexible hose or fitting assembly.

3.4.4 Each marking shall be legible and durable and applied in any of, or combination of, the above methods.

3.4.5 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.

3.4.6 The FM Approvals Certification Marks (see Appendix B) shall be displayed visibly and permanently on the product. The manufacturer shall not use these marks on any other product unless such product is covered by separate agreement with FM Approvals.

3.5 Manufacturer's Installation and Operation Instructions

Installation instructions, including any special dimension requirements and friction loss data, shall be furnished by the manufacturer. Instructions shall be provided in each shipping container.

3.6 Calibration

All equipment used to verify the test parameters shall be calibrated within an interval determined on the basis of stability, purpose, and usage of the equipment. A copy of the calibration certificate for each piece of test equipment is required for FM Approvals records, indicating that the calibration was performed against working standards whose calibration is certified as traceable to the National Institute of Standards and Technology (NIST) or to other acceptable reference standards and certified by a ISO 17025 calibration laboratory. The test equipment must be clearly identified by label or sticker showing the last date of the calibration and the next due date. A copy of the service accreditation certificate as an ISO 17025, "General Requirements for the Competence of Testing and Calibration Laboratories", calibration laboratory is required for FM Approvals records. The calibration of recently purchased new equipment is also required. Documentation indicating either the date of purchase or date of shipment, equipment description, model and serial number is required for identification. The period from the time the equipment was put into service to the date of testing must be within an interval that does not require the equipment to be calibrated as determined on the basis of the parameters mentioned above.

4 PERFORMANCE REQUIREMENTS

4.1 Examination

4.1.1 Requirement

The flexible hose assembly for flammable gases and / or ignitable liquids shall conform to the manufacturer's drawings and specifications and to FM Approvals requirements.

4.1.2 Test/Verification

A sample shall be examined and compared to drawings and specifications. It shall be verified that the sample conforms to the physical and structural requirements described in Section 3, General Requirements.

4.1.3 All tests shall be conducted with the samples and environment at room temperature, 77 ± 10°F (25 ± 5.5°C).

4.2 Fire Exposure

4.2.1 Requirements

4.2.1.1 A flexible hose assembly designed for use with only flammable gases shall maintain its rated pressure, to a maximum 25 psi (172 kPa), during a one hour exposure to a constant and uniform heat flux of 125 kW/m^2 imposed by a propane sand burner. The assembly is pressurized with air during the test. No leakage is allowed.

4.2.1.2 A flexible hose assembly designed for use with only ignitable liquids shall maintain its rated pressure, to a maximum 150 psi (1034 kPa), for two minutes after a one hour exposure to a constant and uniform heat flux of 125 kW/m^2 imposed by a propane sand burner. This requirement includes a fire exposure test with the assembly filled with stagnant water at ambient pressure followed by a static pressure test with water. No leakage is allowed.

4.2.1.3 A flexible hose assembly designed for use with flammable gases and ignitable liquids shall be tested according to the requirement of a flexible hose assembly designed for use with only flammable gases.

4.2.2 Test/Verification

Tests are conducted according to *FM Approvals Class Number 6036:Fire Exposure Test Procedure.*

4.3 Fatigue

4.3.1 Requirement

A flexible hose assembly shall be subjected to 50,000 cycles of flexing at a rate of 5 to 15 cycles/minute in a direction parallel with the axis of the end fittings while pressurized with water to its rated pressure. There shall be no deterioration of the flexible hose assembly or its performance characteristics. Before and after the Fatigue test, the flexible hose assembly shall not leak or rupture when tested in accordance with the *Hydrostatic Strength Test* requirements.

4.3.2 Test/Verification

Test is performed in accordance with *FM Approvals Class Number 6036: Fatigue Test Procedure.*

4.4 Vibration

4.4.1 Requirements

A flexible hose assembly shall withstand the effects of vibration without deterioration of its performance characteristics. Following exposure to the vibration test the flexible hose assembly shall not leak or rupture when tested in accordance with the *Hydrostatic Strength Test* requirements.

4.4.2 Test/Verification

Test is performed in accordance with *FM Approvals Class Number 6036:Vibration Test Procedure* .

4.4.3 After completion of the vibration test, the flexible hose assembly shall not leak or rupture when tested in accordance with the *Hydrostatic Strength Test* requirements.

4.5 Hydrostatic Strength

4.5.1 Requirement

A flexible hose assembly shall withstand a hydrostatic pressure of five times the rated working pressure without rupture, cracking, permanent distortion, leaking, or deterioration of its performance characteristics.

4.5.2 Test/Verification

Test is performed in accordance with *FM Approvals Class Number 6036: Hydrostatic Strength Test Procedure.*

4.6 Flexibility in Torsion

4.6.1 Requirement

A flexible hose assembly shall withstand six 90 degree (1.57 rad) twists in alternate directions without visible damage and without external leakage while maintaining air pressure of 1.5 times the flexible hose rated working pressure.

4.6.2 Test/Verification

Testing is conducted according to *Method of Test* in Section 2.4.2 part A of ANSI/IAS LC 1-1997 CSA 6.26. No leakage, as indicated on the pressure gage, shall occur during the torque application. After 6 cycles, the leakage rate shall be measured for one hour. The observed leakage rate, corrected to standard conditions of 30 in. mercury at 60°F (76.2 cm mercury at 15.6°C), shall not exceed 1.22 in^3 (20 cm^3) of air after one hour.

4.7 Axial Strength

4.7.1 Requirement

A flexible hose assembly shall withstand a tensile load of 800 lbf/in. (140 kN/m) of nominal inside flexible hose diameter without becoming detached and without external leakage while maintaining air pressure of 1.5 times the flexible hose rated working pressure.

4.7.2 Test/Verification

Testing is conducted according to *Method of Test* in Section 2.5 of ANSI/IAS LC 1-1997 CSA 6.26. A 6 in. (152 mm) sample of flexible hose and one of each type of end fitting shall be assembled according to the manufacturer's instructions. One end of the assembled sample is attached to a fixed pipe to which are connected a pneumatic system capable of supplying clean and dry air and flow measuring device capable of measuring the allowable leakage rate. The flow measuring device shall be located between the air supply and the hose assembly. The other end of the assembled sample is attached to a sealed mechanical means capable of applying a constant tensile force of 800 lbf/in. (140 kN/m) of nominal inside flexible hose diameter. The force is applied for 5 minutes. After the test, the leakage rate shall be measured for one hour. The observed leakage rate, corrected to standard conditions of 30 in. mercury at 60°F (76.2 cm mercury at 15.6°C), shall not exceed 1.22 in^3 (20 cm^3) of air after one hour.

4.8 Torsion Strength of Threaded End Fittings

4.8.1 Requirement

End fittings joined by threading shall not crack, break, or leak as a result of the application of a tightening torque of 1040 in.-lbf (117.5 Nm) per inch (mm) of nominal hose inside diameter and be without external leakage while maintaining air pressure of 1.5 times the flexible hose rated working pressure.

4.8.2 Test/Verification

Testing is conducted according to *Method of Test* in Section 2.8 of ANSI/IAS LC 1-1997 CSA 6.26. Each unique threaded end fitting shall be assembled to its mate according to the manufacturer's specifications. One end of the assembled sample is attached to a pneumatic system capable of supplying clean and dry air and flow measuring device capable of measuring the allowable leakage rate. The flow measuring device shall be located between the air supply and the hose assembly. The other end of the assembled sample shall be sealed. The assembled sample shall be free of leaks. Each tested connection in the assembly shall then be tightened to a torque of 1040 in.-lbf (117.5 Nm) per inch (mm) of nominal hose inside diameter. After the test, the leakage rate shall be measured for one hour. The observed leakage rate, corrected to standard conditions of 30 in. mercury at 60°F (76.2 cm mercury at 15.6°C), shall not exceed 1.22 in^3 (20 cm^3) of air after one hour.

4.9 Impact Strength

4.9.1 Requirement

A flexible hose assembly, for flammable gases and / or ignitable liquids, shall withstand an impact of 30 ft-lbs (40.7 J) while maintaining 1.5 times the flexible hose rated working pressure without leakage.

4.9.2 Test/Verification

Testing is conducted according to *Method of Test* in Section 2.7 of ANSI/IAS LC 1-1997 CSA 6.26. Five samples are subjected to an impact of 30 ft-lbs (40.7 J) in the center of a 1 ft (0.3 m) long sample by dropping a 10 lbf (4.5 kgf) weight, with a ½ in. (13 mm) spherical nose, from a height of 3 ft (0.9 m). Samples are pressurized to 1.5 times the flexible hose rated working pressure. The test is repeated on one of the fittings of each sample.

4.10 Additional Tests

4.10.1 At the discretion of FM Approvals, additional tests may be required depending on design features, results of any tests, material applications, or to verify the integrity and reliability of flexible hoses for flammable gases and / or ignitable liquids.

4.10.2 A re-test shall only be acceptable, at the discretion of FM Approvals, with adequate technical justification of the conditions and reasons for failure.

5 OPERATIONS REQUIREMENTS

A quality assurance program is required to assure that subsequent flexible hoses for flammable gases and / or ignitable liquids produced by the manufacturer shall present the same quality and reliability as the specific flexible hoses for flammable gases and / or ignitable liquids 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 Surveillance Audit

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")
cm = in. x 2.54
mm = in. x 25.4

ft - "feet"; (m - "meters")
m = ft x 0.3048

VOLUME: $in.^3$ – “cubic inches”; (cm^3 – “cubic centimeters”)
$cm^3 = in.^3$ x 16.2

MASS: lb - "pounds"; (kg - "kilograms")
kg = lb x 0.454

PRESSURE: psi - "pounds per square inch"; (bar - "bar")
kPa = psi x 6.895
MPa = psi x 689.5

bar - "bar"; (kPa - "kilopascals")
bar = kPa x 0.01
bar = psi x 0.06895

FORCE lbf –“pound force”; (kN—“kilo-Newton”)
kN = lbf x 224.8

TEMPERATURE: °F - "degrees Fahrenheit"; (°C - "degrees Celsius")
°C = (°F - 32) x 0.556

ANGLE degree; (rad—“radians”)
rad = (degree x π)/180

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.