Hazardous Locations

Hazardous Locations include areas where the risk of a fire or explosion may exist due to the presence of flammable gases, vapors or liquids, combustible dust, or easily ignitable fibers or flyings. While these materials can be found almost anywhere, they are usually present in quantities far less than what is required for a fire or explosion hazard to occur.

Since the broad definition of hazardous location includes any location where these materials are processed, handled, or used areas are defined based on a risk assessment that considers the amount of material that may be present in the air in sufficient quantities for an explosion to occur. A simple example would be an outdoor propane grill that "uses" propane cylinders as the heat source, the grill and surrounding areas are not classified as a hazardous location because the risk of an explosion occurring is negligible. However, a facility that fills propane cylinders would be due to the filling process and volume of gas present.

The terms used to define hazardous areas identified in Codes and Standards for electrical installations:

- International Electrotechnical Commission® (IEC) uses the term "Explosive Atmospheres".
- The National Electrical Code® (NEC) uses the term "Hazardous (Classified) Locations".
  ** US Standards use the term "Explosive Atmospheres" for Zone Equipment and Hazardous Locations for Class/Division Equipment.*
- Canadian Electrical Code® (CE Code) uses the term "Explosive Atmospheres" for the Zone System (Sections 18 and 20) and equipment and Hazardous Locations for the Class/ Division System (in Annex J18 and J20) and equipment.

From an electrical installation perspective, areas identified as hazardous locations do not include all "explosive materials". The NEC®, CE Code® and IEC® specifically exclude high explosives such as propellants, explosives, munitions, peroxides, oxidizers, pyrophoric, and pyrotechnics materials (such as fireworks) and water-reactive elements or compounds.

> *NOTE: There are National regulations that address the manufacturing, handling and use of high explosives. While some regulations may mandate the use of electrical equipment suitable for hazardous locations, it is simply to provide a higher level of safety than general-purpose equipment. Hazardous location electrical equipment is not designed or tested to withstand the risks associated with high explosives.*

Area Classification

All facilities that process, handle, or use flammable gases, vapors or liquids, combustible dusts, or ignitable fibers or flyings are required to have an area classification performed and documented. (The specific rules, applicable Codes and Standards, other requirements and legislation depends on the local authority having jurisdiction over such facilities).

Area classification is essentially a risk assessment. It is a detailed evaluation that considers multiple factors such as the materials expected to be present, their physical properties, ignition temperatures, sources of release, velocity of release, dispersion patterns, mitigation measures (such as ventilation and gas detection), surrounding atmosphere and wind patterns, etc. and lightning protection.

Several industry guidelines recommend area classification be carried out by those who understand the properties of flammable materials and those familiar with the process and the equipment in consultation with safety, electrical, mechanical and other qualified engineering personnel. In some jurisdictions, those performing the area classification are required to have third party credentials (e.g., IECEx CoPC, CompEx, etc.) to verify that they are competent to perform this task. In all cases, common sense, experience and sound engineering judgement are extremely important when defining and documenting an area classification.

An accurate area classification is critical for selecting electrical equipment that is suitable for the location, determining the appropriate installation requirements, defining any mandatory maintenance procedures, personnel health and safety requirements, issuing work permits, vehicle access, etc.

While not a complete list, the following are examples of commonly used documents that provide guidance on area classification:

- **For explosive gas atmospheres:** American Petroleum Institute (API) RP 500 and RP 505, National Fire Protection Association (NFPA) 497, IEC 60079-10-1, Energy Institute Code of Practice (Part 15)
- **For explosive dust atmospheres:** NFPA 499, 654, and IEC 6007910-2
- **For specific types of facilities with explosive atmospheres:** NFPA 664 (Prevention of Fires and Explosions in Wood Processing and Woodworking Facilities), NFPA 829 (Standard for Fire Protection in Wastewater Treatment and Collection Facilities). ANSI/CAN/UL/ULC 1389 (Plant Oil Extraction Facilities i.e., Cannabis Operations).

General Information on Hazardous Locations

Electrical codes and equipment standards for hazardous locations have evolved into two different systems.

In North America, hazardous areas were first identified in the electrical codes in the 1920s and in the 1930s the “Class/Division System” was introduced. Similar systems emerged in other countries around the same time. Work began by the International Electrotechnical Commission® (IEC) on a different system in the 1960s that used the term “Zone” that is different than the Class/Division systems.

The Class/Division System separates hazardous locations into three “Classes” based on physical properties of the material that may be present. Each “Class” is separated into two “Divisions” based on the risk that the explosive material is present in sufficient quantities for an explosion to occur. It further separates the materials into multiple “Groups” based on their physical properties. In contrast, the Zone System separates the same materials into two material types, “gases” and “dusts”, and defines three areas of risk that the explosive material is present in sufficient quantities for an explosion to occur.

While there are some slight country specific differences, the rest of the world uses the “Zone System” which is based on the IEC 60079 Series of Standards.

The United States and Canada are similar (but not identical) in their hazardous area requirements, including area classification, product standards and acceptable wiring methods. While specific requirements differ, both the United States and Canada have incorporated the IEC Zone System of Area Classification into their electrical codes.

Both the Class/Division system and Zone system provide effective solutions for electrical equipment used in hazardous locations and both have excellent safety records.

In the United States, NEC Articles 500 through 517 contain the installation Rules for Hazardous (Classified) Locations which permits the use of either the Division System or Zone System.

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In Canada, the Canadian Electrical Code (CE Code), Part 1 – Section 18 contains the installation Rules for Explosive Atmospheres and mandates the use of the Zone system for all new construction. Facilities constructed before the introduction of the Zone System, are permitted to continue using the CE Code, Part 1 – Annex J18 that addresses the Class/Division System.

The introduction of the Zone System into both the NEC and CE Code identified areas using "Class-Zone" to align with "Class/Division". In 2015, the CE Code removed the term "Class" when referring to the "Zone" System, the NEC followed in 2020. Both Codes continue to use "Class" when referring to Class/Division locations.

Class/Division System – Material Definition

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

Class II - locations that are hazardous because of the presence of combustible dust.

Class III - location in which easily ignitable fibers/flyings are handled, manufactured, or used.

Zone System – Material Definition

Explosive Atmospheres – mixture with air, under atmospheric conditions, of flammable substances in the form of gas, vapor, dust, fibers, or flyings which, after ignition, permits self-sustaining propagation.

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

Explosive Dust Atmosphere – mixture with air, under atmospheric conditions, of flammable substances in the form of dust, fibers, or flyings which, after ignition, permits self-sustaining propagation.

NOTE: The Zone System for Explosive Dust Atmospheres incorporates Class III easily ignitable fibers/flyings.

The table below provides a simple comparison between the "Class/Division" System and the "Zone" System.

EXPLOSIVE ATMOSPHERE	CLASS/DIVISION SYSTEM	ZONE SYSTEM
Gases and Vapors	Class I	Explosive Gas Atmospheres, Zones 0, 1 and 2
Combustible Dusts	Class II	Explosive Dust Atmospheres, Zones 20, 21 and 22
Easily Ignited Fibers & Flyings	Class III	

General Properties of Hazardous Location Materials

Simply because hazardous location materials are present does not mean that the conditions necessary for an explosion to occur also exist. With explosive materials several other factors must occur simultaneously to result in an explosion. Larger dust particles are referred to as fibers and flyings. While there is no serious risk of an explosion with fibers and flyings, if sufficient material is present, there is the risk of a flash fire, which spreads at near explosive speeds.

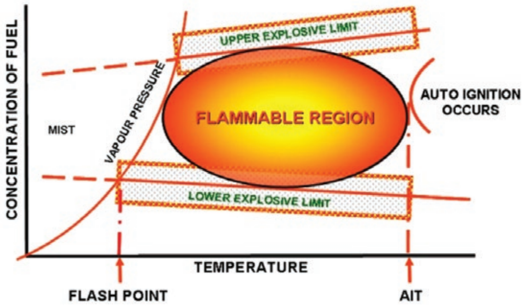
Although there is the risk of an explosion with both explosive gas and dust materials, the factors required for that to occur are somewhat different. In both cases the material needs to mix with air (to provide the oxygen required), be in specific fuel to air concentrations (flammable limits), and then encounter an ignition source with sufficient energy to start an explosion.

The physical properties of gases and vapors allow them to easily mix with air whereas dusts tend to settle on surfaces. If gas is released into the atmosphere it can rise, settle, or linger in the air around, based on the vapor density, and dispersion depends on the air movement in the area. For a dust to form an explosive cloud it needs to be suspended. This can take place in process equipment, leaking equipment, or by strong air movement which could be caused by a smaller explosion.

HAZARDOUS LOCATION DATA

Flammable Limits

With all flammable gases or vapors there is a minimum and maximum concentration in oxygen (air) beyond at which an explosion cannot occur. These minimum and maximum concentrations are called the flammable or explosive limits. If the mixture has too little fuel (a lean mixture) or if there is too much fuel (a rich mixture), it cannot be ignited or cause an explosion. The flammable limits of gases and vapors are usually measured in percentage in air, by volume and referred to as the lower explosive limit (LEL) and upper explosive limit (UEL). Some materials have very broad flammable limits, whereas others have very narrow flammable limits.



While combustible dusts suspended in air have measurable lower flammable limits, there is no finite upper limit; even as the dust approaches the density of the solid material from which it originates. The lower explosive limit for combustible dust suspended in air is usually so dense that visibility beyond one or two meters is impossible. The lower flammable limit of dust air mixtures is usually measured in ounces per cubic foot.

Oxygen

For an explosion to occur oxygen must be present and be mixed within the explosive limits of a fuel. While sufficient oxygen is usually available in the air around us, it is not the only source. For example, a mixture of the (now seldom used) aesthetic gases, ethyl ether, and nitrous oxide can produce violent explosions because oxygen is provided by the nitrous oxide.

If the oxygen concentration exceeds that normally found in air (21% by volume) flammable limits are normally expanded and the ignition energy needed to cause an ignition decreases. An explosion with increased oxygen is often considerably more violent than if the oxygen concentration had been the same as in air.

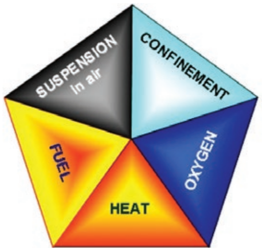
The Fire Triangle

For a fire or explosion to occur, three conditions must exist in the correct combination.

- There must be a fuel (flammable gas or vapor) in ignitable quantities
- There must be an ignition source (heat or a spark) with sufficient energy to cause the material to ignite
- There must be oxygen present (e.g., oxygen in air)

By removing any one or more of these three components, it is impossible for a fire or explosion to occur. This is the basis of the various methods of protection used in the design of electrical equipment permitted for use in hazardous locations.

The Dust Pentagon



The fire triangle indicates the conditions required for combustion for gases and vapors. Dust explosions however require two other factors to sustain an explosion: suspension and containment. This is called the Dust Pentagon.

- There must be a fuel (combustible dust) in ignitable quantities
- There must be an ignition source (heat or spark) with sufficient energy to cause the material to ignite
- There must be oxygen present (e.g., oxygen in air)
- The dust must be suspended in air
- The area must be confined (e.g., inside a building)

While dust that is not suspended in air may pose fire risk, it will not normally explode. Catastrophic dust explosions differ from those involving gases and vapors. With dust, a fire could result in an initial explosion in processing equipment or confined location (such as a dust collection system). This can cause any accumulations of dust in the area to become dispersed in the air which would result in a secondary, far more powerful explosion. Should subsequent explosions occur, the dust dispersion could increase, and intensity of the explosions also increases.

As with the Fire Triangle, eliminating of one of the components of the Dust Explosion Pentagon can prevent an explosion from happening. In most Class II locations, the elimination of oxygen or confinement by buildings or process equipment is difficult to eliminate. However, the other components of the Dust Pentagon can be controlled through proper design, operation and maintenance. Good housekeeping is extremely important in the prevention of dust explosions.

Hazardous Location – Area Classification for Explosive Gas Atmospheres

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

Hazardous Locations or Explosive Gas Atmospheres are defined as those in which flammable gases or vapors are, or may be, present in the air in quantities sufficient to produce an explosive gas atmosphere. The use of the two similar terms, 'gas' and 'vapor' is intended to differentiate between a gas as being in the gaseous state such as hydrogen or methane, and a vapor that flashes off (rises) from a liquid such as gasoline under normal atmospheric conditions.

General

The subdivision of Class I locations into Zones or Divisions is based on the probability of an explosive material being present in sufficient quantities for an explosion to occur. If the risk is extremely low, the location may be considered a non-hazardous location. A good example of a low-risk area is a family residence that uses a natural gas or propane furnace for heating. The gas could, and on extremely rare occasions does, leak into the home and encounter an ignition source which can result in an explosion, often with devastating consequences. However, since the risk is so low, because of the safety systems built into the gas supply and equipment, these areas are not classified as "hazardous locations".

Unclassified Locations

The NEC defines these locations as those *"determined to be neither Class I, Division 1; Class I, Division 2; Zone 0; Zone 1; Zone 2; Class II, Division 1; Class II, Division 2; Class III, Division 1; Class III, Division 2; Zone 20; Zone 21; Zone 22; nor any combination thereof."*

The American Petroleum Institute (API) adds to this, *"there are locations that contain explosive gases or vapors that are not necessarily classified. This would include all-welded closed piping systems or continuous metallic tubing without valves, flanges and containers or vessels used for storage or transport of materials that are Department of Transport (DOT) approved for that purpose."*

Ordinary locations (CE Code)

The Canadian Electrical Code uses the term "Ordinary Locations" instead of "Unclassified Locations". The CE Code defines "Ordinary Locations" as "a dry location in which, at normal atmospheric pressure and under normal conditions or use, electrical equipment is not unduly exposed to damage from mechanical causes, excessive dust, moisture, or extreme temperatures, and in which electrical equipment is entirely free from the possibility of damage through corrosive, flammable, or explosive atmospheres."

The CE Code also identifies Damp, Dry, Outdoor and Wet Locations which are also "unclassified locations".

Class I, Division System Area Classification Definitions

Class I, Division 1

Class I, Division 1 locations are defined as those in which hazardous concentrations of flammable gases or vapors exist continuously, intermittently, or periodically under normal operating conditions. This is a very broad definition as there are no times associated with (intermittently) or (periodically), so it is open to interpretation.

Class I, Division 1 also includes areas where explosive material may exist frequently due to regular repair or maintenance operations, normal leakage, and locations where the breakdown or faulty operation of electrical equipment or processes may release ignitable concentrations of flammable gases or vapors.

An example of such a location might be an area where a flammable liquid is stored under cryogenic conditions. A leak of the extremely low temperature liquid directly onto electrical equipment could cause failure of the electrical equipment. Simultaneously, vapors from the evaporating liquid could be within the flammable range.

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Class I, Division 2

Class I Division 2 areas are defined as "areas where flammable volatile liquids, flammable gases, or vapors are, processed, handled or used, but in which the liquids, gases, or vapors are normally 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 systems or the abnormal operation of the equipment". Or, "where hazardous concentrations of gases or vapors are normally prevented by positive mechanical ventilation, but which may become hazardous as the result of failure or abnormal operation of the ventilating equipment".

Zone System (Explosive Gas Atmospheres) Area Classification Definitions

Zone 0

Areas in which an explosive gas atmosphere is present continuously, or for long periods, or frequently

NOTE: Zone 0 would include the most dangerous areas defined as Class I, Division 1. Some documents recommend against the use of electrical equipment in certain Class I, Division 1 locations.

Zone 1

Areas in which an explosive gas atmosphere is likely to occur occasionally in normal operation

NOTE: Zone 1 is similar to the majority of Class I, Division 1 locations but excludes the highest risk locations. By omitting Zone 0 locations, Zone 1 allows for other types of equipment protection to be used.

Zone 2

Areas in which an explosive gas atmosphere is not likely to occur in normal operation, but if it does occur, will persist for a short period only

NOTE: These locations are basically identical to Class I, Division 2 locations.

Comparing the Class/Division and Zone System Area Classification for Explosive Gas Atmospheres

Both Class/Division and Zone area classification is based on "normal operation" and do not consider "catastrophic failures".

Class I, Division 1, Zone 0, and Zone 1 all represent the areas with highest probability that an explosive gas atmosphere may develop in normal operation. Class I, Division 1 identifies areas where the hazard is expected to occur during normal operation and will be present continuously, periodically, or intermittently.

The Zone System Area Classification separates Class I, Division 1 into two different Zones based on how long the material is expected to be present and the associated risks. Zone 0 areas are those where the material is expected to be present continuously. Zone 1 areas are those where the material is expected to be present periodically or intermittently.

NOTE: The definitions for continuously, periodically, and intermittently are somewhat subjective. There are multiple documents to assist users in developing an area classification for the Class/Division System. Some documents for the Zone System include guidelines based on hours per year to define the various Zones. In all cases, sound engineering judgement and experience are important.

The lower risk areas of Class I, Division 2 and Zone 2 are basically identical. Both consider areas where the material is not expected to be present in sufficient quantities for an explosion to occur under "normal operating conditions" and if a release does occur it will exist only for a "short period of time". Again, what constitutes abnormal conditions and short period of time can be somewhat subjective.

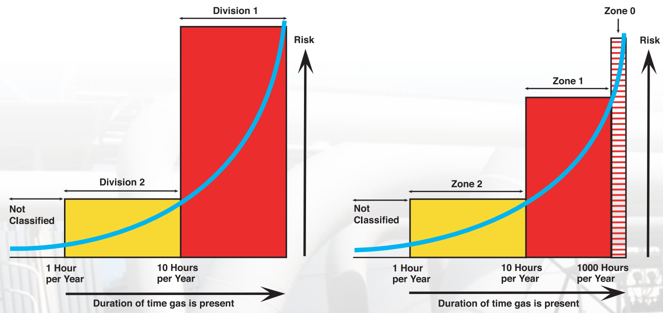
Although the hours identified in the Zone System could be applied to the Class/Division system, these are not intended as absolute numbers. For example, while an area where the material is in explosive range more than 1000 hours per year would be identified as Zone 0, that doesn't mean an area that is likely to be in the same range for over 900 hours per year should be identified as Zone 1. Similarly, if the probability of a gas release in a building was extremely low, it would likely be identified as Zone 2 based on the 10 hours per year limit. However, for unmanned facilities in remote locations, it would likely take longer than ten hours for personnel to reach the location to take corrective action which would justify a higher area classification.

It is also important to consider the boundaries between hazardous areas. Zone 2 or Division 2 locations normally exist adjacent to Zone 1 or Division 1 locations (unless separated by an impervious barrier or partition). If the area classification depends on artificial ventilation, a failure of the system would allow the flammable material to migrate into lower classified or even unclassified locations.

TYPE OR GRADE OF RELEASE	ZONE	FLAMMABLE MIXTURE PRESENT
Continuous	0	1000 hours per year or more (10%)
Primary	1	Between 10 and 1000 hours per year or more (0.1% to 10%)
Secondary	2	Less than 10 hours per year (0.01% to 0.1%)
Unclassified		Less than 1 hour per year (Less than 0.01%)*

The above is a combination of Tables 2 and 3 from API RP505
**Some controversy surrounds the 1 hour per year figure. The IEC does not define hours per year.*

The illustrations below compare the similarities and differences between the Division System and the Zone System. Essentially, the greater the amount of material involved or longer the time it is present, the higher the risk.



The key difference between the two systems is that the Zone system looks at the areas with the highest level of risk. Over 1000 hours per year is identified as "Zone 0", and 10 to 1000 hours per year as "Zone 1". The Class I, Division 1 higher risk areas are the combination of Zones 0 and 1. The criteria used to identify the lower risk areas of Zone 2 and Division 2 is virtually identical.

The table below provides a comparison between the "Class/Division" System and the "Zone" System.

CLASS I	DIVISION SYSTEM	ZONE SYSTEM	NOTES:
Gases and Vapors	Division 1	Zone 0	Zone 0 locations are a typically less than 1% of hazardous locations in a facility.
		Zone 1	While the wiring practices and acceptable products differ, Zone 1 encompasses most of Class I, Division 1.
	Division 2	Zone 2	Zone 2 and Class I, Division 2 are essentially the same

Hazardous Location – Gas Material Groups

In terms of physical properties, each gas has specific properties that includes ignition temperature, flash point, flammable limits, minimum ignition energy and specific gravities (how they move in air). Gases or vapors are categorized by two common factors; the minimum amount of energy required for them to ignite, and the maximum gap, between two flat surfaces, an exploding gas can pass through without igniting a surrounding atmosphere of the same gas.

Minimum Ignition Energy (MIE) is the minimum energy input required to initiate combustion. This is the smallest amount of energy stored in a capacitor that when discharged across a spark gap can ignite a stoichiometric mixture of the gas. All hazardous location materials have a minimum ignition energy that is specific to its chemical or mixture, the concentration, pressure, and temperature.

Minimum Ignition Current (MIC) is the smallest amount of current flowing in a circuit that will cause a spark when the current flow is interrupted which cause an explosion in a fuel oxygen mixture. Minimum ignition current can come from multiple sources which includes discharge of a capacitive circuit, interruption of an inductive circuit, intermittent making and breaking of a resistive circuit, or hot wire fusing. If the MIC of a material is known, electrical circuits can be designed so that any sparks created do not have enough energy to cause an explosion. Controlling the spark energy is the basic concept in intrinsically safe and non-inductive equipment.

Maximum Experimental Safe Gap (MESG) is maximum spacing between flat surfaces of a specified width in experimental test equipment that will prevent the propagation of an explosion from inside the explosion test chamber to a surrounding flammable atmosphere. The MESG is determined using a testing chamber such as the Westerberg Explosion Test Vessel. A similar, but not identical, method to determine MESG is defined in IEC 60079-20-1 *(Material characteristics for gas and vapor classification - Test methods and data).*

While there are slight discrepancies between the North American and IEC values, the intent is basically the same. The reasons for the differences are the introduction of new test parameters and rounding. When North America adjusted their evaluation methods, the definition for some materials also changed. The committees responsible for those changes decided not to reclassify the materials. This is the primary reason some gases in the division system are not aligned with those in the Zone system.

While an area classification is based on the specific types of material present, electrical equipment is tested and approved for use in multiple explosive gas atmospheres. Without gas groups, the certification of electrical equipment would be extremely difficult, and the cost would be prohibitive.

This allows multiple gasses and vapors to be "grouped" together based on their "Minimum Igniting Current (MIC) Ratio" and the "Maximum Experimental Safe Gap (MESG)" between surfaces that will allow an explosion to propagate from a contained atmosphere, such as an enclosure, to an outer atmosphere. These are measured based on the "most easily ignited" or "stoichiometric" gas-air mixture ratio. The ignition energy required increases as the percent air/mixture ratio deviates from the stoichiometric ratio.

The grouping is therefore based on the two key factors; maximum gap an exploding gas can pass through is based on laboratory tests performed in an apparatus, which varies both the width and gap of a joint and the pressure rise caused by an explosion.

Class/Division – Material (Gas) Groups (Groups A, B, C, & D)

Material identification

Group A

The highest explosion pressures of the materials grouped are generated by acetylene, the only material in Group A. Thus, explosionproof equipment designed for Group A must be very strong to withstand the explosion pressures generated and must have a very small gap between joint surfaces. Equipment suitable for Group A is more difficult to design, resulting in less explosionproof equipment listed for this Group than other Groups.

Group B

Group B materials produce lower explosion pressures than acetylene. This allows explosionproof enclosures for Group B to be less robust than those designed for Group A. Because of the high explosion pressures in Groups A and B, and the small gaps permitted between mating surfaces to prevent propagation of an explosion, there are no explosionproof motors listed for use in either Group A or B locations.

Group C

The chemical materials in Group C fall within the range between Groups B and D in both the explosion pressures generated and the gap between mating surfaces of explosion proof equipment that will prevent an explosion.

Group D

Group D is the most common group encountered in the field, and there is more equipment available for this group than for any other group.

Zone System – Material (Gas) Groups (IIC, IIB, IIB+H2 & IIA)

Zone Gas Groups General information

The Zone gas groups are based on the IEC and prefixed by “II” which means equipment intended for surface industries. The prefix “I” identifies equipment intended for underground coal mining. Since the NEC does not deal with mining; references to “I” are excluded.

Group IIC

(Basically, the combination of the Division system Groups A and B) includes materials such as acetylene, butadiene, propylene oxide, carbon disulphide or hydrogen or other gases or vapors of equivalent hazard. The majority of Zone equipment is designed for IIC.

Group IIB

(Basically, the same as Division System Group C) includes materials such as cyclopropane, diethyl ether, ethylene, ethylene oxide, hydrogen sulfide, or unsymmetrical dimethyl hydrazine (UDMH), or other gases or vapors of equivalent hazard.

Group IIB +Hydrogen (or IIB+H2)

The identification of Group IIB +Hydrogen excludes acetylene and equates to the Division System Group B definition. The issue was that acetylene explosion will propagate through any flat joint. Group IIB+H2 was introduced to allow for enclosure for hydrogen atmospheres that do not propagate through properly designed flat joints.

Group IIA

(Basically, the same as Division System Group D) includes materials such as acetaldehyde, acetone, alcohol, ammonia, benzine, butane, gasoline, hexane, isoprene, lacquer solvent vapors, natural gas, propane, propylene, styrene, vinyl chloride, xylenes, or other gases or vapor of equivalent hazard.

HAZARDOUS LOCATION DATA

Comparing Class/Division & Zone System Gas groups

The first definitions of flammable gases in North American Standards appeared in 1935 and were based on theoretical calculations. In the 1960s an engineer at UL developed an instrument called the Westerberg Explosion Test Vessel that could vary gap and joint width dimensions of a chamber to perform an actual test. In the early 1970s, the IEC® developed a different test vessel that could perform the same test. Although most of the results were similar, they were not identical. Both Systems grouped materials based on the test results.

In the 1997 Edition of NFPA 497 a new method to estimate the group classification of a mixture was introduced. While some materials, mostly Groups C and D, no longer met the new definitions exactly, based on the safety of historical practices, the standard committee decided not to reclassify them.

This results in slight differences in how gases are identified in the Zone system versus the same gas in the Division System. For purposes of increasing equipment selection in North America, the area classification should identify both the Zone and Division gas group.

GAS GROUPS	
DIVISION	ZONE
A	IIC
B	
B*	(IIB + H_2)
C	IIB
D	IIA

** Added to accommodate equipment that excluded acetylene atmospheres*

COMPARISON OF DIVISION AND ZONE SYSTEM GAS GROUPS EVALUATION					
DIVISION SYSTEM			ZONE SYSTEM		
Group	MESG (mm)	MIC Ratio	Group	MESG (mm)	MIC
Not Classified	< 0.076 (e.g. Carbon Disulphide)		IIC	≤ 0.50	≤ 0.45
A	Acetylene (Has same MESG and MIC Ratio as group B, but generates much higher explosive pressures)				
B	> 0.076	≤ 0.40			
	≤ 0.45				
C	> 0.45	> 0.40	IIB	> 0.50	> 0.45
	≤ 0.75	≤ 0.80		≤ 0.90	≤ 0.80
D	> 0.75	> 0.80	IIA	> 0.90	> 0.80

Hazardous Location – Temperature Considerations

Ambient Temperature

The ambient temperature is the surrounding temperature of the environment in which a piece of equipment is installed, whether it is indoors or outdoors. Certain heat producing equipment such as lighting fixtures list a Temperature Code or T-Code at a given ambient temperature. (See below)

A heat producing product is considered acceptable for the location, provided the minimum ignition temperature of the hazardous material present and the ambient temperature of the location do not exceed the limits set by the manufacturer. If the ambient temperature is higher than the maximum stated on the name plate, it might still be acceptable to use the product under certain conditions, provided the minimum ignition temperature of the hazardous material has not been exceeded. In all cases, consult the factory for assistance.

Operating Temperature

The rated operating temperature for hazardous (classified) products is determined by conducting laboratory test in an ambient temperature of 40°C. Products certified by the various agencies consider products certified to their standards to be suitable for different temperature ranges. The range for the range for UL is -25°C to +40°C, the range for CSA is -50°C to +40°C, and the range for IEC is -20°C to +40°C.

Temperature Code or T-Code

The *"Temperature Code"* or *"T-Code"* identifies the hottest surfaces of a product, measured during testing, that could encounter an explosive atmosphere.

The autoignition temperature (AIT) is the minimum temperature that will cause an explosive material to ignite without a spark or flame. The lowest published ignition temperature for a material is used to determine the acceptability of equipment.

Use of the T-Code allows the user to select equipment for multiple hazardous materials that may have different autoignition temperatures. In some cases, the NEC requires the T-Code marked on a product to be reduced by 80% for additional safety. In North America, a T-Code must be marked on all equipment where any exposed surface exceeds 100°C. This is different to IEC (Zone) equipment where the T-Code is always marked on the product.

There is a relationship between the ambient temperature where the equipment is being used and the T-Code and the various product Standards identify a specific ambient temperature range for which the equipment is suitable. Products are often tested for a different ambient temperature based on market need. For example, the standard ambient temperature range for Zone equipment is -20°C to +40°C but it is common to find equipment suitable for a different range such as -50°C to +60°C.

All heat-producing electrical equipment such as lighting fixtures, motors, electrical trace heating, etc. must operate below the autoignition temperature of the explosive materials in the surrounding area.

Where a product does not align with ambient range, there is a somewhat linear relationship between it and T-Code that is occasionally considered. For example. a product that indicates T-2 (300°C) at a 40°C ambient would increase the surface temperatures to approximately 310°C at a 50°C ambient, which might be acceptable to the user in certain cases. This is only a rule of thumb and does not consider the effect of a higher ambient on the performance or life of the product. Operating equipment above the maximum ambient temperature marked on the product should not be done without consulting the manufacturer.

The T-Codes used in the Division System are slightly different from those in the Zone System. While the basic numeric values are identical, the Division System has additional temperature levels which are not used in the Zone System. Internationally only Canada permits the use of the additional levels for both Division and Zone locations.

TEMPERATURE CODES NEC(DIV.) & CEC (DIV./ZONE)	TEMPERATURE CODES (ZONES) NEC/IEC/ATEX	MAXIMUM TEMPERATURE	
		°C	°F
T1	T1	450	842
T2	T2	300	572
T2A	—	280	536
T2B	—	260	500
T2C	—	230	446
T2D	—	215	419
T3	T3	200	392
T3A	—	180	356
T3B	—	165	329
T3C	—	160	320
T4	T4	135	275
T4A	—	120	248
T5	T5	100	212
T6	T6	85	185

Hazardous Location – Area Classification for Explosive Dust Atmospheres

North America – General Information

The NEC and CE Code contain two systems that deal with combustible or explosive dusts. Similar to the Rules for explosive gas atmospheres, the NEC allows the user to use either the Class/Division System or Zone System. The CE Code mandates use of the Zone System for all new construction, with facilities constructed before the introduction of the Zone System for dust atmospheres being permitted to continue using the Class/Division Rules.

NEC Article 502 contains the Rules for areas classified using the Division System and Article 506 contains the Rules for the Zone System. The CE Code uses Section 18 for the Zone Rules and Annex J18 for the Division Rules.

Similar to Class I locations, Class II locations are separated into Divisions or Zones based on the likelihood combustible dust being suspended in the atmosphere in sufficient quantities to produce ignitable mixtures or where a failure or abnormal operation of equipment might produce a hazardous concentration of dust.

Unlike gases and vapors, particle size is a key factor in identifying Class II materials. The definition of a Class II dust is any finely divided solid material that is 420 microns or smaller in diameter (material passing through a No. 40 Standard Sieve) and presents a fire or explosion hazard when dispersed and ignited in air.

An example of the importance of particle size is wood; a log could burn but not explode, and the size of the wood decreases so does its ability to burn. When the wood reaches the size of a fine sawdust is it easier for it to become suspended in air at which point it can become highly explosive.

Class II, Division System Area Classification Definitions

Class II, Division 1

A Class II, Division 1 location is one where combustible dust is normally in suspension in the air in sufficient quantities to produce ignitable mixtures, or where mechanical failure or abnormal operation of equipment or machinery might cause an explosive or ignitable dust-air mixture to be produced and might also provide a source of ignition through simultaneous failure of electrical equipment.

Typical Class II Dust Location

Class II, Division 2

A Class II, Division 2 location is one where combustible dust is not normally in the air in quantities sufficient to produce explosive or ignitable mixtures, and dust accumulations are not normally sufficient to interfere with the normal operation of electrical equipment, such as clogging ventilating openings or causing bearing failure. It includes locations where combustible dust may be in suspension in the air only as a result of infrequent malfunctioning of handling or processing equipment, and those locations where dust accumulation may be on or in the vicinity of the electrical equipment and may be sufficient to interfere with the safe dissipation of heat from the equipment, or may be ignitable by abnormal operation or failure of the electrical equipment.

GUIDE TO CLASSIFICATION OF CLASS II LOCATIONS BY DIVISION*		
THICKNESS OF DUST LAYER ON EQUIPMENT**	DUST GROUP	DIVISION
Greater than 1/8 in.	E, F, G	1
1/8 in or less but surface color not discernible	E	1
1/8 in or less but surface color not discernible	F, G	2
1/8 in or less and surface color discernible under dust layer	E, F, G	non-classified

* *From NFPA 497B*

** *Based on build-up of dust level in a 24-hr period on the major portions of the horizontal surfaces.*

Zone System (Explosive Dust Atmospheres) Area Classification Definitions

The North American Class/Division system for dusts (Class II) is quite different to the IEC system for Explosive Dust Atmospheres. In 2005 the NEC added Rules for Explosive Dust Atmospheres in Article 506, and in 2015 the CE Code similar Rules to Section 18. Similar to how the adoption of IEC System for Explosive Gas Atmospheres the NEC permits use of either the Class/Division System or Zone System, whereas in Section 18 the CE Code mandates the use of the Zone System for all new construction and allows existing facilities to continue to use the Class/ Division Rules in Annex J.

Perhaps the most significant difference between the systems is that the Zone system includes both Class II (dusts) and Class III (easily ignited fibers and flyings).

CLASS II SYSTEM DUST AND CLASS III FIBERS AND FLYINGS	ZONE SYSTEM FOR EXPLOSIVE DUST ATMOSPHERES
Class II, Divisions 1 & 2	Zones 20, 21, 22
Class III, Divisions 1 & 2	

Like the system for Explosive Gas Atmospheres, the Zone system for combustible dusts has three levels of hazard as opposed to the 2 levels of hazard in the Class/Division system.

Zone 20

Area in which an explosive atmosphere in the form of a cloud of combustible dust in air is present continuously, or for long periods or frequently.

Zone 21

Area in which an explosive atmosphere in the form of a cloud of combustible dust in air is likely to occur in normal operation occasionally.

Zone 22

Area in which an explosive atmosphere in the form of a cloud of combustible dust in air is not likely to occur in normal operation but, if it does occur, will persist for a short period only.

Hazardous Location – Gas Material Groups

Class II – Material (Dust) Groups (E, F and G)

Class II substances are divided into three groups for similar reasons to those of Class I materials, equipment design and area classification. Class II groups are based on different characteristics than those of Class I, given the requirements for an explosion to occur and the protection methods required for equipment. In Class II locations the ignition temperature, the electrical conductivity, and the thermal blanketing effect of the dust are critical when dealing with heat-producing equipment, such as lighting fixtures and motors. It is these factors which are the deciding factors in determining the Class II groups.

Group E

This includes metal dusts, such as aluminums and magnesium. These dusts are highly abrasive and can cause overheating in equipment such as motor bearings, and if allowed to enter an enclosure, metal dusts are likely to cause an electrical fault in the equipment. Since Group E dust have the potential to be the source of the equipment failure, source of ignition and fuel for an explosion simultaneously, any accumulation is normally considered to be Division 1.

Group F

These are carbonaceous, the primary dust in this group being coal dust. These dusts have somewhat lower ignition temperatures than those in Group E and a higher thermal insulating value than a layer of a Group E dust. Therefore, Group F dusts require careful control of the temperature on the surface of electrical equipment to prevent an explosion. Such dusts are semi-conductive, which is not usually an issue when dealing with equipment rated 600 volts or less.

Group G

This includes plastic dusts, most chemical dusts, and food and grain dusts. These are not electrically conductive. Group G dusts generally have the highest thermal insulating characteristics and the lowest ignition temperatures. Electrical equipment for use in Group G atmospheres must have very low surface temperatures to prevent ignition of a dust layer by the heat generated within the equipment.

While it is common for Class I products to be certified for use in Class II locations, it is not always the case. Given the different design requirements, equipment suitable for Class I locations are not necessarily suitable for Class II locations, nor is equipment suitable for Class II locations necessarily suitable for Class I locations. Equipment must be designed, approved and marked for use in specific hazardous locations.

Manufacturers typically develop equipment to suit a wide range of hazardous locations to be more cost effective. The equipment is marked as such and may have different temperature limitations on heat producing devices for different types of hazardous material. As always, care must be taken in selecting equipment for any hazardous location.

Temperature Restrictions

In Class II areas all products must operate at temperatures as shown below based on whether they are heat producing or subject to overloading or not and based on the Group which they fall under. Class III products in all cases must operate below 165°C.

TEMPERATURE RESTRICTIONS						
	EQUIPMENT THAT IS NOT SUBJECT TO OVERLOADING		EQUIPMENT (SUCH AS MOTORS OR POWER TRANSFORMERS)			
			NORMAL OPERATION		ABNORMAL OPERATION	
Class II Groups	°C	°F	°C	°F	°C	°F
E	200	392	200	392	200	392
F	200	392	150	302	200	392
G	165	329	120	248	165	329

Zone System – Material (Dust) Groups (IIA, IIB, IIC)

Zone Dust Groups General information

The Zone explosive dust groups are based on the IEC and prefixed by "III". Underground mining uses the same Dust Groups.

Note: the NEC does not deal with mining; references to "I" are excluded.

Group IIIC

Combustible dust with electrical resistivity equal to or less than 103 Ω·m

NOTE: Metal dust is treated as conductive dust because it is assumed that surface oxidation cannot be depended upon to always ensure electrical resistivity greater than 1 × 103 Ω·m.

Group III includes metal dusts, such as aluminums and magnesium. These dusts are highly abrasive and can cause overheating in equipment such as motor bearings, and if allowed to enter an enclosure, metal dusts are likely to cause an electrical fault in the equipment. Since Group IIIC dusts have the potential to be the source of the equipment failure, source of ignition and fuel for an explosion simultaneously, any accumulation is normally considered to be Zone 0.

Group IIB

Non-conductive dust with electrical resistivity greater than 103 Ω·m

Group IIIB includes all non-conductive dust. This equates to most of the dusts identified as Class II Groups F and G.

Group IIA

Easily ignited fibers and flyings. Essentially this is "big" dust and includes all the materials identified as Class III. Group IIIA materials are not likely to be suspended in the air in sufficient quantities to produce an ignitable mixture. Group IIIA materials do not present an explosion hazard but they can support a flash fire.

Hazardous Location – Area Classification for Easily Ignitable Fibers or Flyings

Class III locations address the presence of easily ignitable fibers or flyings, but in which the fibers or flyings are not likely to be in suspension in the air in quantities sufficient to produce ignitable mixtures. While easily ignitable fibers and flyings do not present an explosion hazard, their presence increases the risk of a "flash fire" which can progress at near explosive speed. A typical example of this type of material is the cotton lint that accumulates in the lint trap of clothes dryers. Listed clothes dryers are designed so that even if the lint ignites, the fire will be contained within the dryer enclosure.

NOTE: Applies only to the Class/Division System. The equivalent to "Class III" locations are identified as a "Group IIIA" Explosive Dust Atmospheres in the Zone system

Class III, Division 1 Locations

Typical locations include facilities with equipment that produces ignitable fibers or flyings (textile mill machinery, for example) or where the material is collected and packaged (for example, where the material is placed into bags).

Class III, Division 2 Locations

Typical locations include facilities where easily ignitable fibers are stored or handled, that are separate from the manufacturing process.

Class III Material Groups

There are no Material Groups identified in the Class III System.

Explosive Dust Atmospheres – Comparing Division and Zone Dust Groups

The main difference between the two systems for combustible or explosive dusts is that the Zone System has only two dust groups as opposed to the Class/Division system that has three. The Zone system also includes what the Class/Division system identifies as Class III simply as a third Dust Group (IIIA). This means installation Rules in the NEC and CE Code for explosive dust atmospheres become the same for Class II and Class III. Using the Class/Division system, the Rules for Class III installations and equipment are less stringent than those used for Class II.

ZONE DUST GROUPS		
TYPE OF DUST	DIVISION DUST GROUP	ZONE DUST GROUP
Conductive dust	Class II, Group E	IIIC
Non-conductive dust	Class II, Groups F, G	IIIB
Combustible flyings	Class III Locations	IIIA

Equipment Standards for Hazardous Locations

Determining which type of equipment is acceptable for a specific hazardous location is predicated by a combination of the installation codes, certification requirements, user requirements and the authority having jurisdictions. The following is a brief outline of the types of equipment for each location. Details on equipment construction are provided in the next section.

Class/Division Equipment

Electrical equipment must be designed and manufactured so that it does not become a source of ignition when installed in a hazardous location. The NEC and CE Code are very specific on which types of equipment are permitted to be installed in the various hazardous locations and equipment must be certified or approved by a Nationally Recognized third-party Certification Body. The certification of equipment also addresses any NEC and CE Code installation requirements that may apply.

The US Occupational Health and Safety Administration (OSHA) registers Nationally Accredited Testing Laboratories (NRTL) that are approved to test and certify equipment to ANSI and other hazardous location Standards. The Standards Council of Canada (SCC) registers Certification Bodies (CB) to test and certify equipment to Canadian hazardous location Standards. In many cases, NRTLs and CBs are registered with both OSHA and SCC to simplify North American approvals. In both cases, acceptance of an NRTL or CB is determined by the Authority Having Jurisdiction (AHJ) responsible for the installation (AHJs do not always accept every NRTL or CB).

While Class/Division products are predominantly used in Canada and the US, other jurisdictions may permit their use. In some countries, North American companies are permitted to construct facilities using the Class/Division system and equipment. This needs to be confirmed with the local AHJ.

Class I, Division 1 Equipment

For Class I, Division 1 locations, most devices that produce ignition-capable arcs or temperatures must be installed in an explosionproof enclosure. The wiring system connected to these enclosures must be sealed (using explosionproof sealing fittings or cable glands) to prevent any internal ignition from escaping through the wiring connection(s). While the exceptions to this requirement are rare (examples such as oil immersed transformers, purged systems (to NFPA 496), submerged pumps with additional protective controls, etc.), and different product certification, installation rules and maintenance requirements often apply.

Low energy systems often specify Intrinsically Safe (or Intrinsic Safety) technology. The “Intrinsically Safe” or “Intrinsic Safety” (IS) concept involves more than simply the purchasing and installing of a single product. IS systems are an engineered solution which evaluates everything from the power source to the end device (including all components and wiring). Intrinsic Safety installations are addressed in NEC Articles 504 and 505 and CE Code Appendix F.

Class I, Division 2 Equipment

There are more options for equipment design in Class I, Division 2 locations. Certain types of industrial or “non-hazardous” equipment, such as terminals and non-sparking motors are permitted. This type of equipment does not need to be marked as suitable for use in Class I, Division 2 locations. For equipment that produces ignition-capable arcs or temperatures such as lighting fixture and control devices, a Class I, Division 2 approval is required. There are standards that are specific to Class I, Division 2 equipment and products approved for Zones (using CSA/UL 60079 standards) are permitted.

NOTE: Equipment that produces ignition-capable arcs or temperatures is often installed in Explosionproof or Flameproof (Ex d) enclosures to simplify certification. If such equipment is installed in a Class I, Division 2 location, it is important to understand that the installation Rules for Class I, Division 1 normally apply.

Class II, Division 1 Equipment

Class II, Division 1 equipment is designed to exclude dust from entering an enclosure and control the surface temperatures. There are multiple tests for gaskets, heat dissipation, impact, etc. that ensure the equipment can be safely used. The sealing requirements for equipment are quite different than those for explosionproof equipment since the objective is to keep dust out of the enclosure, not to prevent an internal explosion from escaping.

NOTE: The CSA and UL requirements for Class II certification are somewhat different. Although UL 1203 and CSA C22.2 No 25 are aligned, both include specific joint dimensions and testing requirements. The CSA Standard permits the use of IEC/CSA 60079-31 (which has different joint requirements and test requirements) as an alternate to those in CSA C22.2 No 25. Currently, UL 1203 does not accept UL 60079-31 in place of the legacy requirements.

Class II, Division 2 Equipment

The equipment requirements are much less stringent than those for Class II, Division 1. Both the NEC and CE Code permit devices that produce ignition-capable arcs or temperatures to be installed in “dust-tight” enclosures although the definition varies slightly. The NEC identifies Types 3, 3S, 3SX, 4, 4X, 5, 6, 6P, 12, 12K, and 13 enclosures as acceptable, whereas CSA only permits Types 4, 4X and 5 enclosures. For some products (such as lighting fixtures) the requirements for Class II, Division 1 and Class II, Division 2 products are basically the same, so products tend to be approved for both locations.

Class III, Equipment

There are no US or Canadian Standards that specifically address Class III locations. The key determination is to prevent materials entering equipment and temperature control. The Class III temperature maximum is 165°C and gasketed enclosure/equipment that operates below that temperature could be approved.

Zone Equipment Standards

The IEC technical committee TC 31 is responsible for developing and maintaining approximately 100 IEC standards related to explosive atmospheres. This includes equipment standards, installation, maintenance and refurbishment requirements, non-electrical standards, area classification, material test methods, etc. Most of these standards are in the IEC 60079 Series and IEC 80079 Series.

Globally, Zone equipment is designed, tested and approved to the IEC 60079 Series of Standards. However, not all versions of these standards are identical. Many countries adopt IEC Standards but include “National Deviations” to address issues such as installation, certification, and other safety requirements which result in multiple versions of the same standard.

North American versions of the IEC 60079 Series include additional safety requirements and ensure products comply with the installation rules. The Canadian and US committees responsible for adopting the IEC 60079 Series attempt, whenever possible, to avoid any technical differences between the CSA and UL versions.

The EU uses parallel voting that allows them to adopt IEC standards as EN Standards which rarely include National Deviations.

Recently, requirements for mechanical protection were included in the IEC 80079 Series of Standards (based on EN Standards). These are used in conjunction with IEC 60079 Series for product certification. North America has not included these requirements at this time.

Zone Equipment based on IEC 60079 Series

The Zone system is a bit different to the Class/Division system. The Class/Division system marks product with the specific location where it may be used whereas the Zone system isn’t always as clear. Zone products are approved for a “Type of Protection” and marked accordingly. The installation Codes then identify which Types of Protection are suitable for each hazardous location. This means a product approved for example as “flameproof” Ex d would be marked with the protection method, material Group and T-Code (e.g., Ex d IIC T6) and the user determines where it may be used. This becomes complicated when multiple Types of Protection are used in a single product (e.g., Ex d,e,m.q IIC T6). (US Standards require the addition of appropriate Zone suitability, Canada does not.)

HAZARDOUS LOCATION DATA

To simplify the marking, the IEC 60079 Standards added "Equipment Protection Levels" (EPL) which includes a "Level of Protection" to identify which Zone the equipment is suitable for. EPL uses "G" for Explosive Gas Atmospheres and "D" for Explosive Dust Atmospheres. There are three Levels of Protection that define the Zone suitability (a, b, c). (Unlike the material classification where "C" is the highest level of protection, with EPL "a" is the highest level of protection).

NOTE: IEC 60079 Standards also identify an EPL equipment for use in Explosive Atmospheres in Mines Susceptible to Firedamp as "M". Mining installations are not included in the NEC or CEC.

- **EPL Ga** — equipment for Explosive gas Atmospheres, having a "very high" level of protection, which is not a source of ignition in normal operation, during expected malfunctions or during rare malfunctions
- **EPL Gb** — equipment for Explosive gas Atmospheres, having a "high" level of protection, which is not a source of ignition in normal operation or during expected malfunctions
- **EPL Gc** — equipment for Explosive gas Atmospheres, having an "enhanced" level of protection, which is not a source of ignition in normal operation, and which may have some additional protection to ensure that it remains inactive as an ignition source in the case of regular expected occurrences (for example failure of a lamp)
- **EPL Da** — equipment for Explosive dust Atmospheres, having a "very high" level of protection, which is not a source of ignition in normal operation, during expected malfunctions, or during rare malfunctions
- **EPL Db** — equipment for Explosive dust Atmospheres, having a "high" level of protection, which is not a source of ignition in normal operation or during expected malfunctions
- **EPL Dc** — equipment for Explosive dust Atmospheres, having an "enhanced" level of protection, which is not a source of ignition in normal operation, and which may have some additional protection to ensure that it remains inactive as an ignition source in the case of regular expected occurrences (for example failure of a lamp)

EPL G a

Protection Level
a – Highest (Zone 0, 20)
b – High (Zone 1, 21)
c – Enhanced (Zone 2, 22)

Material
G – Explosive Gas Atmosphere
D – Explosive Dust Atmosphere

Equipment Protection Level

EPL	ZONE SUITABILITY
Ga	Zone 0
Gb	Zone 1
Gc	Zone 2
Da	Zone 20
Db	Zone 21
Dc	Zone 22

Levels of Protection for Ex Equipment

To align with the EPL marking system, current IEC 60079 Series Standards have added "Levels of Protection" in addition to each "Type of Protection". At this time, the addition of this to all IEC 60079 Series Standards may not be complete and products approved to earlier versions of a standard might not be marked with a Level of Protection or EPL. As products evolve and certifications are updated this will be corrected.

Original Marking

Ex e

Type of Protection

New Marking

Ex eb

Level of Protection
Type of Protection

ATEX Zone Equipment Category of Use

Unlike the IEC System that identifies the Type and Level of protection to indicate the area in which a product may be installed (e.g., Gb or Db), ATEX uses the term "Category of Use".

There are three Category of Use designations

- 1 = Zone 0 or 20
- 2 = Zone 1 or 21
- 3 = Zone 2 or 22

The Category of Use is prefaced by the same industry/area designation used in IEC

- I = Mines susceptible to fire damp
- II = Surface areas where explosive gas may be present
- III = Surface areas where explosive dust may be present

Equipment Construction and Approval for use in Hazardous Locations

There are two basic concepts used in the construction and design of electrical equipment to prevent the ignition of an explosive atmosphere, “Containment” and “Prevention (elimination or mitigation)”:

- “Containment” places all the elements of the fire triangle into an enclosure (such as an explosion-proof or flameproof enclosure) to contain an internal explosion and prevents an ignition of the surrounding atmosphere. For dust atmospheres it is more common to exclude the dust pentagon from entering enclosures and prevent any heat generated by the equipment from becoming a source of ignition.
- “Prevention” (elimination or mitigation) basically eliminates the explosion risk by removing one or more components of the fire triangle or dust pentagon. It is impossible to ignite an explosive gas or dust atmosphere unless the “fuel” is mixed with oxygen, or a to ignite fuel-air mixture without an ignition source.

Explosion Proof or Flameproof (Type of Protection ‘d’, ‘da’, ‘db’, ’dc’) (contains the fire triangle in an enclosure)

(Related Standards; Explosionproof - UL 1203 or CSA C22.2 No. 30. Flameproof - IEC/UL/CSA 60079-1)

While basic protection concepts of explosionproof and flameproof are the same, the standards, testing, certification and installation requirements are different. Both are designed to contain an internal explosion of gas or vapor and prevent any hot or burning materials from escaping to prevent an ignition of the surrounding atmosphere.

Explosionproof and flameproof enclosures permit multiple joint types in their construction and each has slightly different requirements.

- **Threaded Joints** used for conduit entries and enclosure covers.
- **Flat Joints** between two mating surfaces that are typically bolted together.
- **Cylindrical (spigot) Joints** two concentric surfaces to allow movement for actuators (e.g., pushbuttons, selector switches), shafts for electric motors, etc.
- **Rabbet Joints** typically used for larger diameter, cylindrical parts, (e.g., between a motor end bell and the main frame).
- **Labyrinth Joints** used for both rectangular and cylindrical parts, these joints force hot gases to make several right-angle turns to cool them before exiting an enclosure.

Since enclosures can “breathe” due to environmental changes, flammable gases and vapors are expected to enter an enclosure and therefore must be capable of withstanding an internal explosion. Enclosures are constructed to prevent hot gases generated during an explosion to cool sufficiently as they escape through the joints of the enclosure, preventing the ignition of a surrounding explosive atmosphere.

While many of the testing requirements for explosionproof and flameproof are similar, the specific values are different. The explosion or flame propagation tests involve filling an enclosure with a specific gas/oxygen mixture and surrounding it with the same gas. The gas inside is ignited and if the enclosure doesn’t rupture or deform and the outer gas doesn’t ignite, the product passes the test. The explosion test is repeated multiple times to establish a safety factor and the maximum pressure generated inside the enclosure is recorded. In the overpressure test, a hydrostatic pressure is applied at multiple times that of the recorded explosion pressure, and if the enclosure doesn’t rupture or deform during this test, the product passes.

Key differences between Explosionproof and Flameproof Equipment

- The explosion or flame propagation tests in UL 1203 or CSA C22.2 No. 30 are technically harmonized. This test requires a length of rigid metal conduit (with size requirements) to be attached to the equipment and a sparking device (e.g., spark plug) at the end of the conduit is used to ignite the mixture. The resulting explosion pressurizes the gas ahead of it, increasing the gas pressure inside the enclosure which results in a higher explosion inside the enclosure (this is referred to as pressure piling).

NOTE: Until recently, there were several differences in the UL and CSA standards, and that passed one standard wouldn’t always pass the other. This was corrected in the 2019 edition of C22.2 No. 30 for most products. The CSA standard allows special construction methods not permitted by UL 1203.

- The explosion or flame propagation tests in IEC/UL/CSA 60079-1 are similar to those used for for explosionproof, except the rigid conduit isn’t used and the sparking device is inside the enclosure. Since the effect of the pressure piling is eliminated, the test typically result in lower explosion pressures during testing.

HAZARDOUS LOCATION DATA

- Hydrostatic pressure tests required by the explosionproof standard are higher than those in the flameproof standards.
- Joint minimum width dimensions are larger, and the maximum gap between joint surfaces is smaller in the explosionproof Standards than those in the flameproof Standard.

The result is Explosionproof enclosures typically have a heavier wall construction that Flameproof (Ex d) products.

There are also differences in the NEC and CE Code on how these products are installed. In both Codes, explosionproof enclosures require conduit seals to be installed within 450mm (18") from the enclosure (or as marked on the product, some specify a shorter distance). Flameproof enclosures require conduit seals to be installed within 50mm (2") from the enclosure.

The installation rules for installing explosionproof equipment using cable are slightly different in the NEC and CE Code. The NEC allows cable seals to be installed up to 450mm (18") from the enclosure, whereas CE Code requires cable seals to be installed within 50mm (2"). Both Codes also require that cables entering an explosionproof enclosure that is marked "factory sealed" or "seals not required" to seal the cable at the point of entry.

For flameproof equipment, both the NEC and CE Code require cable seals to be installed within 50mm (2") of the enclosure.

NOTE: Ex 'da' is only permitted for certain types of gas detection equipment, Ex 'dc" is not commonly used in North America.

Encapsulation – Type of Protection ('m', 'ma', 'mb' and 'mc') (removes fuel from the fire triangle.)

(Related Standards; IEC/UL/CSA 60079-18)

Encapsulation is a type of protection in which the parts that can ignite an explosive atmosphere are enclosed in a resin (plastic). The resin must be sufficiently resistant to environmental influences that the explosive atmosphere cannot be ignited by either sparking or heating, which may occur within the device. This is typically used with small contacts such as used in relays or electronic devices.

Hermetically Sealed (removes fuel from the fire triangle.)

Common examples of hermetically sealed equipment include contact blocks or reed switches. With these methods, the arcing components of the switch are encased in a glass tube. The connecting wires are fused to the glass, sealing the unit to prevent any ingress of flammable gases and limits the heat generated. Hermetically sealed equipment is suitable for Class I, Division 2 or Class II, Division 1.

Increased Safety – Type of Protection ('e', 'eb', 'ec') (removes heat from the fire triangle.)

(Related Standards; IEC/UL/CSA 60079-7)

This protection system is for equipment that, under normal operating conditions, does not produce ignition-capable arcs, sparks, or high temperatures. It provides special increased spacing between live parts and live parts of opposite polarity or grounded metal parts. Special insulating materials are used to reduce the likelihood of arc tracking along with special terminals to reduce the likelihood of high temperatures caused by loose connections and temperature control on heat producing equipment. Ex 'e' or Ex 'eb is commonly used for protection of squirrel cage motors, terminals, and connection boxes (junction boxes). However, it does not allow the approval of LED luminaires due to risk of the components generating an ignition capable arc when they fail.

Ex 'ec' has less stringent requirements for enclosures and other devices and does allow for the approval of LED luminaires.

Intrinsically Safe ('i', or 'IS') Intrinsic Safety – Type of Protection ('ia', 'ib' and 'ic') (removes heat from the fire triangle.)

(Related Standards; UL 915, C22.2 No. 157 (being withdrawn replaced by CSA 60079-11). IEC/UL/CSA 60079-11)

The Intrinsic Safety concept limits the amount of energy in a circuit so that any spark caused by a short circuit or overvoltage is incapable of igniting a gas-air mixture. North American 'i' and 'IS' concepts were based on IEC Standards therefore they are basically identical to Ex and 'ia'. Types 'i', 'IS' and 'ia' are suitable for use in Zone 0 locations, Type "Ex ib" is suitable for use in Zone 1 locations, and the recently introduced Ex 'ic' is suitable for use in Zone 2 locations.

The Intrinsic Safety concept limits the amount of fault current or the energy within the entire circuit to a level below that which could ignite the surrounding atmosphere. For testing purposes, the most easily ignited gas mixture is used. Barrier devices are commonly used in the circuit to limit the energy (often called a Zener Diode Barrier although other barriers are available). While this type of device controls the energy feeding a circuit, they do not prevent other components such as capacitors, cables, etc. from storing energy which could be an issue on the complete system. Therefore, Intrinsic Safety is a "system approach" and no single device provides total protection.

Non-Sparking – Type of Protection ('nX', nR) (removes fuel or heat from the fire triangle.)

(Related Standards; UL 121201 and C22.2 No. 213. IEC/UL/CSA 60079-15)

The original IEC 60079-15 Standard Type "n" contained the requirements for all equipment suitable for use in Zone 2 locations. For several reasons, IEC 60079 Standards decided to move sections of 60079-15 into the other Standards that better addressed the concept, (for example, the Ex nL requirements for energy limitation devices, was moved to IEC 60079-11). This led to the introduction of the "Level of Protection" to the various "Types of Protection" and "Equipment Protection Level" marking discussed earlier.

IEC 60079-15 also contains the requirements for Restricted breathing Ex 'nR' equipment.

Non-Incendive Equipment (removes heat from the fire triangle.)

(Related Standards; UL 121201 and C22.2 No. 213)

Non-Incendive is similar to Intrinsic Safety Ex 'ic' in that it addresses spark energy. It is intended for Class I, Division 2 or Class II, Division 1 locations. It also considers contacts for making or breaking an incendive circuit where the contact mechanism is constructed so that the component is incapable of igniting the specified flammable gas or vapor-air mixture. The housing of a non-incendive component is not intended to exclude the flammable atmosphere or contain an explosion.

Oil Immersion – Type of Protection ('o', 'ob', 'oc') (removes fuel and oxygen from the fire triangle.)

(Related Standards; IEC/UL/CSA 60079-6)

This concept involves immersing any device that produces ignition-capable arcs or sparks or high temperatures in an oil that prevent them from coming into contact with the outer atmosphere. Historically, large transformers or circuit breakers used this technique however its use today is limited.

Purged and Pressurized Type of Protection ('p', 'px', 'pxb', 'py', 'pyb', 'pz', 'pzc') (removes fuel from the fire triangle.)

(Related Standards; NFPA 496. IEC/UL/CSA 60079-2 and IEC/UL/CSA 60079-13)

This type of protection prevents the surrounding atmosphere from entering an enclosure by maintaining a positive pressure within the unit. Clean air or inert gas is used to maintain a higher pressure than the surrounding atmosphere. In purging, the electrical equipment is interlocked with a system which cycles clean air within the unit to remove explosive gases prior to start up.

The IEC Standard has become quite complicated and has multiple levels of protection identified.

There is also the NFPA 496 Standard used for the Division system and Zone 2.

NFPA 496 Identifies three types of pressurization as follows: (removes fuel from the fire triangle.)

TYPE	EXPLANATION
X	Changes the area within the unit from Class I, Division 1 to non- hazardous
Y	Changes the area within the unit from Class I, Division 1 to Class I, Division 2
Z	Changes the area within the unit from Class I, Division 2 to non- hazardous

Powder Filled Apparatus Type of Protection ('q, 'qb', 'qc') (confines all the elements in the fire triangle in an enclosure)

(Related Standards; IEC/UL/CSA 60079-5)

This type of protection requires surrounding electrical apparatus with a material in finely granulated quartz (or very small glass beads) to prevent any arc which may occur within the enclosure from igniting the surrounding atmosphere. The material has two purposes, it reduces the amount of explosive gas that can accumulate and provides a flamepath to quench any explosion. Equipment can have no moving parts, which are in direct contact with the filling materials, and the enclosure must have a minimum protection of IP 54.

Dust- Ignition-Proof Equipment (removes fuel from the fire triangle.)

(Related Standards; Explosionproof - UL 1203 or CSA C22.2 No. 25)

This concept is similar to Dust-Tight however enclosures are designed to contain an internal dust explosion. Since the explosive pressures generated by gases, therefore dust-ignition proof enclosures typically have thinner walls than explosion-proof equipment. In most equipment used today, dust tight provides a more cost-effective option.

Dust-Tight Equipment (removes fuel from the fire triangle.)

(Related Standards; Explosionproof - UL 1203 or CSA C22.2 No. 25)T

The objective of Dust-Tight is to prevent dust from entering an enclosure and limits the maximum surface temperature while in operation. Since combustible cannot enter the enclosure, it is not required to withstand an internal explosion, but it does need to withstand impact testing. Dust-tight equipment can require testing for internal arcing faults if required to ensure the circuit over-current protection will

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activate to prevent an increase in temperature. Flat joints in Dust-Tight equipment can be gasketed and have minimum width requirements. The primary requirement of all joints is to prevent dust from entering an enclosure.

Dust layers can build up on equipment which can decrease the heat dissipation generated by the equipment inside. This would increase the surface temperature even under normal operating conditions. The surface temperature tests are conducted with the equipment covered with as much dust as can possibly remain on the equipment.

The applicable testing standards for North America are UL 1203 and CSA C22.2 No. 25. While these standards were aligned in 2017, there remains a couple of key differences. UL 1203 has different dust penetration tests than IEC 60079-31 and specific joint dimension requirements. C22.2 No. 25 permits the same dust penetration tests and joint requirements used in IEC 60079-31 as an alternative to those in UL 1203.

Equipment Dust Ignition Protection by Enclosure “t” (‘ta’, ‘tb’, ‘tc’) (removes fuel from the fire triangle.)

(Related Standards; IEC/UL/CSA 60079-31)

Much like North American dust tight requirements, the objective of the IEC 60079-31 is to prevent dust from entering the enclosure and limiting surface temperatures. All joints must meet IP 6X for Zone 20 and Zone 21, and IP 5X for Zone 22. Unlike UL 1203, there are no minimum joint dimensions that must be met.

Non-electrical requirements “h” (removes heat from the fire triangle.)

(Related Standards; IEC/UL/CSA 80079 Series)

The IEC 80079 Series of Standards address the non-electrical methods and types of protection for non-electrical equipment. Currently these requirements do not apply in North America. The IEC 80079 Series Standard was based on the (EU) EN 13463 series that was used in the ATEX System. The IEC 80079 identifies Type of Protection (Ex ‘h’). Older ATEX equipment used “c”, “b” and “k”. These symbols are still used internally within ISO 80079-37, but they do not appear in the equipment marking.

Environmental Protection of Enclosures

North America Environmental Protection Standards

The following are environmental protection designations, which are specified in addition to electrical or hazardous location requirements. Many people refer to the NEMA (National Electrical Manufacturers Association) when requesting enclosure types, however the NEMA 250 Standard is for reference only. In North America products are tested and approved to UL 50/CSA C22.2 No. 94 (harmonized Standard) and identified as enclosure "Type" followed by the appropriate number as defined below.

NOTE: Canada has never had an equivalent standard to NEMA 250 (some think there is and incorrectly change "NEMA" to "CEMA").

Type 1 Enclosures

Intended for indoor use primarily to provide a degree of protection against limited amounts of falling dirt.

Type 2 Enclosures

Intended for indoor use primarily to provide a degree of protection against limited amounts of falling water and dirt.

Type 3 Enclosures

Intended for outdoor use primarily to provide a degree of protection against rain, sleet, windblown dust; and damage from external ice formation.

Type 3R Enclosures

Intended for outdoor use primarily to provide a degree of protection against rain, sleet; and damage from external ice formation, and must have a drain hole.

Type 3S Enclosures

Intended for outdoor use primarily to provide a degree of protection against rain, sleet, windblown dust; and to provide for operation of external mechanisms when ice laden.

Type 4 Enclosures

Intended for indoor or outdoor use primarily to provide a degree of protection against windblown dust and rain, splashing water, hose directed water; and damage from external ice formation.

Type 4X Enclosures

Intended for indoor or outdoor use primarily to provide a degree of protection against corrosion, windblown dust and rain, splashing water, hose directed water; and damage from external ice formation.

Type 5 Enclosures

Intended for indoor use primarily to provide a degree of protection against settling airborne dust, falling dirt, and dripping non-corrosive liquids.

Type 6 Enclosures

Enclosures constructed for either indoor or outdoor use to protect against hose-directed water, damage from external ice formation, and the entry of water during occasional temporary submersion at a limited depth.

Type 6P Enclosures

Enclosures constructed for either indoor or outdoor use to provide a degree of protection against hose-directed water, damage from external ice formation, and the entry of water during occasional prolonged submersion at a limited depth.

Type 12 Enclosures

Intended for indoor use primarily to provide a degree of protection against circulating dust, falling dirt, and dripping non-corrosive liquids.

Type 12K Enclosures

Intended knockouts are intended for indoor use primarily to provide a degree of protection against circulating dust, falling dirt, and dripping non-corrosive liquids.

Type 13 Enclosures

Intended for indoor use primarily to provide a degree of protection against dust, spraying of water, oil, and non-corrosive coolant.

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COMPARISON OF THE TYPICAL DEGREES OF PROTECTION PROVIDED BY UL 50/CSA C22.2 NO. 94 ENCLOSURES										
PROVIDES A DEGREE OF PROTECTION AGAINST THE FOLLOWING CONDITIONS	TYPE OF ENCLOSURE									
	1*	2*	4	4X	5	6	6P	12	12K	13
Access to hazardous parts	X	X	X	X	X	X	X	X	X	X
Ingress of solid foreign objects (falling dirt)	X	X	X	X	X	X	X	X	X	X
Ingress of water (Dripping and light splashing)	—	X	X	X	X	X	X	X	X	X
Ingress of solid foreign objects (Circulating dust, lint, fibers, and flyings**)	—	—	X	X	—	X	X	X	X	X
Ingress of solid foreign objects (Settling airborne dust, lint, fibers, and flyings**)	—	—	X	X	X	X	X	X	X	X
Ingress of water (Hosedown and splashing water)	—	—	X	X	—	X	X	—	—	—
Oil and coolant seepage	—	—	—	—	—	—	—	X	X	X
Oil or coolant spraying and splashing	—	—	—	—	—	—	—	—	—	X
Corrosive agents	—	—	—	X	—	—	X	—	—	—
Ingress of water (Occasional temporary submersion	—	—	—	—	—	X	X	—	—	—
Ingress of water (Occasional prolonged submersion)	—	—	—	—	—	—	X	—	—	—

** For additional information refer to www.nema.org*

DEGREES OF PROTECTION PROVIDED BY NEMA 7, 8, 9 AND 10 FOR INDOOR HAZARDOUS LOCATIONS For outdoor locations, these will require additional approval to the applicable UL 50/CSA C22.2 No. 94 Standards									
PROVIDES A DEGREE OF PROTECTION AGAINST ATMOSPHERES TYPICALLY CONTAINING		ENCLOSURE TYPES 7 AND 8, CLASS I GROUPS**				ENCLOSURE TYPE 9, CLASS II GROUPS			
(See NFPA 497M for Complete Listing)	CLASS	A	B	C	D	E	F	G	10
Acetylene	I	X	—	—	—	—	—	—	—
Hydrogen, manufactured gas	I	—	X	—	—	—	—	—	—
Diethyl ether, ethylene, cyclopropane	I	—	—	X	—	—	—	—	—
Gasoline, hexane, butane, naphtha, propane, acetone, toluene, isoprene	I	—	—	—	X	—	—	—	—
Metal dust	II	—	—	—	—	X	—	—	—
Carbon black, coal dust, coke dust	II	—	—	—	—	—	X	—	—
Flour, starch, grain dust	II	—	—	—	—	—	—	X	—
Fibers, flyings*	III	—	—	—	—	—	—	X	—
Methane with or without coal dust	MSHA	—	—	—	—	—	—	—	X

** For Class III locations, see the requirements NEC and CE Code.*
** The enclosures must also be suitable for the specific area classification in terms of Class, Division and Temperature Code.*

NEMA Definitions for Hazardous Location Enclosures (not identified in UL 50/CSA C22.2 No. 94)

NEMA type enclosures occasionally appear in specifications or on product literature and are specific to the US only. These enclosure Types are not identified in the UL 50/CSA C22.2 No. 94 Standard. The following is a reference from NEMA type to Class Designation.

NEMA 7 Enclosures

Intended for indoor use in locations classified as Class I, Groups A, B, C, or D, as defined in the NEC.

NEMA 8 Enclosures

Intended indoor or outdoor use in locations classified as Class I, Groups A, B, C, or D, as defined in the NEC.

NEMA 9 Enclosures

Intended for indoor use in locations classified as Class II, Groups E, F, and G, as defined in the NEC.

NEMA 10 Enclosures

Are constructed to meet the applicable requirements of the Mine Safety and Health Administration (MSHA).

IEC Environmental Protection Standards

Like the North American CSA/UL Type enclosure standards, the international system is based on the IEC 60529 Standard that defines the tests used to identify the degree of protection provided by an enclosure. The IEC uses an "Ingress Protection Rating" (IP code) to define the type of protection provided by equipment using the letters 'IP' followed by two numeric digits (and an optional letter). The IP Rating defines the effectiveness of the enclosures against intrusion of solid materials and liquids.

- The first digit indicates the level of human protection from moving or hazardous parts, as well as the protection of the enclosed equipment from other materials such as dirt, grit and dust.
- The second digit defines the protection level that the enclosure has from the harmful ingress of water (liquids) from sprays or drips, moisture (humidity), or from submersion.

IP Type of Protection Chart (to IEC 60529)

SOLID OBJECTS OR DUST		LIQUIDS OR DUST	
0	**No protection** against contact and ingress of objects or Dust	0	**No Protection** – against the ingress of any liquids or dust
1	**>50 mm** – such as any large surface of the body, such as the back of the hand, buy no protection against deliberate contact with a body part	1	**Dripping Water** – Protected against vertically falling water drops.
2	**>12.5 mm** – such as fingers or similar objects	2	**Dripping water when tilted up to 15°** – Vertically dripping water shall have no harmful effect when the enclosure is tilted at an angle up to 15° from its normal position.
3	**>2.5 mm** – such as Tools, thick wires, etc.	3	**Spraying Water** – Water falling as a spray at any angle up to 60° from the vertical shall have no harmful effect.
4	**>1 mm** – such as most wires, screws, etc.	4	**Splashing Water** – Water splashing against the enclosure from any direction shall have no harmful effect.
5	**Dust Protected** – Ingress of dust is not entirely prevented, but it must not enter in sufficient quantity to interfere with the satisfactory operation of the equipment; complete protection against contact	5	**Water Jets** – Water projected by a nozzle (6.3mm) against enclosure from any direction shall have no harmful effects.
6	**Dust Tight** – No ingress of dust; complete protection against contact	6	**Powerful Water Jets** – Water projected in powerful jets (12.5mm nozzle) against the enclosure from any direction shall have no harmful effects.
		7	**Immersion up to 1m** – Protected against the effects of temporary immersion between 15cm and 1m. Duration of the test is 30 minutes.
		8	**Immersion Beyond 1m** – The equipment is suitable for continuous immersion in water under conditions which are specified by the manufacturer. There are no defined tests for this rating. The depth can be whatever is required for the application. For example, subsea electrical connectors are available that are suitable for use at depths up to 13,000 m

Example 6 5

6 = Dust Protected
(No dust ingress allowed)

5 = Protection against water Jets
(Some moisture may enter that would not affect equipment)

NOTE: An enclosure that can protect against water ingress when submersed, even at extreme depths an IP68 enclosure that passes the ingress test at 100m, could fail the tests using powerful water jets since one test compresses the enclosure opening (door) while the does the opposite. Therefore, it would be incorrect to use an IP 67 or IP 68 enclosure when the installation requires an IP 66.

The IEC 60529 Ratings do not align with the CSA/UL Type dust to differences in the other tests performed such. door and cover securement, corrosion resistance, effects of icing, gasket aging and oil resistance and coolant effects. The following table is an approximation only between IEC 60529 and UL 50/CSA C22.2 No. 94 from an ingress protection perspective. The table does not consider the additional tests required in UL 50/CSA C22.2 No. 94 or the any additional tests for enclosure required in the IEC 60079 Series of Standards for Ex Equipment.

UL 50/CSA C22.2 NO. 94 ENCLOSURE TYPE	IEC 60529 IP PROTECTION
1	IP 10
2	IP 11
3, 3R, 3S	IP 54
4, 4X	IP 55
5	IP 52
6. 6P	IP 67
12, 12K	IP 52
13	IP 54

Hazardous Location Equipment Certification

North American System

While CSA, FM and UL Standards are similar, some technical differences in specific product standards do exist. While Canada has one National Standard for each type of equipment, the US System can have multiple Standards. In the US there is one ANSI Standard and there can be various non-ANSI versions. In the US, the AHJ has discretion over which Standards they accept.

For equipment suitable for use in hazardous locations or explosive atmospheres, there are two approaches. Products may be certified to either Class/Division Standards or IEC Zone based Standards. The UL Standard Technical Panel (STP 60079) and CSA Integrated Committee on Hazardous Location Products (ICHL) are responsible for adopting the IEC 60079 Standards which includes adding National Deviations to address specific safety issues and accommodate electrical Code requirements. UL STP 60079 and ICHL work closely to minimize any deviations that would cause technical barriers to trade between the two countries. Similarly, ICHL has removed technical barriers between the Class/Division standards wherever possible.

NOTE: Some differences remain between Canadian and US in the standards for wire and cable, plugs and receptacles and cable glands for use in hazardous locations due to differences in the applicable Electrical Codes

The certification of equipment using Class/Division or CSA/UL 60079 Standards for Zones includes testing and approval to all applicable "ordinary location" Standards. (For example, an empty explosionproof outlet box would need to meet the standards for general requirements, threading in addition to the hazardous location requirements.) Both Canada and the US certification system follows the ISO/IEC Guide 17067 *"Conformity assessment - Fundamentals of Product Certification and guidelines for product certification schemes"* and are defined as 3rd a party conformity assessment system.

Acceptance of product certification is up to the "Authority Having Jurisdiction" (AHJ) responsible for electrical installations in a specific location.

IECEx Certified Equipment Scheme.

The IECEx System is one of four international conformity assessment systems operated under the International Electrotechnical Commission (IEC) – Conformity Assessment Board (CAB). The objective of the IECEx is to facilitate international trade in equipment and services for use in explosive atmospheres, while maintaining the required level of safety.

The IECEx System operates three International Certification Schemes:

- IECEx Certified Equipment Scheme
- IECEx Certified Services Scheme
- IECEx Certificate of Personal Competence Scheme

IECEx Certified Equipment Scheme accredits certification bodies (Ex CB) to perform the evaluation and testing of equipment for explosive atmospheres (Ex Equipment) and the issuing of IECEx Certificates of Conformity (CoC). The Ex CBs are regularly audited as part of the "peer assessment' process to confirm they continue to follow the IECEx rules and testing procedures. The IECEx follows various ISO/IEC 17000 series of Standards such as ISO/IEC Guide 17067 *"Conformity assessment - Fundamentals of Product Certification and guidelines for product certification schemes"* and are defined as a 3rd party conformity assessment system.

Should there be any questions or discrepancies on how Ex CBs are applying the Standards, IEC TC 31 is asked to investigate and where necessary issue a "formal Interpretation sheet". Separate to this process, IECEx can issue "ExTAG Decision Sheets" which record a decision on how all ExCBs will apply a certain requirement of the Standard and provides a quick means to achieve a resolution for industry, instead of waiting for the standard to be revised/updated.

An IECEx Certification of Equipment has three parts:

- Quality Assessment Report **(QAR)** which assesses and monitors the manufacturer's processes
- Ex Test Reports **(ExTR)** documenting the testing performed.
- IECEx Certificate of Conformity **(CoC)**

The QAR demonstrates that all manufacturing locations where an "IECEx certified" product is manufactured have been audited and have been confirmed as capable of manufacturing product identical in design and performance to the tested sample. Regular "Surveillance Audits" are to confirm manufacturers continue to meet the requirements of their QAR and a Full Audit, and updated QAR is required every three years. If issues or problems are identified during the audit, corrective actions must be taken or the QAR can be withdrawn.

The ExTR confirms that Ex Equipment sample, representative of production, was tested and passed all the applicable IEC or ISO Standards requirements and records the actual results of those tests. Regular audits are conducted at the manufacturing location(s) to confirm the equipment in production continues to meet all relevant requirements of the ExTr.

When the ExTR and QAR are completed satisfactorily, the IECEx CoC can be issued by the Ex CB to confirm the equipment has met all the requirements and is suitable for use in explosive atmospheres. The IECEx CoC authorizes the manufacturer to include the IECEx CoC reference number on the product label. The Ex CBs places these results of the QAR, ExTR and CoC into the IECEx system and the applicable documents are issued. The CoC is issued via the IECEx "On-Line" Certificate system via the IECEx official website, and fully available for public viewing. The On-Line electronic version of the CoC is the "Master Controlled" version of the CoC and is issued in "real-time" see https://www.iecex-certs.com/#/home.

Acceptance of the IECEx CoC is determined by the local Authority Having Jurisdiction (AHJ) that is responsible for hazardous location installations. The acceptance varies by economic region, country, (or areas within each) and to some extent the user.

NOTE: Other IECEx Schemes, the IECEx Certified services Scheme and IECEx Certificate of Personal Competence are not subject to such regulations and as such have very wide acceptance.

Several countries have no regulations that prevent direct market acceptance of IECEx certified equipment, and currently Australia, Israel, Malaysia, New Zealand and Singapore accept an IECEx CoC with no additional requirements. The US Coast Guard (USCG) and India accept an IECEx CoC but may have other limitations. In all cases, the user must confirm with their local AHJ what approvals are required.

Many other countries do not accept the IECEx CoC alone and require additional evaluation. Specific country requirements vary and typically administrative (e.g., non-tariff trade barriers) or technical (additional requirements to address safety concerns and regulatory issues) are added to obtain a specific "country approval". For example, In North America all Ex Equipment is tested and approved to all the applicable ordinary location equipment standards and must comply with the Electrical Codes Rules. Currently there are 63 IECEx Certification Bodies, 68 IECEx Test laboratories and 4 IECEx authorized Test Facilities (with additional new ExCB. ExTL and ExATF applications in process).

The IECEx CoC along with the supporting ExTR and QAR offer a "Fast-Track" way to obtain multiple national approvals which can significantly reduce testing and certification costs, as well are the time to market. The unique advantage of the IECEx Certified Equipment Scheme is that QARs, ExTrs and CoCs are transferable between the member certification bodies. That means the relevant information from one Ex CB can be used another Ex CB for other certification purposes. For example, in North America, an NRTL or SCC CB can accept (depending on National Deviations) an IECEx QAR and ExTr, issued by any Ex CB, to satisfy their Ex requirements and only need to address the ordinary location requirements and address any Electrical Code issues. Similarly, for an ATEX approval, the IECEx CoC can be used for the technical requirements and then only the EU ESHRs need be addressed.

NOTE: While an IECEx CoC can be used to obtain an ATEX DoC, the reverse is not usually true. The primary objective of ATEX is to meet the EU Essential Health and Safety Requirements, not the standards requirements. An ATEX DoC ***cannot be used to obtain*** *an IECEx CoC (or other most approvals). For global certification of electrical equipment, it is best to start with an IECEx CoC. IECEx Guide IECEx 01A provides a simple explanation of the differences between the IECEx and ATEX systems for product approval. This free publication is available in at https://www.iecex.com/publications/guides/ .*

Most IECEx Member Countries have an Ex CB and/or Ex TL and most North American OSHA and SCC accredited CBs (for hazardous location equipment) are also IECEx CBs. For further information on member countries and organizations, see www.iecex.com. The site also includes a series of IECEx Guides on each of the IECEx Schemes.

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ATEX System (European Union)

The European Committee for Electrotechnical Standardization (CENELEC) is responsible for standardization in the electrotechnical engineering field. CENELEC Standards are intended to eliminate any potential trade barriers to facilitate trade between member countries, cut compliance costs, and support the development of the Single European Market. CENELEC Standards are referred to as "Euro Norms" (EN) Standards and the EN 60079 Series is harmonized with IEC 60079 Standards through parallel voting.

European Union's (EU) Directive 2014/34/EU (which replaced Directive 94/9/EC) is commonly referred to as ATEX (from the French for **AT**mosphères EXplosibles). **ATEX** addresses Equipment and Protective systems intended for use in Potentially Explosive Atmospheres. ATEX is a Regulatory Framework (**NOT** a Certification system) through which the EU Commission allows suppliers to offer Ex products for sale in the EU based on the seller's declaration of product compliance with the Essential Health and Safety Requirements (EHSR) of Annex II of the ATEX Directive.

ATEX is not a traditional certification system since conformity assessment principles are not consistently applied and compliance to Standards used is not a mandatory requirement. An ATEX Certificate does not confirm compliance with any particular Standard, EN or other Standards such as UL or CSA can be used in the assessment to demonstrate compliance with the ESHRs. (Most manufacturers use relevant Standards to demonstrate compliance with the applicable EHSRs.)

Depending on the type equipment multiple EU directives may apply such as the Equipment and Protective Systems intended for Use in Potentially Explosive Atmospheres Regulations, Electrical Equipment Safety Regulations, Electromagnetic Compatibility Directive, Low Voltage Directive, Machinery Directive, Personal Protective Equipment Directive 89/686/EEC, Pressure Equipment Directive, Simple Pressure Vessels Directive, Radio Equipment Directive, Gas Appliances Directive, Construction Products Regulation and Marine Equipment Directive. The primary objective of ATEX is not about safety, it is to confirm equipment complies with the EU Essential Health and Safety Requirements (EHSR) to facilitate trade between the member states.

In the EU "New Approach Notified and Designated Organizations" (NANDO) System, member countries authorize "Notified Bodies" (NB). ATEX 2014/34/EU introduced requirements for a Notified Body to have national accreditation, previously this was not required. (Many NBs are also IECEx CBs that has a more rigorous assessment process).

NOTE: There are multiple NANDO accredited Notified Bodies operating in the EEA. Under the Canada-Europe Free Trade Agreement, the following Canadian Certification Organizations can issue an ATEX DoC; CSA Group Testing Certification Inc., LabTest Certification Inc., Intertek Testing Services Na Inc., NEMKO North America Inc., QPS Evaluation Services, Inc. This is important for manufacturers and OEM organizations as these organization can issue multiple approvals (Canada, US, IECEx and ATEX) from a single office.

The manufacturer (which could be a seller, trade agent, distributor, etc.) must involve a NB to assess electrical equipment intended for use Zones 0, 1, 20, 21. However, NBs are not involved in the assessment of equipment suitable for use in Zone 2 and Zone 22; this is solely the responsibility of the manufacturer to determine if the equipment complies with the applicable ESHRs to claim ATEX compliance. Manufactures are also responsible confirming ordinary location standards (and ESHR) compliance for all Ex Equipment.

ATEX Declaration of Conformity (DoC) consist of multiple parts:

- **Ex Quality Assessment Notifications (QAN)** - these document the suitability of the manufacturer's QA system as related to ISO/IEC 80079-34. (This follows a similar process used for an IECEx QAR).
- **EU Type Examination Certificates** – document the evaluation and testing of the equipment to the applicable Standards used.

Based on the QAN and the EU Type Examination assessments (Issued by NB for Zones 0, 1, 20, 21 only) the manufacturer can issue a Declaration of Conformity (DoC). The DoC is, theoretically, issued the day the equipment is "placed on the market" (shipped or sold). (For Zone 2 and Zone 22 equipment the manufacturer is responsible for the QAN and EU Type Examination information). Notified Bodies are not permitted to issue DoCs (and no central database exists for this information, as is done by IECEx). In all cases, it is the sole responsibility of the manufacturer to issue the DoC and they must have a technical file to support the document.

Since the primary objective of the ATEX DoC is to confirm compliance with EU ESHRs and it permits the use of different standards (and 100% compliance is not mandatory), an ATEX DoC is not accepted by all jurisdictions. It is not usually possible to use an ATEX DoC to obtain an IECEx CoC or accepted for other country approvals. For example, the USCG has specifically banned vessels with equipment certified to ATEX only from operating in US waters, Australia does not accept ATEX equipment and an ATEX DoC cannot be used as proof of compliance to obtain an IECEx CoC or for any North American approvals. (However, an IECEx CoC can be used to support an ATEX DoC).

NOTE: ATEX compliance is mandatory for members of the European Economic Area (EEA) which includes the EU countries (Austria, Belgium, Bulgaria, Croatia, Republic of Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Poland, Portugal, Romania, Slovakia, Slovenia, Spain and Sweden) the three European Free Trade EFTA European Free Trade Association (EFTA) states (Iceland, Liechtenstein, and Norway) as well as two countries under Mutual Recognition Agreements (Switzerland and Turkey).

NOTE: At the time of writing, with the United Kingdom's (UK) departure from the EU (Brexit) and their status within the EEA is not complete. (See information under UK and Northern Ireland).

UK System

The UK (or Great Britain (GB)) refers to the landmass encompassing England, Scotland and Wales and their associated islands. The UK does not include Northern Ireland which is treated differently. UK officially severed its membership in the EU January 1, 2020. There was a transition period that ended on January 1, 2021, and products were ready to ship (fully manufactured) before that date, the CE mark can be applied, and the exemption ends 31 December 2022 at which point the UK Conformity Assessment mark is mandatory.

The new UK requirements for equipment suitable for use in explosive atmospheres and the applicable ESHRs are essentially identical to those used under EU ATEX system. Only the approval mark changes.

The "new" UKCA conformity assessment mark replaces CE mark and is required on similar lists of items. Most UK based "EU NBs" have been approved as "UK NBs" and are authorized to assess equipment and issue a UK DoC (same process as used under ATEX). The same manufacturer declarations of conformity apply for Zone 2 and 22 as those used in the ATEX System.

NOTE: For companies the build assemblies, all the equipment and components must bear a UKCA mark; a CE mark (alone) is no longer acceptable.

NOTE: The UK has accredited several UK Notified Bodies. Under the Canada-UK Free Trade Agreement several applications have been submitted for Canadian CBs to become UK NBs. This will be important to manufacturers and OEM companies since these organization would be able to issue multiple approvals (ATEX, Canada, IECEx, UK and US) from a single office.

Northern Ireland (UK) System

The requirements in Northern Ireland are "complicated" to say the least. Addressing the unique issues and concerns relating to Northern Ireland post-Brexit has been a major issue in negotiations between the UK government and the European Union. Technically, Northern Ireland is part of England, but not part of the UK (GB). And Northern Ireland has a close economic and social relationship with the Republic of Ireland, which is an independent state and EU member.

Under the current EU-UK (Brexit) agreement, Northern Ireland continues to follow EU rules on product standards, and goods can move freely between the Northern Ireland border with the Republic of Ireland border and all EU countries. For the movement of goods between and Great Brittan (and to secure the EU border) inspections and document checking is performed in Great Britain. (This continues to be of some concern in GB). Northern Ireland will continue to accept CE marked products and can issue ATEX DoCs. They can also import and use UKCA marked products but cannot apply the UKCA mark to goods. This created the need for a separate mark (UKNI) for goods produced in Northern Ireland that are exported to the UK.

NOTE: The use of the UKNI may be confusing, see https://www.gov.uk/guidance/using-the-ukni-marking for further information.

The Northern Ireland requirements for equipment suitable for use in explosive atmospheres can be either identical to ATEX or the UK Systems. Only the approval marks change.

Hazardous Location Equipment Class/Division Equipment Marking

Both the NEC and CE Code require equipment approved to Class/Division Standards to be marked with the location it permitted to be used. The minimum marking includes the Class, Division and Material Group. A Temperature Code is included on products that have a surface temperature above 100°C in normal operation and any environmental ratings that apply. If the product was tested for an environmental rating (as explained above, e.g., Type 4), those are included on the label.

Most Product Standard(s) identify the maximum and minimum ambient temperature range in which equipment may be safely used. There are differences in the North American ambient temperature range in several Class/Division Standards such explosionproof where UL specifies -25°C to + 40°C and CSA specifies -50°C to + 40°C. Since multiple Standards typically apply to a single product, and the difference in US and CA Standards, it is common to include the ambient temperature range on the product label.

For Class I, Division 1, equipment can be marked in multiple ways. At a minimum it must include the Class, the Material Group(s) and if the equipment is expected to have a surface temperature at or above 100°C in normal service, a Temperature Code. Variations include.

- Class I, Groups B, C, D*
- Class I, Division 1, Groups B, C, D*
- Class I, Division 1 and 2, Groups B, C, D*
  - » *Note: The Gas Groups are specific to the approvals (this could be (A, B, C, D, (B, C, D), (C, D) or simply (D).
  - » *Note: If the equipment operates above 100°C, it must include the T-Code (T-5 to T1)
  - » Class II equipment would include Division 1 or 2 and the Dust Groups (E, F, G)
  - » Class III would include Division 1 or 2 but has no material Groups

It is common for there to be difference between the Class I, Division 1 and Class I, Division 2 markings. For example, a Class I, Division 1, Groups B, C, D could also be marked as Class I, Division 2, Groups A, B, C, D due to differences in the standards. Products may be specifically approved for Class I, Division 2, only (which would include the Material Group(s) and T-Code as applicable).

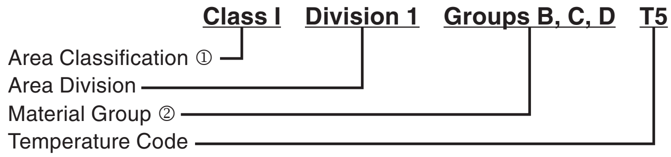
Empty enclosures for use as junction boxes for wire terminations are available for use in Class I, Division 1 locations. However, when other equipment, such as control devices, relays etc., are installed the completed assembly normally requires additional assessment by a certification body or the AHL (the explosionproof enclosure isn't re-evaluated, just the component spacing, wire access, etc.).

There are no "empty enclosures" rated for Class I, Division 2 since it is the components that determine the suitability for the location, not the enclosure. Products suitable for use in Class I, Division 2 locations do not necessarily require any hazardous location markings, such as non-sparking motors, terminal boxes, cable glands and fittings. This type of equipment is identified in the NEC and CE Code.

NOTE: Historically, some certification bodies had incorrectly approved empty enclosures for Class I, Division 2 but have been corrected (de-listed)

NEC (Article 500) and CE Code (Section 18) Marking for Class/Division Equipment

The basic marking for Division product is as follows. Abbreviations may be used for example "**Cl**." Or "**C**', instead of the word "**Class**" or "**Div.**" or "**D**" instead of the word "**Division**". In all cases, the equipment is suitable for Class I, II or III, **Division 1** is suitable for use in Class I, II or III, **Division 2** locations (providing the Material Group(s) and T-Code are acceptable). Equipment marked with **Division 2** is never suitable for **Division 1**.



① *Class I = Gas, Class II = Dust, Class III = Fibers and Flyings*

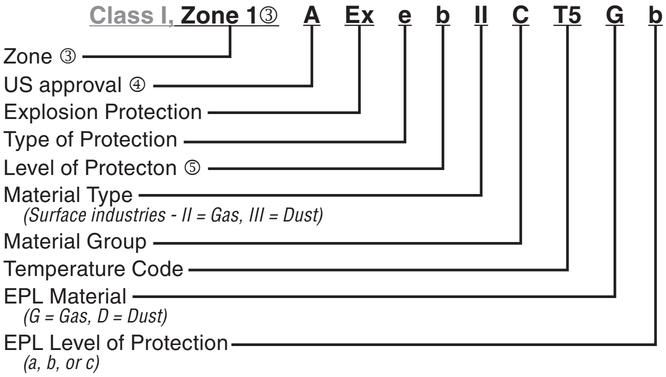
② *Class I, Gasses and Vapors (A, B, C, D), Class II. Combustible Dust (E, F, G) Class III, Fibers and Flyings has no material Groups*

North American Zone Equipment Marking

NEC Zone Equipment Marking

The US marking requirements for equipment approved for Zone equipment are unique. Much like the Class/Division system, equipment approved to Zone Standards (UL 60079 Series) must be marked with the Zone in which they are suitable to be used as well as the Type of Protection. The “Ex” marking required in the IEC/CSA 60079 Standards is prefaced with the letter “A” or “AEx” to indicate the equipment is certified to US Standards. Prior to 2020, the NEC it was mandatory to include the applicable “Class” and Zone” on equipment. This changed in the NEC 2020 Edition to remove the “Class” marking with only the Zone marking being required. The US deviations to the IEC Standards permit the inclusion of “additional marking” for convenience (for example, Class/Division marking).

NOTE: The CE Code does not recognize the “AEx” marking, However the CE Code recognize the use of “(A)Ex” where products are approved to both the CSA and UL versions of IEC 60079 Standards.



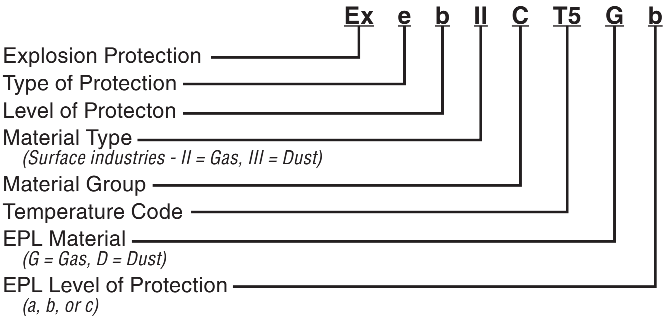
③ *Prior to 2021, NEC required equipment to marked with both Class and Zone, the applicable Zone marking is still required.*

④ *“AEx” identifies to US Standards.*

⑤ *Level of Protection was not required on older products. For example, both AEx e and AEx eb identify the same Type of Protection*

CE Code Marking for Zone Equipment

The CE Code uses the same marking system identified in the IEC 60079 Series of Standard. The Canadian deviations to the IEC Standards permit the inclusion of “additional marking” for convenience (for example, Class/Division and Zone location marking and (A)Ex, etc.). Users need to confirm the Type of Protection and Level of Protection is suitable for the location where the equipment is installed. The CE Code contains notes in Appendix B to recommend the used of the Equipment Protection Level (EPL) to determine the appropriate location of use.



Certification Marking of Equipment for use in Explosive Atmospheres

North American Certification Marks

In the US, equipment certification is issued by a "Nationally Recognized Testing Laboratory" (NRTL) approved by the Occupational Health and Safety Administration (OSHA). In Canada, equipment certification is issued by a "laboratory and certification body" (CB) accredited by the Standards Council of Canada (SCC). Both the NEC and CE Code require products include a "certification mark" issued by an accredited NRTL or CB. Final acceptance of specific certification marks is at the discretion of the AHJs (some jurisdictions may not accept all certification marks).

Most NRTLs and CBs use the terms "approved" and "certified" when referring to equipment that meets the requirements of the applicable Standards. Only Underwriter Laboratories Inc. (UL) identifies three different levels of certification as follows.

LISTED

Listed means the same as certified or approved. This means a product has been fully investigated to a specific set of construction standards. In hazardous locations, Zone type products must be specifically "Listed" for the location.

CLASSIFIED

Classified products are different than listed products. Products carrying this mark have been evaluated for specific properties. Although UL has a Canadian mark, CSA has no equivalent certification process.

Most NRTLs and CBs test and approve component products that are incomplete or restricted in performance capabilities. Components are intended to be used with other certified equipment (for example, an actuator may be approved as a component but cannot be used unless it is installed in an appropriate (approved) enclosure). Components are not intended for separate installation in the field, most AHJs require assemblies containing multiple components to be submitted to a CB for additional approvals. (This is similar to the "U" certificates in the IECEx and ATEX systems)

Several NRTLs and CBs are listed with both OSHA and SCC to approve products for both Canada and the US. This can simplify the approval process for original equipment manufacturers (OEMs) and panel builders as it allows them to provide a single product that complies with the NEC and CE Code.

USA OSHA NATIONALLY RECOGNIZED TESTING LABORATORIES (NRTL)	CANADA SCC ACCREDITED CERTIFICATION BODY
CSA	CSA
FM	FM
Intertek	Intertek
LabTest	LabTest
MET	MET
QPS	QPS
UL	UL
DEKRA*	ESAFE*
SGS*	

NOTE: OSHA and SCC define the specific Standards to which these agencies can test and certify products to. There can be differences the Scope of Accreditation of some organizations.

** Not accredited in both countries*

The certification mark of each agency may include the letters "US" or "C" to identify suitability for each country. Logos that include "US" on the right side and "C" on the left identify the product is approved for use in both countries. The CB logos can be confusing since the certification logos themselves remain the same, only the "US" and "C" inclusions change.

Most NRLTs issue component listing of products which means that selected products may be offered in modular form, which the customer may assemble without affecting the listing.

Certification Marks for the USA only

Certification Marks for Canada only

Certification Marks for both Canada and US

CERTIFICATION MARKINGS

Similar to equipment marking, country specific marks are used by UL and CSA to identify approved components.

Component Marks

(products must be installed with other equipment)

	US	Canada	Canada & US
UL		c	c US
CSA	US		c US

North American Certification Marking Specific to Zone Locations

In addition to the information above, equipment certified to the CSA/UL/IEC 60079 Standards must also include the certification file number. Some Class/Division product will also include the certification file number, but the format is different.

CSA	22	CA	1234567	
UL	22	US	1234567	X
QPS	22	CA	1234567	U
Certification Body	Year certified (last 2 digits)	Country (CA or US)	Certificate Number	Special Conditions of Use

There are two “special conditions of use”:

- “X” indicates there are special instructions for the safe installation and use of a product contained in the manufacturers’ instructions that must be followed.
- “U” indicates the product is an Ex Component that must be installed in or with other Ex Equipment. An additional certification is required for the competed assembly

International Certification Marks

IECEx Marking

Until recently, IECEx used two separate graphical symbols for brand identification and marketing purposes. This included both the registered trademarks of IEC® and IECEx®.

A different graphic symbol was used to indicate “IECEx Approval” that could be used much like the certification agency marks in North America. The use of the IECEx approval logo is authorized under the IECEx Mark Licensing Scheme and is connected to an IECEx CoC. The IECEx mark is optional and not commonly used at this time.

After a review in 2020, IECEx decided to use a single mark for both marketing purposes and to indicate equipment compliance. When used in print material (including literature, website, media publication, etc.) there are no licensing requirements. However, the mark cannot be used on equipment, product packaging, business cards, letterhead, stationary, etc. (except for certain IECEx members) unless a license is obtained through the IECEx Mark licensing Scheme.

The requirements for equipment marking include those identified in The IEC 60079 Series and the inclusion of the IECEx Certificate of Compliance Number.

Ex Equipment Marking (Based on IEC 60079)

Ex	e	b	II	C	T5	G	b
Explosion Protection	Type of Protection	Level of Protecton	Material Type *(Surface industries - II = Gas, III = Dust)*	Material Group	Temperature Code	EPL Material *(G = Gas, D = Dust)*	EPL Level of Protection *(a, b, or c)*

IECEx Certificate of Compliance Number

IECEx	UL	22	.	1234	
IECEx	CSA	22	.	1234	U
IECEx	PTB	22	.	1234	X
IECEx (CoC) *(always included)*	IECEx Certification Body	Year certified (last 2 digits)	Separates year & Certificate number	Certificate Number	Conditions of Use “U” or “X” *(blank if there are no conditions of use)*

CERTIFICATION MARKINGS

ATEX Marking for the EUROPEAN ECONOMIC AREA (EEA)

When the ATEX assessment has been completed, the manufacturer can place the CE Mark and other information on the product and issue the DoC at time of shipment. The marking is placed either on the equipment, packaging or instructions (often used for very small parts). The letters must be vertically equal in dimensions and must not be smaller than 5 millimeters. If there are other Directives which cover the product as well, the CE marking must be affixed only when all the Directives have been met.

CE The CE mark indicates a specific product complies with all the applicable European Union (EU) directives that apply to it. Directives for a particular type of product such as electromagnetic compatibility (EMC) or electromagnetic interference (EMI). This mark is self declared by the manufacturer.

Ex The "Hex EX" mark identifies the equipment complies with all the applicable ATEX Directive. All equipment for use in explosive atmospheres, for use in the EU, include the CE and EX logos as well as the specific equipment marking.

Specific Equipment Marking

CE 2899 Ex II 2 G Ex eb IIC T5 Gb

- EU Conformity *(Meets all applicable EU ESHRs)*
- Notified Body Number
- Meets ATEX directive(s)
- Equipment Group ①
- Equipment Category of Use ②
- Explosive atmosphere type *(G = Gases, D = Dust)*
- IEC/EN 60079 Marking *(Same as IECEx and CSA)*

① *Equipment Groups*
- *I = Mines Susceptible to Firedamp*
- *II = Surface Industries - Explosive Gas atmospheres*
- *III = Surface Industries - Explosive Dust atmospheres*

② *Equipment Category of Use*
- *1 = Zone 0*
- *2 = Zone 1*
- *3 = Zone 2*

UKCA Marking for the UK (GB)

UK CA The UKCA marking is identical to the CE marking with just the CE replaced by the UKCA symbol. Currently. the UK will continue to follow the basic ATEX marking system, with the only differences being the Standards used are the BS EN IEC 60079 and BS EN 80079 Series.

UKCA 2899 Ex II 2 G Ex eb IIC T5 Gb

- UKCA Conformity *(Meets all applicable UK ESHRs)*
- UK Notified Body Number
- Meets ATEX directive(s)
- Equipment Group ①
- Equipment Category of Use ②
- Explosive atmosphere type *(G = Gases, D = Dust)*
- BS EN IEC 60079 Marking *(Same as ATEX, IECEx, and CSA)*

① *Equipment Groups*
- *I = Mines Susceptible to Firedamp*
- *II = Surface Industries - Explosive Gas atmospheres*
- *III = Surface Industries - Explosive Dust atmospheres*

② *Equipment Category of Use*
- *1 = Zone 0*
- *2 = Zone 1*
- *3 = Zone 2*

Northern Ireland (UK) Marking

UK NI Products produced in Northern Ireland intended for shipment to the UK would follow the UKNI marking system. Therefore, the UKNI mark would simply replace the UKCA mark shown above.

UKNI 2899 Ex II 2 G Ex eb IIC T5 Gb

- UKNI Conformity *(Meets all applicable UK ESHRs)*
- UK Notified Body Number
- Meets UK (EX) directive(s)
- Equipment Group ①
- Equipment Category of Use ②
- Explosive atmosphere type *(G = Gases, D = Dust)*
- BS EN IEC 60079 Marking *(Same as ATEX, IECEx, and CSA)*

① *Equipment Groups*
- *I = Mines Susceptible to Firedamp*
- *II = Surface Industries - Explosive Gas atmospheres*
- *III = Surface Industries - Explosive Dust atmospheres*

② *Equipment Category of Use*
- *1 = Zone 0*
- *2 = Zone 1*
- *3 = Zone 2*

Other country specific certification and marking requirements

Many other countries have specific requirements for approval to be used in their country. In some cases, this is merely an administration procedure, in others additional technical requirements must be met. Some Countries require the use of a certification mark or logo as evidence of compliance. In most cases, the specific country approval can be based on an IECEx CoC.

Some examples include:

- Brazil all Ex equipment requires Inmetro approval.
- China requires a China Compulsory Certificate (CCC) mark issued by the Certification and Accreditation Administration of the People's Republic of China
- India has a combination of the PESO (Petroleum and Explosives Safety Organization) and DGMS (Director General of Mines Safety) approvals to import product.
- United Emirates Conformity used the Emirates Assessment Scheme (ECAS) requires an ECAS Certificate of Conformity and the Emirates Quality Mark (EQM)
- Saudi Arabia requires a Saudi Standards, Metrology and Quality Organization (SASO) Recognition Certificate (SIRC). SASO requires both IECEx CoC and IECEE (IEC Conformity Assessment Scheme for Electrical and Electronic Equipment) CoC (or an ExTr and EETr)
- South Africa requires a South African Bureau of Standards (SABS) mark on Ex equipment

For specific details on specific requirements for each contact the country organization or your Certification Body for additional information. Or contact Killark for assistance in understanding the global requirements for product certification.

Various Hubbell organizations (including Austdac, Chalmit, GaiTronics, Hawke and Killark) offer a wide range of products for use in explosive atmospheres, many of which include multi-country certification

North American Use of Equipment marked For Class/Division or Zones

Both the NEC and CE Code permit the use of Class/Division marked equipment to be used in Zone Locations and Zone marked equipment to be used in Class/Division locations. The CE Code includes Table 18 whereas the NEC currently has this information in text. (The 2023 NEC Edition is expected to add a similar table to that used in the CE Code)

<table>
<tr><th colspan="2">CLASS/DIVISION SYSTEM</th><th colspan="2">ZONE SYSTEM</th></tr>
<tr><th>AREA CLASSIFICATION</th><th>SUITABLE EQUIPMENT</th><th>AREA CLASSIFICATION</th><th>SUITABLE EQUIPMENT</th></tr>
<tr><th colspan="2">CLASS I, GASSES AND VAPORS</th><th colspan="2">EXPLOSIVE GAS ATMOSPHERES</th></tr>
<tr><td rowspan="2">Class I, Division 1</td><td rowspan="2">Equipment marked Class I, Division 1
Purged equipment to NFPA 496 Types X, Y
Intrinsic safety IS, I.S., Exi, Exia
Encapsulation ma ①
Flameproof da ②
Inherently safe optical radiation op is, with EPL Gb**
Optical system with interlock op sh, with EPL Gb**</td><td>Zone 0</td><td>Intrinsically safe, IS, I.S., Exi, Exia,
Encapsulation ma ①
Flameproof da ①②
Equipment marked EPL Ga</td></tr>
<tr><td>Zone 1</td><td>Equipment suitable for use in Zone 0
Equipment marked Class I, Division 1
Purged equipment to NFPA 496 Types X, Y
Intrinsic safety ib
Encapsulation ma, mb
Flameproof d. db
Intrinsic safety i, ib
Increased safety e, eb
Pressurized enclosure p, px, pxb, py, pyb
Powder filling q, qb
Liquid immersion o, ob
Electrical resistance trace heating 60079-30-1, EPL Gb
Inherently safe optical radiation op is, with EPL Gb**
Optical system with interlock op sh, with EPL Gb**
Protected optical radiation op pr, with EPL Gb**
Equipment marked EPL Ga or Gb</td></tr>
<tr><td>Class I, Division 2</td><td>Equipment suitable for use in Class I, Division 1
Equipment suitable for use in Zone 0
Equipment suitable for use in in Zone 1
Equipment to NFPA 496 Type Z
Type of Protection “n” (Group II) nA, nC, nL, nR
Intrinsic safety ic
Encapsulation mc
Flameproof dc
Intrinsic safety ic
Increased safety ec
Pressurized enclosure pz, pzc
Liquid immersion oc
Electrical resistance trace heating 60079-30-1, EPL Gc
Skin effect trace heating with EPL Gc**
Impedance heating with EPL Gc**
Inherently safe optical radiation op is, with EPL Gc**
Optical system with interlock op sh, with EPL Gc*
Protected optical radiation op pr, with EPL Gc**
Equipment marked EPL Ga, Gb or Gc
Other electrical apparatus‡</td><td>Zone 2</td><td>Equipment suitable for use in Zone 0
Equipment suitable for use in Zone 1
Equipment suitable for use in Class I, Division 1
Equipment suitable for use in Class I, Division
Equipment to NFPA 496 Type Z
Type of Protection “n” (Group II) nA, nC, nL, nR
Intrinsic safety ic
Encapsulation mc
Flameproof dc
Intrinsic safety ic
Increased safety ec
Pressurized enclosure pz, pzc
Liquid immersion oc
Electrical resistance trace heating 60079-30-1, EPL Gc
Skin effect trace heating with EPL Gc**
Impedance heating with EPL Gc**
Inherently safe optical radiation op is, with EPL Gc**
Optical system with interlock op sh, with EPL Gc*
Protected optical radiation op pr, with EPL Gc**
Equipment marked EPL Ga, Gb or Gc
Other electrical apparatus‡</td></tr>
</table>

HAZARDOUS LOCATION DATA

CLASS/DIVISION SYSTEM		ZONE SYSTEM	
AREA CLASSIFICATION	**SUITABLE EQUIPMENT**	**AREA CLASSIFICATION**	**SUITABLE EQUIPMENT**
CLASS II, COMBUSTIBLE DUSTS		**EXPLOSIVE DUST ATMOSPHERES**	
Class II, Division 1	Equipment suitable for use in Class II, Division 1 Purged equipment to NFPA 496 Types X, Y Intrinsic safety ia Encapsulation ma Protection by Enclosure ta Inherently safe optical radiation op is, with EPL Da** Optical system with interlock op sh, with EPL Da**	Zone 20	Equipment suitable for use in Class II, Division 1 Intrinsic safety (Group III) ia Intrinsically safe, IS, I.S., Exi, Exia Encapsulation ma ① Protection by enclosure (Group III) ta Inherently safe optical radiation op is, with EPL Da** Optical system with interlock op sh, with EPL Da** Equipment marked EPL Da
		Zone 21	Equipment suitable for use in Zone 20 Equipment suitable for use in Class II, Division 1 Intrinsic safety (Group III) ib Protection by enclosure (Group III) tb Pressurized enclosure (Group III) p, px, pxb, py, pyb Encapsulation mb Inherently safe optical radiation op is, with EPL Db** Optical system with interlock op sh, with EPL Db** Protected optical radiation op pr, with EPL Db** Electrical resistance trace heating 60079-30-1, EPL Db Skin effect trace heating with EPL Db** Equipment marked EPL Db
Class II, Division 2	Equipment suitable for use in Class II, Division 1 Equipment suitable for use in Class II, Division 2 Equipment suitable for use in Zone 20 Equipment suitable for use in Zone 21 Other electrical apparatus‡ <u>Suitable enclosures:</u> (CE Code) Types 4, 4X and 5 (NEC) Type 3, 3S, 3SX, 4, 4X, 5, 6, 6P, 12, 12K, and 13	Zone 22	Equipment suitable for use in Zone 20 Equipment suitable for use in Zone 21 Equipment suitable for use in Class II, Division 1 Equipment suitable for use in Class II, Division 2 Intrinsic safety (Group III) ic Encapsulation mc Protection by enclosure (Group III) tc Electrical resistance trace heating 60079-30-1, EPL Dc Skin effect trace heating with EPL Dc** Impedance heating with EPL Dc** Inherently safe optical radiation op is, with EPL Dc** Optical system with interlock op sh, with EPL Dc* Protected optical radiation op pr, with EPL Dc** Equipment marked EPL Dc Other electrical apparatus‡ <u>Suitable enclosures:</u> (CE Code) Types 4, 4X and 5 (NEC) Type 3, 3S, 3SX, 4, 4X, 5, 6, 6P, 12, 12K, and 13
CLASS III, EASILY IGNITED FIBERS AND FLYINGS		*Note: The Zone System incorporates the requirements for Class III materials Class III, Division 1 equates to Zone 20 and Zone 21 Class III, Division 1 equates to Zone 22*	
Class III, Division 1	Class II, Division 1 Class II, Division 2 Class III, Division 1 EPL Da, Db or Dc Other electrical apparatus‡ <u>Suitable enclosures:</u> (CE Code) Types 4, 4X and 5 (NEC) Type 3, 3S, 3SX, 4, 4X, 5, 6, 6P, 12, 12K, and 13		
Class III, Division 2	Same as above		

① *Must be wired as intrinsically safe*

② *For Gas Detection products only*

‡ *Other acceptable equipment*

- *For Class I, Division 1 & Zone 1, examples include a submersible pump with a float switch that disconnects the power before it reaches the motor or pressurized systems Type X or Y*
- *For Class I, Division 2, & Zone 2 examples include; non-sparking motors, Type 4 enclosure with terminals, ordinary location fittings and cable glands, etc.*
- *For Class II, Division 1 & Zone 21, examples include pressurized systems Type X or Y*
- *For Class II, Division 2 & Zone 22, examples include, switches, controllers, circuit breakers, and fuses or terminals installed in (CE Code Type 4 or 5) or (NEC Type 3, 3S, 3SX, 4, 4X, 5, 6, 6P, 12, 12K, and 13) enclosures and ordinary location fittings and cable glands, etc.*
- *Class III, Division 1 and Division 2, switches, controllers, circuit breakers, fuses, control transformers, resistors, utilization equipment (fixed and portable), electric cranes, hoists, or similar equipment installed in (CE Code Type 4 or 5) or (NEC Type 3, 3S, 3SX, 4, 4X, 5, 6, 6P, 12, 12K, and 13) enclosures and ordinary location fittings and cable glands, etc..*

HAZARDOUS LOCATION DATA

A more basic comparison is as follows:

<table>
<tr><th colspan="4">BASIC MARKING REQUIRED FOR EQUIPMENT USED IN HAZARDOUS LOCATIONS</th></tr>
<tr><th colspan="2">CLASS DIVISION SYSTEM ①</th><th colspan="2">ZONE SYSTEM ①</th></tr>
<tr><th colspan="2">CLASS I, GASSES AND VAPORS</th><th colspan="2">EXPLOSIVE GAS ATMOSPHERES</th></tr>
<tr><td rowspan="2">Class I, Division 1</td><td rowspan="2">Class I, Division 1
EPL Ga
② Other acceptable equipment</td><td>Zone 0</td><td>EPL Ga</td></tr>
<tr><td>Zone 1</td><td>Class I, Division 1
EPL Ga or Gb</td></tr>
<tr><td>Class I, Division 2</td><td>Class I, Division 1
Class I, Division 2
EPL Ga, Gb or Gc
② Other acceptable equipment</td><td>Zone 2</td><td>Class I, Division 1
Class I, Division 2
EPL Ga, Gb or Gc
② Other acceptable equipment</td></tr>
<tr><th colspan="2">CLASS II, COMBUSTIBLE DUSTS</th><th colspan="2">EXPLOSIVE DUST ATMOSPHERES</th></tr>
<tr><td rowspan="2">Class II, Division 1</td><td rowspan="2">Class II, Division 1
EPL Da
② Other acceptable equipment</td><td>Zone 20</td><td>Class II, Division 1
EPL Da</td></tr>
<tr><td>Zone 21</td><td>Class II, Division 1
EPL Da or Db
② Other acceptable equipment</td></tr>
<tr><td>Class II, Division 1</td><td>Class II, Division 1
Class II, Division 2
EPL Da, Db or Dc
② Other acceptable equipment</td><td>Zone 22</td><td>Class II, Division 1
Class II, Division 2
EPL Da, Db or Dc
② Other acceptable equipment</td></tr>
<tr><th colspan="2">CLASS III, EASILY IGNITED FIBERS & FLYINGS</th><td colspan="2" rowspan="2">Same as Zone 22</td></tr>
<tr><td>Class III, Division 1</td><td>Class II, Division 1
Class II, Division 2
Class III, Division 1
EPL Da, Db or Dc
Enclosure See notes
② Other acceptable equipment</td></tr>
<tr><td>Class III, Division 2</td><td>Class II, Division 1
Class II, Division 2
Class III, Division 1
Class III, Division 2
EPL Da, Db or Dc
Enclosure See notes
② Other acceptable equipment</td><td colspan="2">Same as Zone 22</td></tr>
</table>

NOTE: EPL marking will include the "Ex" Type of Protection and Level of Protection used in the construction of the product. This information may identify specific installation requirements. For example, Ex 'd' or 'db" enclosures require an explosion seal to be installed within 50mm. or Ex 'e' or 'eb' enclosure require the use of an Ex 'e' or 'eb' cable gland.

① *Equipment marking must include the applicable Material (Gas or Dust),Group(s) and T-Code*

② *Other acceptable equipment*

- *For Class I, Division 1 & Zone 1, examples include a submersible pump with a float switch that disconnects the power before it reaches the motor or pressurized systems Type X or Y*
- *For Class I, Division 2, & Zone 2 examples include; non-sparking motors, Type 4 enclosure with terminals, ordinary location fittings and cable glands, etc.*
- *For Class II, Division 1 & Zone 21, examples include pressurized systems Type X or Y*
- *For Class II, Division 2 & Zone 22, examples include, switches, controllers, circuit breakers, and fuses or terminals installed in (CE Code Type 4 or 5) or (NEC Type 3, 3S, 3SX, 4, 4X, 5, 6, 6P, 12, 12K, and 13) enclosures and ordinary location fittings and cable glands, etc.*
- *Class III, Division 1 and Division 2, switches, controllers, circuit breakers, fuses, control transformers, resistors, utilization equipment (fixed and portable), electric cranes, hoists, or similar equipment installed in (CE Code Type 4 or 5) or (NEC Type 3, 3S, 3SX, 4, 4X, 5, 6, 6P, 12, 12K, and 13) enclosures and ordinary location fittings and cable glands, etc.*

Trademarks

The designs of Killark products are original and proprietary and in many instances are covered by patents.

Killark products are designed to be installed as governed by the National Electric Code. The products are designed to conform with suitable Third Party Certifier standards where such standards exist. Most Killark standard cataloged products are covered by third party certification reports and inspection procedures. These certifications are a matter of record and are indicated by the product identification marking and the certifier's logo. Generally, the marking is required on the product itself, however, under certain circumstances, the marking may be applied to the carton only.

In general, products are Third Party Certified as complete assemblies, however, exceptions do exist. One such exception would be separate shipment of control station cover assemblies and the splice boxes. In some instances, components may be covered (i.e., UL Recognized) for use in other equipment which will be submitted for certification of the complete assembly. The nature of the agreements with Third Party Certifiers requires that product deviations from the originally submitted design be resubmitted for evaluation prior to application of the logo. It is not uncommon for re-submittals to take a substantial length of time.

Generally, Killark's standard cataloged products are covered by one or more of the following Third Party certifiers: Underwriters Laboratories Inc., Factory Mutual Research Corporation, Canadian Standards Association, and other ATEX/IECEx third party certifiers. Products covered are indicated by the Third Party Certifiers logo and file number on the individual catalog pages. There may be instances where not all products on a particular page containing a logo are listed. When certification information is required, consult the factory or refer to the appropriate certifier for listings.

HUBBELL®
KILLARK®

Registered Logotype and Trademark of:
Killark
A Division of Hubbell Incorporated (Delaware)
St. Louis, MO USA

Manufacturer of Electrical Products for Hazardous and Non-Hazardous Locations:
Fittings, Enclosures, Distribution Equipment, Plugs and Receptacles, Controls and Lighting Fixtures.

ACCEPTOR® Plugs and Receptacles

ACCEPTOR is a registered trademark identifying Killark Interchangeable Plug and Receptacle System.

Always-Thread® ANTI-SEIZE LUBRICANT

Always-Thread is a registered trademark identifying Killark Lubricant.

CELOX®

CELOX is a registered trademark identifying Killark epoxy resin.

CERTI*LITE*® Lighting

CERTI*LITE* is a registered trademark identifying Killark Luminaires.

CorroSAFE™ Electrical Conduit Fittings

CorroSAFE is a trademark identifying a protective coating.

CLENCHER® Cable Connectors

CLENCHER is a registered trademark identifying Killark Cable Connectors.

DURALOY® Electrical Conduit Fittings

DURALOY is a trademark identifying a Tri-Coat protective finish used on Iron Electrical Conduit Fittings.

ENVIRO*RITE*® Lighting

ENVIRO*RITE* is a registered trademark identifying Killark Luminaires.

TRADEMARKS

EXPB™

EXPB is a trademark identifying Killark Panelboards.

HAZCON® Controls

HAZCON is a registered trademark identifying Killark Factory Sealed Control Stations.

HOSTILE*LITE*® Lighting

HOSTILE*LITE* is a registered trademark identifying Killark Luminaires.

HP20®

HP20 is a registered trademark identifying RigPower connectors.

K-PAK®

Is a registered trademark identifying Killark Shelf packaging.

LINEAR*LITE*™* Lighting

* R marca registrada MEXICO

LINEAR*LITE* is a trademark identifying Killark Fluorescent Luminaires.

LINEAR*LITE*™* E

* R marca registrada MEXICO EMERGENCY

LINEAR*LITE* E is a trademark identifying Killark Emergency Fluorescent Luminaires.

MARI*GARD*® Lighting

MARI*GARD* is a registered trademark identifying Killark Stainless Steel Floodlights.

MCC-1™

MCC-1 is a trademark identifying RigPower connectors.

PETRO*BRIGHT*®

PETRO*BRIGHT* is a registered trademark identifying Killark Fluorescent Luminaires.

PRISM® Enclosures

PRISM is a registered trademark identifying Killark Enclosures, Motor Controls, Disconnect Switches and Panelboards.

QUANTUM® Enclosures for Hazardous & Hostile Locations

QUANTUM is a registered trademark identifying Killark Electrical Junction Boxes and Enclosures.

RMP®II

RMP is a registered trademark identifying RigPower connectors.

SEAL-X® Control Stations

SEAL-X is a registered trademark identifying Killark Factory Sealed Control Stations.

SEAL-XM® Factory Sealed Control Stations

SEAL-XM is a registered trademark identifying Killark Control Stations.

Secure Mount®

Secure Mount is a registered trademark identifying RigPower connectors.

StrateLine™

StrateLine is a trademark identifying Vantage connectors.

TECHNeTERM® Terminal Enclosures

TECHNeTERM is a registered trademark identifying Killark Increased Safety Terminal Enclosures.

Vantage® Technology Connectors

Vantage Technology is a trademark identifying Vantage Connectors

VersaMATE® Plugs & Receptacles

VersaMATE is a registered trademark identifying Killark Pin & Sleeve Plugs and Receptacles.

Z SERIES® Cord Connectors — Cord and Cable Connectors

Z-SERIES is a registered trademark identifying Killark Cord and Cable Connectors.