



*Member of the FM Global Group*

**Approval Standard  
for  
Intrinsically Safe  
Apparatus  
and Associated Apparatus  
for Use in Class I, II, and  
III, Division 1, Hazardous  
(Classified) Locations**

**Class Number 3610**

**January 2010**

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# 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.

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# I. INTRODUCTION

## 1.1 Purpose

This standard serves as the basis for Approval of intrinsically safe apparatus and associated apparatus.

## 1.2 Scope

This standard provides requirements for the construction and testing of electrical apparatus, or parts of such apparatus, whose circuits are incapable of causing ignition in:

Classes I, II & III, Division 1 hazardous (classified) locations as defined in Article 500 of the National Electrical Code®, ANSI/NFPA-70 (NEC®).

This standard is intended to be used in conjunction with FM Approval Standard 3600 which includes the general requirements that apply to all types of classified location protection methods.

Intrinsically Safe Equipment and/or circuits for use in Class I, Division 1, Groups A, B, C and/or D Hazardous (Classified) Locations shall comply with all applicable requirements in ANSI/ISA-60079-11 2009 for Category “ia”, Group IIC, IIB and/or IIA as shown in Table 1.2.

Exception: Marking of the equipment shall meet the requirements contained in Clause 5.

<i>FM Approvals sought for Class I, Division 1, Group as follows</i>	<i>Requirements from ANSI/ISA 60079-11 to be applied for the group as follows</i>
A	IIC
B	IIC
C	IIB
D	IIA

## 1.3 Basis for Approval

See Approval Standard 3600.

## 1.4 Approval Application

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

Electrical – Director  
 FM Approvals  
 1151 Boston-Providence Turnpike  
 P.O. Box 9102  
 Norwood, MA 02062, U.S.A.

\*AN ASTERISK FOLLOWING A WORD OR A SECTION NUMBER SIGNIFIES THAT EXPLANATORY MATERIAL APPEARS IN THE APPENDIX.

## 1.5 Basis for Continued Approval

Continued Approval is based upon:

- a) production or availability of the product as currently FM Approved;
  - b) the continued use of acceptable quality control procedures;
  - c) satisfactory field experience;
  - d) compliance with the terms stipulated in the Master Agreement;
- and
- e) re-examination, as necessary, of production samples for continued conformity to requirements.

## 1.6 Basis for Requirements

1.6.1 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.

1.6.2 The requirements of this standard reflect tests and practices used to examine characteristics of intrinsically safe apparatus for the purpose of obtaining Approval. These requirements are intended primarily as guides, and strict conformity is not always mandatory. Devices 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, devices which do meet all 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.

## 1.7 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 issued under a previous edition shall comply with the new version by the effective date or Approval will be withdrawn. The effective date shall apply to the entire Approval Standard, or, where so indicated, to specific paragraphs of the standard.

The effective date of this standard is January 1, 2012 for full compliance with all requirements.

## 1.8 System of Units

Where units of measurement are expressed in U.S. customary units, they are followed by their arithmetic equivalents in International System (SI) units, enclosed in parentheses. Conversions are in accordance with ANSI/IEEE/ASTM SI-10-1997 "Standard for Use of the International System of Units (SI)." Where units of measurement are expressed in SI units, U.S. customary units may also be provided.

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## II. SCOPE

### 2.1 Application

This standard shall apply to the electrical circuits of Intrinsically Safe and Associated Apparatus intended for use in:

Classes I, II and III, Division 1, Groups A, B, C, D, E, F and G, Hazardous (Classified) Locations.

### 2.2\* Requirements

These requirements are based on consideration of ignition in locations made hazardous by the presence of flammable or combustible material under normal atmospheric conditions.

2.2.1 For the purposes of this standard, normal atmospheric conditions are considered to be:

- a) ambient temperature range of  $-25^{\circ}\text{C}$  to  $+40^{\circ}\text{C}$ ;
- b) an oxygen concentration no greater than 21% by volume;
- c) a barometric pressure in the range 0.8 atmosphere to 1.1 atmosphere.

2.2.2 Equipment intended and specified for use in conditions other than those in Clause 2.2.1 may be subject to special investigation.

### 2.3 Mechanisms of Ignition

2.3.1 This standard does not cover mechanisms of ignition from external sources, such as static electricity or lightning, which are not related to the electrical characteristics of the apparatus. However, the possibility of static charge on polymeric materials and ungrounded metal parts shall be considered during the Approval examination.

2.3.2 This standard does not cover apparatus based on high voltage electrostatic principles (i.e., electrostatic paint spraying).

### 2.4 Applicability of Other Standards

2.4.1 Except where modified by the requirements of this standard, intrinsically safe and associated apparatus shall comply with the applicable requirements for ordinary locations, in accordance with Clause 2.3 of Approval Standard 3600.

2.4.2 Associated apparatus and circuits shall conform to the requirements of the location in which they are installed.

### 2.5 Control Drawing

A control drawing shall be provided for all intrinsically safe apparatus or associated apparatus that requires interconnection to other circuits or apparatus resulting in an intrinsically safe system.

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- 2.5.1 An intrinsically safe system could consist of the interconnection of intrinsically safe apparatus and associated apparatus investigated as a system, or the interconnection of such apparatus separately investigated under the entity evaluation concept.

## 2.6 Definitions

- 2.6.1 **Control Drawing** – A drawing or other document provided by the manufacturer of the intrinsically safe or associated apparatus that details the allowed interconnections to other circuits or apparatus. If the intrinsically safe or associated apparatus is investigated under the entity concept, the control drawing shall include the applicable electrical parameters to permit selection of apparatus for interconnection.
- 2.6.2 **Entity Evaluation Concept** – A method used to determine acceptable combinations of intrinsically safe apparatus and connected associated apparatus that have not been investigated in such combination.

# III. APPARATUS FOR CLASS II AND CLASS III LOCATIONS

## 3.1 Requirements

Intrinsically safe and associated apparatus intended for use in Class II or Class III, Division 1 hazardous locations shall meet all requirements of Clauses I through III.

## 3.2 Specific Requirements for Intrinsic Safety

- 3.2.1 Apparatus and associated wiring that meet the requirements of Clauses I through III of this standard, as applicable, also shall be considered to meet the requirements for Class II and Class III locations, if they comply with Clause 3.2.2 and meet the requirements of either Clause 3.2.3 or 3.2.4.
- 3.2.2 The temperature of exposed surfaces of apparatus shall be less than the marked temperature class when tested according to the procedures described in Clause 4.3.
- Note:** See the latest edition of NFPA 499 “Recommended Practice for the Classification of Combustible Dusts and of Hazardous (Classified) Locations for Electrical Installations in Chemical Process Areas”, for minimum ignition temperatures of specified dusts.
- 3.2.3 Circuits of intrinsically safe apparatus shall be enclosed in a dust-tight enclosure meeting the requirements of Clause 3.3. The apparatus shall also meet spark ignition requirements for Class I, Group C and D locations.
- 3.2.4\* Circuits of intrinsically safe apparatus not enclosed in a dust-tight enclosure meeting the requirements of Clause 3.3 shall meet the spark ignition requirements specified in Clause 3.2.3. In this case, it shall be assumed that all spacings do not meet the creepage and clearance distance requirements and that all connections between live or grounded parts and conductors are in the most unfavorable condition. The number of such connections is unlimited.

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### 3.3\* Dust-Tight Enclosures

For the purposes of this standard, an enclosure is considered dust-tight if it meets the requirements of Clause 3.3.1. or 3.3.2 or if it complies with the requirements of Clause 4.2 or if it is dust-ignitionproof. In addition, a portable apparatus shall be dust-tight after the drop test described in Clause 4.1.

3.3.1 An enclosure is considered suitable if it conforms to applicable requirements for enclosures for ordinary locations and if it has no openings and if all joints are either threaded with a 3 full-thread minimum engagement or sealed by continuous welding, brazing, soldering or fusion of glass.

3.3.2 Parts of apparatus within an enclosure suitable for ordinary locations which are encapsulated to a depth of at least 1 mm (0.04 in.) shall be considered dust-tight.

## IV. TEST PROCEDURES

### 4.1 Drop Test

Portable apparatus shall be subjected to the following drop test. Intrinsic safety shall not be affected.

- a) The apparatus shall be dropped at least six times, but not more than once on one surface, edge or corner, from a height of 1 meter (39.4 in.) on to a smooth horizontal concrete floor.
- b) If appropriate, a nonrestrictive guide may be used to assure a free-fall drop on the surface to be tested.

### 4.2 Dust-Tight Enclosure Test

For the purpose of this standard, an enclosure is considered suitable for Class II and III locations if it meets the requirements of this clause.

4.2.1 The test is a circulating dust method conducted by using equipment in which talcum powder is maintained in suspension in a suitable closed chamber. The talcum powder used shall pass through a square-meshed sieve whose nominal wire diameter is 50 micrometers and whose nominal width between wires is 75 micrometers. The amount of talcum powder used is 2 kg per cubic meter of the test chamber volume and is not to be used for more than 20 tests.

4.2.2 The equipment under test is to be supported inside the test chamber, and the pressure inside the equipment is to be maintained below atmospheric pressure by a vacuum pump. If the enclosure has a single drain hole, the suction connection is to be made to a hole specially provided for the purpose of the test. If there is more than one drain hole, the other drain holes are to be left open for the test. The object of the test is to draw into the equipment, if possible, a minimum of 80 times the volume of air in the enclosure without exceeding an extraction rate of 60 volumes per hour with a suitable depression. In no event shall the depression exceed 200 mm of water. If an extraction rate of 40 to 60 volumes per hour is obtained, the test is to be stopped after two hours. If, with a maximum depression of 200 mm of water, the extraction rate is less than 40 volumes per hour, the test is to be continued until 80 volumes have been drawn through, or a period of eight hours has elapsed.

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4.2.3 No visible dust shall be detected inside the enclosure at the end of the test.

### 4.3 Dust Blanketing Temperature Test

4.3.1 The apparatus shall be mounted in its normal position and shall be covered with the dust mixture specified in this clause until no more will stay on the enclosure or component (see Clause 3.2.2 note) or to a depth of 12 mm (0.48 in.) whichever is less. The dust shall be fine enough to pass through a 100-mesh screen and shall be one of the following:

- a) Wheat, flour or corn dust (or a mixture of both);
- b) Aluminum oxide dust or magnesium dust for Group E only equipment.

4.3.2 The apparatus shall be operated under fault conditions appropriate to the device until all temperatures become constant (see Clause 3.2).

4.3.3 Excursions of temperatures of small components above the temperature class are permitted as long as there is no evidence of charring or ignition of the test dust specified in 4.3.1.

## V MARKING

### 5.1 Intrinsically Safe Apparatus

The minimum marking of intrinsically safe apparatus shall be readily visible by the user and shall include the following:

- a) Manufacturer's name or trademark, address, and type or model designation;
- b) Where repair is possible, a warning label stating:

**“WARNING: SUBSTITUTION OF COMPONENTS MAY IMPAIR INTRINSIC SAFETY”.**

- c) Where the manufacturer does not specify live maintenance procedures, a warning label stating to the effect:

**“WARNING”:** followed by words stating to the effect **“TO PREVENT IGNITION OF FLAMMABLE OR COMBUSTIBLE ATMOSPHERES, DISCONNECT POWER BEFORE SERVICING”.**

Where the manufacturer specifies and provides live maintenance procedures, the word **“WARNING”:** followed by words stating to the effect **“TO PREVENT IGNITION OF FLAMMABLE OR COMBUSTIBLE ATMOSPHERES, READ, UNDERSTAND AND ADHERE TO THE MANUFACTURER'S LIVE MAINTENANCE PROCEDURES”**

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- d) Reference to a control drawing number, except for apparatus not intended to be connected to other apparatus or circuits.
- e) The Approval Mark according to Appendix B.
- f) The words Intrinsicly Safe and the Class, Division and Group for which the equipment was approved. Exception: the division marking is not required for equipment evaluated for Division 1.
- g) Maximum operating temperature or temperature class as appropriate. Refer to the latest edition of the Approval Standard 3600.
- h) The maximum input power, maximum input voltage, maximum input current, maximum unprotected internal capacitance and maximum unprotected internal inductance if evaluated under the entity concept, along with their designations, e.g.  $V_{max} = 24 \text{ Vdc}$ . Exception: when included in the control drawing.

## 5.2 Associated Apparatus

The minimum marking of associated apparatus shall be readily visible by the user and include the following:

- a) Manufacturer's name or trademark, address, and type or model designation;
- b) Connections for intrinsically safe circuits (e.g. terminals, plugs, receptacles) shall be identified. The color blue may be used to identify such connections;
- c) Control drawing number, except for apparatus not intended to be connected to other apparatus or circuits;
- d) Where repair is possible a warning label stating:

**“WARNING: SUBSTITUTION OF COMPONENTS MAY IMPAIR INTRINSIC SAFETY”**

- e) The FM Approval Mark, Appendix B.
- f) The words “associated apparatus” or “provides intrinsically safe circuits” or equivalent along with the Class, Division and Group for which the intrinsically safe circuits were approved. Exception: the division marking is not required for equipment evaluated for Division 1.

Examples:

Associated Apparatus providing Intrinsically Safe Circuits for Class I, Division 1, Groups C and D, Provides Intrinsically Safe Circuits for Class I, Division 1, Groups C and D.

- g) The maximum voltage ( $U_m$ ) and frequency which can be applied to the non-intrinsically safe terminals of the associated apparatus.
- h) The maximum output power, maximum output voltage, maximum output current, maximum allowed capacitance and maximum allowed inductance if evaluated under the entity concept, along with their designations, e.g.  $V_{max} = 24 \text{ Vdc}$ . Exception: when included in the control drawing.

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### 5.3 Marking Battery-Powered Apparatus

5.3.1 When the batteries used are not intrinsically safe, the apparatus shall be marked with a warning such as:  
**“WARNING — BATTERIES MUST BE CHANGED IN AN UNCLASSIFIED LOCATION ONLY.”**

5.3.1.1 If there are two or more replaceable batteries, where there are two or more replaceable batteries the warning marking shall also warn against mixing of different manufacturers' batteries and mixing of new with used batteries.

5.3.1.2 Apparatus or battery packs provided with external contacts for recharging the batteries shall be marked with the following or equivalent:

**“CAUTION: TO REDUCE THE RISK OF EXPLOSION, RECHARGE THE BATTERIES IN AN UNCLASSIFIED LOCATION”.**

### 5.4 Marking Abbreviations

The following are acceptable for marking brevity:

Class: CL

Division – DIV

Group: GP

Hazardous Location: HAZ. LOC.

Intrinsically Safe: INT. SAFE or IS

### 5.5 Marking Drawings

5.5.1 The manufacturer's drawing delineating marking shall be reviewed prior to apparatus Approval and all subsequent revisions shall be reviewed by FM Approvals.

5.5.2 A reference to accompanying literature, that provides special installation, maintenance, or operating instructions. If this information is not on the apparatus, it shall be included or referenced on the control drawing.

## VI. MANUFACTURING REQUIREMENTS

### 6.1 Demonstrated Quality Control Program

6.1.1 A Quality Control Program is required to assure that each subsequent device 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.

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

- a) existence of corporate quality control guidelines;
- b) incoming assurance, including testing;
- c) in-process assurance, including testing;
- d) final testing and audit;
- e) equipment calibration;
- f) drawing and change control;
- g) packaging and shipping; and
- h) handling 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:

- a) engineering drawings;
- b) engineering change requests;
- c) engineering orders;
- d) 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)**

The facilities and procedure audit shall comply with the appropriate facilities and procedure audit Clause contained in the latest edition of the Approval Standard 3600.

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## APPENDIX A

### Additional Information

Appendix A is not part of this standard, but is included for informational purposes only.

- \*A2.2 Oxygen enrichment decreases the energy necessary for ignition. The minimum ignition energy of mixtures of flammable materials with oxygen may be one hundredth of that required for the same material mixed with air.

As a general rule, the minimum ignition energy is inversely proportional to pressure squared. When examining a situation where the gas mixture is not at atmospheric pressure, one must consider whether a flammable mixture exists at higher pressure conditions. When a gas mixture is at high pressure many flammable materials will condense.

- \*A3.2.4 If an enclosure is not dust-tight the possibility of reduction of spacings by conductive dusts must be considered. Therefore, the most hazardous combination of such reduction of spacings is specified. Typically, this would necessitate the device being evaluated with all capacitors considered to be paralleled, all inductors connected in series, and the effective resistive load on circuits supplying the device to the loads which produce the highest surface temperatures (maximum power transfer) and a short circuit (maximum ignition current).

Although Group G dusts are usually considered nonconductive, the same requirement is applied. It was not felt necessary to specify a different requirement and to sort out the possibility of degradation of dust characteristics over a long period of time in the presence of moisture, other conductive agents, etc. It is recognized that this requirement is excessive for Group G applications, especially where there is no possibility of the dust being wet and contaminated with conductive materials.

- \*A.3.3 The dust-tight enclosures defined by these requirements are intended to prevent potentially hazardous accumulation of dusts. These requirements are less stringent than requirements for enclosures for non-intrinsically safe equipment in Class II, Division 1 locations. Those latter enclosures must have more stringent requirements because the apparatus inside may be ignition capable by arc or temperature in normal operation. Such is not the case with intrinsically safe apparatus.

- \*A6.2 An initial inspection of the product manufacturing facility is part of the Approval investigation. Its purpose is to determine that equipment, procedures, and the manufacturer's controls are properly maintained to produce a product of the same quality as initially tested.

In accordance with the requirements contained in the FM Approvals Master Agreement form executed at the conclusion of each Approval project, follow-up inspections are required at least on an annual basis.

## APPENDIX B

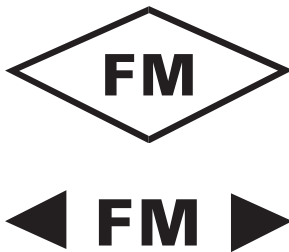
### FM Approvals Certification Marks

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.