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Standard

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

ISA-S12.12 — Nonincendive Electrical Equipment for Use in Class I and II, Division 2 and Class III, Divisions 1 and 2 Hazardous (Classified) Locations

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Contents

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 incendive levels and may also have field wiring that is incendive. 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 ignitible 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).

> **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 nonincendive field wiring in Class I and II, Division 2 and Class III, Divisions 1 and 2 hazardous (classified) locations as defined in the National Electrical Code.

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.

***NOTE:** An asterisk following a word or a section number signifies that explanatory material appears in the Appendix.

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 art 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:

a) an ambient temperature of –13°F (–25°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: 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, Class II, Division 2 and Class III, Divisions 1 and 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 dust-tight: So constructed that dust will not enter the enclosing case under specified test conditions.

3.2 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.

3.3 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.

[1]NFPA Standard 496-1993, Purged and Pressurized Enclosures for Electrical Equipment in Hazardous (Classified) Locations.

3.4 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.

3.5 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.

3.6 nonincendive circuit*: A circuit in which any arc or thermal effect produced under normal operating conditions of the equipment is not capable, under the conditions prescribed in this standard, of igniting the specified flammable gas, vapor-in-air mixture, dust, fibers, or flyings.

3.7 nonincendive component: Component having contacts for making or breaking a specified incendive circuit in which the contacting mechanism is constructed so that the component is not capable of ignition of the specified flammable gas or vapor-in-air mixture, when tested according to Section 12. The housing of a nonincendive component is not intended to either (1) exclude the flammable atmosphere or (2) contain an explosion.

3.8 nonincendive equipment: Equipment having electrical/electronic circuitry that is incapable, under normal operating conditions, of causing ignition of a specified flammable gas or vapor-in-air mixture due to arcing or thermal means.

3.9 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 effect, of igniting a specified flammable gas, vapor-in-air mixture, dust, fibers, or flyings. Normal operating conditions include opening, shorting, or grounding the field wiring.

3.10 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.

3.11 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.

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 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[2] 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 100°C (212°F) 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 National Electrical Code.

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.

> **NOTE:** This subsection 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 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 2 locations or housed in an enclosure suitable for Division 1 locations.

[2] ANSI/ISA-S82.01, S82.02, and S82.03-1988, Safety Standard for Electrical and Electronic Test, Measuring, Controlling and Related Equipment.

6 Requirements for Class II, Division 2, 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 Section 13 or 14 or shall be a nonincendive circuit meeting the requirements of Section 7, 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 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 1 through 8 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.[3]

7.1.1 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; and

c) Intermittent making and breaking of resistive circuits.

7.1.2* The maximum voltage and current levels (DC or AC peak) in circuits determined to be

[3] Figures 1, 2, 3, 4, 7, and 8 are reprints from Certification Standard SFA 3012, 1972 Edition, with permission of the Department of Trade and Industry, British Approvals Service, for Electrical Equipment in Flammable Atmospheres. Figures 5 and 6 are from "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 7 and 8 represent capacitor discharge only. They do not include the additional current that may be available from the power supply.

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.

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 shall be subject to special investigation.

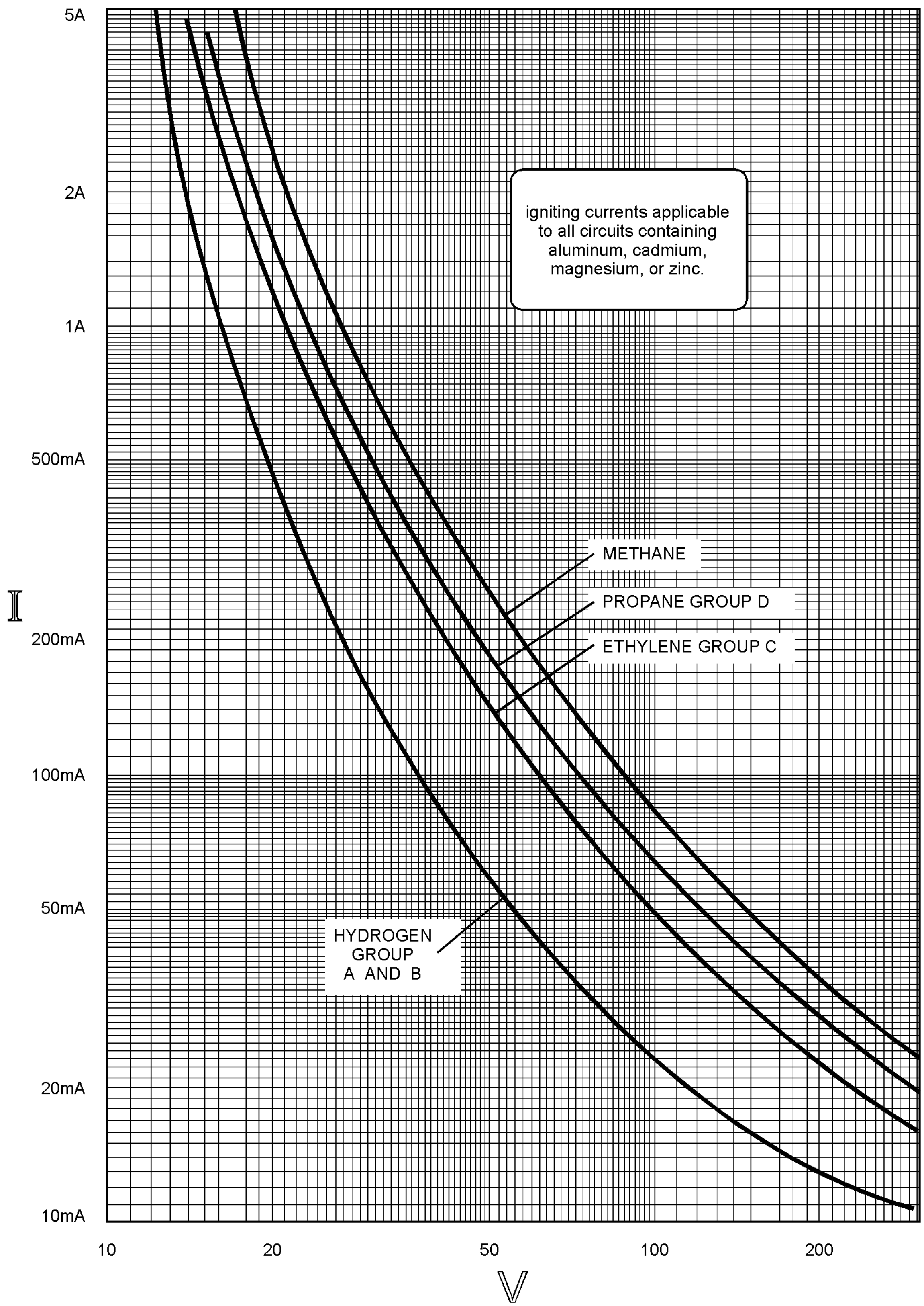

Figure 1 — Resistance circuits (L≤5 μH)

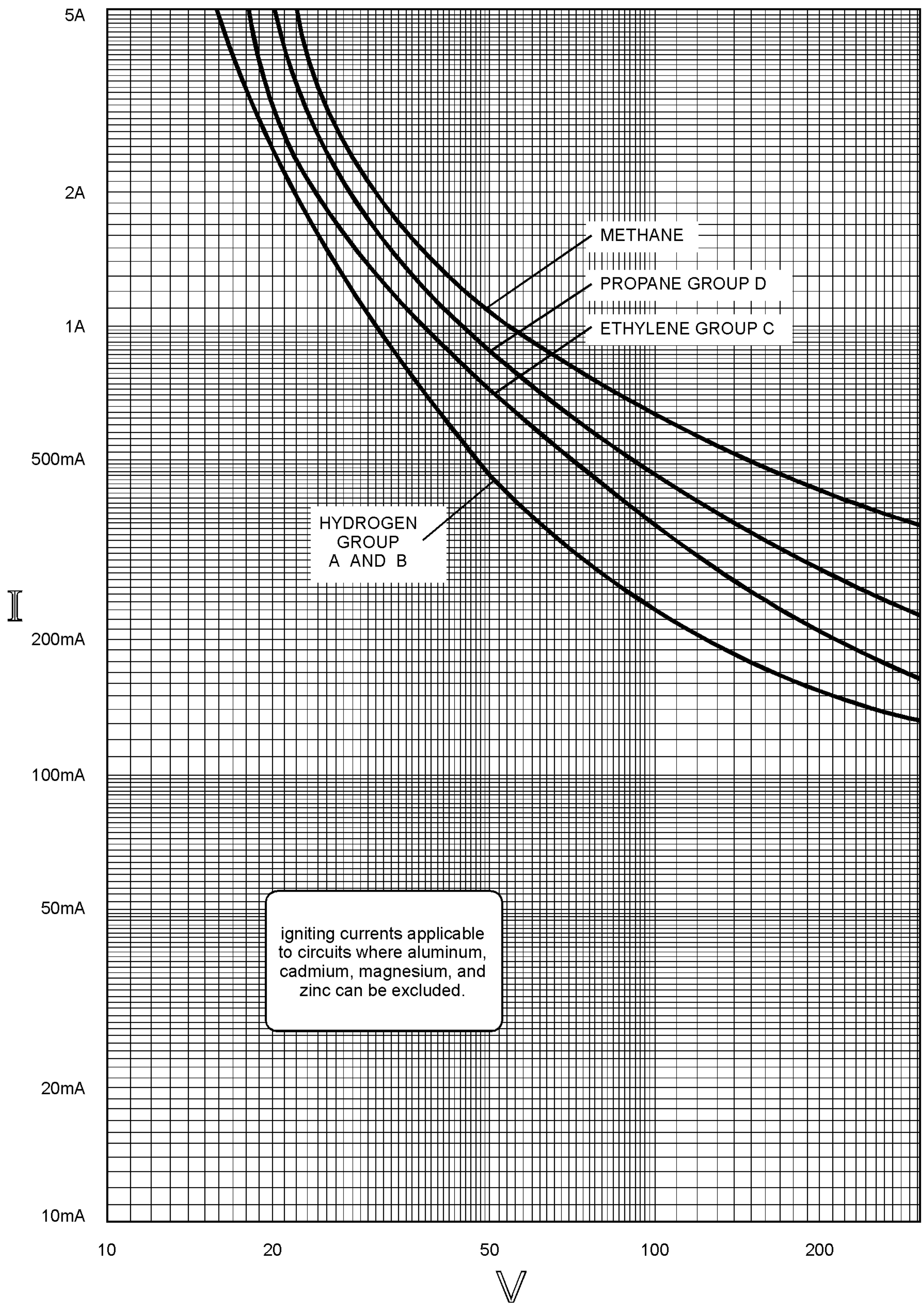

Figure 2 — Resistance circuits (L≤5 μH)

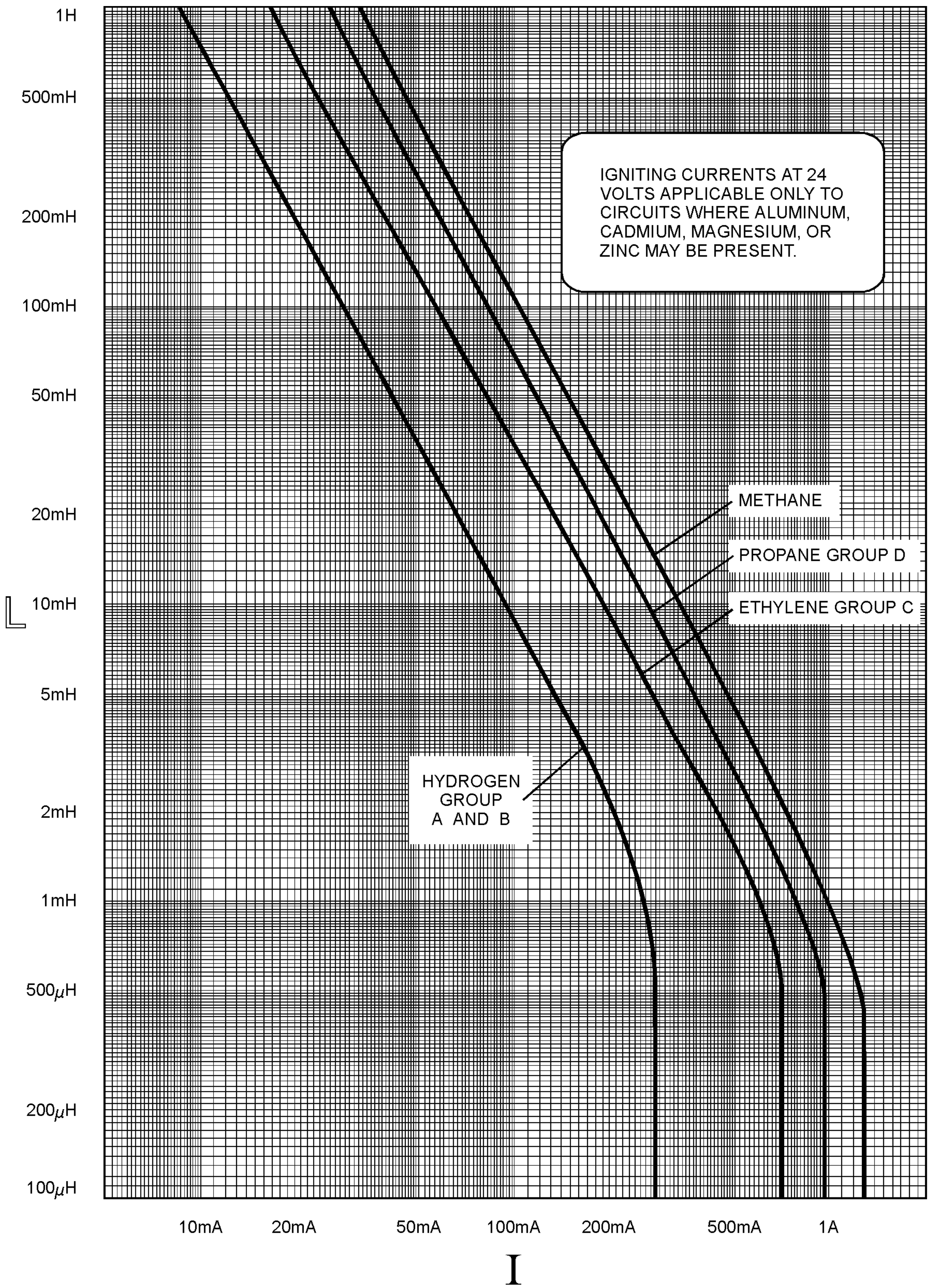

Figure 3 — Inductance circuits

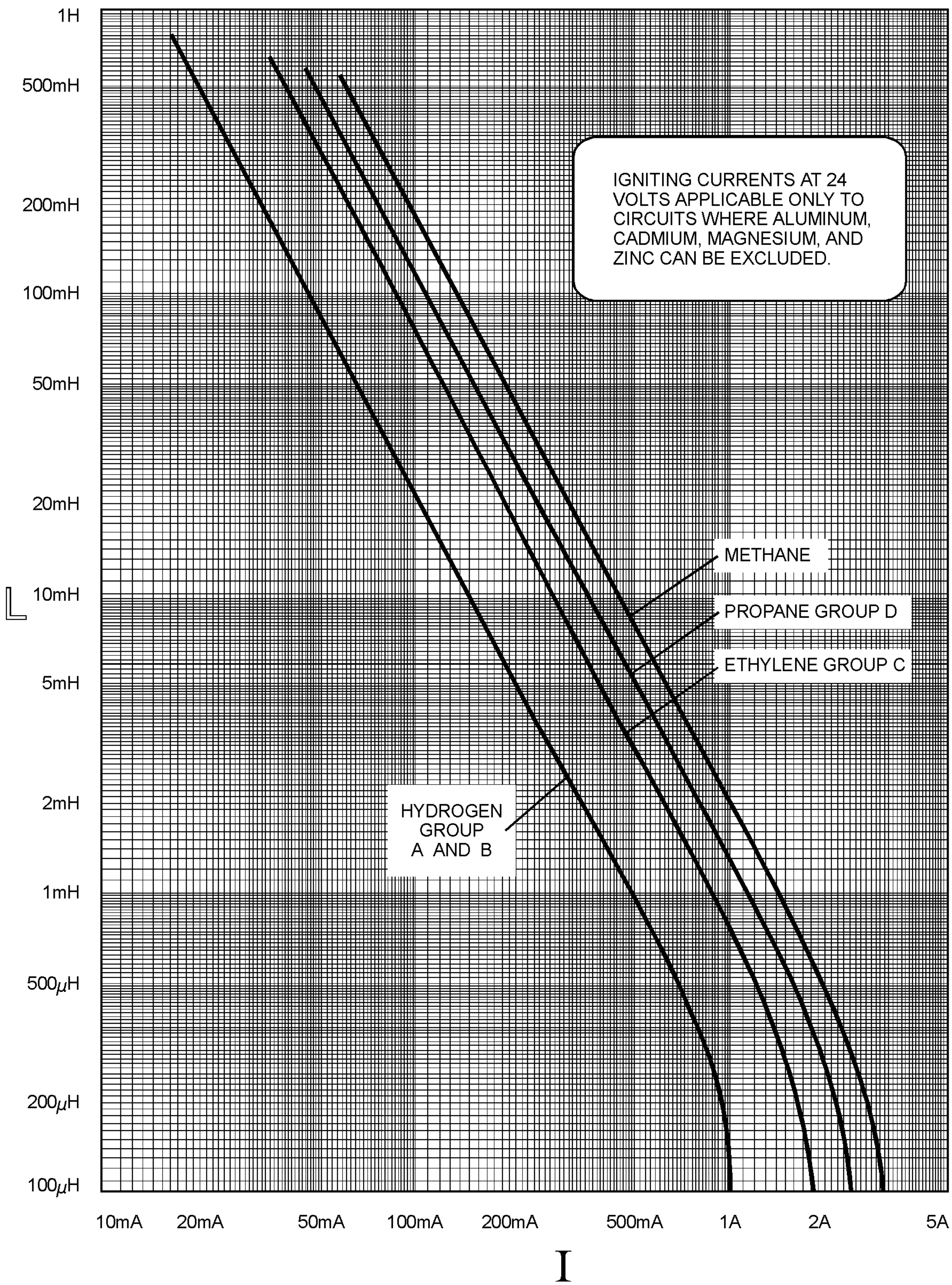

Figure 4 — Inductance circuits

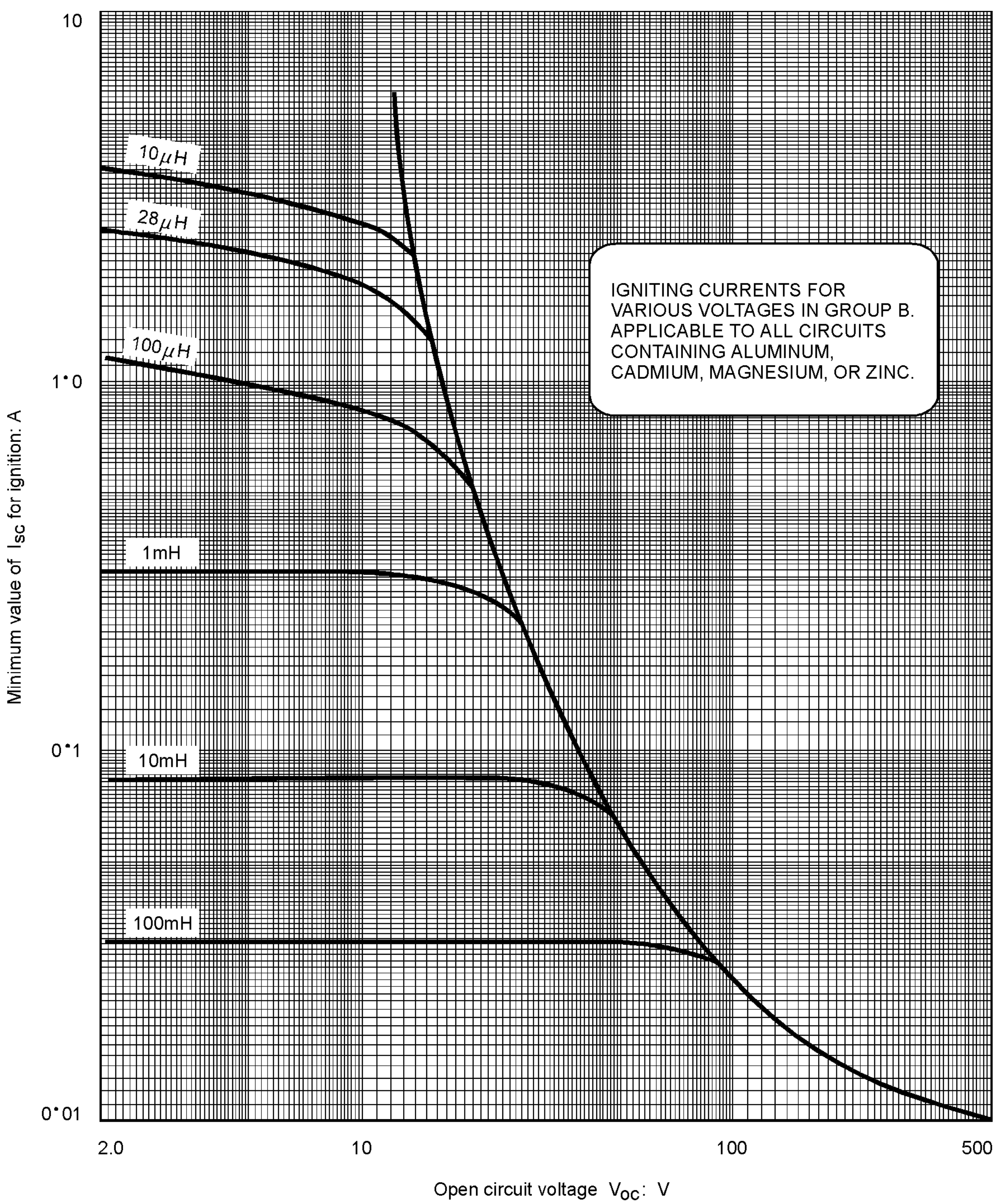

Figure 5 — Inductance circuits

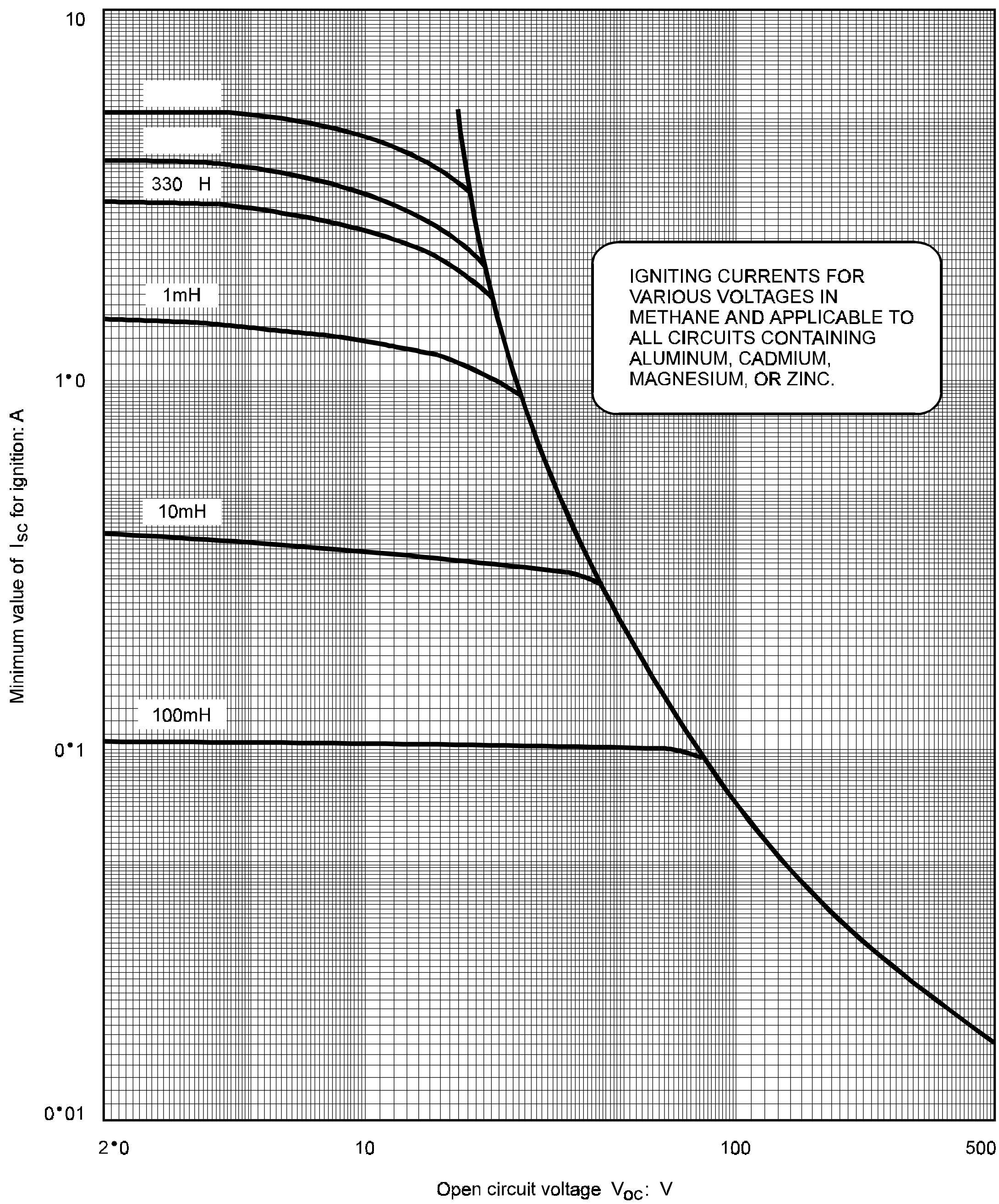

Figure 6 — Inductance circuits

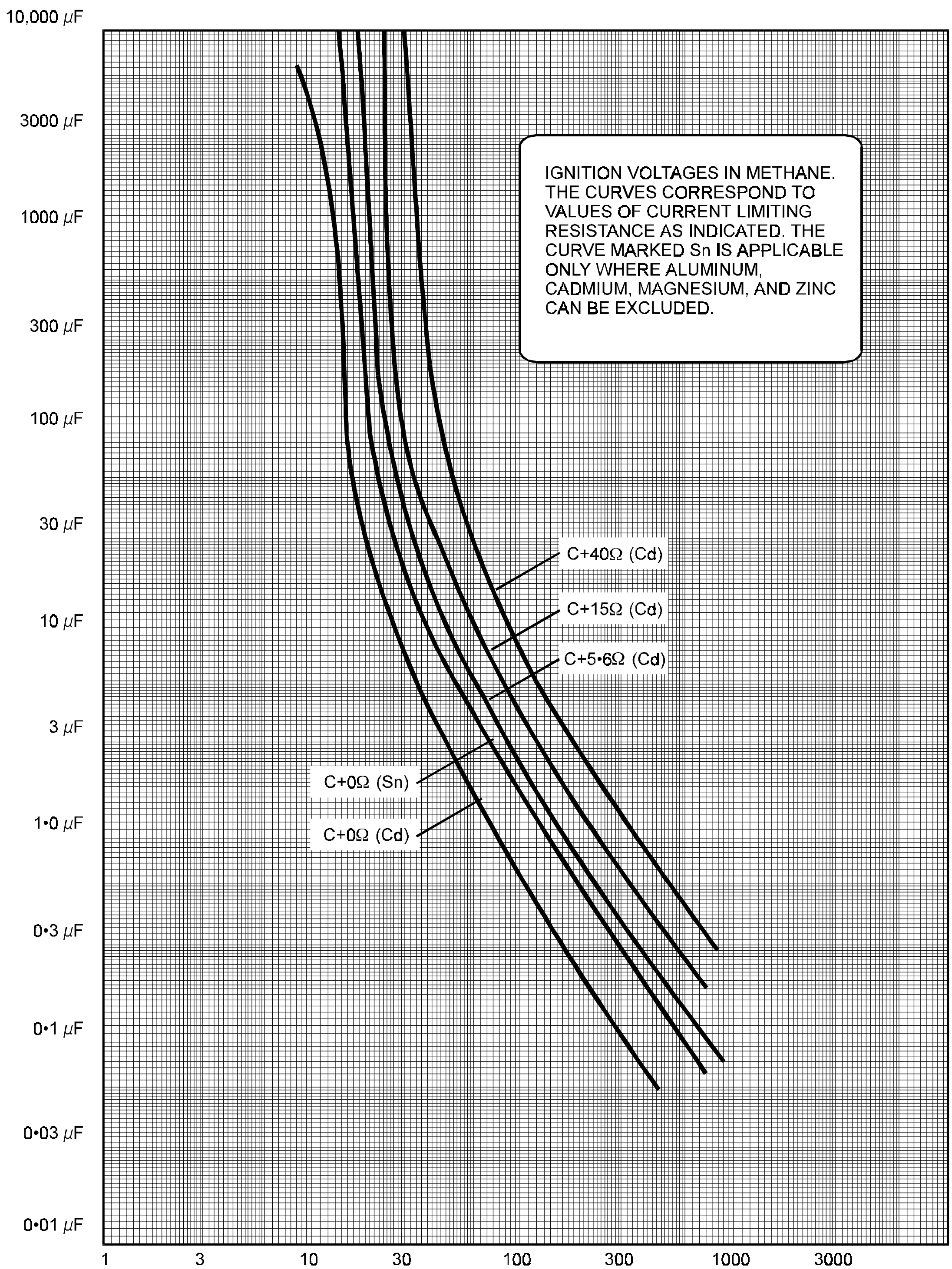

Figure 7 — Capacitance circuits

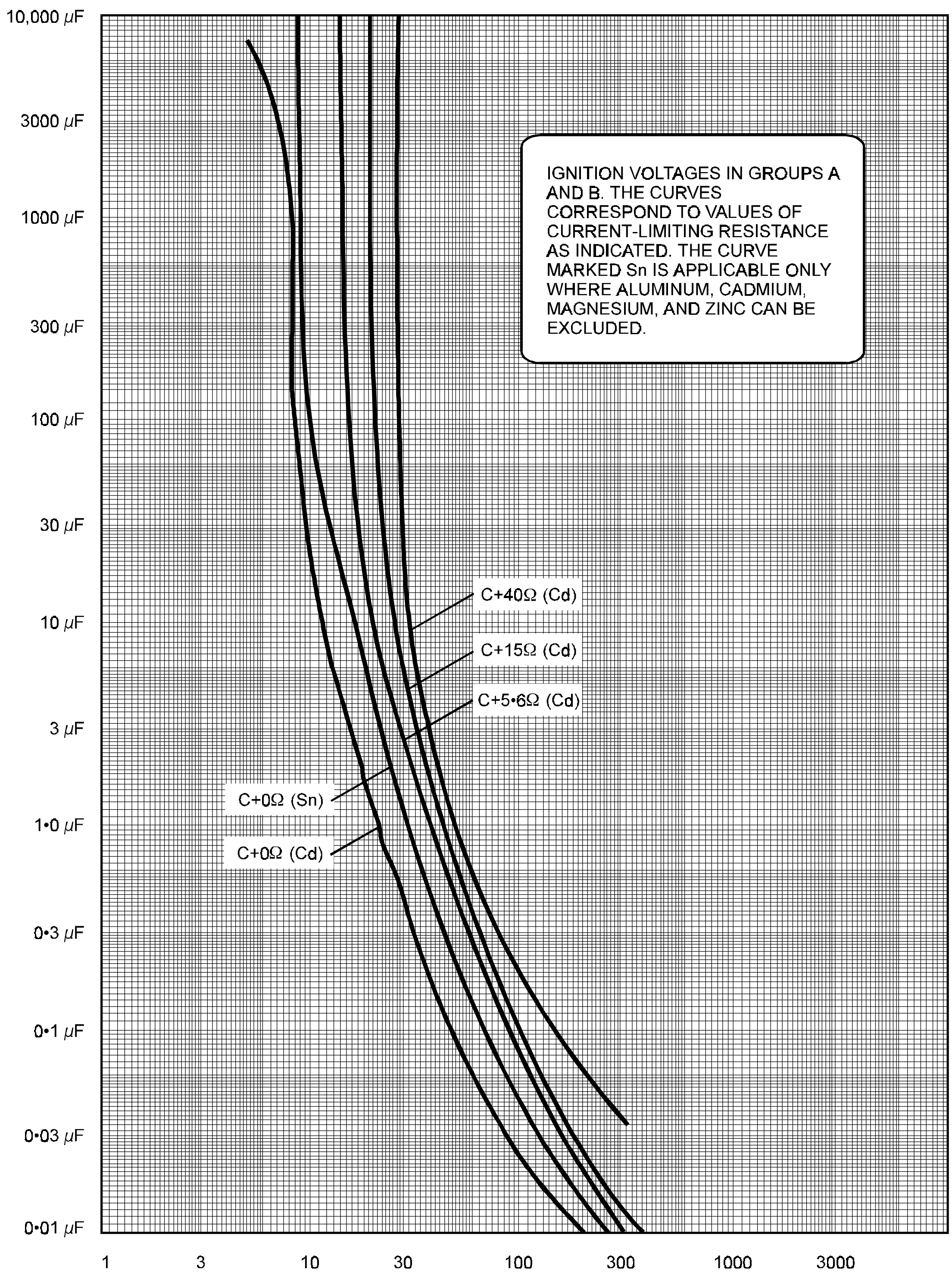

Figure 8 — Capacitance circuits

8* Normally nonarcing components

8.1 Make/break components that are to be considered nonarcing in normal operation shall comply with the requirements of 8.2 through 8.5, as applicable.

8.2 Connectors and plug-in components used in incendive circuits and incorporated within equipment shall be considered normally nonarcing if disconnection is not required under operational maintenance conditions and if they require a separating force of at least 3.4 pounds (15 N) or if they are mechanically prevented from separating. If accessible during operational maintenance, connectors in an incendive circuit shall be provided with a caution marking in accordance with 9.2.

EXCEPTION: Plug-in components must pass a pull test of only 3 times the weight of the component.

8.3 In incendive circuits, fuses that are removable during operational maintenance shall be removable only with the use of a tool. The fuseholders for such fuses shall be provided with a caution marking in accordance with 9.2 and located adjacent to the fuseholder.

8.4 Circuit breakers that cannot be manually switched off, i.e., have only a reset button, may be used in circuits that are not subject to overloading in normal use. All such circuit breakers shall be provided with a caution marking in accordance with 9.3 and located adjacent to the circuit breaker.

8.5 In incendive circuits, removable lamps that are accessible during operational maintenance shall be removable only with the use of a tool. The lamp holders for such lamps shall be provided with a caution marking in accordance with 9.2 and located adjacent to the lampholder. The lamp holder shall provide protection to prevent breakage of the bulb.

EXCEPTION: A tool need not be required to remove the lamp if the lamp is accessible only after removal of a separate protective cover. The cover need not require a tool to remove.

8.6 If accessible during operational maintenance, connectors used for nonincendive field wiring shall not be interchangeable with other field wiring connectors.

EXCEPTION: Where interchange does not affect nonincendive circuits or where connectors are so identified that interchange is unlikely, interchangeable connectors are allowed.

8.7 If accessible only by the use of a tool, manually operated make/break components in an incendive circuit are considered normally nonarcing components.

9 Marking

9.1 In addition to the marking required for general-purpose equipment, the equipment shall be marked with the following minimum information.

9.1.1* Hazardous location suitability**:** Class, Division, and Group(s). In lieu of Group(s), a specific gas, vapor, or dust.

9.1.2* Temperature marking according to 10.2.

9.1.3* Any other markings or cautions necessary for the installation and safe operation of the equipment.

The international symbol ⚠ may be used to refer the operator to an explanation in the equipment instructions.

9.2 Connectors, fuseholders, and lampholders required to be marked according to Subsections 8.2, 8.3, and 8.5 shall be marked with the following or an equivalent warning:

> **WARNING:** DO NOT REMOVE OR REPLACE WHILE CIRCUIT IS LIVE UNLESS THE AREA IS KNOWN TO BE NONHAZARDOUS.

If practical, this marking shall be either on or adjacent to the component. Otherwise, this marking shall be displayed on a prominent place on the enclosure.

9.3 Circuit breakers, required to be marked according to 8.4, shall be marked with the following or an equivalent warning:

> **WARNING:** DO NOT RESET CIRCUIT BREAKER UNLESS POWER HAS BEEN REMOVED FROM THE EQUIPMENT OR THE AREA IS KNOWN TO BE NONHAZARDOUS.

9.4* The following information shall either be marked on the equipment or contained in the instruction manual for equipment with nonincendive field wiring connections.

9.4.1 Connections for nonincendive field wiring shall be clearly identified.

9.4.2* Equipment supplying energy:

a) V_{oc} — maximum open circuit output voltage;

b) I_{sc} — maximum short circuit output current;

c) C_a — maximum allowable connected capacitance and L_a — maximum allowable connected inductance; or

d) C_n — maximum allowable connected capacitance based upon the normal circuit voltage (V_n) and L_n — maximum allowable connected inductance based upon the normal circuit current (I_n).

NOTE: In addition to the above, parameter L/R may also be marked, where L/R is the maximum allowable ratio of inductance to resistance.

9.4.3* Equipment receiving energy:

a) V_{max} — maximum input voltage;

b) I_{max} — maximum input current;

c) C_i — maximum internal capacitance; and

d) L_i — maximum internal inductance.

EXCEPTION: Equipment supplied as a system, including cables supplied for field wiring, need not comply with 9.4.

10 Surface temperature requirements

10.1* The maximum temperature of any surface that may come in contact with a flammable gas or vapor-in-air mixture or dust, fibers, or flyings shall be determined under normal operational conditions. Such measurements need not be made on the internal parts of sealed devices. Measurements shall be made at any convenient ambient temperature between 50°F (10°C) and 104°F (40°C), corrected linearly to 104°F (40°C).

10.2* Equipment that attains temperatures higher than 212°F (100°C) based on a 104°F (40°C) ambient shall be marked either by the temperature code as given in Table 1, or by the specific temperature as measured according to 10.1, corrected linearly to a 104°F (40°C) ambient.

> **NOTE:** Component surface temperature may exceed the marked temperature rating if it can be demonstrated that no hazard exists.

Table 1 — Temperature identification numbers (Temperature codes)

Degrees F	Degrees C	Temperature Code
842	450	T1
572	300	T2
536	280	T2A
500	260	T2B
446	230	T2C
419	215	T2D
392	200	T3
356	180	T3A
329	165	T3B
320	160	T3C
275	135	T4
248	120	T4A
212	100	T5
185	85	T6

Temperature codes without the alpha suffix (A, B, C, or D) agree with the temperature identification system specified by the International Electrotechnical Commission (IEC 79 Series Publications).

11* Evaluation of nonincendive circuits

11.1 The spark test apparatus used for performing ignition tests on circuits shall consist of an explosion chamber at least 15.25 cu. in. (250 cm^3) in volume, in which circuit-making and circuit-breaking sparks can be produced in the presence of the prescribed test gas.

11.2 Components of the contact arrangement are a cadmium disc with 2 slots and 4 tungsten wires of 0.008 in. (0.2 mm) diameter, which slide over the disc. The free length of the tungsten wires shall be 0.44 in. (11 mm). The driving spindle, to which the tungsten wires are attached, shall make 80 revolutions per minute. The spindle on which the cadmium disc is mounted shall revolve in the opposite direction. The ratio of the speeds of the driving spindle to the disc spindle shall be 50 to 12. The spindles shall be insulated from one another and from the housing. See Figure 9. The explosion chamber shall be able to withstand pressures of 213.2 lb/in.^{2} (1470 kPa) or shall be provided with suitable pressure relief. When cadmium, zinc, or magnesium will not be present, the cadmium disc may be replaced by a tin disc.

11.3* Gas mixture

11.3.1 For Group D, the test mixture shall be 5.25 ±0.25 percent propane by volume in air.

11.3.2 For Group C, the test mixture shall be 7.8 ±0.5 percent ethylene by volume in air.

11.3.3 For Groups A and B, the test mixture shall be 21 ±2 percent hydrogen by volume in air.

11.3.4 For Classes II and III, the test mixture shall be 5.25 ±0.25 propane by volume in air.

11.3.5* Equipment that is intended for use in a specific gas or vapor-in-air may be tested in the most easily ignitible concentration of that gas or vapor-in-air mixture in lieu of the mixtures specified in 11.3.1 through 11.3.3.

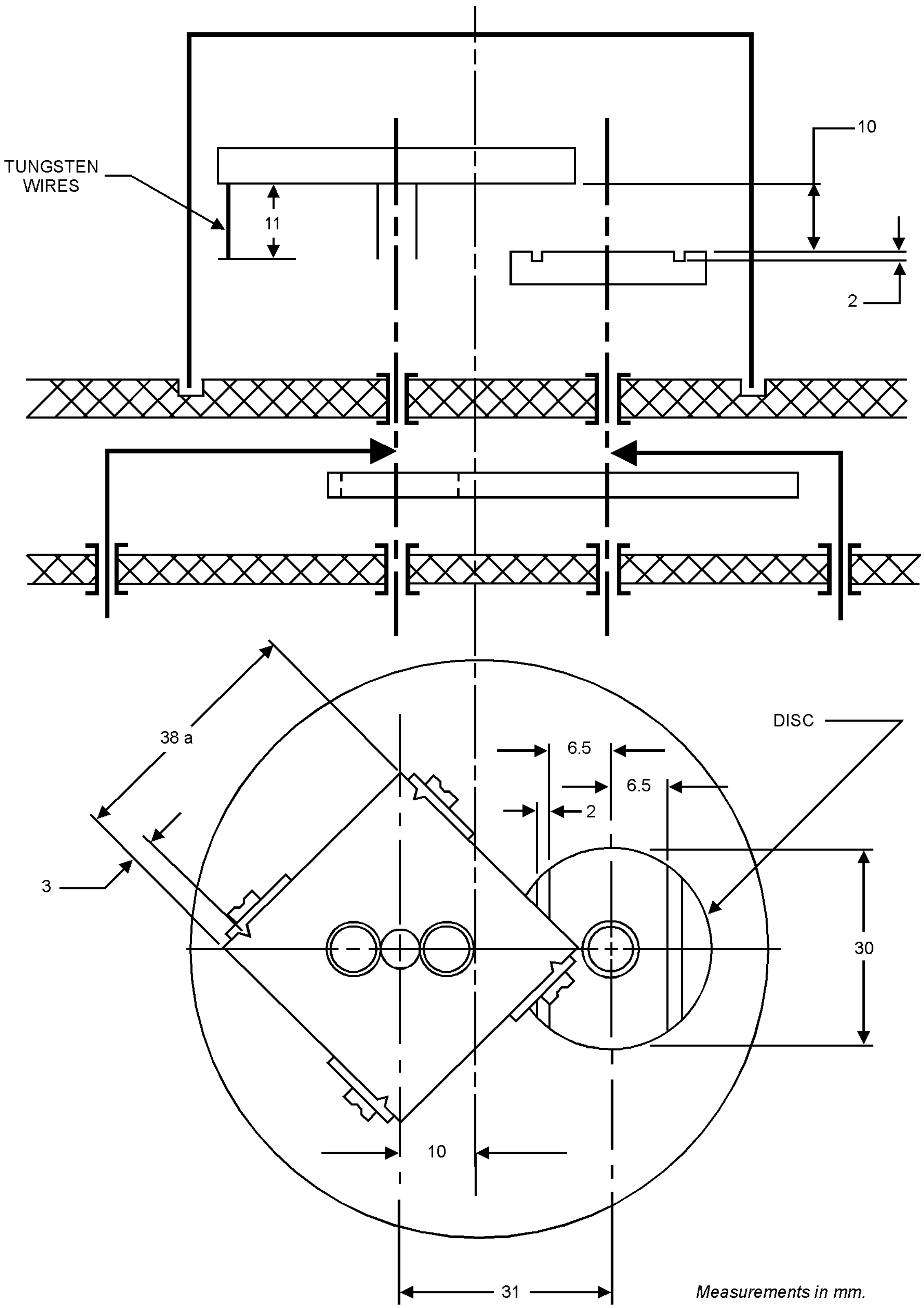

Figure 9 — Test apparatus for evaluating nonincendive circuits

11.4* Sensitivity verification of spark test apparatus

11.4.1 The sensitivity of the spark test apparatus shall be verified before and after each test series conducted in accordance with 11.4.2. The test apparatus shall be operated in a 24 V DC circuit containing a 95 mH air-core coil. The currents in these circuits shall be set at the corresponding value given for the appropriate group in Tables 2 or 3, as applicable.

11.4.2 Verification of the apparatus shall be satisfactory if ignition of the gas occurs within 400 revolutions of the tungsten wire holder.

Table 2 — Current in verification circuit

Cadmium Disk	
Group	**Inductive Circuit**
D	100 mA
C	65 mA
A & B	30 mA

Table 3 — Current in verification circuit

Tin Disk	
Group	**Inductive Circuit**
D	110 mA
C	90 mA
A & B	50 mA

11.5* Tests

11.5.1 The spark test apparatus shall be connected in the circuit under test at each point where an interruption normally occurs, taking into account the requirements of this standard.

11.5.2 Ignition test conditions

There shall be no ignition of the test mixture under any of the following conditions:

a) For line-connected equipment, the input voltage shall be increased to 110 percent of nominal line voltage.

b) All adjustments shall be set at their most unfavorable positions.

c) All circuits shall be tested for the following number of revolutions of the tungsten wire holder in the spark test apparatus:

   1) For DC circuits, not less than 400 revolutions — 200 revolutions at each polarity.

   2) For AC circuits, not less than 1000 revolutions.

11.5.3 The test apparatus shall be verified according to 11.4 after each ignition test. The ignition test shall be considered invalid if the verification test is unsatisfactory.

12* Evaluation of nonincendive components

12.1 Nonincendive components shall be subjected to the tests specified in 12.2.

12.1.1 A nonincendive component is limited in use to the rating for which it has been satisfactorily tested according to 12.2.

12.1.2 Nonincendive components shall be preconditioned by being operated a minimum of 6000 times at the rate of approximately 6 times per minute while carrying their normal electrical load.

12.2* Spark ignition test for nonincendive components

12.2.1* Following the preconditioning test, the nonincendive component shall be placed in a suitable test chamber of at least ten (10) times the volume of the device and connected to an electrical load of 150 percent of the AC or DC current (75 percent maximum power factor if for AC) and at maximum voltage of the circuit for which the component is being tested.

EXCEPTION: The 75 percent power factor requirement may be neglected for totally resistive loads only.

12.2.1.1 Components intended for use with high inrush current loads (e.g., motor or tungsten lamp loads) shall be subjected to overload testing that is representative of actual circuit applications. Preconditioning and overload conditions shall be according to the requirements of national standards that cover these applications.

12.2.2* Nonincendive components shall be filled with and surrounded by a gas mixture according to 11.3.1 through 11.3.3. Passing any one of the following tests is evidence that the component is nonincendive.

12.2.2.1 Remove the housing adjacent to the contacts to permit free access of the air-gas mixture to the contacts.

12.2.2.2 Drill at least two holes in the enclosure that will assure propagation of an ignition from the inside to the outside of the enclosure. The test gas shall flow through the device. A tube may be connected to one of the holes for this purpose.

12.2.2.3 Draw a vacuum within the chamber and maintain the vacuum for 100 seconds. Fill the test chamber with the specified air-gas mixture and maintain the concentration for 100 seconds before applying the required electrical load. An explosion detection device (e.g., a pressure transducer) shall be connected to the device under test to detect ignition.

12.2.3* The component shall be operated a minimum of 50 times at not less than 10-second intervals, renewing the air-gas mixture after each set of 10 operations (or more frequently, if necessary to ensure the presence of the air-gas mixture within the nonincendive component). There shall be no ignition of the air-gas mixture.

13* Evaluation of sealed device

13.1 This section covers the requirements for electrical equipment or parts of electrical equipment or components that contain normally arcing parts or heat-producing surfaces that, by their location in a sealed enclosure, are intended to be made incapable of causing ignition of the specified gas or vapor-in-air mixtures at their most easily ignitible concentration.

13.1.1 Hermetically sealed devices (see definition in Section 3) shall be considered to meet these requirements without test.

13.2* Except as permitted in 13.1.1, the free internal volume of the device shall be less than 6.1 in^3 (100 cm^3).

13.3 Resilient gasket seals or poured seals shall be arranged so that they are not subject to mechanical damage during normal operational conditions and shall retain their sealing properties for the intended conditions of use.

13.3.1 Sealing and encapsulating material shall have softening or melting points at least 36°F (20°C) higher than the maximum expected operating temperature of the device.

13.4* A sealed device shall have structural integrity and shall be constructed of materials suitable for the intended environment with full consideration for anticipated atmospheric contaminants and corrosive compounds. The enclosure shall be sufficiently rugged to withstand normal handling and assembly operations without damage to any seals provided.

13.5 To ensure that damage affecting safety of operation will not occur during normal operational conditions of the sealed device, three samples shall be preconditioned by oven aging according to 13.5.1 and subjected to an air leakage test according to 13.5.2.

13.5.1* Oven aging If the device contains a gasket or seal of elastomeric or thermoplastic material or a composition gasket utilizing an elastomeric material, each sample shall be subjected to temperature aging in a circulating air oven in accordance with the following formula:

$$t = 2685e^{-(0.0693)(T - T1)}$$

where:

t = the test time in hours;

e = 2.7183;

T = the aging temperature in °C; and

T1 = the maximum rated operating temperature in °C (40°C minimum).

13.5.2* Air leakage test

Each of the samples shall pass one of the following tests:

a) At an initial temperature of 77°F (25°C) the test samples shall be immersed in water at a temperature of 122°F (50°C) to a minimum depth of 1 in. (25 mm) for a minimum of 1 minute. If no bubbles emerge from the samples during this test, they are considered to be "sealed" for the purpose of this standard.

b) The test sample shall be immersed to a minimum depth of 3 in. (75 mm) in water contained in an enclosure that can be partially evacuated. The air pressure within the enclosure shall then be reduced by 4.7 in. (120 mm) of mercury. If no visible bubbles emerge from the samples during this test, samples are considered to be "sealed" for the purpose of this standard.

c) The test sample shall be shown to leak at a rate not greater than 10^{-5} ml of air per second at a pressure differential of 1 atmosphere (101.3 kPa) by means of a suitable leak rate detector.

14 Evaluation of enclosures for Class II and III

14.1* An enclosure that is required to exclude the entry of dust shall pass any one of the tests according to 14.2, 14.3, or 14.4.

14.1.1 A length of conduit may be installed in the enclosure under test to equalize the internal and external pressures, but it shall not serve as a drain.

14.1.2 A gasket used to make an enclosure dust-tight shall be made of material acceptable for the purpose, e.g., plant-fiber sheet packing or similar material. A gasket of elastomeric or thermoplastic material may be used if it is resistant to aging when tested in accordance with 14.1.3. Gaskets shall be either secured or captive if they could be dislodged during installation or maintenance of the equipment. (See ANSI/ISA-S82.01, .02, and .03 for the construction techniques of gaskets.)

14.1.3* Aging test

A gasket of an elastomeric or thermoplastic material, or a composition gasket utilizing an elastomeric material, shall be of such quality that samples have a tensile strength of not less than 60 percent and an elongation of not less than 75 percent of values determined for unaged samples, when subjected to temperature aging in a circulating air oven in accordance with the following formula:

$$t = 2685e^{-(0.0693)(T - T1)}$$

where:

t = the test time in hours;

e = 2.7183;

T = the aging temperature in °C; and

T1 = the maximum rated operating temperature in °C (40°C minimum).

14.2 Dust-blast method

The enclosure shall be subjected to a blast of compressed air mixed with dry Type 1 general-purpose Portland cement (or equivalent) using a suction-type sandblast gun that is equipped with a 3/16-inch (4.8-mm) diameter air jet and a 3/8-inch (9.5-mm) diameter nozzle. The air shall be at a supply pressure of 90-100 psi (620-690 kPa). The cement is to be supplied by a suction feed. A minimum of 4 pounds of cement per linear foot (6 kg/m) of test length (sum of height, width, and depth) of the enclosure under test is to be applied at a minimum rate of 5 pounds (2.3 kg) per minute. The nozzle is to be held 12-15 inches (305-381 mm) from the enclosure, and the blast of air and cement is to be directed at all points of potential dust entry, such as, but not limited to, seams, joints, and external operating mechanisms. There shall be no visible dust inside the enclosure at the end of this test.

14.3* Circulating dust method

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

Enclosures shall be determined to fit in one of two categories:

a) Enclosures where the normal cycle of the equipment causes a reduction in the air pressure within the enclosure below the surrounding atmosphere (e.g., caused by thermal cycling effect); or

b) Enclosures where reductions in pressure below the surrounding atmospheric pressure are not caused by normal cycles of the equipment.

For enclosures of category (a) the equipment under test should be supported inside the test chamber, and the pressure inside the equipment should be maintained below atmospheric pressure by a vacuum pump. If the enclosure has a single drain hole, the suction connection shall be made to this hole and not to one specially provided for the purpose of the test. If there is more than one drain hole, the other drain holes shall be sealed for the test. The object of the test is to draw into the equipment, if possible, a minimum of 80 times the volume of air in the enclosure without exceeding an extraction rate of 60 volumes per hour with a suitable depression. In no event shall the depression exceed 200 mm of water. If an extraction rate of 40 to 60 volumes per hour is obtained, the test shall be stopped after 2 hours. If, with a maximum depression of 200 mm of water, the extraction rate is less than 40 volumes per hour, the test shall be continued until 80 volumes have been drawn through, or a period of 8 hours has elapsed. For an enclosure of category (b), the equipment under test should be supported in its normal operating position inside the test chamber, but the test chamber shall not be connected to a vacuum pump. Any drain hole normally open shall be left open for the duration of the test. The test shall continue for a period of 8 hours. If it is not possible to place the complete assembly in the test chamber, one of the following procedures shall be used:

a) Individual testing of separate enclosed sections of the equipment;

b) Testing of representative parts of the equipment (such as doors, ventilating openings, joints, and shaft seals), with the vulnerable parts of the equipment (such as terminals and slip rings) in position at the time of testing; or

c) Testing of smaller equipment having the same full-scale design details.

The enclosure shall be deemed to pass the test if no visible dust is detected inside the enclosure at the end of the test.

14.4 Atomized-water method

The enclosure shall be sprayed with atomized water using a nozzle that produces a round pattern 3-4 inches (76-102 mm) in diameter, 12 inches (305 mm) from the nozzle. The air pressure shall be 30 ±1 psi (207 ±6 kPa). The water is to be supplied by a suction feed with a siphon height of 4-8 inches (102-204 mm). A minimum of 5 ounces of water per linear foot (485 ml/m) of test length (sum of height, width, and depth) of the enclosure under test shall be applied at a minimum rate of 3 gallons (11 liters) per hour. The nozzle shall be held 12-15 inches (305-381 mm) from the enclosure, and the spray of water shall be directed at all points of potential dust entry including, but not limited to, seams, joints, and external operating mechanisms. To pass the test there shall be no visible water inside the enclosure at the end of this test.

15 Drop test

15.1 Portable equipment shall be subjected to a drop test as specified in 15.2. There shall be no damage to the equipment that may affect its acceptability for use in Division 2 locations.

15.2 Equipment is to be dropped six times, not more than once on any one equipment surface, from a height of 3 feet (0.9 m) onto a smooth concrete floor. A nonrestrictive guide may be used.

16 Manufacturer's instructional manual

16.1 The manufacturer's instructional material shall include, in addition to the information required for ordinary locations, the information shown in 16.2 through 16.5 to emphasize the precautions required when operating the equipment in a Division 2 location.

16.2 The following or equivalent specification for the location of the equipment shall be included:

> **THIS EQUIPMENT IS SUITABLE FOR USE IN CLASS (AS APPLICABLE), DIVISION 2, GROUPS (AS APPLICABLE) OR NONHAZARDOUS LOCATIONS ONLY.**

16.3 The following or equivalent information for use of the equipment shall be included.

16.3.1 A list of the equipment or combinations of equipment that may be connected to each nonincendive field circuit shall be provided. Alternatively, the parameters listed under 9.4.2 and 9.4.3 may be provided.

16.3.2 Sufficient information to allow the user to correct the temperature code rating for ambient temperatures exceeding 104°F (40°C) up to maximum rated temperature if a linear correction is not considered by the manufacturer to be suitable.

16.4* If equipment contains sealed components the following shall be provided:

16.4.1 A warning such as: **"WARNING: EXPOSURE TO SOME CHEMICALS MAY DEGRADE THE SEALING PROPERTIES OF MATERIALS USED IN THE FOLLOWING DEVICES"**; identification of the sealed devices.

16.4.2 The list of materials used in the construction of these devices:

Name of sealed device — Generic name of the material and the supplier's name and type designation.

16.4.3 Periodically inspect the devices named above for any degradation of properties and replace if degradation is found.

16.5 The following warning or equivalent warnings for repair of the equipment shall be included.

16.5.1 If replacement of a component could ignite the flammable atmosphere:

> **WARNING:** EXPLOSION HAZARD. DO NOT REMOVE OR REPLACE LAMPS OR FUSES UNLESS POWER HAS BEEN DISCONNECTED OR THE AREA IS KNOWN TO BE NON-HAZARDOUS.

16.5.2 If disconnecting the equipment supply could ignite the flammable atmosphere:

> **WARNING:** EXPLOSION HAZARD. DO NOT DISCONNECT EQUIPMENT UNLESS POWER HAS BEEN DISCONNECTED OR THE AREA IS KNOWN TO BE NONHAZARDOUS.

16.5.3 If components are relied upon to make the equipment suitable for Division 2 locations, these components shall be individually identified. The following is an example of identifying such components:

> **WARNING:** SUBSTITUTION OF THE FOLLOWING COMPONENTS MAY IMPAIR SUITABILITY FOR DIVISION 2:

Reference designation	Description	Type of Protection
K3	Relay	Sealed contacts
OL1	Thermal switch	Hermetically sealed contacts
M1	Fan	Brushless motor
S6	Switch	Nonincendive component

16.6 Documentation accompanying nonincendive components that are not factory-installed in equipment shall state the circuit parameters for which the components have been determined to be safe.

Appendix A

Explanatory material

This appendix is not part of this standard but is included for informational purposes only. The paragraph numbers herein refer to those starred in the standard.

A.1.1 General information

This standard was prepared to provide more detailed requirements than the requirements identified in the NEC for electrical equipment suitable for use in Class I and II, Division 2 and Class III, Divisions 1 and 2 hazardous (classified) locations.

This standard reinforces the practice of many years in North America of supplying general-purpose electrical equipment for use in Class I, Division 2 locations where the equipment is of normal industrial quality and in which sources of electrical or thermal ignition do not exist under normal operational conditions.

The principles involved are based on the low probability of the presence of an explosive gas-air mixture occurring for a substantial period of time in an area classified as Division 2, coincident with an abnormal condition in the electrical equipment capable of igniting the gas mixture.

Reference information was obtained from CSA Standard C22.2-No. 157-M1979, Intrinsically Safe and Nonincendive Equipment for Use in Hazardous Locations, and IEC 79-15, Apparatus with Type of Protection 'n.' The latter document defines equipment for use in IEC Zone 2 classified areas.

A.2.8 The experimental data on which the requirements of this document are based were determined under normal laboratory atmospheric conditions. Ignition parameters are not easy to extrapolate from normal laboratory conditions to other conditions (such as might exist in process vessels) without careful engineering consideration. Increasing the initial temperature of a flammable or combustible mixture will decrease the amount of energy required to cause ignition so that, at the autoignition temperature of a gas or vapor, the electrical energy required for ignition will be zero. The nature of the energy variation between these limits is not well documented. Temperature variations also can change the concentrations of flammable materials in the mixture.

Oxygen enrichment decreases the energy necessary for ignition. The minimum ignition energy of mixtures of flammable materials with oxygen may be as low as 1 percent of that required for the same material mixed with air.

As a general rule, the minimum ignition energy of a gas or vapor is inversely proportional to pressure squared. When examining a situation where the gas mixture is above atmospheric pressure, one must consider whether a flammable mixture exists under such pressure conditions. At high pressure, many flammable materials will condense.

A.3 Nonincendive circuit The concept of a nonincendive circuit for equipment in Division 2 locations was first identified in ISA Recommended Practice RP12.2. This recommended practice covered certain aspects of equipment for use in Division 2 locations. ISA-RP12.2 was withdrawn following the availability of NFPA 493, which is concerned only with intrinsically safe equipment suitable for use in Division 1 and Division 2 locations. However, NEC Article 501-3 (b)(1)c and other codes recognize nonincendive circuits. ISA-S12.12 defines such circuits and provides a procedure for testing.

A.3 Nonincendive field wiring is recognized in the EXCEPTION shown in NEC Sections 501-4 (b) and 502-4 (b).

A.5.1.1 It is recognized that other means of protection are acceptable. Purging and positive pressurization are described in NFPA 496-1993,[A1] and oil immersion requirements are covered in ANSI/UL 698-1984,[A2] Articles 501-3 (b)(1)a and 501-6 (b)(1) of the National Electrical Code, and Section 18-160 (b) of the Canadian Electrical Code (Part 1) C22.1-1990.

A.5.4 It is unlikely that some malfunction will occur causing a fuse to open concurrent with the location becoming flammable. For "signaling," "alarm," "remote-control," and "communications" systems, Article 501-14(b)(3) of the 1990 edition of the NEC permits fuses in a general-purpose enclosure in Division 2 locations.

A.5.5 Switches not integral to the equipment should be suitable for the locations in which they are installed.

A.6.1 The National Electrical Code recognizes only dust-tight enclosures for Class III. In view of this limitation, other alternatives were not included in this edition of the standard.

A.7.1 Figures 1 through 8 represent very simple circuits. Unless the circuit can clearly be identified as conforming to the special conditions from which the curves are derived, analysis may prove invalid. Testing is required in such cases. As an illustration, the capacitance discharge curves do not include the effects of the charging circuit.

A.7.1.2 It is recognized that the margin of safety lies in the use of (a) a test apparatus more sensitive than any probable ignition condition and (b) an ideal gas mixture.

A.8 Section 8 applies to components that would cause ignition-capable arcs if the make/break contacts interrupt the circuit. They are permitted because the arc is likely to occur only during servicing if the component complies with the requirements in this section. This section is written essentially for parts replaced, disconnected, or operated during servicing — such as fuses, lamps, connectors, and tool-accessible controls and switches.

A.9.1.1 - 9.1.3 In addition to the markings required by this standard, it may be desirable for equipment manufacturers to mark equipment in accordance with IEC 79-15 when the equipment meets the IEC 79-15 requirements.

If the IEC 79-15 marking practice is used, the following should be shown:

a) The symbol "Ex n," followed by

b) The group symbol "IIA," "IIB," or IIC," whichever represents the applicable gas group, followed by

c) The temperature identification number or maximum surface temperature according to Section 10.2 of this standard (do not use temperature codes with letter suffix), followed by

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[A1] NFPA Standard 496-1993, Purged and Pressurized Enclosures for Electrical Equipment in Hazardous (Classified) Locations.

[A2] ANSI/UL Standard 698-1984, Industrial Control Equipment for Use in Hazardous (Classified) Locations; or Canadian Standards Association Standard C22.2 No. 25-1966, Enclosures for Use in Class II, Groups E, F, and G Hazardous Locations. ANSI C33.30 was renamed ANSI/UL 698-73, Industrial Control Equipment for Use in Hazardous Locations, Class I, Groups A, B, C, D, and Class II, Groups E, F, and G, November 24, 1982.

d) The symbol "/X" if there are any special conditions of use in the manufacturer's instructions that are relevant to the safety of the equipment.

Example: Ex n IIA T4/X

Some equipment may be suitable for more than one group or zone (class or division). It may not be practical to provide markings on the equipment. The complexity of such marking may require the use of a reference document. In these instances, permanent reference should be made on the marking plate to a system or equipment control drawing (e.g., for hazardous location suitability, reference Dwg. No. XXX).

A.9.4 The exception to Section 501-4(b) of NFPA 70 states: "Wiring in nonincendive circuits shall be permitted using any of the methods suitable for wiring in ordinary locations." This exception is intended to permit what is termed "nonincendive field wiring" by this standard.

One problem facing both manufacturers and users in applying the nonincendive field wiring concept is the ability to interconnect different manufacturers' equipment with nonincendive field circuit connections and be assured the combination will provide a nonincendive field circuit. In order to facilitate this interconnection, the marking method covered in this section provides a convenient way to assess the compatibility of different manufacturers' equipment with respect to nonincendive field circuits. The values of V_n, I_n, C_n, and I_n are used to determine compatibility of equipment that would not be determined compatible using the values of V_{oc}, I_{sc}, C_a,and L_a that are used when determining the compatibility in intrinsically safe circuits.

The criteria for the comparison are that the voltage (V_{max}) and current (I_{max}) that the load device can receive must be equal to or greater than the normal circuit voltage (V_n) and normal circuit current (I_n) that can be delivered by the source device. V_{oc} and I_{sc} could be substituted for V_n and I_n respectively to provide a conservative analysis that would be identical to the one done for intrinsically safe circuits. In addition, the maximum capacitance (C_i) and inductance (L_i) of the load, which is not prevented by circuit components from providing a stored energy charge to the field wiring (e.g., a diode across a winding to clamp an inductive discharge), plus the capacitance and inductance of the interconnecting wiring must be equal to or less than the capacitance (C_n) or inductance (L_n) that can be driven by the source device. Again C_a and L_a could be substituted for C_n and L_n, respectively, to provide a conservative analysis that would be identical to the analysis made for intrinsically safe circuits.

The capacitance and inductance of the interconnecting wiring must be equal to or less than the capacitance (C_a) or the inductance (L_a) that can be driven by the source. When cable parameters are unknown, the following values may be used:

Capacitance: 200 pF/m (60 pF/ft)

Inductance: 0.66 µH/m (0.20 µH/ft)

A.9.4.2 Items (c): After determining the maximum open circuit voltage (V_{oc}) and maximum short-circuit current (I_{sc}) of the source device according to 7.1.2, determine the appropriate values of maximum allowed capacitance (C_a) and maximum allowed inductance (L_a) from Figures 3 through 8.

A.9.4.2 Items (d): After determining the normal circuit voltage (V_n) and normal circuit current (I_n) of the source device according to 7.1.2, determine the appropriate values of maximum allowed capacitance (C_n) and maximum allowed inductance (L_n) from Figures 3 through 8.

A.9.4.2 NOTE: Maximum L/R ratio

The maximum L/R ratio, as currently used in the U.K. and Europe, is another parameter that is assigned to the field wiring terminals of equipment supplying energy to nonincendive field wiring and nonincendive equipment. This parameter allows the distributed nature of cable resistance and inductance to be considered, rather than multiplying the cable inductance per-unit-length times the total length of the cable, and comparing it to the lumped inductance value, L_a. The L/R ratio for a cable is calculated with the cable short circuited, and as long as the L/R ratio is less than the source L/R rating, the cable inductance can be disregarded.

> **NOTE:** Using the L/R ratio, the cable inductance will rarely be a problem, however, the total cable capacitance (capacitance per-unit-length times the cable length) must be added to the receiving equipment internal capacitance C_i, and the total must not exceed C_a.

In a two-wire circuit the maximum allowable load-plus-line inductance is determined by the maximum short circuit current. Assume that L_a is the maximum allowable connected inductance, line and load. If all the inductance is in the line (long cable), the inductance of the line is proportional to the resistance and to the length. Maximum energy storage occurs when the sum of the line and load resistance equals the internal resistance of the source (V_{oc}/I_{sc}), the current = $I_{sc}/2$, and the inductance is 4 L_a. The maximum L/R ratio is, therefore, given by the following equation:

$$\text{Maximum L/R ratio} = 4\,L_a(I_{sc}/V_{oc}).$$

If the line is short and all the inductance is in the load, the same results are obtained. Therefore, safety is assured if either the above situation exists or if both the line and load have L/R ratios that do not exceed the above limit. Other conditions must be evaluated individually.

Marking Example:

V_{oc} = 40 V

I_{sc} = 64 mA

C_a = 0.14 µF

L_a = 19 mH

C_n = 0.6 µF @ V_n= 24 V dc

L_n = 190 mH @ I_n = 20 mA

L/R = 122 µH/ohm

A.9.4.3

a) Determine V_{max} from the appropriate curve, based on the maximum unprotected capacitance at the field wiring terminals of the device.

b) Determine I_{max} from the appropriate curve, based on the maximum unprotected inductance at the field wiring terminals.

c) Determine, either analytically or experimentally, from the values of V_{max} and I_{max} determined in steps (a) and (b) above, that the device will not produce an ignition-capable temperature rise of components for that combination. Verify also that some lower value of current will not cause ignition-capable hot spots. Since this step can be quite time consuming, a manufacturer may arbitrarily specify a voltage lower than V_{max} as determined in step (a).

A.10.1 Tests should be performed under "worst-case" heating conditions; for example, the highest or lowest extreme of specified supply voltage plus the worst-case load conditions.

A.10.2 Caution needs to be exercised in the interpretation of the temperature identification code. The temperatures given in Table 1 are based on operation at a 40°C ambient temperature; the maximum specified ambient temperature rating of the equipment may exceed 40°C.

A.10.2 NOTE: The lowest ignition temperature of the ignitible atmospheres concerned may be above the maximum surface temperature. However, for components having a total surface area of 10 cm^2 or less (e.g., transistors or resistors used in low-power circuits protected by the energy limitation technique), their surface temperature may exceed that for the temperature class marked on the electrical apparatus if there is neither a direct nor an indirect risk of ignition from these components, applying the safety margin following:

50 K for T1, T2, and T3, or

25 K for T4, T5, and T6

where K is Kelvins.

The safety margin shall be ensured by experience of similar components or by test of the electrical apparatus itself in representative ignitible mixtures.

> **NOTE:** During the above test, the safety margin may be provided by increasing the ambient temperature an appropriate amount.

If the temperature of a component is below the auto-ignition temperature (AIT) of a given material, the component can be considered suitable for use in a circuit without regard to thermal ignition. When the temperature of a component is above the AIT, it must be determined by test whether or not it will thermally ignite the material. The ability of any small component to thermally ignite a material is dependent on the AIT of the material it is exposed to and the temperature, size, and shape of the heated component. A test that has been used to verify the suitability of a small component (from a thermal standpoint) may be conducted using a 5 percent diethyl ether-in-air mixture. Diethyl ether represents the material having the lowest AIT of the Class I atmospheres currently listed in NFPA 325M or 497. Various characteristics of diethyl ether are as follows:

Name	**Formula**	**LFL % of Vol**	**UFL % of Vol**	**AIT**	**SP.GR (Water = 1)**	**Vapor density (Air = 1)**
diethyl ether*	$C_2H_5OC_2H_5$	1.9	36	320°F (160°C)	0.7	2.6

*Synonyms: ether, ethyl ether, diethyl oxide, ethyl oxide.

The test apparatus shall consist of a test enclosure with a gas-tight cover and viewing port. The enclosure shall contain a low-velocity fan, a diethyl ether dish, through-wall component terminal connections, and an igniter for mixture-ignition verification. The component under test shall be suspended within the enclosure with connections (via the terminal connections) to the external associated component's circuitry or power source. An appropriate amount of liquid ether shall be placed in the dish. If a 3-liter enclosure is used, 0.65 cm^3 of liquid ether will be needed for a 5 percent mixture. The cover shall be closed, and the fan shall be turned on to aid in the evaporation process and to maintain a homogeneous mixture. Power shall be applied to the component until thermal equilibrium is reached, the component fails open, or the surrounding material is ignited. If the component fails to ignite the mixture, the sensitivity of the mixture shall be verified by activating the igniter circuit. A minimum of six tests shall be made.

A.11 The test apparatus using 0.2-mm diameter fine tungsten wires yields low ignition currents. Since the tungsten wires reach a high temperature when the test currents approach 3 A, testing with higher currents may require wires of a different material (such as copper), or a different type of apparatus may be needed. The apparatus described above is suitable for testing circuits up to 300 V. For tests of capacitance circuits, modified apparatus (such as apparatus with one or more of the tungsten wires removed) is required.

A.11.3 The purity of commercially available gases and vapors normally is adequate for these tests, but those of purity less than 95 percent should not be used. The effect of normal variations in laboratory temperature and pressure and of the humidity of the air in the gas mixture is also likely to be small. Any significant effects of these variables will become apparent during the routine verification of the sensitivity of the spark test apparatus.

A.11.3.5 The most easily ignitible concentration may not be the stoichiometric mixture.

A.11.4 Tables 2 and 3 tabulate the various currents at which ignition must and must not occur in order to verify that the spark test apparatus is working properly.

A.11.5 Tables A.2 and A.3, which provide additional information related to Tables 2 and 3, Section 11.4, may be needed to allow adequate charging time.

Table A.2 — Current in calibration circuit for cadmium disk

Group	Must not ignite	Must ignite
D	71 mA	100 mA
C	49 mA	65 mA
A & B	25.5 mA	30 mA

Table A.3 — Current in calibration circuit for tin disk

Group	Must not ignite	Must ignite
D	98 mA	110 mA
C	77 mA	90 mA
A & B	41 mA	50 mA

A.12.2 These requirements were obtained from CSA and IEC reference documents.

A.12.2.1 A plastic bag may be used as a test chamber. The test factor of 150 percent of rated load is greater than the requirement of the IEC 79-15 document; it is identical to the CSA document.

A.12.2.2 The CSA standard specifically requires that a nonincendive component be evacuated prior to filling it with the test mixture. This is only one of several ways to ensure that the component is filled with the test mixture. Therefore, this specific test method is not required in this standard.

Historically, these three test methods have been used by the approval bodies in North America. However, depending on the preparation of the test sample, different results may occur. Therefore, passing any one of the tests is acceptable.

A.12.2.3 Depending on the method used to fill the nonincendive component, more frequent renewing of the gas or vapor-in-air mixture may be required.

A.13 These requirements were obtained from IEC 79-15 (1987). For products to be used in damp environments, polymeric enclosures should be tested for resistance to fungi according to ASTM G21-1970 (1985).

The free internal volume applies to each independent chamber containing arcing contacts.

A.13.2 The 100 cm^2 limitation is consistent with both the IEC and the CSA referenced documents.

A.13.4 The principle applied to "sealed devices" is not one that prevents entry of the external atmospheres, but rather restricts it to a degree commensurate with the probabilities that relate to the presence of an ignitible gas-air mixture in a Division 2 location. Sealed devices are covered in both CSA Standard C22.2 No. 213- M1987 and IEC 79-15 (1987).

For static seal applications, most commercially available sealing materials, even sealing materials that are considered unacceptable for process wetted applications, are suitable for short term vapor exposure (short term is relative to Division 2 exposure).

Dynamic seals are inherently more susceptible to mechanical damage and, therefore, warrant a more comprehensive evaluation involving the expected chemical exposure and the dynamic motion of the component.

The NACE/Materials Technology Institute has been conducting tests of plastics and elastomers for years, but has been unsuccessful in determining a relationship of vapor exposure over time to predicted life. For this reason, the solvent exposure test that was contained in previous editions of this standard has been omitted.

A.13.5.1 This equation is based on the Arrhenius equation. It relates the rate of most chemical reactions and how they increase rapidly with increasing temperature.

A.13.5.2 Historically, these three test methods have been used by approval bodies in North America. Different results may occur; however, passing any one of the tests is acceptable.

A.14.1 Historically, these three test methods have been used by approval bodies in North America. Different results may occur; however, passing any one of the tests is acceptable.

A.14.1.3 This equation is based on the Arrhenius equation. It relates the rate of most chemical reactions and how they increase rapidly with increasing temperature.

A.14.3 This test is based on the IEC 529 test for IP 6X enclosures.

A.16.4 No simple test of components can verify compatibility with every chemical that might be present in all foreseeable concentrations. Therefore, the user of sealed devices must assure, by testing, reference to the literature, or by contacting the manufacturer of the sealing material, that chemicals in the atmosphere surrounding the device are not likely to degrade the sealing of the device. Because this judgment is not precise, sealed components should be inspected periodically for any sign of attack or degradation. If signs of physical degradation, (e.g.— crazing, swelling, or deformation) are observed, the component should be replaced.

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