



Member of the FM Global Group

Examination Standard for Electrical Equipment for Use in Hazardous (Classified) Locations – General Requirements

Class Number 3600

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Foreword

This standard 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 this standard is to present the criteria for examination of various types of products and services.

Examination in accordance with this standard shall demonstrate compliance and verify that quality control in manufacturing shall ensure a consistent and reliable product.

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1 INTRODUCTION

1.1 Purpose

- 1.1.1 This standard states testing and certification requirements for electrical equipment for use in hazardous (classified) locations.
- 1.1.2 Testing and certification criteria may include, but are not limited to, performance requirements, marking requirements, examination of manufacturing facility(ies), audit of quality assurance procedures, and a surveillance program.

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.
- FM Approvals Examination Standard 3610;
 - FM Approvals Examination Standard 3611;
 - FM Approvals Examination Standard 3613;
 - FM Approvals Examination Standard 3615;
 - FM Approvals Examination Standard 3616;
 - FM Approvals Examination Standard 3650;
 - FM Approvals Examination Standard 3620;
 - FM Approvals Examination Standard 6320; and
 - FM Approvals Examination Standard 7320.
- 1.2.2 The following standards are applicable to electrical equipment for Zone 0; Zone 1; Zone 2; Zone 20; Zone 21; or Zone 22 hazardous (classified) locations.
- ANSI/UL 60079-0;
 - ANSI/UL 60079-1;
 - ANSI/UL 60079-2;
 - ANSI/UL 60079-5;
 - ANSI/UL 60079-6;
 - ANSI/UL 60079-7;
 - ANSI/UL 60079-11;
 - ANSI/UL 60079-13
 - ANSI/UL 60079-15;
 - ANSI/UL 60079-18;
 - ANSI/UL 60079-25;
 - ANSI/UL 60079-26;

- ANSI/UL 60079-28;
- ANSI/UL 60079-30-1;
- ANSI/UL 60079-31;
- ANSI/UL 60079-33;
- ANSI/UL 80079-36; and
- ANSI/UL 80079-37.

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® (NEC®), ANSI/NFPA 70;
- b) Associated equipment located outside of the hazardous (classified) location whose design and construction may influence those parts of the equipment within the hazardous (classified) location.

1.3 Basis for Certification

Certification is based upon satisfactory evaluation of the product and the manufacturer in the following major areas:

1.3.1 Examination and tests on production samples shall be performed to evaluate:

- the suitability of the product;
- the proper operation and performance of the product as specified by the manufacturer and required for certification; 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 may be 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. Subsequent surveillance may be required by the certification agency in accordance with the certification scheme to ensure ongoing compliance.

1.4 Basis for Continued Certification

The basis for continual certification may include, but is not limited to, the following based upon the certification scheme and requirements of the certification agency:

- production or availability of the product as currently certified;
- the continued use of acceptable quality control procedures;
- satisfactory field experience;
- compliance with the terms stipulated by the certification;
- examination of production samples for continued conformity to requirements, and
- satisfactory surveillance audits conducted as part of the certification agency's product surveillance program.

1.5 Effective Date

The effective date of this certification standard mandates that all products tested for certification after the effective date shall satisfy the requirements of this standard.

The effective date of this standard is eighteen (18) months after the publication date of the standard for compliance with all requirements.

1.6 System of Units

Units of measurement used in this Standard are United States (U.S.) customary units. These are followed by their arithmetic equivalents in International System (SI) units, enclosed in parentheses. The first value stated shall be regarded as the requirement. The converted equivalent value may be approximate. Conversion of U.S. customary units is in accordance with ANSI/IEEE/ASTM SI 10.

1.7 Normative References

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies.

FM Approvals Examination Standard 3610, *Intrinsically Safe Apparatus and Associated Apparatus for Use in Class I, II and III, Division 1 Hazardous (Classified) Locations*

FM Approvals Examination Standard 3611, *Electrical Equipment for Use in Class I, Division 2; Class II, Division 2; and Class III, Divisions 1 and 2 Hazardous (Classified) Locations*

FM Approvals Examination Standard 3613, *Electric Flashlights and Lanterns for Use in Class I, II, and III, Division 2, Hazardous (Classified) Locations*

FM Approvals Examination Standard 3615, *Explosionproof Electrical Equipment*

FM Approvals Examination Standard 3616, *Dust-Ignitionproof Electrical Equipment*

FM Approvals Examination Standard 3620, *Purged and Pressurized Electrical Equipment*

FM Approvals Examination Standard 3650, *Electric Submersible Motors*

FM Approvals Examination Standard 3810, *Electrical Equipment for Measurement, Control and Laboratory Use*

FM Approvals Examination Standard 6320, *Combustible Gas Detectors*

FM Approvals Examination Standard 7320, *Electric Heaters and Catalytic Heaters*

ANSI/UL 60079-0, *Explosive atmospheres – Part 0: Equipment – General Requirements*

ANSI/UL 60079-1, *Explosive Atmospheres – Part 1: Equipment protection by flameproof enclosures “d”*

ANSI/UL 60079-2, *Explosive Atmospheres – Part 2: Equipment protection by pressurized enclosures “p”*

ANSI/UL 60079-5, *Explosive Atmospheres – Part 5: Equipment protection by Powder filling “q”*

ANSI/UL 60079-6, *Explosive Atmospheres – Part 6: Equipment protection by liquid immersion “o”*

ANSI/UL 60079-7, *Explosive Atmospheres - Part 7: Equipment protection by increased safety “e”*

ANSI/UL 60079-11, *Explosive Atmospheres – Part 11: Equipment protection by intrinsic safety “i”*

ANSI/UL 60079-13, *Explosive Atmospheres – Part 13: Equipment Protection by Pressurized Room “p” and Artificially Ventilated Room “v”*

ANSI/UL 60079-15, *Explosive Atmospheres – Part 15: Equipment protection by type of protection “n”*

ANSI/UL 60079-18, *Explosive Atmospheres – Part 18: Equipment protection by type of protection Encapsulation “m”*

ANSI/UL 60079-25, *Explosive Atmospheres – Part 25: Intrinsically Safe Electrical Systems*

ANSI/UL 60079-26, *Explosive Atmospheres – Part 26: Equipment with Equipment Protection Level (EPL) Ga*

ANSI/UL 60079-28, *Explosive Atmospheres – Part 28: Protection of Equipment and Transmission Systems using Optical Radiation*

ANSI/UL 60079-30-1, *Explosive Atmospheres – Part 30-1: Electrical Resistance Trace Heating – General and Testing Requirements*

ANSI/UL 60079-31, *Explosive Atmospheres – Part 31: Equipment dust ignition protection by enclosure “t”*

ANSI/UL 60079-33, *Explosive Atmospheres – Part 33: Equipment protection by special protection “s”*

ANSI/UL 80079-36, *Explosive Atmospheres – Part 36: Non-Electrical Equipment for Explosive Atmospheres – Basic Method and Requirements*

ANSI/UL 80079-37, *Explosive Atmospheres – Part 37: Non-Electrical Equipment for Explosive Atmospheres – Non-Electrical Type of Protection Constructional Safety*

ANSI/ASTM E230, *Standard Specification for Temperature-Electromotive Force (emf) Tables for Standardized Thermocouples*

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°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 Approvals Examination Standard 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.

2.5 Certification Application Requirements

The manufacturer shall provide the following preliminary information with any request for certification consideration:

- A complete list of all models, types, sizes, and options for the products or services being submitted for certification consideration;
- general assembly drawings, complete set of manufacturing drawings, materials list, anticipated marking format, piping and electrical schematics, conduit entry gauging, nameplate format, brochures, sales literature, spec. sheets, installation, operation and maintenance procedures, etc... ; and
- 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.

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 Table 1. Equipment which is certified 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 1. 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 ANSI/ASTM E230.

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 Zone 0; Zone 1; Zone 2; Zone 20; Zone 21; or Zone 22, hazardous (classified) locations shall be marked in accordance with the Standards listed in 1.2.2.

Note: Electrical equipment examined for Zone 0; Zone 1; Zone 2; Zone 20; Zone 21; or Zone 22 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 FM 3610.

Exception 2: Electrical equipment for Zone 0; Zone 1; Zone 2; Zone 20; Zone 21; or Zone 22, 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 FM Approvals Examination Standard 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 Zone 0; Zone 1; Zone 2; Zone 20; Zone 21; or Zone 22, 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/UL 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 4.2.2, followed by mechanical strength tests per 4.1 and hydrostatic tests per FM Approvals Examination Standard 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) shown in Table 2 from the Hazardous (Classified) rating of the equipment.

Example: “Not including acidic atmospheres”

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

Exception 3: Intrinsically safe electrical equipment complying with FM Approvals Examination Standard 3610.

Exception 4: Electrical equipment complying with FM Approvals Examination Standard 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 cm³/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 2 – 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 4.3.1, followed by mechanical strength tests per 4.1 and hydrostatic tests per FM Approvals Examination Standard 3615 to confirm that the type of protection has not been compromised.

Exception - Electrical equipment for Zone 0; Zone 1; Zone 2; Zone 20; Zone 21; or Zone 22.

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 and may be documented in the certification report.
- Continued conformance to this standard is verified by the certifiers surveillance program.
- Quality of performance is determined by field performance and by periodic re-examination and test.

5.1.2 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.

5.1.3 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.

5.1.4 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.

5.1.5 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 certification report, may be required to be reported to, and authorized by, the certification agency prior to implementation for production.
- Records of all revisions to all certified products shall be maintained..

5.2 Surveillance Audit Program

5.2.1 An audit of the manufacturing facility may be part of the certification agencies surveillance requirements 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 certified.

- 5.2.2 Certified products or services shall be produced or provided at, or provided from, location(s) disclosed as part of the certification examination. Manufacture of products bearing a certification mark is not permitted at any other location prior to disclosure to the certification agency.

6 BIBLIOGRAPHY

ISO/IEC 17025, *General Requirements for the Competence of Testing and Calibration Laboratories*.

ANSI/NFPA 70, *National Electrical Code*® (NEC®)