

Subject 120101

March 31, 2017

SUMMARY OF TOPICS

The following changes in requirements to the Standard for Safety for Definitions and Information Pertaining to Electrical Equipment in Hazardous Locations, UL 120101, are being proposed for preliminary review and comment only:

1. For Preliminary Review Only: Proposed Second Edition of the Standard for Definitions and Information Pertaining to Electrical Equipment in Hazardous Locations, UL 120101

COMMENTS DUE: MAY 15, 2017

This proposal is for review and comment only (no ballot at this time). Please note that comments on a preliminary review document will not receive a response from the proposal author through CSDS. Instead, the proposal author will be asked to review the comments and adjust the proposals and/or supporting rationale as the author determines to be appropriate. The preliminary review process is an informal mechanism that provides authors with the opportunity to refine their proposals before they advance to the next stage in UL's standards development process.

In some cases, the author of the proposals may choose to discontinue them. In this case, the author need not do anything after preliminary review has ended. Normally, the next step in the process is the more formal STP ballot and stakeholder review process. Only comments posted during the STP ballot and stakeholder review process will be provided with a response in CSDS.

For your convenience in review, proposed additions to existing requirements are shown underlined and proposed deletions are shown ~~lined-out~~.

1. For Preliminary Review Only: Proposed Second Edition of the Standard for Definitions and Information Pertaining to Electrical Equipment in Hazardous Locations, UL 120101

BACKGROUND

This document was developed by ISA12 and is now being maintained by UL STP 60079.

RATIONALE

Proposal submitted by: Brad Zimmermann, STP 60079 Chair on behalf of the TG79X-1R Committee Members

This proposed new edition is to provide an update to the most recent information in the related field.

It is the proposal submitter's opinion that this proposal affects the following topics/sections of the Standard:

- instruction requirement.

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PROPOSAL

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1 Purpose

This document provides definitions and information pertaining to protection techniques, terminology, and the installation of electrical equipment in hazardous (classified) locations and provides an introduction and basic background to the ISA 12, Electrical Safety, series of publications and committee activities. It replaces ANSI/ISA-12.01.01-2009, *Definitions and Information Pertaining to Electrical Instruments in Hazardous (Classified) Locations*, published in 2009.

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 document provides general guidance for safe design, installation, and maintenance of electrical equipment 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 document 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 document is not necessarily relevant to the hazards posed by pyrophoric materials, explosives or propellants containing their own oxidizers.

2.3 This document is concerned only with design, manufacture, installation, maintenance, and test criteria related to arcs, sparks, or hot surfaces produced by electrical and non-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 the applicable ordinary location requirements (e.g., ANSI/ISA- UL 61010-1).

* Under development (Mechanical and ESD for example). Some equipment may produce static electricity or cause high temperatures or sparks due to mechanical failure. The materials of construction of parts in such equipment will be an important consideration for application in hazardous locations.

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

2.5 This document 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.

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

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

- a) an ambient temperature range of -20 °C (-4 °F) to 40 °C (104 °F) for zones and to -25 °C (-13 °F) to +40 °C (104 °F) for divisions;
- b) air with normal oxygen content, typically 21 percent by volume;
- c) a pressure of 80 kPa (11.6 psia) to 110 kPa (16 psia); and

NOTE Equipment specified for atmospheric conditions beyond the above is generally permitted but may 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 document 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 document except for those specific sections of documents referenced elsewhere in this document.

2.10 In accordance with the purpose of this document, 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 following are terms and definitions commonly used for hazardous (classified) locations.

NOTE The list is not intended to be all inclusive. Throughout this document, reference is made to areas, spaces, locations, and zones. These terms should be considered interchangeable terms designating a three-dimensional space. Additional definitions may be found in IEC 60050-426 (The International Electrotechnical Vocabulary (IEV 426-04-07)).

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 Limit, LFL.

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 equipment meeting one or more types of protection in **ANSI/ISA-UL 60079-0** or **ANSI/ISA-61241-0**.

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 **ATEX, ATEX Directive** European Directive 94/9/EC (also referred to as ATEX 95 or 100a Directive) for electrical and mechanical equipment used in hazardous locations. A parallel directive for use, 1999/92/EC (also referred to as ATEX 137 Directive) requires zoning and risk assessment in the workplace.

3.8 **authority having jurisdiction (AHJ)** 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.

3.9 **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.

3.10 **bonding** ~~Connecting to establish electrical continuity and conductivity 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.~~

3.11 **cable gland** a device permitting the introduction of an electric cable into electrical equipment.

3.12 **certificate** document that assures the conformity of a product, process, system, person, or organization with specified requirements

3.12 **certified** generic term referring to 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.

3.13 **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 3.117, 3.119, and 3.121 for definitions of Class I, Zones 0, 1, and 2.

3.14 **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.

Note: In some Division 1 locations, ignitable concentrations of flammable gases or vapors may be present continuously or for long periods of time. Examples include the following:

(1) The inside of inadequately vented enclosures containing instruments normally venting flammable gases or vapors to the interior of the enclosure

(2) The inside of vented tanks containing volatile flammable liquids

(3) The area between the inner and outer roof sections of a floating roof tank containing volatile flammable fluids

(4) Inadequately ventilated areas within spraying or coating operations using volatile flammable fluids

(5) The interior of an exhaust duct that is used to vent ignitable concentrations of gases or vapors

Experience has demonstrated the prudence of avoiding the installation of instrumentation or other electrical equipment in these particular areas altogether or where it cannot be avoided because it is essential to the process and other locations are not feasible, using electrical equipment or instrumentation approved for the specific application or consisting of intrinsically safe systems.

3.15 **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.

3.16 **Class II location** a location that is hazardous because of the presence of combustible dust.

3.17 **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.

3.18 **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 equipment, 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.

3.19 **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.

3.20 **Class III, Division 1 location** a location in which easily ignitable fibers or materials producing combustible flyings are handled, manufactured, or used.

3.21 **Class III, Division 2 location** a location in which easily ignitable fibers are stored or handled (except in the process of manufacture).

3.22 **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 equipment.

3.23 **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. Refer to 6.2.2.

3.24 **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.

3.25 **degree of protection (IP)** a system of rating standard levels of protection provided by equipment for the protection of persons against contact with live or moving parts inside the equipment, as well as the protection provided by equipment 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.

3.26 dust, combustible Dust particles that are 500 microns or smaller (material passing a U.S. No. 35 Standard Sieve as defined in ASTM E 11-09. Standard Specification for Wire Cloth and Sieves for Testing Purposes) and present a fire or explosion hazard when dispersed and ignited in air.

Note: See ASTM E 1226-12a. Standard Test Method for Explosibility of Dust Clouds, or ISO 6184-1. Explosion protection systems – Part 1: Determination of explosion indices of combustible dusts in air, for procedures for determining the explosibility of dusts.

~~US definition – 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.~~

~~IEC definition – finely divided solid particles, 500 µm or less in nominal size, which may be suspended in air, may settle out of the atmosphere under their own weight, may burn or glow in air, and may form explosive mixtures with air at atmospheric pressure and normal temperatures~~

3.27 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.

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

3.29 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.

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

3.31 EEx designation of explosion-protected electrical equipment complying with EN50014.

NOTE 1 When EN50014 was replaced by EN60079-0 in 2004, the marking was replaced with just Ex.

NOTE 2 The publication of EN60079-0 was just the next edition of EN50014 and does not indicate that equipment certified to EN50014 was immediately made obsolete, but might not comply with the latest requirements.

3.32 electrical equipment 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.

3.33 enclosure type a North American system of rating standard levels of protection provided to electrical equipment 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.

3.34 **encapsulation** a type of protection in which the parts that could ignite an explosive atmosphere by either sparking or heating are enclosed in a compound in such a way that this explosive atmosphere cannot be ignited. This type of protection is referred to as “m.”

3.35 **energized** electrically connected to a source of potential difference.

3.36 **entity concept** a concept that allows interconnection of intrinsically safe equipment 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 equipment 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 equipment, 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 ANSI/ISA-RP12.06.01.

3.37 **entry, direct** a method of connection of an electrical equipment 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)

3.38 **entry, indirect** a method of connection of an electrical equipment 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)

3.39 **equipment protection level EPL** level of protection assigned to equipment based on its likelihood of becoming a source of ignition and distinguishing the differences between explosive gas atmospheres, explosive dust atmospheres, and the explosive atmospheres in mines susceptible to firedamp (Annex A).

NOTE Although the marking identifying the equipment protection level (EPL) may appear on equipment, the 2011 NEC does not recognize the concept of employing the equipment protection level in a complete risk assessment of an installation.

3.40 **Ex** designation of explosion-protected electrical equipment in accordance with the IEC 60079 series standards or national adoptions.

3.41 **Ex component** part of electrical equipment for explosive atmospheres which is not to be used alone in such atmospheres and which requires additional evaluation of any electrical equipment with which it is used.

3.41 **IEC Ex Certification Scheme** an international system of certification for explosion-protected electrical equipment and personnel administered by the IECEx Management Committee and described by IECEx 01. The goal of this scheme is that a manufacturer of hazardous location electrical equipment would be able to obtain a single ‘IEC 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. More information can be found at www.iecex.com.

3.42 **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.

3.43 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.

3.44 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.

3.45 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.

3.46 flameproof a type of protection of electrical equipment 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 EQUIPMENT.

3.47 flammable limits: the flammable limits of a gas or vapor are the lower (LFL) and upper (UFL) flammable limit, stated in percent by volume of gas in a gas-air mixture, between which a flammable mixture is formed.

NOTE 1 For additional information refer to NFPA Fire Protection Handbook and IEC 80079-20-1.

NOTE 2 In the past, flammable and explosive have been used interchangeably in many texts, but the trend is to avoid the confusion that this causes. The term flammable relates to the properties of the material that determine its ability to produce self-sustaining flame propagation in any direction (upwards, sideways or downwards). The term explosive relates to flame propagation that is accompanied by pressure rise and noise (usually higher-speed propagation) and is significantly affected by (non-material related) test-chamber conditions (geometry, degree of confinement...). LFL concentrations are typically lower than LEL concentrations for the same material and UFL concentrations are typically higher than UEL concentrations for the same material.

3.48 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 Fire Protection Handbook.

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

3.50 **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 Fire Protection Handbook.

3.51 **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.

3.52 **grounded (earthed)** connected to earth or to some conducting body that serves in place of earth.

3.53 **group** a classification of combustible materials.

NOTE Refer to Clause 4 for additional information.

3.54 **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.

3.55 **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.

3.56 **high temperature equipment** as specified by NEC, Articles 501.15 and 505.16, the term "*high temperatures*" is to be interpreted as those where 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.

3.57 **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*.

3.58 **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 Fire Protection Handbook.

NOTE 2 A distinction is made between ignition temperature and flash point. See FLASH POINT.

3.59 **ignition capable** equipment or wiring that under normal conditions, or under specified abnormal conditions, can release sufficient electrical or thermal energy (including electrostatic, frictional sparking or hot surfaces) to cause ignition of a specific explosive atmosphere.

3.60 increased safety a type of protection applied to electrical equipment 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.”

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

3.62 intrinsic safety a type of protection in which a portion of the electrical system contains only intrinsically safe equipment, 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 equipment 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.

3.63 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.

3.64 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.

3.65 intrinsically safe electrical equipment electrical equipment in which all the circuits are intrinsically safe circuits.

3.66 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 ANSI/ISA-RP12.06.01.

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

3.68 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.

3.69 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 30. It should also be noted that these classes have no relation to the hazardous location classes

3.70 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.

3.71 lower explosive limit (LEL) refer to 3.47 NOTE 2.

3.72 lower flammable limit (LFL) refer to FLAMMABLE LIMITS.

3.73 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.

3.74 maintenance, live any maintenance activity that occurs while power is still connected to the equipment.

3.75 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.

3.76 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.

3.77 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 equipment (including specified abnormal conditions).

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

3.79 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.

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

3.81 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.

3.82 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.

3.83 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 60079-11.

3.84 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.

3.85 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.

3.86 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 NONINCENDIVE FIELD WIRING.

3.87 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.”

3.88 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.”

3.89 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 NONINCENDIVE CIRCUIT.

3.90 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.

3.91 oil-immersion type of protection in which the electrical equipment or parts of the electrical equipment 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.”

3.92 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 equipment 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.

3.93 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.”

3.94 pressurization, Type X a method of reducing the classification within an enclosure from Division 1/Zone 1 to nonhazardous (unclassified). See 6.2.1.

3.95 pressurization, Type Y a method of reducing the classification within an enclosure from Division 1/Zone 1 to Division 2/Zone 2. See 6.2.1.

3.96 pressurization, Type Z a method of reducing the classification within an enclosure from Division 2/Zone 2 to nonhazardous (unclassified). See 6.2.1.

3.97 protection, type of the specific measures applied to electrical equipment to avoid ignition of a surrounding explosive atmosphere. Examples are “e” and “n.”

3.98 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.

3.99 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.

3.100 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.

3.101 **qualified person** one familiar with the construction and operation of the equipment and the hazards involved

3.102 **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.”

3.103 **safe area** refer to NONHAZARDOUS (UNCLASSIFIED) LOCATION.

3.104 **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.

3.105 **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.

3.106 **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.

3.107 **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.”

3.108 **simple apparatus (as applied to intrinsic safety)** a device that will not generate or store more than 1.5 V, 0.1 A, or 25 mW. Examples are: switches, thermocouples, light-emitting diodes, and resistance temperature detectors (RTDs).

3.109 **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.

3.110 **special protection** a protection technique other than those that have been standardized.

3.111 **temperature, ambient** the temperature of air or other media where electrical equipment is to be used.

3.112 **temperature Class** a system of classification by which one of 14 temperature classes (for zones, six temperature classes) is allocated to equipment. The temperature class represents the maximum surface temperature of any part of the equipment that may come in contact with the flammable gas or vapor mixture. See Table 1.

3.113 **type of protection** refer to PROTECTION, TYPE OF.

3.114 **upper explosive limit (UEL)** refer to 3.47 NOTE 2.

3.115 **upper flammable limit (UFL)** refer to FLAMMABLE LIMITS.

3.116 **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.

3.117 **Zone 0 (IEC)** an area in which an explosive gas atmosphere is present continuously or for long periods. (IEV 426-03-03, modified).

3.118 **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 505.5 (B)(1))

3.119 **Zone 1 (IEC)** an area in which an explosive gas atmosphere is likely to occur in normal operation. (IEV 426-03-04)

3.120 **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 505.5 (B)(2))

3.121 **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)

3.122 **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 505.5 (B)(3))

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3.123 Zone 20

3.123.1 **(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 61241-10 (soon to become IEC 60079-10-2) – 2.11).

3.123.2 **(NEC)** an area where combustible dust or ignitable fibers and flyings are present continuously or for long periods of time in quantities sufficient to be hazardous.

3.124 Zone 21

3.124.1 **(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 61241-10 (soon to become IEC 60079-10-2) – 2.12).

3.124.2 **(NEC)** an area where combustible dust or ignitable fibers and flyings are likely to exist occasionally under normal operation in quantities sufficient to be hazardous

3.125 Zone 22

3.125.1 **(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 explosive 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 61241-10 (soon to become IEC 60079-10-2) – 2.13)

3.125.2 **(NEC)** an area where combustible dust or ignitable fibers and flyings are not likely to occur under normal operation in quantities sufficient to be hazardous.

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 equipment 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, 505 and 506 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 and 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 1 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 a 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 2 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 3 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.

NOTE 4 Equipment for divisions is marked for each group that it is rated for (ex: CI D2 ABCD). Prior to 1971, a piece of equipment that was rated for group B may not have been acceptable for groups C and D because its maximum surface temperature was tied to the gas group, rather than a separate temperature code. This is why we mark all of the gas groups for divisions and not for Zones.

4.1.2 Groups (NEC Article 505/CSA C22.1 Section 18/IEC 60079-20-1)

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 and 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.

NOTE 3 Equipment tested and marked for group IIC may also be used in IIB and IIA areas.

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.

NOTE 3 Equipment tested and marked for group IIB may also be used in IIA.

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 60079-20-1.

4.1.3 Dust Groups

4.1.3.1 Groups (NEC Article 506)

There dust groups are currently no dust groups defined in NEC article 506.

4.1.3.2 Groups (IEC 60079-0)

Electrical equipment of Group III is intended for use in places with an explosive dust atmosphere other than mines susceptible to firedamp. Electrical equipment of Group III is subdivided according to the nature of the explosive dust atmosphere for which it is intended.

Group III subdivisions:

(A) Group IIIC. Combustible metal dust.

Note: Group IIIC is equivalent to Class II, Group E.

(B) Group IIIB. Combustible dust other than combustible metal dust.

Note: Group IIIB is equivalent to Class II, Groups F and G.

(C) Group IIIA. Solid particles, including fibers, greater than 500 µm in nominal size, which may be suspended in air and could settle out of the atmosphere under their own weight.

Note: Group IIIA is equivalent to Class III. Examples of flyings include rayon, cotton (including cotton linters and cotton waste), sisal, jute, hemp, cocoa fiber, oakum, and baled waste kapok.

~~• IIIA, Combustible flyings — solid particles, including fibres, greater than 500 µm in nominal size which may be suspended in air and could settle out of the atmosphere under their own weight~~

~~• IIIB, Non-conductive dust — combustible dust with electrical resistivity greater than $10^8 \Omega \cdot m$~~

~~• IIIC, Conductive dust — combustible dust with electrical resistivity equal to or less than $10^8 \Omega \cdot m$~~

~~NOTE — IEC 61241-2-2 contains the test method for determining the electrical resistivity of dusts.~~

NOTE: Equipment tested and marked for group IIIC may also be used in IIIB and IIIA areas. Equipment tested and marked for group IIIB may also be used in IIIA.

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 Table 1:

Table 1 - MESG apparatus comparison

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
‡ Additional testing on the Westerberg Apparatus has demonstrated that this theory was true, and the MESG value for diethyl ether more than doubled. Further, Westerberg apparatus testing has also shown that the hydrogen MESG value is 0.23 mm.		

Papers have been written to attempt to explain the reasons for these differences in the test data. One, by H. Phillips, entitled "Differences Between Determinations of Maximum Experimental Safe Gaps in Europe and U.S.A.," appeared in a 1981 edition of the *Journal of Hazardous Materials* and cited a condition of spontaneous combustion in one portion of the Westerberg Apparatus, which was reflected in materials, like diethyl ether, having low ignition temperatures.

While acetylene remains segregated in Group A because of the high explosion pressure, which results from its very fast flame speed, newer test methodologies have defined other types of protection methods that now consider acetylene and hydrogen to be of equivalent hazard. One such method examines the MINIMUM IGNITION CURRENT required to ignite a specific combustible material. This testing produced more variability when the results of specific combustible materials were compared. However, it was found that the minimum ignition currents of one test could be favorably compared with those of other tests if a ratio value based on methane was applied. This testing has resulted in the generation of MIC Ratio data.

Other testing has been performed when it was incorrectly assumed that factors called minimum ignition energy (MIE) and autoignition temperature (AIT) were related and could be used to place materials into Groups. The fact that these were independent factors resulted in deletion of AITS as a basis for Group determination in the 1971 NEC.

MIEs have been found to exhibit theoretical results, which do not translate into practical designs that can be applied to actual electrical devices with their associated energy levels.

Since the primary concern is to have electrical devices that can safely operate when used in locations classified by Class, Group, and Division, the delineations for the gas groups have been defined on the basis of MESG and MIC RATIO.

Further details may be found in NFPA 497.

4.2.2 Division 2 concept

The concept of Division 2, a location in which flammable material will be present only occasionally, was initiated in North America. It was recognized that if the probability of the presence of flammable material is low, the protective measures necessary to prevent an explosion can be less restrictive (and normally also much less expensive) than those required in Division 1 locations. In Division 1 locations the probability that the flammable material is present is much higher than in Division 2 locations because in the former, the flammable atmosphere is present frequently during normal operations. Although many international corporations, particularly oil and chemical companies, used the North American nomenclature and practice, it was not until the 1960s that Division 2 began to be accepted outside North America. At the present time the concept of Division 2 area classification is recognized universally. The relaxation of protective measures in Division 2 has not yet reached the same level of acceptance, however. In Japan, for example, some methods of protection permitted in Division 2 and Zone 2 by the National Electrical Code and the Canadian Electrical Code are not yet recognized.

4.2.3 Zone concept

In the 1960s Europe made its own contribution to the practice of area classification by introducing the concept of Zone 0. The intent of defining Zone 0 was to define those locations in which the flammable material is present such a high percentage of the time that extraordinary measures should be taken to protect against ignition by electrical equipment. The objective of defining Zone 0 and Zone 1 was to allow a less restrictive practice in the remainder of locations formerly classified within Division 1. IEC has recognized three levels of probability that a flammable concentration is present. In IEC terminology, these three levels are Zones 0, 1, and 2. North American Division 1 includes both Zone 0 and Zone 1, and North American Division 2 is basically equivalent to Zone 2. Though the definitions of zones are similar in almost all standards, the application of the words to specific industrial situations is different.

4.2.4 Temperature classification

Prior to 1971 the autogenous ignition (or autoignition) temperature, AIT, was a criterion for group classification. Inclusion of the AIT as one of the classification criteria caused problems for those trying to classify new materials that had not been tested, because other flammability and combustion parameters of flammable gases and vapors are not correlated to AIT. For example, the AIT of diethyl ether is 160°C (320°F). Hydrogen has an AIT of approximately 520 °C (968 °F). Methane has an AIT of approximately 630 °C (1166 °F). Yet hydrogen is much more easily ignited by an arc than diethyl ether. Methane is much less easily ignited. Hydrogen requires very close-fitting flanges to prevent transmission of an explosion, but the flanges for an enclosure to protect against transmission of an explosion in diethyl ether may be much more widely separated, i.e., the MESG of diethyl ether is several times that of hydrogen.

When the 1971 *National Electrical Code* and the *Canadian Electrical Code* removed AIT as one of the criteria for material classification, the practice of temperature marking was introduced. Table 1 lists the temperature codes recognized in the NEC. Enclosures containing heat-producing devices must be marked by a temperature code or with the maximum surface temperature of the enclosure based on 40°C (104°F) ambient. Those that do not have an alphabetical suffix, i.e., T1-T6, are recognized internationally by the International Electrotechnical Commission (IEC), by CENELEC, and by many national standards bodies. In the United States and Canada, equipment of the nonheat-producing type (such as junction boxes, conduit, and fittings) and equipment of the heat-producing type (such as industrial process transmitters and transducers) having a maximum temperature not more than 100 °C (212 °F) need not be marked. The temperature classification marking also applies to surfaces other than those of the enclosures in the case of intrinsically safe and nonincendive equipment.

Table 2 Table 1 – Temperature class

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

4.2.5 Grouping of materials

4.2.5.1 A hazard grouping of materials is always relative to a stated property, i.e., to a particular ignition mechanism or a means of hazard reduction. Materials that are very much alike relative to ignition by electrical arcs or materials that have similar MESG may behave quite differently with respect to ignition by a hot surface.

4.2.5.2 Table 3 Table 2 compares several countries'/organizations' designations of gas groups. At the present time most national standards use the IEC group designations, where "II" indicates an above-ground facility and "I" indicates a hazard due to methane in the below-ground works of a mine. The comparisons of Table 3 Table 2 are approximate. For example, North American Group C is approximately the same list of materials as IEC Group IIB. Grouping is an arbitrary designation of dividing lines in a continuous series of values of a particular parameter.

Table 3 Table 2 – Comparison of classification of flammable vapors and gases (approx.)

IEC (60079-12)	Europe (ATEX)	North America Zone	North America Division	Base test gas
IIA	IIA	IIA	D	propane, methane
IIB	IIB	IIB	C	Ethylene
			B	Hydrogen
IIC	IIC	IIC		Acetylene, Hydrogen
			A	Acetylene

5 Equipment certification in the United States

5.1 US land-based installations

The Federal requirements for electrical installations in industrial and commercial (non-mining) areas are given in the Code of Federal Regulations (CFR), Title 29 – Labor. The particular requirements for electrical installations in hazardous locations are given in Part 1910, Sub-part S of 29 CFR. This adopts many of the provisions of the National Electrical Code (NEC)* as providing the minimum required levels of safety. Articles 500 to 516 of the NEC, which deal with installations in hazardous locations, are

particularly cited as having mandatory application. In Articles 500 to 516 of the NEC it is required as a minimum that electrical equipment for use in hazardous locations shall be 'approved' for use in the particular location concerned. Approved is defined in the NEC as 'acceptable to the authority having jurisdiction'. In many cases, specific sections additionally require the equipment to be 'listed' (tested and certified) by a nationally recognized testing laboratory (NRTL) such as Underwriters Laboratories (UL), FM Approvals (FM) or Intertek Testing Services NA Inc. (Intertek). The NRTL must be recognized by the Occupational Safety and Health Administration (OSHA) to test and evaluate products to specific product safety standards. There are specific applications where only 'listed' equipment is permitted.

5.2 Intro to coal mine explosion hazards and MSHA permissibility

Gas or dust explosions are some of the greatest hazards faced by underground coal mine workers. Methane gas is released during the mining process and accumulates in areas that are not well ventilated. Coal dust can form explosive dust clouds. Coal dust layers may accumulate on equipment or in entries, posing a fire hazard or explosion enhancement hazard should the dust be entrained into the air. Methane ignitions or explosives, for example, can disperse coal dust layers into the atmosphere that subsequently ignite and propagate as powerful explosions.

The Mine Safety and Health Administration (MSHA) requires equipment used in certain locations of underground mines to be "permissible". The term permissible refers to equipment that meets MSHA specifications for the construction and maintenance of such equipment, to assure that such equipment will not cause a mine explosion or fire. The MSHA Approval and Certification Center approves and certifies certain mining products for use in underground coal and gassy underground metal mines. Technical experts evaluate and test equipment, instruments, and materials for compliance with Title 30 of the US Code of Federal Regulations. Products evaluated and tested range from extremely small electronic devices to very large mining systems. Following successful completion of evaluation and testing of a product, a license is issued authorizing a manufacturer to produce and distribute products for use in mines. MSHA provides administrative and technical information for product approval and acceptance programs through the MSHA web site at <http://www.msha.gov/>.

5.3 US Shipping

Electrical installations in hazardous areas on US inspected vessels (tankers, barges, offshore supply vessels, mobile offshore drilling units, floating offshore facilities, and roll-on roll-off vessels) are regulated in Title 46 Code of Federal Regulations (46 CFR) U.S. Coast Guard, Department of Homeland Security in Subpart 111.105. The installations are required to comply with certain provisions of NEC Articles 500-505, ANSI/ISA-RP12.06.01, NFPA 496, and IEC 60092-502, as applicable; or the incorporated Parts of IEC 60079 Series Publications.

Equipment installations under 46 CFR 111.105-7, -9 and -11 are required to be tested or approved, and listed or certified for use in the hazardous locations by an independent laboratory. Independent laboratory means a laboratory that is accepted by the Commandant of the US Coast Guard under 46 CFR Subpart 159.010. Presently, the list of USCG accepted laboratories includes: Baseefa (UK), CESI (Italy), CSA, DNV (Norway), EXAM (Germany), FM, Intertek, KEMA (DEKRA) (Netherlands), LCIE (France), MET, NEMKO (Norway), PTB (Germany), QPS, SGS North America, SIRA (UK), TUV Nord (Germany), UL (US), and UL (Denmark).

6 Protection techniques for electrical equipment in hazardous (classified) locations

The most basic protection technique is to avoid placing electrical equipment in a hazardous (classified) location. Facility planning should take this factor into account, leaving only those situations where there is no alternative.