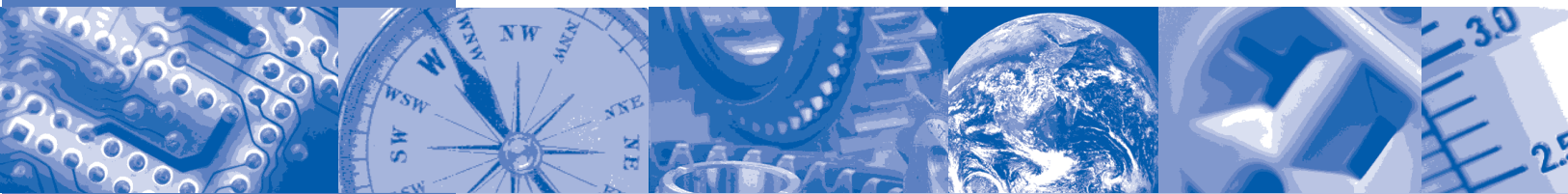


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Nonincendive Electrical Equipment for Use in Class I and II, Division 2 and Class III, Divisions 1 and 2 Hazardous (Classified) Locations



**ISA—The Instrumentation,
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1 Purpose

1.1* The purpose of this standard is to provide minimum requirements for the design, construction, and marking of electrical equipment or parts of such equipment for use in Class I and Class II, Division 2 and Class III, Divisions 1 and 2 hazardous (classified) locations. This equipment, in normal operation, is incapable of causing ignition of the surrounding atmosphere under the conditions prescribed in this standard, although the equipment may contain electronic components that operate at incandive levels and may also have field wiring that is incandive. In addition, it is the intent of this document to establish uniformity in test methods for determining the suitability of the equipment and associated circuits and components as they relate to potential ignition of a specific flammable gas or vapor-in-air mixture, combustible dust, easily ignitable fibers, or flyings.

2 Scope

2.1 This standard applies only to equipment, circuits, and components designed specifically for use in Class I and II, Division 2 and Class III, Divisions 1 and 2 hazardous (classified) locations as defined in the National Electrical Code® (NEC®) ANSI/NFPA 70.

NOTE — Some equipment designed for use in ordinary locations is permitted by the NEC® for installing in Division 2 locations. The judgment of acceptability for the installation would be determined by the authority having jurisdiction. Such equipment would not have the hazardous location marking or documentation described in this standard. It is anticipated that such equipment would comply with the other requirements in this standard and that the determination of compliance is elementary (e.g., a nonarcing instrument inside a NEMA Type 4 or 12 enclosure used in a Class II, Division 2 location).

2.2 This standard also applies to certain ordinary (unclassified) location equipment specifically designed to directly connect to nonincandive field wiring in Class I and II, Division 2 and Class III, Divisions 1 and 2 hazardous (classified) locations as defined in the NEC®.

2.3 This standard is primarily intended to provide requirements for electrical and electronic test, measuring, and controlling equipment.

2.4 This standard is concerned only with equipment construction and test criteria related to electrical or thermal ignition of specified flammable gases, vapors, combustible dusts, fibers, and flyings in air.

2.5 This standard is not intended to cover equipment for use in Class I and Class II, Division 1 locations, such as equipment constructed to be intrinsically safe, dust ignition-proof, or explosion-proof. Such equipment is, however, suitable for use in Class I and Class II, Division 2 locations in the same group for which it is suitable in Division 1.

2.6* This standard does not cover mechanisms of ignition from external sources, such as static electricity or lightning, that are not related to the electrical characteristics of the equipment.

2.7 This standard is not intended as an instructional manual for untrained persons. It is intended to promote uniformity of practice among those skilled in the area of design, construction, and application of equipment suitable for Class I and Class II, Division 2 and Class III, Divisions 1 and 2 locations.

2.8* The requirements of this standard are based on consideration of ignition in locations made hazardous by the presence of flammable gases, vapors, combustible dusts, fibers, and flyings under the following ambient conditions:

NOTE — An asterisk following a word or a clause number signifies that explanatory material appears in annex A.

- a) an ambient temperature of -20°C to 40°C
- b) an oxygen concentration of not greater than 21 percent by volume
- c) a pressure of 80 kPa (0.8 bar) to 110 kPa (1.1 bar)

NOTE — If equipment is specified to operate in conditions outside the ranges listed above, the requirements of this standard may not ensure the desired level of safety.

2.9 This standard covers portable battery-powered equipment other than flashlights and lanterns for Class I and Class II, Division 2, and Class III, Divisions 1 and 2 hazardous (classified) locations.

2.10 This standard does not cover equipment that utilizes purged or pressurized enclosures. Such equipment is, however, considered suitable for use in Class I and Class II, Division 2 locations when designed to meet the requirements of ANSI/NFPA 496.¹

2.11 This standard does not cover electric lighting fixtures for use in Division 2 hazardous (classified) locations.

2.12 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.

3 Definitions

For the purposes of this standard, the following definitions 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
- 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 or associated nonincendive field wiring apparatus that details the allowed interconnections with other circuits or equipment. The control drawing includes the applicable electrical parameters to permit selection of equipment for interconnection.

3.3 dust-tight:

so constructed that dust will not enter the enclosing case under specified test conditions.

¹ NFPA Standard 496-1998, Purged and Pressurized Enclosures for Electrical Equipment in Hazardous (Classified) Locations

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 equipment.

3.9 maximum external inductance (L_a):

maximum value of inductance in a circuit that can be connected to the connection facilities of the nonincendive field wiring equipment.

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 nonincendive field wiring equipment without invalidating nonincendive safety.

3.11 maximum input power (P_i):

maximum power in an external circuit that can be applied to the connection facilities of the equipment.

3.12 maximum input voltage (V_{max}):

maximum voltage (peak a.c. or d.c.) that can be applied to the connection facilities of the equipment without invalidating the type of protection.

3.13 maximum internal capacitance (C_i):

total equivalent internal capacitance of the equipment, which is considered as appearing across the connection facilities of the equipment.

3.14 maximum internal inductance (L_i):

total equivalent internal inductance of the equipment which is considered as appearing at the connection facilities of the nonincendive field wiring equipment.

3.15 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 nonincendive field wiring equipment.

3.16 maximum normal 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 equipment.

3.17 maximum normal 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 equipment under normal operation.

3.18 maximum output power (P_o):

maximum electrical power in a circuit that can be taken from the equipment.

3.19 nonhazardous locations:

locations which are not required to have been evaluated by the process defined in ANSI/NFPA 70:1999 Section 500-5 (a) or Section 505-5 (a).

3.20* nonincendive circuit:

a circuit, other than 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-, or dust-air mixture.

3.21 nonincendive component:

a component having contacts for making or breaking an incendive circuit and the contacting mechanism shall be constructed so that the component is incapable of igniting the specified flammable gas or vapor-air mixture. The housing of a nonincendive component is not intended to exclude the flammable atmosphere or contain an explosion.

3.22 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 due to arcing or thermal means.

3.23* 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. Normal operation includes opening, shorting, or grounding the field wiring.

3.24 nonincendive field wiring apparatus:

apparatus intended to be connected to nonincendive field wiring.

3.25 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.

3.26 operator-accessible:

readily accessible to the operator during normal use without use of a tool.

3.27 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 clause 13 for detailed requirements for sealed devices.

3.28 unclassified locations:

locations that have been evaluated by the classification process defined in ANSI/NFPA 70:1999 Section 500-5 (a) or Section 505-5 (a) 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.

4 General requirements

Requirements for equipment intended to be used in Class I and Class II, Division 2 and Class III, Divisions 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, fibers, or flyings. The tolerances associated with the components of the equipment shall 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 equipment² 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 clause 8;
- b) used in a nonincendive circuit that meets the requirements of clause 7;
- c) a nonincendive component that meets the requirements of clause 12; or
- d) a sealed device that meets the requirements of clause 13.

5.1.2 Equipment with a surface temperature in excess of 100°C shall comply with the requirements of clause 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.

² ANSI/ISA-82.02.01-1999 (IEC 1010-1 Mod), Safety Standard for Electrical and Electronic Test, Measuring, Controlling, and Related Equipment - General Requirements; ANSI/ISA-82.02.02-1996 (IEC 1010-2-031), Safety Requirements for Electrical Equipment for Measurement, Control and Laboratory Use (Identical to IEC 1010-2-031: Particular Requirements for Hand-Held Probe Assemblies for Electrical Measurement and Test); ANSI/ISA-82.02.04-1996 (IEC 1010-2-032), Safety Requirements for Electrical Equipment for Measurement, Control, and Laboratory Use (Identical to IEC 1010-2-032: Particular Requirements for Hand-Held Current Clamps for Electrical Measurement and Test); and ISA-82.03-1988, Safety Standard for Electrical and Electronic Test, Measuring, Controlling, and Related Equipment (Electrical and Electronic Process Measurement and Control Equipment) (Partial Revision and Redesignation of ANSI C39.5-1974).

NOTE — Although general-purpose enclosures normally will suffice, particular attention should be given to the possible need for weatherproofing, general protection from corrosion (e.g., ANSI/UL 50, Enclosures for Electrical Equipment), and preventive maintenance.

5.3 Equipment shall be capable of being installed according to the applicable requirements of the NEC®.

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

NOTE — This subclause precludes a fuse housed in a general-purpose enclosure from being used in a motor circuit where a possibility of a stalled motor opening the fuse exists, or where there is the possibility of an overload not caused by a fault in the circuit.

5.5* If a fuse is provided, a switch suitable for the location where it is installed shall 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 shall be of a type suitable for use in Division 2 locations or alternatively protected for use in Division 1 locations.

6 Requirements for Class II, Division 2 and Class III, Divisions 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 clause 13 or 14 or shall be a nonincendive circuit meeting the requirements of clause 7, with consideration for possible ignition in accordance with 7.2 due to the ingress of dust 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 clause 14.

NOTE — Consideration shall 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
- 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 clause 11
- b) Comparing the maximum calculated or measured values of current, voltage, and associated inductances and capacitances to the appropriate values in figures 1 through 8 to establish that the current and voltage levels are below those specified in 7.3; for Class II and III locations the curves for propane are to be used

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
- d) Grounding, opening, and shorting of nonincendive field wiring circuits

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

- a) the current from figures 1 through 6; and
- b) the voltage from figures 7 and 8.

The maximum normal output voltage and the maximum short-circuit current shall be determined under the worst-case normal operation.

NOTE — Figures 1 and 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 are subject to special investigation.

7.4* Use the maximum normal output circuit voltage (V_{oc}), and maximum short-circuit current (I_{sc}) of associated nonincendive field wiring apparatus. Employ applicable ignition figures 1 to 8 to determine the maximum allowable connected capacitance (C_a) and maximum allowable connected inductance (L_a).

7.5* For evaluating nonincendive field wiring apparatus, determine the maximum unprotected capacitance (C_i) and maximum unprotected inductance (L_i). These parameters shall be below the limits shown in figures 1 to 8 based on the maximum normal input voltage (V_{max}) and the maximum normal input current (I_{max}) of the nonincendive field wiring apparatus.

7.6* For nonincendive field wiring circuit evaluations the maximum normal input voltage (V_{max}) of the nonincendive field wiring apparatus shall be equal to or greater than the maximum normal open circuit voltage (V_{oc}) of the associated nonincendive field wiring apparatus. Additionally, the maximum normal input current (I_{max}) of the nonincendive field wiring apparatus shall be equal to or greater than the maximum normal short circuit current (I_{sc}) of the associated nonincendive field wiring apparatus.

EXCEPTION: For nonincendive field wiring apparatus that controls its own normal operating current, the maximum normal input current (I_{max}) of the nonincendive field wiring apparatus need not correspond to the maximum normal output current (I_o) of the associated nonincendive field wiring apparatus (e.g., 4-20 mA measurement and control devices). Likewise, the maximum normal input voltage (V_{max}) of nonincendive field wiring apparatus that controls its own normal operating voltage need not be greater than the maximum normal output voltage (V_{oc}) of the associated nonincendive field wiring apparatus (e.g., current to pressure valve controllers that are voltage clamped at the terminals). Details of the permitted connections shall be provided on a control drawing.

7.7 Nonincendive field wiring enables interconnection of nonincendive field wiring apparatus with associated nonincendive field wiring apparatus not specifically examined in combination as a system when one of the following conditions is true:

- a) Normal operating voltage or current not controlled by the nonincendive field wiring apparatus

$$V_{max} \geq V_{oc}; I_{max} \geq I_{sc}; C_a \geq C_i + C_{cable}; L_a \geq L_i + L_{cable}$$