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Standard

Definitions and Information Pertaining to Electrical Instruments in Hazardous (Classified) Locations



The International Society for Measurement and Control

ISA-S12.1, Definitions and Information Pertaining to Electrical Instruments in Hazardous (Classified) Locations

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Preface

This preface is included for informational purposes and is not Part of ISA-S12.1.

This standard has been prepared as part of the service of ISA toward a goal of uniformity in the field of instrumentation. To be of real value, this document should not be static, but should be subject to periodic review. Toward this end, the society welcomes all comments and criticisms, and asks that they be addressed to the Secretary, Standards and Practices Board, ISA, 67 Alexander Drive, P.O. Box 12277, Research Triangle Park, NC 27709, Telephone (919) 549-8411.

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1 Purpose

This standard provides definitions and information pertaining to protection techniques, terminology, and the installation of electrical instruments in hazardous (classified) locations and provides an introduction and basic background to the ISA-SP12, Electrical Safety, series of publications and committee activities. It replaces the original ISA-RP12.1, Electrical Instruments in Hazardous Atmospheres, published in 1960.

This document provides a general review of applicable codes and standards, and it should not be used in lieu of those codes and standards for equipment design, manufacture, installation, and maintenance.

2 Scope

2.1 This standard provides general guidance for safe design, installation, and maintenance of electrical instrument systems in hazardous (classified) locations using appropriate means to prevent ignition of flammable gases and vapors, flammable liquids, combustible dusts, or ignitable fibers or flyings.

2.2 This standard covers only locations made hazardous, or potentially hazardous, due to the presence of flammable gases or vapors, flammable liquids, combustible dusts, or ignitable fibers or flyings. The standard is not necessarily relevant to the hazards posed by pyrophoric materials such as explosives or propellants containing their own oxidizers.

2.3 This standard is primarily intended to provide guidelines for electrical process measurement and control instruments; however, the principles may be applied to other types of electrical equipment.

2.4 This standard is concerned only with equipment design, construction, installation, and test criteria related to arc or thermal ignition in electrical equipment that may cause ignition of flammable gas or vapor-in-air mixtures, clouds or blankets of combustible dust, or easily ignitable fibers or flyings. Equipment should also comply with ordinary location requirements (e.g., [ISA-S82.01](#) and [ISA-S82.03](#)) for particular types of equipment.

2.5 This standard does not cover mechanisms of ignition from external sources, such as static electricity or lightning. Some process-sensing instruments may produce static electricity. The materials of construction of parts in such instruments will be an important consideration for application in hazardous locations. The extra precautions necessary for this are beyond the scope of this standard.

2.6 This standard does not consider the effects of installation in corrosive atmospheres and the resulting deleterious conditions to the original design integrity of the equipment. The additional precautions necessary for these conditions are outside the scope of this document.

2.7 This standard is not an instruction manual for untrained persons. However, it is intended to provide guidance to those involved with the design, manufacture, installation, and maintenance of instruments used in hazardous (classified) locations. It is also intended to promote uniformity of practice among those skilled in the art. Nothing contained in this standard is to be construed as a fixed rule without regard to sound engineering judgment.

2.8 For hazardous location equipment, atmospheric conditions are generally considered to be:

- a) an ambient temperature range of -13°F (-25°C) to 104°F (40°C);
- b) an oxygen concentration of not greater than 21 percent by volume;
- c) a pressure of 12.5 psia (86 kPa) to 15.7 psia (108 kPa); and
- d) a relative humidity of 5% to 95%.

NOTE: Equipment specified for atmospheric conditions beyond the above may be subject to additional requirements.

2.9 Specialized industries such as, but not limited to, mining and shipping may be regulated by the specific authority having jurisdiction. This standard does not include specific requirements or the rules and regulations unique to any specific industry.

2.10 Various organizations have developed codes, guides, and standards that have substantial acceptance by industry and governmental bodies. Codes, guides, and standards useful in the design and installation of electrical instruments in hazardous (classified) locations are listed in [Appendix C](#). These are not considered to be a part of this standard except for those specific sections of documents referenced elsewhere in this standard.

2.11 Due to the purpose of this standard, an attempt was made to avoid originality in principles whenever possible, but rather to utilize definitions, explanations, etc., from accepted publications. As a result, much of the material, except for minor changes, is directly as published by others. While specific credit is not given for each reference, all references are included in [Appendix B](#).

3 Definitions

The list is not intended to be all inclusive. Throughout this standard, reference is made to areas, spaces, locations, and zones. These terms should be considered interchangeable terms designating a three-dimensional space. The term "international" is used to designate practices other than those of the United States and Canada.

3.1 accessible surface: A surface to which a flammable or combustible mixture has access.

3.2 adequately ventilated area: An adequately ventilated area is an area that has a ventilation system (natural or artificial) that, as a minimum, prevents the accumulation of gases or vapors to an explosive level. Most standards and recommended practices recommend preventing levels in excess of 25 percent LEL.

NOTE: Adequate ventilation of an area alone is not an effective means for the prevention of dust explosions.

3.3 approved: Acceptable to the authority having jurisdiction.

NOTE 1: See "authority having jurisdiction."

NOTE 2: In determining the acceptability of installations or procedures, equipment, or material, the authority having jurisdiction may base acceptance on compliance with appropriate standards. In the absence of such standards, said authority may require evidence of proper installation, procedure, or use. The authority having jurisdiction may also refer to the listing or labeling practices of product-testing organizations. These organizations are in a position to determine compliance with appropriate standards for the current production of listed or labeled items.

3.4 arcing device: A device, such as make/break component, that under normal conditions produces an arc with energy sufficient to cause ignition of an ignitable mixture. See also "nonincendive circuit."

3.5 associated apparatus: Apparatus in which the circuits are not intrinsically safe themselves but affect the energy in the intrinsically safe circuits and are relied upon to maintain intrinsic safety. Associated electrical apparatus may be either:

- a) electrical apparatus that has an alternative type of protection for use in the appropriate hazardous (classified) location, or
- b) electrical apparatus that is not protected and, therefore, cannot be used within a hazardous (classified) location.

See also "intrinsic safety."

3.6 authority having jurisdiction: The organization, office, or individual that has the responsibility and authority for approving equipment, installations, or procedures.

NOTE: The phrase "authority having jurisdiction" is used in a broad manner since "jurisdiction" and "approval" agencies vary, as do their responsibilities. Where public safety is primary, the authority having jurisdiction may be a federal, state/provincial, local, other regional department, or an individual such as an inspector from a labor or health department, electrical inspector, or others having statutory authority. An insurance inspection agency, rating bureau, or other insurance company representative may be the "authority having jurisdiction." An owner or his designated agent may also assume the role. At government-owned installations, the commanding officer, departmental official, or designated agent may be the "authority having jurisdiction."

3.7 bonding: The permanent joining of metallic parts to form an electrically conductive path that will assure electrical continuity and the capacity to conduct safely any current likely to be imposed.

3.8 certified equipment: Equipment that has been evaluated by a recognized testing agency and confirmed to be in compliance with the applicable standard(s).

NOTE: Some agencies use the terms "approved," "listed," or "labeled equipment" to indicate compliance with the applicable standard.

3.9 Class I location: A location in which flammable gases or vapors are or may be present in the air in quantities sufficient to produce ignitable mixtures.

3.10 Class I, Division 1 location: A location (1) in which ignitable concentrations of flammable gases or vapors can exist under normal operating conditions; (2) in which ignitable concentrations of such gases or vapors may exist frequently because of repair or maintenance operations or because of leakage; or (3) in which breakdown or faulty operation of equipment or processes might release ignitable concentrations of flammable gases or vapors and might also cause simultaneous failure of electrical equipment that could act as a source of ignition.

3.11 Class I, Division 2 location: A location (1) in which volatile flammable liquids or flammable gases are handled, processed, or used, but in which the liquids, vapors, or gases will normally be confined within closed containers or closed systems from which they can escape only in case of accidental rupture or breakdown of such containers or systems, or in case of abnormal operation of equipment; (2) in which ignitable concentrations of gases or vapors are normally prevented by positive mechanical ventilation and might become hazardous through failure or abnormal operation of the ventilating equipment; or (3) that is adjacent to a Class I, Division 1 location and to which ignitable concentrations of gases or vapors might occasionally be communicated unless such communication is prevented by adequate positive-pressure ventilation from a source of clean air and effective safeguards against ventilation failure are provided.

Electrical conduits and their associated enclosures separated from process fluids by a single seal or barrier are classified as a Class I, Division 2 location if the outside of the conduit and enclosures is a nonhazardous (unclassified) location. Refer to [6.1.3.2](#).

3.12 Class II location: A location that is hazardous because of the presence of combustible dust.

3.13 Class II, Division 1 location: A location (1) in which combustible dust is in the air under normal operating conditions in quantities sufficient to produce explosive or ignitable mixtures; (2) in which mechanical failure or abnormal operation of machinery or equipment might cause such explosive or ignitable mixtures to be produced and might also provide a source of ignition through simultaneous (the word "simultaneous" is not included in the Canadian definition) failure of electric equipment, operation of protection devices, or from other causes; or (3) in which combustible dusts of an electrically conductive nature may be present in hazardous quantities.

3.14 Class II, Division 2 location (United States): A location in which combustible dust is not normally in the air in quantities sufficient to produce explosive or ignitable mixtures and dust accumulations are normally insufficient to interfere with the normal operation of electrical equipment or other apparatus, but combustible dust may be in suspension in the air as a result of infrequent malfunctioning of handling or processing equipment and where combustible dust accumulations on, in, or in the vicinity of the electrical equipment may be sufficient to interfere with the safe dissipation of heat from electrical equipment or may be ignitable by abnormal operation or failure of electrical equipment.

3.15 Class II, Division 2 location (Canada): A location in which combustible dusts are not normally in suspension in air or likely to be thrown into suspension by the normal or abnormal operation or the failure of equipment or apparatus in quantities sufficient to produce explosive or ignitable mixtures, but in which:

- a) deposits or accumulations of dust may be sufficient to interfere with the safe dissipation of heat from electrical equipment or apparatus; or
- b) deposits or accumulations of dust on, in, or near electrical equipment may be ignited by arcs, sparks, or burning material from the electrical equipment.

3.16 Class III location: A location that is hazardous because of the presence of easily ignitable fibers or flyings but in which such fibers or flyings are not likely to be in suspension in the air in quantities sufficient to produce ignitable mixtures.

3.17 Class III, Division 1 location: A location in which easily ignitable fibers or materials producing combustible flyings are handled, manufactured, or used.

3.18 Class III, Division 2 location: A location in which easily ignitable fibers are stored or handled (except in the process of manufacture).

3.19 Code of Practice: An international term referring to a document that describes basic safety features and methods of protection and recommends the selection, installation, and maintenance procedures that should be followed to ensure the safe use of electrical apparatus.

3.20 continuous dilution: The technique of supplying a protective gas flow continuously to an enclosure containing an internal potential source of flammable gas or vapor for the purpose of diluting any flammable gas or vapor that could be present to a level well below its LEL. Refer to [5.2.2](#).

3.21 control drawing: A drawing or other document provided by the manufacturer of the intrinsically safe or associated apparatus that details the allowed interconnections between the intrinsically safe and associated apparatus.

3.22 degrees of protection of enclosures: An international system of rating standard levels of protection provided by enclosures for the protection of persons against contact with live or moving parts inside the enclosure, as well as the protection provided by an enclosure against ingress of solids and/or liquids. This type of protection classification is in addition to (and not an alternative to) the types of protection necessary to ensure protection against ignition in hazardous (classified) locations. Definitions are found in IEC Publications 529 and 144. This system is similar to the NEMA enclosure rating system in the United States.

3.23 dust: Any finely divided solid material 420 μm^* or smaller in diameter (material passing a U.S. No. 40 sieve).

NOTE: Larger-sized particles can also cause explosions.

3.24 dust, combustible: Dust that (when mixed with air in certain proportions) can be ignited and will propagate a flame. The combustible properties of dust are dependent upon test conditions and dust particle size, chemical structure, and other dust particle characteristics.

3.25 dust-ignitionproof: A term used in the United States to describe an enclosure that will exclude ignitable amounts of dusts or amounts that might affect performance or rating and that, when installed and protected in accordance with the original design intent, will not permit arcs, sparks, or heat otherwise generated or liberated inside the enclosure to cause ignition of exterior accumulations or atmospheric suspensions of a specified dust.

NOTE: Such equipment installed in Class II locations shall be able to function at full rating without developing surface temperatures high enough to cause excessive dehydration or gradual carbonization of any organic dust deposits that may occur.

3.26 dust layer, combustible: Any surface accumulation of combustible dust that is thick enough to propagate flame or will degrade and ignite.

3.27 dust-protected enclosure: An international term describing an enclosure in which the ingress of dust is not totally prevented, but dust does not enter in sufficient quantity to interfere with the safe operation of the equipment or accumulate in a position within the enclosure where it is possible to cause an ignition hazard.

3.28 dust-tight: An enclosure so constructed that dust will not enter the enclosing case under specified test conditions. Refer to [5.2.5](#).

*Most documents use 74 μm^* (U.S. No. 200 standard sieve).

3.29 encapsulation: An international term describing a type of protection in which the parts that could ignite an explosive atmosphere by either sparking or heating are enclosed in an encapsulant in such a way that this explosive atmosphere cannot be ignited. This type of protection is referred to by CENELEC as "Ex m" in draft Standard EN50028.

NOTE: Encapsulation is the potting or casting of electrical components with epoxy, elastomer, silicone, asphaltic, or similar compounds for the purpose of excluding moisture or vapors. Encapsulated components are not necessarily hermetically sealed.

3.30 explosionproof enclosure: An enclosure that is capable of withstanding an explosion of a gas or vapor within it and of preventing the ignition of an explosive gas or vapor that may surround it and that operates at such an external temperature that a surrounding explosive gas or vapor will not be ignited thereby. This type enclosure is similar to a flameproof enclosure.

3.31 explosionproof equipment (apparatus): Equipment or apparatus enclosed in an explosionproof enclosure.

3.32 fault (as applicable to intrinsically safe systems): A defect or electrical breakdown of any component, spacing, or insulation that alone or in combination with other defects or breakdowns may adversely affect the electrical or thermal characteristics of the intrinsically safe system. If a defect or breakdown leads to defects or breakdowns in other components, the primary and subsequent defects and breakdowns are considered to be a single fault. Certain components may be considered not subject to fault when analyses or tests for intrinsic safety are made. See also "protective component."

3.33 fibers and flyings: Materials not normally in suspension in air; such materials are of larger particle size than dusts. Fibers and flyings include materials such as cotton linters, sawdust, textile fibers, and other large particles that are usually more a fire hazard than an explosion hazard.

3.34 fibers and flyings, easily ignitable: Fibers and flyings that are easily ignitable including rayon, cotton (including cotton linters and cotton waste), sisal or henequen, istle, jute, hemp, tow, cocoa fiber, oakum, baled waste kapok, Spanish moss, excelsior, and other materials of similar nature.

3.35 flameproof enclosure: An international term describing an enclosure that can withstand the pressure developed during an internal explosion of an explosive mixture and that prevents the transmission of the explosion to the explosive atmosphere surrounding the enclosure and that operates at such an external temperature that a surrounding explosive gas or vapor will not be ignited thereby. This enclosure is similar to an explosionproof enclosure. This type of protection is referred to by IEC as "Ex d."

3.36 flammable (explosive) limits: The flammable (explosive) limits of a gas or vapor are the lower (LFL or LEL) and upper (UFL or UEL) percentages by volume of concentration of gas in a gas-air mixture that will form an ignitable mixture. Reference NFPA 325M.

3.37 flammable liquid: Any liquid having a flash point below 100°F (37.8°C) and having a vapor pressure not exceeding 40.1 psia (276 kPa) at 100°F (37.8°C).

3.38 flammable gas or vapor: Any substance that exists in the gaseous or vapor state at normal atmospheric temperature and pressure and that is capable of being ignited and rapidly oxidizing when mixed with proper proportions of air or oxygen.

3.39 flash point: The minimum temperature at which a liquid emits vapor in a concentration sufficient to form an ignitable mixture with air near the surface of the liquid but not sufficient to sustain combustion, as determined by appropriate test procedures and apparatus.

3.40 ground: A conducting connection, whether intentional or accidental, between an electrical circuit or equipment and the earth or to some conducting body that serves in place of the earth.

3.41 grounded (earthed): Connected to earth or to some conducting body that serves in place of earth.

3.42 group: Lists of materials of similar explosion hazard. Refer to [Section 4](#).

3.43 hazardous (classified) location: A location in which fire or explosion hazards may exist due to flammable gases or vapors, flammable liquids, combustible dust, or easily ignitable fibers or flyings.

3.44 hermetically sealed device: A device that is sealed against the entrance of an external atmosphere and in which the seal is made by fusion. Continuous soldering, brazing, welding, and the fusion of glass to metal are examples of recognized methods.

3.45 high temperature device: A device in which the maximum operating temperature (including ambient temperature effect) exceeds 80 percent of the autoignition temperature in degrees Celsius (°C) of the gas or vapor involved.

3.46 ignitable gas mixture: A gas-air mixture that is capable of being ignited by an open flame, arc or spark, or high temperature.

3.47 ignition (autoignition) temperature: The minimum uniform temperature required to initiate or cause self-sustained combustion of a solid, liquid, or gaseous substance (independent of any other ignition source).

NOTE: A distinction is made between ignition temperature and flash point. See "flash point."

3.48 ignition capable: Equipment or wiring that under normal conditions may release sufficient electrical or thermal energy to cause ignition of a specific ignitable atmosphere.

3.49 increased safety: An international term that describes a type of protection in which various measures are applied so as to reduce the probability of excessive temperatures and the occurrence of arcs or sparks in the interior and on the external parts of electrical apparatus that do not produce them in normal service.

This type of protection is referred to by IEC as "Ex e." These measures typically involve "robust" construction features such as special cable glands, specially spaced and secured terminal connections, double insulation of windings, rugged enclosure design, or combinations of such features.

3.50 internal wiring: Wiring and electrical connections that are made within apparatus by the manufacturer. Within racks or panels, interconnections between separate pieces of apparatus made in accordance with detailed instructions from the apparatus manufacturer are also considered to be internal wiring.

3.51 intrinsic safety: A type of protection in which a portion of the electrical system contains only intrinsically safe equipment (apparatus, circuits, and wiring) that is incapable of causing ignition in the surrounding atmosphere. No single device or wiring is intrinsically safe by itself (except for battery-operated self-contained apparatus such as portable pagers, transceivers, gas detectors, etc., which are specifically designed as intrinsically safe self-contained devices) but is intrinsically safe only when employed in a properly designed intrinsically safe system. This type of protection is referred to by IEC as "Ex i." See also "associated equipment (apparatus)."

3.52 intrinsic safety barrier: A component containing a network designed to limit the energy (voltage and current) available to the protected circuit in the hazardous (classified) location under specified fault conditions.

3.53 intrinsically safe circuit: A circuit in which any spark or thermal effect, produced either normally or in specified fault conditions, is incapable, under specified test conditions, of causing ignition of a mixture of flammable or combustible material in air in the mixture's most easily ignited concentration.

3.54 intrinsically safe equipment (apparatus, circuits, and wiring): Equipment and wiring that, under normal or abnormal conditions, are incapable of releasing sufficient electrical or thermal energy to cause ignition of a specific hazardous atmospheric mixture in its most easily ignitable concentration.

3.55 intrinsic safety ground bus: A grounding system that has a dedicated conductor separate from the power system so that ground currents will not normally flow and that is reliably connected to a ground electrode (e.g., in accordance with Article 250 of NEC, ANSI/NFPA 70, or Section 10 of CEC Part 1, CSA C22. 1).

3.56 intrinsically safe system: An assembly of interconnected intrinsically safe apparatus, associated apparatus, other apparatus, and interconnecting cables in which those parts of the system that may be used in hazardous (classified) locations are intrinsically safe circuits.

3.57 labeled equipment: Equipment or materials, to which has been attached a label, symbol, or other identifying mark of an organization concerned with product evaluation, that may maintain periodic inspection of the production of labeled equipment or materials, and by whose labeling the manufacturer indicates compliance with appropriate standards or performance in a specified manner.

NOTE: Some agencies use the terms "approved," "listed," or "certified equipment" to indicate compliance with the applicable standard.

3.58 liquid, combustible: A liquid having a flash point at or above 100°F (37.8°C). Combustible liquids are subdivided as follows:

- a) Class II liquids include those having flash points at or above 100°F (37.8°C) and below 140°F (60°C).
- b) Class IIIA liquids include those having flash points at or above 140°F (60°C) and below 200°F (93°C).
- c) Class IIIB liquids include those having flash points at or above 200°F (93°C).

Reference NFPA 321, Basic Classification of Flammable and Combustible Liquids, for additional information.

3.59 listed: Equipment or materials, included in a list published by an organization concerned with product evaluation, that maintains periodic inspection of production of listed equipment or materials and whose listing states either that the equipment or materials meets appropriate standards or has been tested and found suitable for use in the specified manner.

NOTE: The means for identifying listed equipment may vary for each organization concerned with product evaluation, some of which do not recognize equipment as listed unless it is also labeled. The authority having jurisdiction should be familiar with the system employed by the listing organization to identify a listed product. Some agencies use the terms "approved," "labeled," or "certified equipment" to indicate compliance with the applicable standard.

3.60 lower explosive limit (LEL): Refer to "flammable (explosive) limits."

3.61 lower flammable limit (LFL): Refer to "flammable (explosive) limits."

3.62 maintenance, corrective: Any maintenance activity that is not normal in the operation of 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, replacement of defective components, adjustment of internal controls, and the like.

3.63 maintenance, operational: Any maintenance activity, excluding corrective maintenance, intended to be performed by the operator and required in order for the equipment to serve its intended purpose. Such activities typically include the correcting of "zero" on a panel instrument, changing charts, record keeping, adding ink, and the like.

3.64 make/break component: 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, connectors, and motor brushes.

3.65 maximum surface temperature: The highest temperature attained by a surface accessible to flammable gases, vapors, or combustible dusts under conditions of operation within the ratings of the apparatus (including recognized overloads and defined fault conditions).

3.66 minimum cloud ignition temperature: The minimum temperature at which a combustible dust atmosphere will autoignite and propagate an explosion.

3.67 minimum dust layer ignition temperature: The minimum temperature of a surface that will ignite a dust lying on it after a long time (theoretically, until infinity). In most dusts, free moisture has been vaporized before ignition.

3.68 minimum explosive (dust) concentration: The minimum concentration of a dust cloud that, when ignited, will propagate a flame away from the source of ignition.

3.69 minimum ignition energy: The smallest amount of energy that can ignite the most easily ignitable mixture of a specific gas or vapor-in-air mixture or dust-in-air mixture.

3.70 nonhazardous (unclassified) location: A location in which fire or explosion hazards are not expected to exist specifically due to the presence of flammable gases or vapors, flammable liquids, combustible dusts, or ignitable fibers or flyings. Internationally, such a location is referred to as a safe area.

3.71 nonincendive circuit: A circuit in which any arc or thermal effect produced in normal operating conditions of the equipment is not capable, under prescribed conditions, of igniting the specified flammable gas, vapor-in-air mixture, combustible dusts, or ignitable fibers or flyings.

3.72 nonincendive component: A 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 as specified by appropriate test procedure. The housing of a nonincendive component is not intended to (1) exclude the flammable atmosphere or (2) contain an explosion.

3.73 nonincendive equipment: Equipment having electrical/electronic circuitry and components that are incapable, under normal conditions, of causing ignition of a specified flammable gas or vapor-in-air mixture due to arcing or thermal effect. This type of protection is referred to by IEC as "Ex n." Ex n protection is limited to gas and vapor hazards.

NOTE: Normal use includes operation:

- a) at rated voltage, current, and frequency;
- b) under specified environmental conditions;
- c) with all adjustments at most unfavorable settings;
- d) with all tool-removable parts in place; and
- e) of make/break (arcing) components.

3.74 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 a specified flammable gas or vapor-in-air mixture or combustible dust-in-air mixture. Normal operation includes opening, shorting, or grounding the field wiring.

3.75 normal conditions: As related to intrinsically safe and nonincendive systems, equipment is under normal conditions when it conforms electrically and mechanically with its design specifications and is used within the limits specified by the manufacturer.

Normal conditions for intrinsically safe equipment include the following:

- a) supply voltage at maximum rated value;
- b) environmental conditions within the ratings given for the apparatus or associated apparatus;
- c) tolerances of all components in the combination that represents the most unfavorable condition;
- d) adjustments at their most unfavorable settings; and
- e) opening of any one, shorting of any two, and grounding of any one of the field wires of the intrinsically safe circuit(s).

NOTE: CSA practice differs in philosophy for condition e). The CSA wording would be: "The shorting, opening, grounding, or any combination of these conditions at field wiring terminals of the circuit."

Normal conditions for nonincendive equipment include the following:

- a) supply voltage, current, and frequency at rated values;
- b) environmental conditions within the ratings given for the apparatus;
- c) all tool-removable parts (e.g., covers) in place;
- d) all operator-accessible adjustments at their most unfavorable setting; and
- e) opening, shorting, and grounding of the nonincendive field wiring.

3.76 oil-immersed equipment: Equipment immersed in electrical insulating oil for the purpose of preventing an ignitable gas or vapor from coming in physical contact with the source of ignition. This type of protection is referred to by IEC as "Ex o."

NOTE: This type of equipment may also serve the purpose of preventing a particular corrosive gas or vapor from coming in physical contact with the electrical components, provided one considers the solubility of the corrosive atmosphere in the oil.

3.77 powder filling: An international term that describes a type of protection in which an enclosure of electrical apparatus is filled with a material in a finely granulated state so that, in the intended conditions of service, any arc occurring within the enclosure of an electrical apparatus will not ignite the surrounding atmosphere. No ignition is allowed to be caused either by flame or by excessive temperature of the accessible surfaces of the enclosure. This type of protection is referred to by IEC as "Ex q."

3.78 pressurization: The technique of preventing an external atmosphere, which may be ignitable, from entering an enclosure by maintaining the internal pressure of the enclosure's protective gas (with or without continuous flow) at a pressure level above that of the external atmosphere. This type of protection is referred to by IEC as "Ex p."

NOTE: In the United States, pressurization is the process of supplying an enclosure in a Class II application with clean air or an inert gas, with or without continuous flow, at sufficient pressure to prevent the entrance of combustible dusts. Refer to [5.2.1](#) and [5.2.1.2](#).

3.79 protection techniques: Internationally, a term used to describe a technique of explosion protection that is applied to an apparatus to provide an assurance of safety. Examples are "Type e" and "Type n."

3.80 protective component (as applied to intrinsic safety): A component that is so unlikely to become defective in a manner that will lower the intrinsic safety of the circuit that it may be considered not subject to fault when analyses or tests for intrinsic safety are made.

3.81 protective gas: The gas used for pressurization or for the dilution of flammable gases to a level well below their lower explosive limit, usually below 25 percent LEL. The protective gas may be air, nitrogen, other nonflammable gas, or a mixture of such gases.

3.82 purging: The process of supplying an enclosure with clean air or inert gas at a specified flow rate and positive pressure to reduce the concentration of any flammable gas or vapor initially present to an acceptably safe level and to maintain this safe level by positive pressure with or without continuous flow. Refer to [5.2.1](#) and [5.2.1.2](#) and definitions of Type X, Y, and Z purging.

3.83 purging, Type X: In the United States and Canada, a method of reducing the classification within an enclosure from Division 1 to nonhazardous (unclassified).

3.84 purging, Type Y: In the United States and Canada, a method of reducing the classification within an enclosure from Division 1 to Division 2.

3.85 purging, Type Z: In the United States and Canada, a method of reducing the classification within an enclosure from Division 2 to nonhazardous (unclassified).

3.86 restricted breathing: A Zone 2 protection technique in which the tightness of an enclosure is assured so that short-term presence of a flammable gas or vapor cloud around the enclosure will not cause the concentration inside the enclosure to reach the LEL because of breathing or diffusion.

3.87 safe area: Refer to "nonhazardous (unclassified) location."

3.88 seal, cable, explosionproof: A cable terminator filled with compound and designed to contain an explosion in the enclosure to which it is attached or to minimize passage of flammable gases or vapors from one location to another. A conduit seal may also be used as a cable seal. This method differs from the international practice, which requires cable glands.

3.89 seal, conduit, explosionproof: A sealing fitting, poured with cement-like potting compound, designed to contain an explosion in the enclosure to which it is attached and to minimize passage of flammable gases or vapors from one location to another.

3.90 seal, factory: A seal provided in an explosionproof device during manufacture for the purpose of eliminating the need for an external, field-installed "conduit seal" for that device.

NOTE: Factory seals are typically not rated to withstand process temperature and pressure conditions to which they will be subjected upon failure of the primary process seal or barrier.

3.91 sealed device: A device so constructed that it cannot be opened during normal operational conditions or operational maintenance; it has a free internal volume less than 100 cubic centimeters (6.1 cubic inches) and is sealed to restrict entry of an external atmosphere. Reference [ISA-S12.12](#) for aging, vapor exposure, and leakage test requirements. Reference also IEC 79-15.

3.92 simple apparatus (as applied to intrinsic safety): A device that will not generate or store more than 1.2 V, 0.1 A, 25 mW, or 20 μ J. Examples are: switches, thermocouples, light-emitting diodes, and resistance temperature detectors (RTDs).

3.93 source of release: A point from which flammable gases or vapors, flammable liquid, combustible dusts, or ignitable fibers or flyings may be released into the atmosphere.

3.94 special protection: A protection technique other than those that have been standardized. This type of protection is referred to by IEC as "Type s."

3.95 temperature identification number (temperature class): A system of classification by which one of 14 temperature identification numbers (internationally, six temperature classes) is allocated to an electrical apparatus. The temperature identification number represents the maximum surface temperature of any component that may come in contact with the flammable gas or vapor mixture. See Table 2.

3.96 type of protection: Refer to "protection techniques."

3.97 upper explosive limit (UEL): Refer to "flammable (explosive) limits."

3.98 upper flammable limit (UFL): Refer to "flammable (explosive) limits."

3.99 zone: The international method of specifying the probability that a location is made hazardous by the presence, or potential presence, of flammable concentrations of gases and vapors.

NOTE: Zone classification has not yet been defined for dusts and flyings.

3.100 Zone 0: Classification of a location in which an explosive concentration of a flammable gas or vapor mixture is continuously present or is present for long periods. The area classified as Zone 0, although not specifically defined, is contained within the United States and Canadian classifications of a Division 1 location and constitutes an area with the highest probability that an ignitable mixture is present.

3.101 Zone 1: Classification of a location in which an explosive concentration of a flammable or explosive gas or vapor mixture is likely to occur in normal operation. The area classified as Zone 1 is contained within the United States and Canadian classifications of a Division 1 location.

3.102 Zone 2: Classification of a location in which an explosive concentration of a flammable or explosive gas or vapor mixture is unlikely to occur in normal operation and, if it does occur, will exist only for a short time. Zone 2 is basically equivalent to the United States and Canadian classifications of a Division 2 location.

4 Area (location) classification

The type of protective technique selected and the level of protection it must provide depend upon the potential hazard caused by using electrical apparatus in a location where a combustible, flammable, or ignitable substance may be present. Area classification schemes and systems of material classification have been developed to provide a succinct description of the hazard so that appropriate safeguards may be selected. All useful area classification systems specify the kind of flammable material that may be present and the probability that it will be present in ignitable concentrations.

4.1 North American methods

4.1.1 In the United States, area classification principles are stated in Article 500 of the National Electrical Code, ANSI/NFPA 70. Similar requirements in Canada are given in the Canadian Electrical Code, Part 1, Section 18, (CSA C22.1).

Various organizations have developed numerous guides and standards that have substantial acceptance by industry and governmental bodies for area classification. Refer to [Appendix C](#).

Area classification descriptions used in the United States and Canada include the following:

Locations are classified (1) by CLASS—the generic form of the flammable materials in the atmosphere (gas or vapor, dusts, or easily ignitable fibers or flyings); (2) by DIVISION—an indication of the probability of the presence of the flammable material in ignitable concentration; and (3) by GROUP—the exact nature of the flammable material. For formal definitions, refer to 3, Definitions. Abbreviated definitions follow.

4.1.1.1 Classes

Class I locations are those in which flammable gases or vapors are, or may be, present in the air in quantities sufficient to produce explosive or ignitable mixtures.

Class II locations are those that are hazardous because of the presence of combustible dusts.

Class III locations are those in which easily ignitable fibers or flyings may be present but not likely to be in suspension in sufficient quantities to produce ignitable mixtures.

4.1.1.2 Divisions

Class 1, Division 1 locations are those in which:

- a) hazardous concentrations exist continuously, intermittently, or periodically under normal operating conditions;

- b) hazardous conditions may exist frequently because of repair or maintenance operations or because of leakage; or
- c) breakage or faulty operation of process or other nonelectrical equipment or processes might release flammable concentrations or gases or vapors and might also cause simultaneous failure of electrical equipment that causes a source of ignition.

Class I, Division 2 locations are those in which:

- a) hazardous volatile liquids, vapors, or gases are normally confined within closed containers or closed systems from which they can escape only in case of accidental rupture or breakdown of such containers or systems, or in case of abnormal operation of equipment;
- b) flammable concentrations are normally prevented by positive mechanical ventilation but might become hazardous through failure or abnormal operation of the ventilating system; or
- c) areas adjacent to Division 1 locations to which hazardous concentrations of gases or vapors might occasionally be communicated.

Class II, Division 1 locations are those in which:

- a) combustible dust is, or may be, in suspension in the air continuously, intermittently, or periodically under normal operating conditions, in quantities sufficient to produce explosive or ignitable mixtures;
- b) breakage or faulty operation of a process or machinery may produce combustible concentrations of dusts and might also cause simultaneous failure of electrical equipment, which, in turn, may act as a source of ignition; or
- c) electrically conductive combustible dusts may be present.

Class II, Division 2 locations are those in which:

- a) combustible concentrations of suspended dust are not likely, but where deposits or accumulations of dust may interfere with the safe dissipation of heat from electrical equipment or apparatus; or
- b) combustible concentrations of suspended dust are not likely, but where deposits or accumulations of dust on, in, or in the vicinity of electrical equipment might be ignited by arcs, sparks, or burning material from such equipment.

Class III, Division 1 locations are those in which easily ignitable fibers or materials producing combustible flyings are handled, manufactured, or used.

Class III, Division 2 locations are those in which easily ignitable fibers may be stored or handled (except in the process of manufacture).

NOTE: Some plant areas in the manufacture, handling, and storage of explosives or ammunition and nitrocellulose products (such as celluloid photographic films), etc., involve conditions that are not covered by NEC Classifications. This is particularly true where black powders, smokeless powder, dust from TNT, and other explosives are present. See NFPA 495, Reference Code for Explosive Materials, for guidance.

4.1.1.3 Groups

The United States and Canadian standards recognize seven groups: Groups A, B, C, D, E, F, and G. Groups A, B, C, and D apply to Class I locations; Groups E, F, and G apply to Class II Locations.

These groups include the following: