

Approval Standard for Nonincendive Electrical Equipment for Use in Class I and II, Division 2, and Class III, Divisions 1 and 2, Hazardous (Classified) Locations

Class Number 3611

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Foreword

Approval Standards are intended to verify that the products and services described will meet stated conditions of performance, safety and quality useful to the ends of property conservation. The purpose of Approval Standards is to present the criteria for Approval of various types of products and services, as guidance for FM Approvals personnel, manufacturers, users and authorities having jurisdiction.

Products submitted for Approval shall demonstrate that they meet the intent of the Approval Standard, and that quality control in manufacturing and/or applications shall ensure a consistently uniform and reliable product or service. Approval Standards strive to be performance-oriented and 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 Master Agreement, satisfactory performance in the field, on successful re-examinations of equipment, materials, and services as appropriate, and on periodic follow-up audits of the manufacturing facility or service/application.

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1.* PURPOSE

- 1.1 This standard states Approval criteria for electrical equipment for use in Class I and II, Division 2, and Class III, Divisions 1 and 2 hazardous (classified) locations as defined in Articles 500, 501, 502, and 503 of the National Electrical Code[®], ANSI/NFPA-70 (NEC[®]).
- 1.2 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 forfeit Approval.

The effective date of this Standard is **January, 2005** for compliance with all requirements.

2. SCOPE

- 2.1 This standard sets performance requirements for the construction and testing of electrical apparatus, or parts of such apparatus, for use in Class I and II, Division 2, and Class III, Divisions 1 and 2 hazardous (classified) locations.
- 2.2 Electrical equipment intended for use in Class I and II, Division 2, and Class III, Divisions 1 and 2 hazardous (classified) locations is apparatus in which any spark or thermal effect, produced under normal conditions, is incapable of causing ignition of a specified mixture of flammable or combustible material in air.
- 2.3 Application and Requirements
 - A. This standard applies only to equipment, circuits, or components designed and assessed specifically for use in Class I and II, Division 2, and Class III, Divisions 1 and 2 hazardous (classified) locations as defined by the NEC[®]. It is recognized that general purpose apparatus may also be suitable for Class I and II, Division 2, and Class III, Divisions 1 and 2 under certain conditions specified in the NEC[®].
 - B. This standard is primarily intended to provide requirements for process measurement and control equipment; however, the principles may be applied to similar types of electrical equipment.
 - C.* The requirements of this standard are based on consideration of ignition in locations made hazardous by the presence of flammable gases or vapor-in-air mixtures, or combustible dusts, and fibers, and flyings under normal atmospheric conditions. For the purposes of this standard, normal atmospheric conditions are considered to be:
 - a) an ambient temperature of -4°F (-20°C) to 104°F (40°C);
 - b) an oxygen concentration of not greater than 21 percent by volume; and
 - c) a pressure of 12.5 to 15.7 psia (86 to 108 kPa)

Note: EQUIPMENT SPECIFIED FOR ATMOSPHERIC CONDITIONS BEYOND THE ABOVE LIMITS IS SUBJECT TO SPECIAL INVESTIGATION.

2.4* Mechanisms of Ignition

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 equipment.

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2.5 Applicability of Other Standards

- A. Except where modified by the requirements of this standard, electrical equipment shall comply with the applicable requirements for ordinary locations, in accordance with Approval Standard 3600.
- B. This standard does not cover equipment for use in Class I and II, Division 1 hazardous locations, such as equipment constructed to be intrinsically safe, explosion-proof or dust-ignition proof; however, such equipment is suitable for use in Class I and II, Division 2, and Class III, Divisions 1 and 2 hazardous (classified) locations in the same Group for which it is suitable in Division 1 when installed in accordance with the NEC®.
- C. This standard does not cover equipment utilizing purged or pressurized enclosures; however, such equipment is considered suitable for use in Class I and II, Division 2 and Class III, Divisions 1 and 2 hazardous (classified) locations when designed to meet the requirements of ANSI/NFPA Standard 496-1998, Purged and Pressurized Enclosures for Electrical Equipment.
- D. For flashlights and lanterns the requirements of this standard are supplemented by Approval Standard 3613 “Electric Flashlights and Lanterns for Use in Class I, Division 2, Class I, Zone 2 Hazardous (Classified) Locations”
- E. This standard does not cover electric lighting fixtures for use in Division 2 hazardous (classified) locations.
- F. This standard does not cover electric motors, electric heaters, heat-tracing cables, and similar heat-producing devices, except where they are an integral part of the equipment under evaluation for use in Division 2 locations. The requirements covered in ANSI standards whose scope includes such equipment will be considered.

2.6 Basis for Requirements

See Approval Standard 3600.

2.7 Basis for Approval

Approval is based upon satisfactory evaluation of the product and the manufacturer. These requirements are listed in Approval Standard 3600.

2.8 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 assurance procedures;
- c) satisfactory field experience;
- d) compliance with the terms stipulated in the Master Agreement;
- e) re-examination as necessary, of production samples for continued conformity to requirements.

2.9 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 10-97 Standard for Use of the International System of Units (SI): The Modern Metric System. Where units of measurement are expressed in SI units, no US customary units may be provided.

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- 2.10 This document does not cover the requirements for Class I, Zone 2 except as permitted by NEC® (ANSI/NFPA 70:1999) Article 505-10 (b)(1). Specific requirements can be found in Approval Standard 3600 and ANSI/ISA 12.12.02 (IEC60079-15-1987 Mod).

3. DEFINITIONS

For purposes of this standard, the following terms apply:

- 3.1 **associated nonincendive field wiring apparatus:** Apparatus in which the circuits are not necessarily nonincendive themselves, but that affect the energy in nonincendive field wiring circuits and are relied upon to maintain nonincendive energy levels. Associated nonincendive field wiring apparatus may be either of the following:
- a) Electrical apparatus that has an alternative type of protection for use in the appropriate hazardous (classified) location or
 - b) Electrical apparatus not so protected that shall not be used in a hazardous (classified) location
- Note:** ASSOCIATED NONINCENDIVE FIELD WIRING APPARATUS HAS DESIGNATED ASSOCIATED NONINCENDIVE FIELD WIRING APPARATUS CONNECTIONS FOR NONINCENDIVE FIELD WIRING APPARATUS AND MAY ALSO HAVE CONNECTIONS FOR OTHER ELECTRICAL APPARATUS.
- 3.2 **control drawing:** A drawing or other document provided by the manufacturer of the nonincendive field wiring apparatus or the associated nonincendive field wiring apparatus that details the allowed interconnections with other circuits or apparatus.
- 3.3 **dust-tight:** Constructed in a manner that dust will not enter the enclosing case under specified test conditions.
- 3.4 **hermetically sealed device:** A device that is sealed against the entrance of an external atmosphere and in which the seal is made by fusion – e.g., soldering, brazing, welding, or the fusion of glass to metal.
- 3.5 **maintenance, corrective:** Any maintenance activity that is not normal in the operation of the equipment and requires access to the equipment's interior. Such activities are expected to be performed by qualified personnel who are aware of the hazards involved. Such activities typically include locating causes of faulty performance, replacing defective components, and adjusting service controls.
- 3.6 **maintenance, operational:** Any maintenance activity, excluding corrective maintenance, that is intended to be performed by the operator and is required for the equipment to serve its intended purpose. Such operational maintenance activities typically include the correcting of “zero” on a panel instrument, changing charts, keeping of records, and adding ink.
- 3.7 **make/break components:** Components having contacts that can interrupt a circuit (even if the interruption is transient in nature). Examples of make/break components are relays, circuit breakers, servo potentiometers, adjustable resistors, switches, and connectors.
- 3.8 **maximum external capacitance (C_a):** Maximum capacitance in a circuit that can be connected to the connection facilities of the apparatus.

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- 3.9 **maximum external inductance (L_a):** Maximum value of inductance in a circuit that can be connected to the connection facilities of the apparatus.
- 3.10 **maximum external inductance to resistance ratio (L_a/R_a):** Ratio of inductance (L_a) to resistance (R_a) of any external circuit that can be connected to the connection facilities of the electrical apparatus without invalidating nonincendive field wiring circuits.
- 3.11 **maximum input current (I_{max}):** Maximum current (peak a.c. or d.c.) that can be applied to the connection facilities of the apparatus.
- 3.12 **maximum input power (P_i):** Maximum power in an external circuit that can be applied to the connection facilities of the apparatus.
- 3.13 **maximum input voltage (V_{max}):** Maximum voltage (peak a.c. or d.c.) that can be applied to the connection facilities of the apparatus without invalidating the type of protection.
- 3.14 **maximum internal capacitance (C_i):** Total equivalent internal capacitance of the apparatus which is considered as appearing across the connection facilities of the apparatus.
- 3.15 **maximum internal inductance (L_i):** Total equivalent internal inductance of the apparatus which is considered as appearing at the connection facilities of the apparatus.
- 3.16 **maximum internal inductance to resistance ratio (L_i/R_i):** Ratio of inductance (L_i) to resistance (R_i) that is considered as appearing at the external connection facilities of the electrical apparatus.
- 3.17 **maximum output current (I_{SC}):** Maximum current (peak a.c. or d.c.) in a circuit that can be taken from the connection facilities of the associated nonincendive field wiring apparatus under normal operation. Normal operation includes opening, shorting, or grounding the field wiring.
- 3.18 **maximum output current — multiple channel apparatus (I_l):** The maximum dc or peak ac current that can be extracted from any combination of terminals of a multiple-channel associated nonincendive field wiring apparatus.
- 3.19 **maximum output power (P_o):** Maximum electrical power in a circuit that can be taken from the apparatus.
- 3.20 **maximum output voltage (V_{oc}):** Maximum output voltage (peak a.c. or d.c.) in a circuit that can appear under open-circuit conditions at the connection facilities of the associated nonincendive field wiring apparatus under normal operation.
- 3.21 **maximum output voltage — multiple channel apparatus (V_l):** The maximum dc or peak ac open circuit voltage that can appear across any combination of terminals of a multiple-channel associated nonincendive field wiring apparatus.
- 3.22 **nonincendive circuit*:** A circuit, other than nonincendive field wiring, in which any arc or thermal effect produced under intended operating conditions of the equipment is not capable, under specified test conditions, of igniting the flammable gas-, vapor-, dust-air mixture, fibers or flyings.
- 3.23 **nonincendive component:** Construction of a component having contacts for making or breaking an incendive circuit and the contacting mechanism such that the component is incapable of igniting the specified flammable gas- or vapor-air dust-air mixture fibers or flyings. The housing of a nonincendive component is not intended to exclude the flammable atmosphere or contain an explosion.

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- 3.24 **nonincendive equipment:** Equipment having electrical/electronic circuitry that is incapable, under normal operating conditions, of causing ignition of a specified flammable gas-, vapor-, or dust-air mixture of fibers or flyings due to arcing or thermal means.
- 3.25 **nonincendive field wiring*:** Wiring that enters or leaves an equipment enclosure and, under normal operating conditions of the equipment, is not capable, due to arcing or thermal effects, of igniting the flammable gas-, vapor-, or dust-air mixture fibers or flyings. Normal operation includes opening, shorting, or grounding the field wiring.
- 3.26 **normal operating conditions:** Conditions under which equipment conforms electrically and mechanically with its design specification and is used within the conditions specified by the manufacturer. These conditions include:
- a) supply voltage, current, and frequency;
 - b) environmental conditions (including process interface);
 - c) all tool-removable parts, (e.g. covers) in place;
 - d) all operator-accessible adjustments at their most unfavorable settings; and
 - e) opening or grounding of any one or shorting of any two of the nonincendive field-wiring conductors.
- 3.27 **operator-accessible part:** A part that is intended for adjustment, switching, or replacement by the operator during intended use or operational maintenance, or a part that is readily accessible to the operator without the use of a tool.
- 3.28 **sealed device:** A device so constructed that it cannot be opened during normal operational conditions or operational maintenance; it is sealed to restrict entry of an external atmosphere. See Section 13 for detailed requirements for sealed devices.
- 3.29 **nonincendive field wiring apparatus:** Apparatus intended to be connected to nonincendive field wiring.
- 3.30 **unclassified locations:** Locations that have been evaluated by the classification process defined in ANSI/NFPA 70 and determined to be neither Class I, Division 1; Class I, Division 2; Class I, Zone 0; Class I, Zone 1; Class I, Zone 2; Class II, Division 1; Class II, Division 2; Class III, Division 1; Class III, Division 2; or any combination thereof.
- 3.31 **maximum output power – multiple channel apparatus (Pt):** The maximum power that can be extracted from any combination of terminals of a multiple-channel associated nonincendive field wiring apparatus.
- 3.32 **current controlled nonincendive field wiring apparatus:** apparatus where the input current is regulated within a set of specific limits as defined by the manufacturer.

Note: THE CURRENT MAY BE REGULATED AT SPECIFIC VALUES WITHIN THE RANGE DEPENDING UPON THE CONDITION BEING MONITORED, FOR EXAMPLE; AS IS THE CASE IN TYPICAL 4-20MA CONFIGURATION.

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4. GENERAL REQUIREMENTS

Requirements for equipment intended to be used in Class I and Class II, Division 2 and Class III, Division 1 and 2 hazardous (classified) locations are established on the basis that the equipment in its normal operating condition is incapable of causing ignition of a specified flammable gas, vapor-in-air mixture, dust, or fibers, or flyings. The tolerances associated with the components of the equipment must be considered. Subsequent arcs or thermal effects within the equipment, resulting from opening, shorting, or grounding of nonincendive field wiring, shall be taken into consideration as they affect the suitability of the equipment for use in Division 2 locations. Equipment also shall comply with the ordinary location requirements for the particular category of equipment except as specifically amended herein.

5. REQUIREMENTS FOR CLASS I, DIVISION 2 EQUIPMENT

5.1 Protection shall be provided according to 5.1.1 and 5.1.2 to ensure that under normal operating conditions such equipment is not capable of igniting the specified flammable gas or vapor-in-air mixture.

5.1.1* Each make/break component shall be either:

- a) a normally nonarcing component that meets the requirements of Section 8;
- b) used in a nonincendive circuit that meets the requirements of Section 7;
- c) a nonincendive component that meets the requirements of Section 12; or
- d) a sealed device that meets the requirements of Section 13;

5.1.2 Equipment with a surface temperature in excess of 212°F (100°C) shall comply with the requirements of Section 10.

5.2 Enclosures shall provide protection to prevent deterioration of the equipment that would adversely affect its suitability for use in Class I, Division 2 locations. Although general-purpose enclosures normally will suffice, particular attention should be given to the possible need for weatherproofing, general protection from corrosion, and preventive maintenance.

5.3 Equipment shall be capable of being installed according to the requirements of the NEC[®] ANSI/NFPA 70.

5.4* Fuses used in circuits that are subject to overloading in normal use must be of a type suitable for use in Division 2 locations or housed in an enclosure suitable for Division 1 locations.

5.5* If a replaceable fuse is provided, a switch suitable for the location where it is installed must also be provided to remove power from the fuse. The switch need not be integral to the equipment if the equipment installation instructions indicate the need for such a switch.

5.6 A circuit breaker that may be used as a switch must be of a type suitable for use in Division 1 locations or housed in an enclosure suitable for Division 1 locations.

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6. REQUIREMENTS FOR CLASS II, DIVISION 2 AND CLASS III, DIVISION 1 AND 2 EQUIPMENT

- 6.1* For Class II, Division 2 equipment, protection shall be provided by the use of an enclosure that meets the requirements of Section 13 or 14 or shall be a nonincendive circuit meeting the requirements of Section 7 with consideration for possible ignition in accordance with Section 7.1.1 due to the ingress of dust (see NOTE below), or by a combination of these methods. For Class III locations, protection shall be provided by a dust-tight enclosure that meets the requirements of Section 14.

Note: CONSIDERATION MUST BE GIVEN TO SHORTING OR BYPASSING COMPONENTS BY CONDUCTIVE DUST.

Exception: *Portable battery-powered equipment for use in Class II, Group G or Class III, need not have all electrical components and wiring enclosed provided both the following conditions are met:*

- a) Entrance of dust does not result in ignition or charring of the dust; and
- b) Circuits with make/break components shall be determined to be nonincendive by testing with a propane-air mixture in accordance with the spark-ignition test. See 11.1 through 11.5 or 7.1.

7.* NONINCENDIVE CIRCUITS AND NONINCENDIVE FIELD WIRING

- 7.1* Either of the following two methods may be employed to determine that a circuit(s) or field wiring is nonincendive:

- a) Testing the circuit according to Section 11; or
- b) Comparing the maximum calculated or measured values of current, voltage, and associated inductances and capacitances to the appropriate values in Figures B-1 through B-8 in Appendix B to establish that the current and voltage levels are below those specified in 7.1.2. For Class II and III locations the curves for propane are to be used.

Note: FIGURES B-1, B-2, B-3, B-4, B-7, AND B-8 APPEARING IN APPENDIX B ARE BASED ON INFORMATION IN CERTIFICATION STANDARD SFA 3012, 1972 EDITION, DEPARTMENT OF TRADE AND INDUSTRY, BRITISH APPROVAL SERVICE FOR ELECTRICAL EQUIPMENT IN FLAMMABLE ATMOSPHERES. FIGURES B-5 AND B-6 ARE BASED ON INFORMATION IN "SOME ASPECTS OF THE DESIGN OF INTRINSICALLY SAFE CIRCUITS," RESEARCH REPORT 256, 1968, BY D. W. WIDGINTON, SAFETY IN MINES RESEARCH ESTABLISHMENT, SHEFFIELD, ENGLAND. FIGURES B-7 AND B-8 REPRESENT CAPACITOR DISCHARGE ONLY. THEY DO NOT INCLUDE THE ADDITIONAL CURRENT THAT MAY BE AVAILABLE FROM THE POWER SUPPLY.

- 7.2 When evaluating a circuit as nonincendive, the following ignition sources shall be considered as normal operating conditions:

- a) Discharge of capacitive circuits;
- b) Interruption of inductive circuits;
- c) Intermittent making and breaking of resistive circuits; and
- d) Grounding opening and shorting on nonincendive field wiring circuits.

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7.3* The maximum voltage and current levels (DC or AC peak) in circuits determined to be nonincendive by the comparison method, for given circuit constants, shall be less than:

- a) 90% of the current from Figures B-1 through B-6, and
- b) 90% of the voltage from Figures B-7 and B-8.

Figures B-1 and B-2 apply only to circuits whose output voltage/current characteristic is a straight line drawn between open-circuit voltage and short-circuit current.

Circuits with nonlinear outputs shall be subject to special investigation.

The maximum normal open-circuit voltage and the maximum short-circuit current shall be determined under the worst-case normal operating conditions.

7.4* For evaluating nonincendive field wiring of equipment supplying energy, use the maximum normal circuit voltage V_{OC} (or V_t), and maximum short circuit current I_{SC} (or I_t), employing applicable ignition figures in Appendix B to determine the maximum allowable connected capacitance, C_a , and maximum allowable connected inductance, L_a , respectively.

7.5* The Nonincendive Field Wiring Circuits Concept allows interconnection of nonincendive apparatus with associated nonincendive apparatus not specifically examined in combination as system when:

$$V_{max} \geq V_{OC} \text{ or } V_t; C_a \geq C_i + C_{cable}; L_a \geq L_i + L_{cable}$$

7.6 Nonincendive field wiring enables interconnection of nonincendive field wiring apparatus with associated nonincendive field wiring apparatus not specifically examined in combination as a system under one of the following conditions:

a) Current Controlled

Normal operating current controlled or limited by the nonincendive field wiring apparatus (unlike the requirements for intrinsically safe apparatus I_{max} of the nonincendive field wiring apparatus need not be greater than the I_{SC} of the associated nonincendive field wiring apparatus)

$$V_{max} \geq V_{OC} \text{ or } V_t; C_a \geq C_i + C_{cable}; L_a \geq L_i + L_{cable}$$

b) Not Current Controlled

Normal operating voltage or current not controlled or limited by the nonincendive field wiring apparatus

$$V_{max} \geq V_{OC} \text{ or } V_t; I_{max} \geq I_{SC} \text{ or } I_t; C_a \geq C_i + C_{cable}; L_a \geq L_i + L_{cable}$$

Note: I_{MAX} MIGHT ALSO BE THE RATED CURRENT OF THE DEVICE.

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