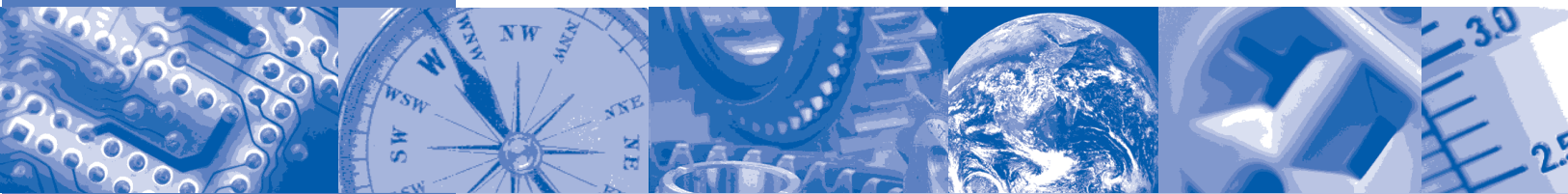


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Definitions and Information Pertaining to Electrical Apparatus in Hazardous (Classified) Locations



**ISA—The Instrumentation,
Systems, and
Automation Society**

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1 Purpose

This Standard provides definitions and information pertaining to protection techniques, terminology, and the installation of electrical apparatus 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 ISA-12.1, *Definitions and Information Pertaining to Electrical Instruments in Hazardous Atmospheres*, published in 1991.

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, maintenance and test criteria.

2 Scope

2.1 This Standard provides general guidance for safe design, installation, and maintenance of electrical apparatus 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 concerned only with design, manufacture, installation, maintenance, and test criteria related to arcs, sparks, or hot surfaces produced by electrical apparatus that may cause ignition of flammable gas or vapor-in-air mixtures, clouds or blankets of combustible dust, or easily ignitable fibers or flyings. Apparatus should also comply with the applicable ordinary location requirements (e.g., ISA-82.01 and ISA-82.03).

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

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

2.6 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 apparatus 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.

2.7 For hazardous location apparatus, atmospheric conditions are generally considered to be

- a) an ambient temperature range of -20 °C (-4 °F) to 40 °C (104 °F);
- b) an oxygen concentration of not greater than 21 percent by volume;
- c) a pressure of 86 kPa (12.5 psia) to 108 kPa (15.7 psia); and

d) a relative humidity of 5 percent to 95 percent.

NOTE — Apparatus specified for atmospheric conditions beyond the average is generally permitted but will be subjected to additional requirements.

2.8 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.

2.9 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 [Annex C](#). These are not considered to be a part of this Standard except for those specific sections of documents referenced elsewhere in this Standard.

2.10 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 [Annex 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.

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 of the Lower Flammable (Explosive) Limit, LFL (LEL).

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

3.3 AEx:

required marking prefix for apparatus meeting one or more types of protection in Section 505-2(c) for installation in accordance with Article 505 of the National Electrical Code, NFPA 70: 1999.

3.4 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.

3.5 arcing device:

an electrical make/break component, that is generally interpreted as capable of producing an arc with energy sufficient to cause ignition of a specific ignitable mixture.

3.6 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 not so protected that shall not be used within a hazardous (classified) location.

[See also INTRINSIC SAFETY.](#)

3.7 authority having jurisdiction:

the organization, office, or individual that has the responsibility and authority for approving equipment, installations, or procedures.

NOTE — The term 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.

3.8 automatic:

self-acting, operating by its own mechanism when actuated by some impersonal influence, as for example, a change in current strength, pressure, temperature, or mechanical configuration.

3.9 bonding:

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

3.10 cable entry (cable gland):

a device permitting the introduction of an electric cable into an electrical apparatus.

3.11 certified:

generic term referring to apparatus 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 apparatus to indicate compliance with the applicable standard.

3.12 Class I location:

a location in which flammable gases or vapors are or may be present in the air in quantities sufficient to produce explosive or ignitable mixtures. See 3.116, 3.118, & 3.120 for definitions of Class I, Zones 0, 1, & 2.

3.13 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.

3.14 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; or (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.

3.15 Class II location:

a location that is hazardous because of the presence of combustible dust.

3.16 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; or (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 failure of electrical 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.

3.17 Class II, Division 2 location:

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.

3.18 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.

3.19 Class III, Division 1 location:

a location in which easily ignitable fibers or materials producing combustible flyings are handled, manufactured, or used.

3.20 Class III, Division 2 location:

a location in which easily ignitable fibers are stored or handled (except in the process of manufacture).

3.21 code of practice:

a term referring to a document that describes basic safety features and methods of protection and recommends, e.g., the selection, installation, inspection, and maintenance procedures that should be followed to ensure the safe use of electrical apparatus.

3.22 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 below its LFL/LEL. [Refer to 5.2.2.](#)

3.23 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.

3.24 degree of protection (IP):

a system of rating standard levels of protection provided by apparatus for the protection of persons against contact with live or moving parts inside the apparatus, as well as the protection provided by apparatus 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 Publication 60529.

NOTE — See also [ENCLOSURE TYPE](#).

3.25 dust, combustible:

any finely divided solid material 420 microns or less in diameter (i.e., material passing a U.S. No. 40 sieve) that presents a fire or explosion hazard when dispersed.

3.26 dust-ignitionproof:

a term used to describe an enclosure that will exclude dust and that, when installed 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 atmosphere suspensions of a specified dust in the vicinity of the enclosure.

3.27 dust layer, combustible:

any surface accumulation of combustible dust that is thick enough to propagate flame or will degrade and ignite.

3.28 dust-protected enclosure:

a 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.

3.29 dusttight:

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

3.30 EEx:

designation of explosion-protected electrical apparatus complying with harmonized CENELEC Standards.

3.31 electrical apparatus:

items applied as a whole or in part for the utilization of electrical energy. These include, among others, equipment for the generation, transmission, distribution, storage, measurement, regulation, conversion, and consumption of electrical energy and items for telecommunication.

3.32 enclosure type:

a North American system of rating standard levels of protection provided to electrical apparatus by enclosures for 1) the protection of persons against contact with live or moving parts inside the enclosure, 2) the protection provided by the enclosure against ingress of solids and/or liquids, 3) the protection provided by the enclosure against the deleterious effects of corrosion, and 4) the protection provided by the enclosure against damage due to the formation of external ice. This enclosure type 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 UL 50 or NEMA 250.

NOTE — See also [DEGREE OF PROTECTION](#).

3.33 encapsulation:

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 as "m."

3.34 energized:

electrically connected to a source of potential difference.

3.35 entity concept:

a concept that allows interconnection of intrinsically safe apparatus to associated apparatus not specifically examined in such a combination. The criteria for interconnection is that the voltage (V_{max}) and current (I_{max}) which intrinsically safe apparatus can receive and remain intrinsically safe, considering faults, must be equal to or greater than the voltage (V_{oc} or V_t) and current (I_{sc} or I_t) levels which can be delivered by the associated apparatus, considering faults and applicable factors. In addition, the maximum unprotected capacitance (C_i) and inductance (L_i) of the intrinsically safe apparatus, including interconnecting wiring, must be equal to or less than the capacitance (C_a) and inductance (L_a) that can safely be connected to the associated apparatus. If these criteria are met, then the combination may be connected without compromising intrinsic safety. For additional information refer to ISA RP12.6.

3.36 entry, direct:

a method of connection of an electrical apparatus to the external circuits by means of the connecting facilities inside the main enclosure or in a terminal compartment having a free opening to the main enclosure. (IEV 426-04-07)

3.37 entry, indirect:

a method of connection of an electrical apparatus to the electrical circuits by means of a terminal box or a plug and socket connection which is external to the main enclosure. (IEV 426-04-08)

3.38 Ex:

designation of explosion-protected electrical apparatus

3.39 Ex component:

part of electrical apparatus for explosive atmospheres which is not to be used alone in such atmospheres and which requires additional evaluation of any electrical apparatus with which it is used.

3.40 Ex Scheme:

an international system of certification for explosion-protected electrical apparatus administered by the IECEE and described by IECEE-04. The eventual goal of this scheme is that a manufacturer of hazardous location electrical apparatus would be able to obtain a single 'Ex' Certificate of Conformity from one Certification Laboratory and provide that product in any participating country without legal or technical obstacle and without the need to get it recertified locally.

3.41 explosionproof:

a term used to describe an enclosure that is capable of withstanding an explosion of a specified gas or vapor that may occur within it and of preventing the ignition of a specified gas or vapor surrounding the enclosure by sparks, flashes, or explosion of the gas or vapor within, and that operates at such an external temperature that a surrounding flammable atmosphere will not be ignited thereby. (NEC)

NOTE — See also [FLAMEPROOF ENCLOSURE](#).

3.42 explosive atmosphere:

a mixture with air, under atmospheric conditions, of flammable substances in the form of gas, vapor, mist, or dust in which, after ignition, combustion spreads throughout the unconsumed mixture.

NOTE — See also [HAZARDOUS \(CLASSIFIED\) LOCATION](#).

3.43 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](#).

3.44 fibers and flyings:

these are materials not normally in suspension in air; and 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.

3.45 flameproof:

a type of protection of electrical apparatus in which an enclosure will withstand an internal explosion of a flammable mixture which has penetrated into the interior, without suffering damage and without causing ignition, through any joints or structural openings in the enclosure, of an external explosive atmosphere consisting of one or more of the gases or vapors for which it is designed. This type of protection is referred to as “d.”

NOTE — See also [EXPLOSIONPROOF APPARATUS](#).

3.46 flammable (explosive) limits:

the flammable (explosive) limits of a gas or vapor are the lower (LFL/LEL) and upper (UFL/UEL) flammable (explosive) limit percentages by volume of concentration of gas in a gas-air mixture that will form an ignitable mixture.

NOTE 1 — For additional information refer to NFPA 325 and IEC 60079-20.

NOTE 2 — The term *explosive* as it relates to atmospheres and mixtures is in the process of being replaced with the more technically correct term *flammable* throughout many national and international standards. This document, however, continues to use the term *explosive* in many of the definitions that are repeated here as those definitions have been derived from documents that have yet to be updated.

3.47 flammable liquid:

any liquid having a flash point below 37.8 °C (100 °F) and having a vapor pressure not exceeding 275 kPa (40 psia) at 37.8 °C(100 °F).

NOTE — For additional information, refer to NFPA 325.

3.48 flammable gas or vapor:

a gas or vapor which, when mixed with air in certain proportions, will form an explosive gas atmosphere.

3.49 flash point:

the minimum temperature at which a liquid gives off vapor in sufficient concentration to form an ignitable mixture with air near the surface of the liquid, as specified by test.

NOTE — For additional information, refer to NFPA 325.

3.50 ground:

a conducting connection, whether intentional or accidental, between an electrical circuit or apparatus and the earth, or to some conducting body that serves in place of the earth.

3.51 grounded (earthed):

connected to earth or to some conducting body that serves in place of earth.

3.52 group:

a classification of combustible materials.

NOTE — [Refer to Clause 4](#) for additional information.

3.53 hazardous (classified) location:

a location in which fire or explosion hazards may exist due to an explosive atmosphere of flammable gases or vapors, flammable liquids, combustible dust, or easily ignitable fibers or flyings.

NOTE — [See also EXPLOSIVE ATMOSPHERE.](#)

3.54 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.

3.55 temperature apparatus:

as specified by NEC, Article 501-5(a)(1), the term *high temperature apparatus* is to be interpreted as apparatus 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.

3.56 identified (as applied to equipment):

recognizable as suitable for the specific purpose, function, use, environment, application, etc., where described in a particular requirement, e.g. NEC.

NOTE — Suitability of equipment for a specific purpose, environment, or application may be determined by a qualified testing laboratory, inspection agency, or other organization concerned with product evaluation. Such identification may include labeling or listing. For additional information see *labeled* and *listed*.

3.57 ignition (autoignition) temperature (AIT):

the minimum temperature required to initiate or cause self-sustained combustion of a solid, liquid, or gas independently of the heating or heating elements.

NOTE 1 — For additional information refer to NFPA 325.

NOTE 2 — A distinction is made between ignition temperature and flash point. [See FLASH POINT.](#)

3.58 ignition capable:

apparatus or wiring that under normal conditions, or under specified abnormal conditions, can release sufficient electrical or thermal energy to cause ignition of a specific explosive atmosphere.

3.59 increased safety:

a type of protection applied to electrical apparatus that does not produce arcs or sparks in normal service and under specified abnormal conditions, in which additional measures are applied so as to give increased security against the possibility of excessive temperatures and of the occurrence of arcs and sparks. This type of protection is referred to as “e.”

3.60 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.

3.61 intrinsic safety:

a type of protection in which a portion of the electrical system contains only intrinsically safe 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 as “i.”

NOTE — See also ASSOCIATED APPARATUS.

3.62 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.

3.63 intrinsically safe circuit:

a circuit in which any spark or thermal effect, produced either normally or in specified fault conditions, is incapable, in the specified test conditions, of causing ignition of a given explosive atmosphere.

3.64 intrinsically safe electrical apparatus:

electrical apparatus in which all the circuits are intrinsically safe circuits.

3.65 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.

NOTE — For further information, refer to Article 504 of NEC, or Section 10 of CSA C22.1, or ISA RP 12.6.

3.66 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.

3.67 labeled:

equipment or materials with a label, symbol, or other identifying mark of an organization that is acceptable to the authority having jurisdiction and concerned with product evaluation that maintains periodic inspection of 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 term *approved*, *listed*, or *certified* to indicate compliance with the applicable standard.

3.68 liquid, combustible:

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

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

NOTE — For additional information, refer to NFPA 325. It should also be noted that these classes have no relation to the hazardous location classes.

3.69 listed:

equipment or materials included in a list published by an organization acceptable to the authority having jurisdiction and concerned with product evaluation, that maintains periodic inspection of production of listed equipment or materials, and whose listing states either that the equipment or material meets appropriate designated standards or has been tested and found suitable for use in a 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 utilize the system employed by the listing organization to identify a listed product.

3.70 lower explosive limit (LEL):

[refer to FLAMMABLE \(EXPLOSIVE\) LIMITS.](#)

3.71 lower flammable limit (LFL):

[refer to FLAMMABLE \(EXPLOSIVE\) LIMITS.](#)

3.72 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 a qualified person. Such activities typically include locating causes of faulty performance, replacement of defective components, adjustment of internal controls, and the like.

3.73 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.

3.74 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.

3.75 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 specified abnormal conditions).

3.76 minimum cloud ignition temperature:

the minimum temperature at which a combustible dust atmosphere will autoignite and propagate an explosion.

3.77 minimum dust layer ignition temperature:

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

3.78 minimum explosive (dust) concentration:

the minimum concentration of a dust cloud that, when ignited, will propagate a flame away from the source of ignition.

3.79 minimum ignition energy (MIE):

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.

3.80 maximum experimental safe gap (MESG):

the maximum clearance between two parallel metal surfaces that has been found, under specified test conditions, to prevent an explosion in a test chamber from being propagated to a secondary chamber containing the same gas or vapor at the same concentration.

3.81 minimum igniting current ratio (MIC Ratio):

the ratio derived by dividing the minimum current required from an inductive spark discharge to ignite the most easily ignitable mixture of a gas or vapor by the minimum current required from an inductive spark discharge to ignite methane under the same test conditions.

NOTE — For additional information, refer to IEC 60079-3.

3.82 nonautomatic:

non-self-acting — requiring personal intervention for control. As applied to an electric controller, nonautomatic control does not necessarily imply a manual controller, but only that personal intervention is necessary.

3.83 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. Such a location may also be referred to as a safe area.

3.84 nonincendive circuit:

a circuit, other than field wiring, in which any arc or thermal effect produced, under intended operating conditions of the equipment, is not capable, under specified test conditions, of igniting the flammable gas-, vapor-, or dust-air mixture. See also 3.87, NONINCENDIVE FIELD WIRING.

3.85 nonincendive component:

a component having contacts for making or breaking an ignition-capable circuit and in which the contacting mechanism is constructed so that the component is incapable of igniting the specified explosive atmosphere. The housing of a nonincendive component is not intended to (1) exclude the flammable atmosphere or (2) contain an explosion. This type of protection is referred to as “nC.”

3.86 nonincendive equipment:

equipment having electrical/electronic circuitry and components that are incapable, under normal conditions, of causing ignition of the flammable gas-, vapor-, or dust-air mixture due to arcing or thermal effect. This type of protection is referred to as “nA,” “nC,” or “nR.”

3.87 nonincendive field wiring:

wiring that enters or leaves an equipment enclosure and, under normal operating conditions of the equipment, is not capable, due to arcing or thermal effects, of igniting the flammable gas-, vapor-, or dust-air mixture. Normal operation includes opening, shorting, or grounding the field wiring. See also 3.84, NONINCENDIVE CIRCUIT.

3.88 normal conditions:

equipment is generally considered to be under normal conditions when it conforms electrically and mechanically with its design specifications and is used within the limits specified by the manufacturer.

3.89 oil-immersion:

type of protection in which the electrical apparatus or parts of the electrical apparatus are immersed in a protective liquid in such a way that an explosive atmosphere which may be above the liquid or outside the enclosure cannot be ignited. This type of protection is referred to as “o.”

3.90 powder filling:

a type of protection in which the parts capable of igniting an explosive atmosphere are fixed in position and completely surrounded by filling material to prevent the ignition of an external explosive atmosphere. This type of protection is referred to as “q.”

NOTE — This type of protection may not prevent the surrounding explosive atmosphere from penetrating into the apparatus and Ex components and being ignited by the circuits. However, due to the small free volumes in the filling material and due to the quenching of a flame that may propagate through the paths in the filling material, an external explosion is prevented.

3.91 pressurization:

the technique of guarding against the ingress of the external atmosphere into an enclosure by maintaining a PROTECTIVE GAS therein at a pressure above that of the external atmosphere. This type of protection is referred to as “p.”

3.92 pressurization, Type X:

a method of reducing the classification within an enclosure from Division 1/Zone 1 to nonhazardous (unclassified). [See 5.2.1.](#)

3.93 pressurization, Type Y:

a method of reducing the classification within an enclosure from Division 1/Zone 1 to Division 2/Zone 2. [See 5.2.1.](#)

3.94 pressurization, Type Z:

a method of reducing the classification within an enclosure from Division 2/Zone 2 to nonhazardous (unclassified). [See 5.2.1.](#)

3.95 protection, type of:

the specific measures applied to electrical apparatus to avoid ignition of a surrounding explosive atmosphere. Examples are “e” and “n.”

3.96 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.

3.97 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 LFL/LEL. The *protective gas* may be air, nitrogen, other nonflammable gas, or a mixture of such gases.

3.98 purging:

in a pressurized enclosure, the operation of passing a quantity of PROTECTIVE GAS through the enclosure and ducts, so that the concentration of the explosive gas atmosphere is brought to a safe level.

3.99 qualified person:

one familiar with the construction and operation of the equipment and the hazards involved.

3.100 restricted breathing:

a 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 LFL/LEL because of breathing or diffusion. This type of protection is referred to as “nR.”

3.101 safe area:

[refer to NONHAZARDOUS \(UNCLASSIFIED\) LOCATION.](#)

3.102 seal, cable, explosionproof:

a cable termination fitting 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 in combination with a cable termination fitting may also be used as a cable seal.

3.103 seal, conduit, explosionproof:

a sealing fitting, filled with a poured 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.

3.104 seal, factory:

a construction where components capable of initiating an internal explosion due to arcing, sparking, or thermal effects under normal conditions are isolated from the wiring system by means of factory installed flameproof seal or joint for the purpose of eliminating the need for an external, field-installed conduit seal and, in some cases, a field-installed cable seal.

3.105 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. This type of protection is referred to as "nC."

3.106 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).

3.107 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.

3.108 special protection:

a protection technique other than those that have been standardized. This type of protection is referred to by IEC 60079-0 as "s."

3.109 temperature, ambient:

the temperature of air or other media where electrical apparatus is to be used.

3.110 temperature identification number (T Code/Temperature Class):

a system of classification by which one of 14 temperature identification numbers (for zones, six temperature classes) is allocated to apparatus. The temperature identification number represents the maximum surface temperature of any part of the apparatus that may come in contact with the flammable gas or vapor mixture. [See Table 1.](#)

3.111 type of protection:

[refer to PROTECTION, TYPE OF.](#)

3.112 upper explosive limit (UEL):

[refer to FLAMMABLE \(EXPLOSIVE\) LIMITS.](#)

3.113 upper flammable limit (UFL):

[refer to FLAMMABLE \(EXPLOSIVE\) LIMITS.](#)

3.114 zone:

a method of specifying the probability that a location is made hazardous by the presence, or potential presence, of flammable concentrations of gases and vapors, or combustible mixtures of dusts.

3.115 Zone 0 (IEC):

an area in which an explosive gas atmosphere is present continuously or for long periods. (IEV 426-03-03, modified).

3.116 Zone 0, Class I (NEC):

a Class I, Zone 0 location is a location (1) in which ignitable concentrations of flammable gases or vapors are present continuously; or (2) in which ignitable concentrations of flammable gases or vapors are present for long periods of time. (NEC Section 505-9(a))

3.117 Zone 1 (IEC):

an area in which an explosive gas atmosphere is likely to occur in normal operation. (IEV 426-03-04)

3.118 Zone 1, Class I (NEC):

a Class I, Zone 1 location is a location (1) in which ignitable concentrations of flammable gases or vapors are likely to exist under normal operating conditions; or (2) in which ignitable concentrations of flammable gases or vapors may exist frequently because of repair or maintenance operations or because of leakage; or (3) in which equipment is operated or processes are carried on, of such a nature that equipment breakdown or faulty operations could result in the release of ignitable concentrations of flammable gases or vapors and also cause simultaneous failure of electrical equipment in a mode to cause the electrical equipment to become a source of ignition; or (4) that is adjacent to a Class I, Zone 0 location from which ignitable concentrations of vapors could be communicated, unless communication is prevented by adequate positive-pressure ventilation from a source of clean air and effective safeguards against ventilation failure are provided. (NEC Article 505-9(b))

3.119 Zone 2 (IEC):

an area in which an explosive gas atmosphere is not likely to occur in normal operation and, if it does occur, is likely to do so only infrequently and will exist for a short period only. (IEV 426-03-05, modified)

3.120 Zone 2, Class I (NEC):

a Class I, Zone 2 location is a location (1) in which ignitable concentrations of flammable gases or vapors are not likely to occur in normal operation, and if they do occur, will exist only for a short period; or (2) in which volatile flammable liquids, flammable gases, or flammable vapors are handled, processed, or used, but in which the liquids, gases, or vapors normally are confined within closed containers or closed systems from which they can escape only as a result of accidental rupture or breakdown of the containers or system, or as the result of the abnormal operation of the equipment with which the liquids or gases are handled, processed, or used; or (3) in which ignitable concentrations of flammable gases or vapors normally are prevented by positive mechanical ventilation, but which may become hazardous as the result of failure or abnormal operation of the ventilation equipment; or (4) that is adjacent to a Class I, Zone 1 location from which ignitable concentrations of flammable gases or vapors could 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. (NEC Section 505-9(c))

3.121 Zone 20 (IEC):

an area in which combustible dust, as a cloud, is present continuously or frequently, during normal operation, in sufficient quantity to be capable of producing an explosible concentration of combustible dust in mixture with air and/or where layers of dust of uncontrollable and excessive thickness can be formed. This can be the case inside dust containment where dust can form explosible mixtures frequently or for long periods of time. This occurs typically inside equipment. (IEC 1241-3 - 2.11)

3.122 Zone 21 (IEC):

an area not classified as Zone 20 in which combustible dust, as a cloud, is likely to occur during normal operation, in sufficient quantity to be capable of producing an explosible concentration of combustible dust in mixture with air. This zone can include, among others, areas in the immediate vicinity of powder filling or

emptying points and areas where dust layers occur and are likely in normal operation to give rise to an explosible concentration of combustible dust in mixture with air. (IEC 1241-3 - 2.12)

3.123 Zone 22 (IEC):

an area not classified as Zone 21 in which combustible dust, as a cloud, can occur infrequently, and persist only for a short period, or in which accumulations or layers of combustible dust can give rise to an explosible concentration of combustible dust in mixture with air. This zone can include, among others, areas in the vicinity of equipment containing dust, and in which dust can escape from leaks and form deposits (e.g. milling rooms in which dust can escape from the mills and then settle). (IEC 1241-3 - 2.13)

4 Area (location) classification

Area classification schemes should specify the kind of flammable material that may be present and the probability that it will be present in ignitable concentrations. 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. The type of protection technique selected and the level of protection it must provide depend upon the potential hazard caused by using electrical apparatus in a location in which a combustible, flammable, or ignitable substance may be present.

4.1 North American methods

In the United States, the area classification definitions are stated in Articles 500 and 505 of the National Electrical Code, (NEC) NFPA 70. In Canada, similar definitions are given in the Canadian Electrical Code (CEC), Part 1, Section 18 and Annex J18 (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 Annex C.](#)

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

- a) CLASS — the generic form of the flammable materials in the atmosphere, which may include gas or vapor, dusts, or easily ignitable fibers or flyings ([see Clause 3](#) for detailed definitions);
- b) DIVISION (or ZONE) — an indication of the probability of the presence of the flammable material in ignitable concentration ([see Clause 3](#) for detailed definitions); and
- c) GROUP — the exact nature of the flammable material (see 4.1.1 & 4.1.2).

4.1.1 Groups (NEC Article 500 / CEC Annex J18)

The United States and Canadian Electrical Codes 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. In NEC these groups are defined as:

Group A - Acetylene

Group B - Flammable gas, flammable liquid-produced vapor, or combustible liquid-produced vapor mixed with air that may burn or explode, having either a MAXIMUM EXPERIMENTAL SAFE GAP (MESG) less than or equal to 0.45 mm or a MINIMUM IGNITING CURRENT RATIO (MIC RATIO) less than 0.4.

NOTE — A typical Class I, Group B material is hydrogen.

Group C - Flammable gas, flammable liquid-produced vapor, or combustible liquid-produced vapor mixed with air that may burn or explode, having either MAXIMUM EXPERIMENTAL SAFE GAP (MESG) values greater

than 0.45 mm and less than or equal to 0.75 mm or a MINIMUM IGNITING CURRENT RATIO (MIC RATIO) greater than or equal to 0.4 and less than or equal to 0.80.

NOTE — A typical Class I, Group C material is ethylene.

Group D - Flammable gas, flammable liquid-produced vapor, or combustible liquid-produced vapor mixed with air that may burn or explode, having a MAXIMUM EXPERIMENTAL SAFE GAP (MESG) greater than 0.75 mm or a MINIMUM IGNITING CURRENT RATIO (MIC RATIO) greater than 0.80, or gases or vapors of equivalent hazard.

NOTE — A typical Class I, Group D material is propane.

Additional information on group classification can be found in NFPA 497, Classification of Flammable Liquids, Gases or Vapors and of Hazardous (Classified) Locations for Electrical Installations in Chemical Process Areas.

Group E – Atmospheres containing combustible metal dusts, including aluminum, magnesium, and their commercial alloys, or other combustible dusts whose particle size, abrasiveness, and conductivity present similar hazards in the use of electrical equipment.

Group F – Atmospheres containing combustible carbonaceous dusts that have more than 8 percent total entrapped volatiles (see ASTM D3175-89 for coal and coke dusts) or that have been sensitized by other materials so that they present an explosion hazard. Coal, carbon black, charcoal, and coke dusts are examples of carbonaceous dusts.

Group G – Atmospheres containing other combustible dusts, including flour, grain, wood flour, plastic, and chemicals.

Additional information on Group Classification can be found in NFPA 499 Classification of Combustible Dusts and of Hazardous (Classified) Locations for Electrical Installations in Chemical Process Areas.

4.1.2 Groups (NEC Article 505/CSA C22.1 Section 18/IEC 60079-12/prEN 60079-12)

These groups are defined as:

Group IIC - Flammable gas, flammable liquid-produced vapor, or combustible liquid-produced vapor mixed with air that may burn or explode, having either MAXIMUM EXPERIMENTAL SAFE GAP (MESG) less than or equal to 0.5 mm or MINIMUM IGNITING CURRENT RATIO (MIC RATIO) less than 0.45, or gases or vapors of equivalent hazard.

NOTE 1 — This group is similar to a combination of Groups A & B as described in 4.1.1, although the MESG and MIC RATIO numbers are slightly different.

NOTE 2 — Typical gases include acetylene, carbon disulfide, hydrogen, and gases or vapors of equivalent hazard.

Group IIB - Flammable gas, flammable liquid-produced vapor, or combustible liquid-produced vapor mixed with air that may burn or explode, having either MAXIMUM EXPERIMENTAL SAFE GAP (MESG) values greater than 0.5 mm and less than or equal to 0.9 mm or MINIMUM IGNITING CURRENT RATIO (MIC RATIO) greater than or equal to 0.45 and less than or equal to 0.80, or gases or vapors of equivalent hazard.

NOTE 1 — This group is similar to Group C as described in 4.1.1, although the MESG and MIC RATIO numbers are slightly different.

NOTE 2 — Typical gases include ethylene and gases or vapors of equivalent hazard.

Group IIA - Flammable gas, flammable liquid-produced vapor, or combustible liquid-produced vapor mixed with air that may burn or explode, having MAXIMUM EXPERIMENTAL SAFE GAP(MESG) greater than 0.9 mm or MINIMUM IGNITING CURRENT RATIO (MIC RATIO) greater than 0.80, or gases or vapors of equivalent hazard.

NOTE 1 — This group is similar to Group D as described in 4.1.1, although the MESG number is slightly different.

NOTE 2 — Typical gases include propane and gases or vapors of equivalent hazard.

Additional information on group classification can be found in IEC 60079-12 & IEC 60079-20.

4.2 Additional background information

4.2.1 History

Historically, the topic of Hazardous (Classified) Locations first appeared in the National Electrical Code (NEC) in 1923, when a new article entitled “Extra-Hazardous Locations” was accepted. This article addressed rooms or compartments in which highly flammable gases, liquids, mixtures or other substances were manufactured, used, or stored. In 1931, “Classifications” consisting of Class I, Class II, etc., for the hazardous locations were defined. However it was not until 1935 that Groups were introduced into the NEC. (Note: Divisions were introduced into the NEC in 1947.) The four gas Groups, A, B, C, and D, complemented the design of electrical equipment used in hazardous (classified) locations and were defined based on the level of hazard associated with explosion pressures of specific atmospheres and the likelihood that the effects of that explosion could be transmitted outside the enclosure. Group A was defined as atmospheres containing acetylene. Group B was defined as atmospheres containing hydrogen or gas or vapors of equivalent hazard. Group C was defined as atmospheres containing ethyl ether vapor; and Group D was defined as atmospheres containing gasoline, petroleum, naphtha, alcohols, acetone, lacquers solvent vapors, and natural gas.

Despite the fact that the introduction of these Groups was done without standardized testing and without the advantage of today’s technological advances or equipment, these definitions have changed little since that time. The first major testing, in fact, was only conducted in the late 1950s, when engineers at Underwriters Laboratories developed a test apparatus that provided a means to determine how various materials behaved with respect to explosion pressures and transmission, when the specific combustible material was ignited in the test vessel. This apparatus, called the Westerberg Explosion Test Vessel, provided standardized documentation of a factor called the Maximum Experimental Safe Gap (MESG) and permitted other materials to be “classified by test” into one of the four gas groups. The results of these tests are contained in Underwriter Laboratories (UL) Bulletin Nos. 58 and 58A (reissued in July, 1993, as UL Technical Report No. 58). In 1971, the International Electrotechnical Commission (IEC) published IEC 79-1A defining a different type of apparatus for obtaining MESG results. While the two MESG test apparatus are physically different in both size and shape, the results are statistically comparative, although in some cases differences have been observed. A sample of values is shown in the following table:

Material	Westerberg apparatus MESG in mm	IEC apparatus MESG in mm
Propane	0.92	0.94
Ethylene	0.69	0.65
Butadiene	0.79	0.79
Diethyl ether	0.30(± 0.60)	0.87
Hydrogen	0.08 (± 0.23)	0.29