



# **Approval Standard for Electrical Equipment for Use in Hazardous (Classified) Locations - General Requirements**

**Class Number 3600**

**December 2011**

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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 surveillance 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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# 1 INTRODUCTION

## 1.1 Purpose

This standard identifies the basis for Approval of electrical equipment for use in hazardous (classified) locations.

## 1.2 Scope

This standard is used in conjunction with the following other standards and standards listed in Paragraph 2.3:

**Note:** In the event of a conflict between the requirements of this general standard and one of the following specific standards, the requirements of the specific standard shall take precedence.

**1.2.1** The following standards are applicable to electrical equipment for Class I, II, or III, Division 1 or 2 hazardous (classified) locations.

**Table 1 - Standards for “Divisions”**

<i>Standard No.</i>	<i>Standard Title</i>
3610	Intrinsically Safe Apparatus and Associated Apparatus for Use in Class I, II and III, Division 1 Hazardous (Classified) Locations
3611	Electrical Equipment for Use in Class I, Division 2; Class II, Division 2; and Class III, Divisions 1 and 2 Hazardous (Classified) Locations
3613	Electric Flashlights and Lanterns for Use in Class I, II, and III, Division 2, Hazardous (Classified) Locations
3615	Explosionproof Electrical Equipment
3616	Dust-Ignitionproof Electrical Equipment
3620 (ANSI/NFPA 496)	Purged and Pressurized Electrical Equipment
6310/6320	Combustible Gas Detectors

**1.2.2** The following standards are applicable to electrical equipment for Class I, Zone 0, 1, or 2 hazardous (classified) locations.

**Table 2 – Standards for “Zones”**

<i>Standard No.</i>	<i>Standard Title</i>
ANSI/ISA 60079-0	Explosive atmospheres – Part 0: Equipment – General Requirements
ANSI/ISA 60079-1	Explosive Atmospheres – Part 1: Equipment protection by flameproof enclosures “d”
ANSI/ISA 60079-2	Explosive Atmospheres – Part 2: Equipment protection by pressurized enclosures “p”
ANSI/ISA 60079-5	Electrical Apparatus for Use in Class I, Zone 1 Hazardous (Classified) Locations. Type of Protection Powder Filling “q”.
ANSI/ISA 60079-6	Electrical Apparatus for Use in Class I, Zone 1 Hazardous (Classified) Locations. Type of Protection Oil Immersion “o”.

<i>Standard No.</i>	<i>Standard Title</i>
ANSI/ISA 60079-7	Explosive Atmospheres - Part 7: Equipment protection by increased safety "e"
ANSI/ISA 60079-11	Explosive Atmospheres – Part 11: Equipment protection by intrinsic safety "i"
ANSI/ISA 60079-15	Electrical apparatus for explosive gas atmospheres. Part 15: Electrical apparatus with type of protection "n"
ANSI/ISA 60079-18	Electrical Apparatus for Use in Class I, Zone 1 Hazardous (Classified) Locations. Type of Protection Encapsulation "m".
ANSI/ISA 60079-31	Explosive Atmospheres – Part 31: Equipment dust ignition protection by enclosure "t"
ANSI/ISA 61241-0	Electrical Apparatus for Use in Zone 20, Zone 21 and Zone 22 Hazardous (Classified) Locations — General Requirements
ANSI/ISA 61241-1	Electrical Apparatus for Use in Zone 21 and Zone 22 Hazardous (Classified) Locations — Protection by Enclosures "tD"
ANSI/ISA 61241-2	Electrical Apparatus for Use in Zone 21 and Zone 22 Hazardous (Classified) Locations — Protection by Pressurization "pD"
ANSI/ISA 61241-11	Electrical Apparatus for Use in Zone 20, Zone 21 and Zone 22 Hazardous (Classified) Locations — Protection by Intrinsic Safety "iD"
ANSI/ISA 61241-18	Electrical Apparatus for Use in Zone 20, Zone 21 and Zone 22 Hazardous (Classified) Locations — Protection by Encapsulation "mD"

### 1.2.3 Application

This standard shall apply to:

- a) Electrical equipment or parts of electrical equipment rated for use in Hazardous (Classified) Locations as defined by the National Electrical Code<sup>®</sup> (NEC<sup>®</sup>), ANSI/NFPA 70;
- b) Associated equipment located outside of the Class I, II or III location whose design and construction may influence those parts of the equipment within the classified location.

### 1.3 Basis for Approval

Approval is contingent upon satisfactory results of analysis of the product (compliance with this standard) and the manufacture of the product in the following major areas:

**1.3.1** Products for which an Approval Standard for product performance exists, shall also be examined in accordance with that Approval Standard. These standards typically include requirements for the following:

- the suitability of the product;
- 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.

**1.3.2** An examination of the manufacturing facilities and audit of quality control procedures shall be made to evaluate the manufacturer's ability to produce a product identical to that which was examined and tested, and the marking procedures used to identify the product. These examinations are repeated as part of FM Approvals' Surveillance Audit program.

#### 1.4 Basis for Continued Approval

Continued Approval is based upon:

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

#### 1.5 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 January 1, 2012 for full compliance with all requirements.

#### 1.6 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. Where units of measurement are expressed in SI units, no US customary units are provided.

## 2 GENERAL INFORMATION

### 2.1 Requirements

These requirements are based on consideration of ignition in locations made hazardous by the presence of flammable or combustible materials under normal atmospheric conditions. The following ranges of temperature, oxygen concentration, barometric pressure, and humidity may not be applicable for all Types of Protection (if not, these may be superseded by other values in the specific standard for the Type of Protection):

- a) ambient temperature range of  $-25^{\circ}\text{C}$  to  $+40^{\circ}\text{C}$ ;
- b) an oxygen concentration not greater than 21% by volume;
- c) a barometric pressure in the range of 0.8 atmosphere to 1.1 atmosphere.

### 2.2 Mechanisms of Ignition

This standard does not address mechanisms of ignition from external sources such as static electricity or lightning, which are not related to the electrical characteristics of the apparatus.

### 2.3 Applicability of Other Standards

Except where modified by the requirements of the standards listed in Paragraph 1.2, electrical equipment shall also comply with the applicable American National Standards Institute (ANSI)

requirements for ordinary locations. In the event that no ANSI Standard exists for the category of equipment, then FM Approval Standard “Electrical and Electronic Test, Measuring, and Process Control Equipment,” Class No. 3810, shall be used as the source document for basic safety requirements.

## 2.4 Classification and Grouping System

Electrical equipment for use in classified locations is identified by Class, Division (Zone), Group, and Temperature Class. A complete description of classifications is given in ANSI/NFPA 70, National Electrical Code®.

# 3 MARKING REQUIREMENTS

## 3.1 General

**3.1.1** In addition to marking information required of ordinary location electrical equipment (see Paragraph 2.3), equipment for use in Class I, II, or III, Division 1 or 2, hazardous (classified) locations shall be marked to show:

- a) The Class, Division, and Group rating according to Paragraph 2.4 of this standard; and
- b) The maximum operating temperature, or temperature class (T-Code) referenced to a 40°C or higher marked ambient according to the following table. Equipment which is Approved for both Class I and Class II shall be marked with the maximum operating temperature or temperature class, as determined by simultaneous exposure to the combinations of Class I and Class II conditions (i.e., dust-blanketing).
- c) Maximum ambient temperature, if greater than 40°C.
- d) Minimum ambient temperature, if less than -25°C.

### EXCEPTIONS:

Exception 1: Equipment of the non heat-producing type, such as junction boxes, conduit, and fittings and equipment of the heat producing type having a maximum operating temperature not more than 100°C shall not be required to have a marked operating temperature or temperature class (T-code).

Exception 2: Fixed luminaires for use in Class I, Division 2 or Class II, Division 2 locations only, shall not be required to be marked to indicate the group.

Exception 3: Equipment for use in Class II locations shall not exceed the ignition temperature of the specific rated dust or 165°C, whichever is lower, when installed in locations which are classified due to organic dusts that may dehydrate or carbonize.

Exception 4: The division marking is optional for all equipment except Division 2, in which case the Division 2 marking is required.

**Table 3. Temperature Class Marking (Division Equipment)**

<i>Max Temperature</i>	<i>Temperature Class</i>
°C	T-Code
450	T1
300	T2
280	T2A
260	T2B
230	T2C
215	T2D
200	T3
180	T3A
165	T3B
160	T3C
135	T4
120	T4A
100	T5
85	T6

Compliance shall be verified by measurement based on the highest temperature which may be attained in service under the most adverse conditions (but within rated values) by any part or surface of the equipment. The most adverse conditions include overloads and fault conditions recognized in the specific standard for the Type of Protection concerned.

Where used for temperature measurements, thermocouple wire shall be Type J or Type K conforming to the requirements for “Special Tolerance” as defined in the table of “Initial Calibration Tolerances for Thermocouples” in *Temperature Measurement Thermocouples*, ANSI/ISA MC96.1-1982.

Unless a specific measurement uncertainty is determined, the measured temperature shall be increased by the following:

5 K for measured temperatures less than or equal to 200°C

10 K for measured temperatures greater than 200°C

**3.1.2** Electrical equipment for use in Class I, Zone 0, 1, or 2, hazardous (classified) locations shall be marked in accordance with the Standards listed in 1.2.2.

Note: Electrical equipment examined for Class I, Zone 0, 1, or 2 is also permitted to be marked with comparable suitability for “Divisions” as permitted by the Standards listed in 1.2.2.

## 3.2 Permanence of Labelling

**3.2.1** Equipment labels containing the data required by this standard and its applicable sub-parts, including adhesion to the equipment enclosure material, shall not degrade due to exposure to chemicals of the Group for which the equipment is rated. Metal labels secured to the product by permanent mechanical means (e.g., drive screws) are considered satisfactory without further tests.

### EXCEPTIONS

Exception 1: Intrinsically Safe electrical equipment complying with Class 3610.

Exception 2: Electrical equipment for Class I, Zones 0, 1, or 2, complying with the standards listed in 1.2.2.

Exception 3: Electrical equipment for Class II or Class III.

Exception 4: Electrical equipment complying with Class 3611.

**3.2.2** Compliance shall be determined by conducting the material compatibility test according to Paragraph 4.2 and verifying that the label remains securely adhered to the equipment.

### 3.3 Additional Marking Information

Additional marking information is identified in standards according to Paragraph 1.2.1 or 1.2.2 for the Type of Protection rating of the equipment.

### 3.4 Marking of Small Equipment

Where the size of the electrical equipment is such that there is insufficient space to permit legible markings in accordance with clause 3, the markings may be included on the smallest unit package.

### 3.5 Marking of Metric Threaded Entries

When metric threaded entries are provided in lieu of NPT threaded entries, the entries must be identified by one of the following means:

- Marking adjacent to the threaded entry
- Text on the product marking identifying the entry thread

## 4 PERFORMANCE REQUIREMENTS

### 4.1 Mechanical Strength

The enclosure for electrical equipment rated for classified locations shall provide the mechanical strength required to resist impact, drop (if hand held or portable), and thermal shock. Damage to the enclosure as a result of impact or drop testing according to this Paragraph shall not invalidate the Type of Protection of the equipment. Superficial damage is not of concern; however, breakage of cooling fins, lens cracking, etc., depending upon the Type of Protection afforded by the equipment, shall be the subject of further investigation and test to assure repeatable satisfactory results.

#### EXCEPTION

Electrical equipment for Class I, Zones 0, 1, or 2, shall comply with the standards listed in 1.2.2.

#### 4.1.1 Drop Tests

Drop tests shall be conducted according to requirements for hand held or portable equipment according to the standards referenced in Paragraph 2.3.

#### 4.1.2 Resistance to Impact

The electrical equipment enclosure and attached parts (i.e., lenses, pilot lights, breather/drains, control operators, flame arrestors, etc.) are subject to the impact energy resulting from a test mass of 1 kg falling vertically from a height of 270 mm. The test mass shall be fitted with a steel hemisphere of 25 mm diameter. The equipment shall be positioned on (not installed in) a concrete surface to simulate rigid installation and the test weight directed to impact any surface of the equipment that may be affected. No location need be subjected to more than one impact. The equipment shall be tested

completely assembled, ready for use, and with any tool-secured guards installed that are normally supplied as part of the equipment. Ambient temperature for the test shall be  $(20 \pm 5)^\circ\text{C}$  except where the electrical enclosure or parts of the enclosure are made of polymeric material; in this case, the impact tests shall be repeated at the upper and lower ambient temperature of the device as marked on the equipment label or listed in product literature.

#### 4.1.3 Thermal Shock Test

This test is performed to verify that all enclosure components critical to the equipment Type of Protection can withstand rapid thermal variations.

A cloth saturated with water at a temperature of  $(10 \pm 5)^\circ\text{C}$  shall be applied to the applicable part with the part at maximum service temperature. Maximum service temperature is the temperature reached when the equipment is operating at maximum rated conditions.

The quantity of water and size of the cloth involved shall be sufficient to completely wet the surface of the equipment under test.

The thermal shock test is primarily intended for glass parts, but shall be conducted on any material that may be adversely affected.

The test results shall be considered satisfactory if no cracks or other failures that may invalidate the equipment Type of Protection are observed.

NOTE: The thermal shock test per ANSI/ISA 60079-0 is considered equivalent.

## 4.2 Non-Metallic Enclosure Materials—Chemical Compatibility for Class I Locations

**4.2.1** Nonmetallic enclosure materials (Exception: replaceable environmental seals, etc.), shall be resistant to chemical or physical change due to solvent exposure. As a result of chemical compatibility testing, there shall be no permanent change in properties that would compromise the Type of Protection afforded by the equipment.

NOTE 1 - Typically, a hardness measurement technique is used to examine for change in properties. Results may be considered satisfactory with no additional testing if there is no change in hardness greater than 15% of initial readings.

NOTE 2 - Additional testing may be required to determine whether the type of protection has been compromised. For example, non-metallic enclosures or parts of enclosures of explosionproof equipment may be subjected to the chemical vapor tests of 5.2.2, followed by mechanical strength tests per 5.1 and hydrostatic tests per FM 3615 to confirm that the type of protection has not been compromised.

### EXCEPTIONS

Exception 1: Materials not passing the required chemical compatibility test for one or more of the six test chemicals may be considered satisfactory if the product nameplate shows the exclusion of the chemical family(ies) from the Hazardous (Classified) rating of the equipment.

Example: "Not including acidic atmospheres"

Exception 2: Electrical equipment for Class I, Zones 0, 1, or 2.

Exception 3: Intrinsically safe electrical equipment complying with Class 3610.

Exception 4: Electrical equipment complying with Class 3611.

**4.2.2** Compliance shall be verified by subjecting the enclosure materials to the vapors of the following test chemicals, each in a closed vessel containing 4 fluid ounces per quart volume (120 cm<sup>3</sup>/l). The tests shall be conducted with the test samples suspended above the liquid level in the vessel and for a period of 150 hours at (20 ±5)°C. Measurement for change in critical properties of the material shall be conducted within one hour after removal from the solvent atmosphere.

**Table 4 – Chemical Families**

<i>Test Chemical</i>	<i>Representative Chemical Family</i>
Acetone	Ketones
Gasoline	Aliphatic Hydrocarbons
Hexane	Aliphatic Hydrocarbons
Methanol	Alcohols
Ethyl Acetate	Esters
Acetic Acid	Acids

### 4.3 Non-Metallic Enclosure Materials—Aging

#### 4.3.1 Requirements

- a) Rubber or neoprene materials that are relied upon for the Type of Protection of the equipment shall be subjected to an oxygen atmosphere at 70°C and 300 psi (2100 kPa) for 96 hours.
- b) All other materials shall be subjected to a test temperature of their maximum service temperature + 20K, but not less than 121°C, for a period of 14 days at atmospheric pressure. Maximum service temperature is the temperature reached when the equipment is operating at maximum rated conditions.

NOTE 1 - Typically, a hardness measurement technique is used to examine for change in properties. Results may be considered satisfactory with no additional testing if there is no change in hardness greater than 15% of initial readings.

NOTE 2 - Additional testing may be required to determine whether the type of protection has been compromised. For example, non-metallic enclosures or parts of enclosures of explosionproof equipment may be subjected to the aging tests of 5.3.1, followed by mechanical strength tests per 5.1 and hydrostatic tests per FM 3615 to confirm that the type of protection has not been compromised.

#### EXCEPTION

Electrical equipment for Class I, Zones 0, 1, or 2.

**4.3.2** Compliance shall be evaluated by reviewing how material changes during aging affect the equipment type of protection.

### 4.4 Metallic Enclosure Materials—Reactance

Copper or copper alloys shall not be used for electrical equipment enclosures intended for Class I, Group A classified locations unless they are coated with tin, nickel, or other coating that has been determined to comply with the requirements or the maximum copper content of the alloy is less than 30%.

Alloys shall not be used for electrical equipment enclosures if they contain, by mass, more than 7.5 % magnesium and titanium.

**Exception** - When the limit is exceeded, the product instructions shall contain sufficient information to enable the user to determine the suitability of the equipment for the particular application, for example, to avoid an ignition hazard due to impact or friction.

## 5 OPERATIONS REQUIREMENTS

### 5.1 Demonstrated Quality Control Program

**5.1.1** A Quality Control Program is required to assure that each subsequent unit produced by the manufacturer shall present the same quality 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 inspection and test
- in-process inspection and test
- final inspection and test
- equipment calibration
- drawing and change control
- packaging and shipping.

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

**5.1.2** 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.

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

### 5.2 Surveillance Audit Program

**5.2.1** 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 design quality as originally verified.

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

## APPENDIX A: 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.