HAZARDOUS (CLASSIFIED) LOCATIONS

Hazardous locations are those locations where fire or explosion hazards may exist due to flammable gases or vapors, flammable liquids, combustible dust, or ignitible fibers or flyings.

Although flammable gases and vapors, and combustible dusts, exist almost everywhere, they are usually present only in minute quantities, much less than necessary for a fire or explosion hazard to exist. Thus, the presence of a flammable gas or vapor, or combustible dust, does not in itself define a hazardous location. These materials must be present in sufficient quantities (concentrations) to present a potential explosion hazard.

Locations where there is an explosion hazard because of the presence of high explosives, such as blasting agents and munitions, are not classified as hazardous locations. There are standards covering the handling and use of such materials, and some of these require electrical equipment suitable for use in hazardous locations. This is because such equipment provides a greater degree of safety than ordinary location or general purpose equipment, not because such equipment has been tested for use in the presence of high explosives.

In a like manner, locations made hazardous because of the presence of pyrophoric materials, such as some phosphorous compounds and finely divided metal powders are not classified as hazardous locations. Pyrophoric is defined in the dictionary as "igniting spontaneously" or "emitting sparks when scratched or struck, especially with steel". Where pyrophoric material or high explosives are present, precautions beyond those in the electrical codes are necessary.

UNDERSTANDING "GLOBAL" HAZARDOUS LOCATIONS

The evolution of hazardous location electrical codes and standards throughout the world has taken two distinct paths. In North America, a "Class, Division" System has been used for decades as the basis for area classification of hazardous (classified) locations. Because the hazards and methods of protecting electrical equipment against these hazards differ for different materials, hazardous locations are divided into three Classes, and two Divisions. The Classes are based on the type of hazard and the explosive characteristics of the material with the Divisions being based on the occurance or risk of fire or explosion that the material presents. While Canada and the United States have some differences in acceptable wiring methods and product standards, their systems are very similar.

In other parts of the world, areas containing potentially explosive atmospheres are dealt with using a "Zone System". Zones are based predominately on the International Electrotechnical Commission (IEC) and the European Committee for Electrotechnical Standardization (CENELEC) standards.

Whereas North America deals with multiple types of hazardous atmospheres, the Zone system presently addresses only flammable gases and vapors which is the equivalent to North America's Class I locations.The most significant difference between the Zone system is that the level of hazard probability is divided into three Zones as opposed to two Divisions.

While specific requirements differ, the United States and Canada have incorporated the Zone System for Class I, hazardous locations into their recent electrical code updates. Both systems provide effective solutions for electrical equipment used in hazardous locations and both have excellent safety records.

In North America Hazardous (Classified) Locations are divided into three Classes based on the explosive characteristics of the material. The Classes of material are further divided into "Divisions" or "Zones" based on the risk of fire or explosion that the material presents. The Zone system has three levels of hazard whereas the Division system has two levels.

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

HAZARDOUS MATERIAL	CLASS, DIVISION SYSTEM	ZONE SYSTEM
Gases or Vapors①	Class I, Div. 1	Zone 0 & Zone 1
	Class I, Div. 2	Zone 2

① *The United States and Canada have adopted Zones for Gases and Vapors.*

HAZARDOUS (CLASSIFIED) LOCATIONS

CLASS I LOCATIONS

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

The term "gases or vapors" is used because of common usage in the English language. The term "gases" is commonly used to refer to materials that are in a gaseous state under normal atmospheric conditions, such as hydrogen and methane. The term "vapors" refers to the gases over a material that is a liquid under normal atmospheric conditions (such as gasoline) but which emits gases within the flammable range under these same atmospheric conditions.

CLASS I, DIVISIONS 1 AND 2 GROUPS A, B, C, AND D LOCATIONS

General

The subdivision of Class I into two divisions identifies the likelihood or risk that an ignitible concentration of gases or vapors will be in the location. Division 1 identifies locations where the risk is high or medium. Division 2 identifies locations where there is a small but still finite risk. If the risk is extremely low, the location is not considered a hazardous location. Such a location is typified by a single family home with natural gas or propane as the energy source for heating. The gas could, and on extremely rare occasions does leak into the home, and an explosion occurs. However the risk is so low (because of the safety systems built into the gas supply and heating equipment) that such locations are not classified as a hazardous location.

Division 1

Class I, Division 1 locations are those where the explosion hazard exists under normal operating conditions. The area may be hazardous all or most of the time, or it may only be hazardous some of the time. Division 1 also includes locations where breakdown or faulty operation of electrical equipment or processes might release ignitible concentrations of flammable gases or vapors, and might also cause simultaneous failure of electrical equipment in such a way as to directly cause the electrical equipment to become a source of ignition. An example of such a location might be an area where a flammable liquid is stored under cryogenic conditions, and a leak of the extremely low temperature liquid directly onto electrical equipment could cause failure of the electrical equipment at the same time the vapors of the evaporating liquid are within the flammable range.

Division 2

Class I, Division 2 locations are those where ignitible concentrations of flammable gases or vapors are not normally present, but could be present in the event of a fault, such as a leak at a valve in a pipeline carrying flammable liquids. Division 2 locations also often exist around Division 1 locations where there is no barrier or partition to separate the Division 1 space from a nonhazardous location, or where ventilation failure (an abnormal condition) might extend the area where flammables exist under normal conditions. Electrical equipment approved for Class I, Division 1 locations is also suitable for use in Division 2 locations.

The frequency of occurance determines the level of hazard for a location, the longer the material is present, the greater the risk.

FREQUENCY OF OCCURRENCE	CLASS, DIVISION SYSTEM	ZONE SYSTEM
Continuous	Class I, Div. 1	Zone 0
Intermittent Periodically		Zone 1
Abnormal Conditions	Class I, Div. 2	Zone 2

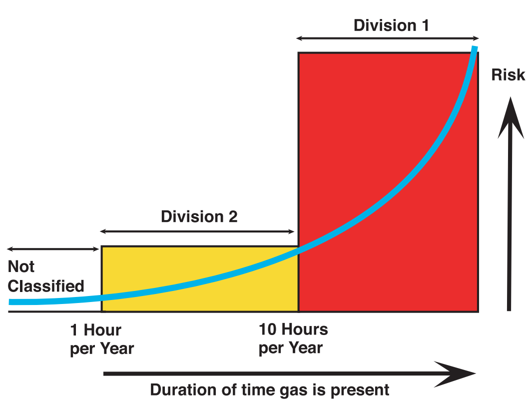
The abnormal conditions of occurrence, or lower risk areas, Division 2 and Zone 2 are basically identical in the Zone and Division system. However, in areas where a hazard is expected to occur during normal operation, Division 1 and Zone 1 and 0, the Zone system deals with highest risk areas Zone 0 separately, and risk associated with the remaining location Zone 1, is considered lower. The Division system tends to be less specific in its consideration of Division 1. The Division system treats all areas where a hazard is expected to occur in normal operation the same.

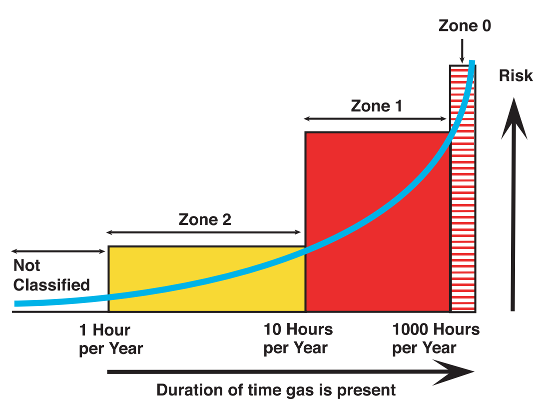
The following chart illustrates the differences between the various Zones.

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%) (1)

This is a combination of Tables 2 and 3 from API RP505
(1) The 1-hour per year in API RP505 is considered to be high by some industry experts.

The illustration below compares the Division and Zone systems in terms of risk assessment.





CLASS I, GROUPS A, B, C, AND D

Class I locations are divided into groups because different materials have different explosion and ignition characteristics. The grouping permits equipment to be tested based on the type of flammable material in which it is intended to be used. It also permits area classification to be based on the type of material anticipated in that location.

The grouping is based on two major factors: the explosion pressure generated during an explosion; and the maximum gap between ground flat mating metal surfaces that will prevent propagation of an explosion through the gap to a flammable atmosphere of the same flammable material and concentration.

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 anticipated, and must have a very small gap between joint surfaces. Explosionproof equipment for Group A is the most difficult to design and there is less explosionproof equipment listed for this group than for any other group.

Group B
Group B materials produce explosion pressures somewhat less than acetylene, and the design of explosionproof enclosures for this group is somewhat less rigorous than for Group A enclosures. However, because of the very high explosion pressures in both Groups A and B, and, in particular, the very small gap between mating surfaces needed 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.

There is no consistent relationship between such properties as ignition temperature, flash point, and flammable limits, and the Class I hazardous location group into which the various materials fall.

TYPICAL GAS	CLASS, DIVISION GAS GROUPS	ZONE GAS GROUPS
Acetylene	A	IIC
Hydrogen	B	IIC
Ethylene	C	IIB
Propane	D	IIA
Methane	D	IIA

CLASS I, ZONES 0, 1 AND 2, GROUPS IIC,IIB, AND IIA, LOCATIONS

General
This method of area classification follows the international method of area classification as developed by the International Electrotechnical Commission (IEC) and European Committee for Electrotechnical Standardization (CENELEC) standards.

Like the subdivisions under Class I locations of Divisions 1 and 2 and for the same reasons, (area classification and equipment testing) hazardous locations are classified by zones instead of divisions.

Zone 0
These are locations in which ignitible concentrations of flammable gases or vapors are present continuously or for long periods of time. Zone 0 represents the most dangerous part of the Division 1 classification.

There are situations where flammable liquids are stored in tanks and the vapor space above the liquid is above the upper flammable limit. If the vapor space is above the upper flammable limit most of the time, the space is not a Zone 0 location because the requirements are for “ignitible concentrations” of flammable gases or vapors (concentrations within the flammable range).

Zone 1
These locations are almost the same as Class I, Division 1 locations in the class, division system except they do not include those locations defined as Class I, Zone 0, where ignitible concentrations are present all or most of the time.

Zone 2
These locations are the same as Class I, Division 2 locations in the class, division system.

CLASS I, GROUPS IIC, IIB, AND IIA
General
In the international system of classification, Group I gas grouping is reserved for classification and equipment intended for use in underground mines. For information on electrical equipment in underground mines, see the Federal Register, regulations of the Mine Safety and Health Administration (MSHA).

Group IIC
This group is the equivalent of a combination of Class I, Groups A and B gases and vapors in the Division system. In the international system of classification, only the gap between machined flat mating surfaces, plus the igniting current (directly related to ignition energy), is considered in grouping materials. Explosion pressure is not one of the considerations. Thus, Groups A and B in the “class, division” system of classification can be grouped together in the international system. Internationally, rigid metal conduit and similar “pipe” wiring systems are not normally used in hazardous locations and thus consideration of pressure piling through a length of conduit (a major problem with acetylene) is unnecessary in the zone system. The maximum safe gap between machined flat mating surfaces is the same for Group A, and B materials.

Group IIB
This group is the equivalent to the Class I, Group C gases and vapors in the Division system.

Group IIA
This group is equivalent to the Class I, Group D gases and vapors in the Division system.

TEMPERATURE CODES (T-CODES)

Class I
The ignition temperature or auto-ignition temperature (AIT) is the minimum temperature required to initiate or cause self-sustained combustion in a substance without any apparent source of ignition. The lowest published ignition temperature should be the one used to determine the acceptability of equipment. This is of particular concern when selecting heat producing equipment such as lighting fixtures or motors which may generate sufficient heat to ignite the surrounding atmosphere.

Class I and Class II, areas use T-Codes or are subject to maximum temperature limitations as shown in the following chart. North America and the IEC are consistent in their temperature or T-Codes. However unlike the IEC, North America includes incremental values as shown below.

NORTH AMERICAN TEMP. CODES US (NEC-500) & CSA	IEC/CENELEC/US (NEC 505) TEMP. CODES	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

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.

A heat producing product is considered acceptable for the location, provided the minimum ignition temperature of the hazardous material present and 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 CSA is –50° C to +40° C, the range for UL is –25° C to +40° C, and the range for IEC and CENELEC is –20° C to +40° C.

CLASS II LOCATIONS

Class II locations are those that are hazardous because of the presence of combustible dust. Note that the dust must be present in sufficient quantities for a fire or explosion hazard to exist. The fact that there is some combustible dust present does not mean a Class II hazardous location exists. To be considered a “dust” the combustible material must exist as a finely divided solid of 420 microns (0.420 mm) or less. Such a dust will pass through a No. 40 U.S. sieve.

CLASS II, DIVISIONS 1 AND 2
GROUPS E, F, AND G LOCATIONS

General
Just as in Class I, Divisions 1 and 2, the subdivision of Class II into Divisions 1 and 2 identifies the likelihood that there will be an explosion hazard.

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 ignitible mixtures, or where mechanical failure or abnormal operation of equipment or machinery might cause an explosive or ignitible dust-air mixture to be produced, and might also provide a source of ignition through simultaneous failure of electrical equipment. A Class II, Division 1 location also exists where combustible dusts of an electrically conductive nature may be present in hazardous quantities (Group E locations). The term “hazardous quantity” is intended to mean those locations where the dust may not be in suspension in the air in sufficient quantity to cause an explosion, but might have settled on electrical equipment so that the electrically conductive particles can penetrate the openings in the electrical equipment enclosure and cause an electrical failure, or where the dust can get into motor bearings and cause excessive temperatures because of bearing failure.

Division 2

A Class ll, Division 2 location is one where combustible dust is not normally in the air in quantities sufficient to produce explosive or ignitible 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 ignitible by abnormal operation or failure of the electrical equipment.

Class II, Groups E, F, and G

The division into three groups in Class II locations is for the same reasons Class I locations are divided into Groups A, B, C, and D: equipment design and area classification. However, the three Class II groups are based on different characteristics than the four Class I groups because the design of dust-ignition proof equipment for Class II locations is based on different principles than the design of explosion proof equipment for Class I locations. In Class II locations the ignition temperature of the dust, the electrical conductivity of the dust, and the thermal blanketing effect the dust can have on heat-producing equipment, such as lighting fixtures and motors are the deciding factors in determining the Class II group.

Group E

Group E dusts include the metal dusts, such as aluminum and magnesium. In addition to being highly abrasive, and thus likely to cause overheating of motor bearings if the dust gets into the bearing, Group E dusts are electrically conductive. If they are allowed to enter an enclosure, they can cause electrical failure of the equipment.

Group F

The Group F dusts are carbonaceous, the primary dust in this group being coal dust. These dusts have somewhat lower ignition temperatures than the Group E dusts and a layer of a Group F dust has a higher thermal insulating value than a layer of a Group E dust, thus requiring more careful control of the temperature on the surface of the equipment. Such dusts are semi-conductive but this is not usually a factor for equipment rated 600 volts and less.

Group G

The Group G dusts include plastic dusts, most chemical dusts, and food and grain dusts. They are not electrically conductive. These dusts, in general, have the highest thermal insulating characteristics and the lowest ignition temperatures. Thus, dust-ignitionproof equipment for use in Group G atmospheres must have the lowest surface temperatures to prevent ignition of a dust layer by the heat generated within the equipment.

Because of the different design characteristics, equipment suitable for Class I locations is not necessarily suitable for Class II locations, and equipment suitable for Class II locations is not necessarily suitable for Class I locations. The equipment must be approved for each class and group of location involved.

Much equipment suitable for Class I locations is also suitable for Class II locations, and is so marked, although when used in Class II locations there may be restrictions, such as lower maximum lamp wattage to maintain the lower surface temperature needed for equipment in dust atmospheres.

TYPE OF MATERIAL	GROUPS	TYPICAL MATERIALS
Electrically Conductive Dusts	E	Powdered metals such as aluminum or magnesium
Carbonaceous Dusts	F	Carbon Black, Coal Dust, Coke Dust
Agricultural Dusts	G	Grain, Flour, Sugars, Spices, Rice, Certain Polymers

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.

	EQUIPMENT THAT IS NOT SUBJECT TO OVERLOADING		EQUIPMENT (SUCH AS MOTORS OR POWER TRANSFORMERS) THAT MAY BE OVERLOADED			
			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

CLASS III LOCATIONS

Class III locations are those that are hazardous because of 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 ignitible mixtures. Easily ignitible fibers and flyings present a fire but not an explosion hazard. 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.

CLASS III, DIVISIONS 1 AND 2

Division 1
This is a location where the equipment producing the ignitible fibers or flyings is located (near textile mill machinery, for example) or where the material is handled (for example, where the material is stuffed into bags).

Division 2
This is a location where the easily ignitible fibers are stored or handled, except in manufacturing processes (which is Division 1).

Class III Groups
There are no groups in Class III locations.

ZONES 20, 21, AND 22 LOCATIONS

The 2005 NEC introduced a new Article 506 that provides an alternate zone system to Class II and Class III. This system, based on the IEC, is for locations that inlcude combustible concentrations of combustible dust or ignitible fibers and flyings.

Zone 20. These are Hazardous (Classified) Locations where areas of combustible dust or ignitible fibers and flyings are present continuously or for long periods of time in quantities sufficient to be hazardous, as classified by 506.5(B) (1) of the 2005 NEC.

Zone 21. These are Hazardous (Classified) Locations where areas of combustible dust or ignitible fibers and flyings are likely to exist occasionally under normal operation in quantities sufficient to be hazardous, as classified by 506.(B)(2) of the 2005 NEC.

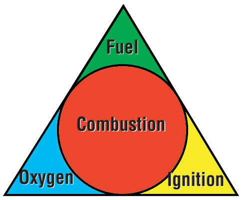
Zone 22. These are Hazardous (Classified) Locations where areas of combustible dust or ignitible fibers and flyings are not likely to occure under normal operation in quantities sufficient to be hazardous, as classified by 506.5(B)(3) of the 2005 NEC.

NOTE: Zones 20, 21, and 22 do not apply to combustible metallic dusts.

EQUIPMENT DESIGN AND CONSTRUCTION

There are a number of ways of protecting electrical equipment so that it cannot cause an explosion when used in a surrounding flammable atmosphere, or ignite a layer of dust or fibers on the equipment. The two most common ways are explosion- proof equipment in Class I, Division 1 and some Division 2 locations and dust-ignitionproof equipment in Class II, Division 1 locations. Flameproof and increased safety equipment is most common in Class I, Zone 1 locations. Intrinsically safe equipment is becoming increasingly more popular in Division 1 and Zone 1 locations. Most Killark equipment for use in hazardous locations is designed to meet the requirements for explosion proof and/or dust-ignitionproof apparatus.

The Fire Triangle



In order for a fire or explosion to occur three conditions must exist. There must be a fuel (the flammable gas or vapor, or combustible dust) in ignitible quantities; there must also be an ignition source (energy in the form of heat or a spark) of sufficient energy to cause ignition; and there must be oxygen, usually the oxygen in the air.
These three conditions are called the fire triangle as shown. Remove any one or more of these three and a fire or explosion cannot occur. This is the basis of the various protection systems for electrical equipment permitted in the electrical codes for use in hazardous locations. These protection methods either contain the internal explosion or eliminate one or more of the fire triangle components necessary for an explosion to occur.

The most common methods of protection used in North America are explosion proof equipment for Class I locations, and dust-ignition proof equipment for Class II locations.

The fuel and oxygen must be in the correct mixture, too little fuel, or a lean mixture, or too much fuel, a rich mixture cannot ignite. These explosive limits are defined as “Lower Explosive Limit” (LEL) and “Upper Explosive Limit” (UEL).

TYPES OF PROTECTION

EXPLOSION PROOF OR FLAMEPROOF TYPE “D” PROTECTION

These protection types are based on containment. The requirements for flameproof are somewhat less severe than the North American requirements for explosionproof equipment. Flameproof equipment is not permitted in Class I, Division 1 locations, and explosion proof equipment is not permitted in Class I, Zone 0 locations.

Since flammable gases and vapors are expected to be inside the enclosure the equipment design must be capable of withstanding an explosion caused by a spark at the contacts of switching devices, high temperature, or an electrical fault. The enclosure is designed so that hot gases generated during an internal explosion are cooled below the ignition temperature of the surrounding flammable atmosphere as they are transmitted through the joints of the enclosure.

In addition, the external surfaces of the enclosure must not be hot enough to ignite the surrounding atmosphere as a result of heat energy within the enclosure. This heat energy may be the result of normal operation of heat-producing equipment, or it may be the result of an electrical arc to the enclosure from an arcing ground fault.

MOULDED/ENCAPSULATED TYPE "m" PROTECTION
This type of protection is one in which the parts than can ignite an explosive atmosphere are enclosed in a resin (plastic) sufficiently resistant to environmental influences in such a way that this explosive atmosphere cannot be ignited by either sparking or heating, which may occur within the encapsulation.

INCREASED SAFETY TYPE "e" PROTECTION
This protection system is for equipment that, under normal operating conditions, does not produce ignition-capable arcs or 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 to reduce the likelihood of arc tracking, special terminals to reduce the likelihood of high temperatures or loose connections, and temperature control on heat producing equipment. It is widely used for protection of squirrel cage motors, terminal boxes, and the terminals of flame proof components.

INTRINSIC SAFETY OR INTRINSICALLY SAFE TYPE "ia", AND "ib" PROTECTION
There are two versions of this protection method in the "Zone" System, "ia" (2 fault) for Zone 0 and less dangerous locations, and "ib" (1 fault) for Zone 1 and 2 locations only. Additionally in the "Class, Division" System intrinsically safe equipment listed for use in Class I, Division 1 locations for the same gas group, and with a suitable temperature rating is permitted in Class I, Zone 0, 1 and 2 locations. There is no "i" marking for intrinsically safe equipment listed in the "Class, Division" System (2 fault type only).

INTRINSICALLY SAFE SYSTEMS
These are low-energy systems designed to assure safety by eliminating the ignition source leg of the fire triangle. The energy in the system is maintained below that needed to ignite the flammable atmosphere, even under fault conditions. Opening, grounding, or short-circuiting of field-installed wiring is considered a condition of normal operation in this protection technique, rather than a fault condition. The common protective device used in intrinsically safe circuits is a Zener Diode Barrier. While this type of device controls the energy going to a circuit, it does not prevent incorrectly installed products such as capacitors, which may store energy, from increasing the maximum current permitted in the system. It is important to understand that intrinsic safety is a "system approach" and that no single device provides total protection.

NON-SPARKING TYPE "nA" PROTECTION
This is protection suitable for use in Class I, Zone 2 or Division 2 locations only. It is subdivided into three categories, "nA", "nC" and "nR".

A - Non-sparking equipment.

C - Sparking equipment in which the contacts are suitably protected other than by restricted breathing.

R - Restricted breathing enclosure. This is similar to hermetically sealed however it also includes other enclosures where the rate of leaking of a flammable into the enclosure is restricted. Special leak tests are conducted on the enclosure.

HERMETICALLY SEALED TYPE "nC" PROTECTION
This protection technique is limited to Zone 2 or Division 2 locations only and works by eliminating the ignition source leg of the fire triangle. It defines "hermetically sealed" as a fusion process such as soldering, brazing, welding, or the fusion of glass to metal. So-called "hermetically sealed" relays that are sealed by use of gaskets are not included in this definition. Typical hermetically sealed devices are mercury-tube switches and reed switches.

NON-INCENDIVE EQUIPMENT TYPE "nC" PROTECTION
This is a method of protection of sparking contacts in Class I, Zone 2 or Division 2 locations. A non-incendive component is one having 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 "o" PROTECTION
This protection technique is also limited to equipment in Division 2 and Zone 1 and 2 locations. It eliminates the ignition source leg of the fire triangle. It works because the ignition source is maintained under oil. There are provisions for assuring that there is always enough oil above the contacts to prevent ignition of a flammable atmospheres This technique is usually used for high-energy contacts, often rated over 600 volts, such as those in circuit breakers, motor controllers and other industrial control equipment. It can, however, be used for any switching device.

PURGED AND PRESSURIZED TYPE "p" PROTECTION

This is a type of protection which prevents the entry of the surrounding atmosphere into the enclosure of the electrical apparatus by maintaining a positive pressure within the enclosure of a protective gas (air, inert, or other suitable gas) at a higher pressure than the surrounding atmosphere.

Purging is the process of supplying an enclosure with a protective gas at a sufficient flow and positive pressure to reduce the concentration of any flammable gas or vapor initially present to an acceptable level. This technique can be used to change a Class I or Class II, Division 1 location into a nonhazardous location or into a Division 2 location, or to change a Class I or II, Division 2 location into a nonhazardous location. It requires a noncombustible enclosure (which may be a control room or a machine room) that is first purged of any combustibles or flammables that may be present, and is then maintained at a positive pressure sufficient to assure that combustibles or flammables cannot enter the enclosure and be ignited by electrical equipment within the enclosure. The purging may be a continuous purge or a single purge with a positive pressure maintained to make up for leaks. The pressurizing medium may be either air, commonly used in a control room where people will be working, or a nonflammable gas. In tanker ships at sea, flue gas is a common purging and pressurizing medium. In instrument enclosures in locations with corrosive atmospheres, specially processed and dried air or gas is used to protect the enclosed equipment against corrosion as well as to provide protection against ignition of exterior flammable gases and vapors, or combustible dusts.

TYPE	EXPLANATION
X	Changes the area within the unit from Division 1 to nonhazardous
Y	Changes the area within the unit from Division 1 to Division 2
Z	Changes the area within the unit from Division 2 to nonhazardous

POWDER FILLING TYPE "q" PROTECTION

This protection system is permitted in Zone 1 and 2 locations. There is no equivalent system recognized in the US NEC 500 electrical code. In this type of protection system the enclosure or the electrical apparatus is filled with a material in a finely divided granulated state so that, in the intended conditions of service, the arc occurring within the enclosure of an electrical apparatus will not ignite the surrounding atmosphere. Further, no ignition can be caused either by flame or excessive temperature of the surfaces of the enclosure. This protection system is used for protection of the components in junction boxes. It is sometimes called "sand filling".

Dust Ignitionproof. This protection technique is permitted for equipment in Zones 20, 21, and 22 locations.

Pressurized. This protection technique is permitted for equipment in Zones 21, and 22 locations.

Intrinsic Safety. This protection technique is permitted for equipment in Zones 20, 21, and 22 locations.

Dusttight. This protection technique is permitted for equipment in Zone 22 locations.

Nonincendive Circuit. This protection technique is permitted for equipment in Zone 22 locations.

Nonincendive Equipment. This protection technique is permitted for equipment in Zone 22 locations.

Special Protection

Some countries permit special protection systems consisting of combinations of other systems or other special systems. UL listed flashlights and lanterns for use in hazardous locations would be an example of such a special protection system.

ENVIRONMENTAL PROTECTION
NEMA ENCLOSURE TYPES AND CSA

DEFINITIONS PERTAINING TO NONHAZARDOUS LOCATIONS

The term NEMA enclosure is common in the US, although products are normally tested to a UL standard. The following are environmental protection designations, which are specified in addition to electrical or hazardous location requirements.

Type 1 Enclosures

Type 1 Enclosures are intended for indoor use primarily to provide a degree of protection against limited amounts of falling dirt. This type is not specifically identified in the CSA Standard.

Type 2 Enclosures

Type 2 Enclosures are intended for indoor use primarily to provide a degree of protection against limited amounts of falling water and dirt.

Type 3 Enclosures

Type 3 Enclosures are 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

Type 3R Enclosures are intended for outdoor use primarily to provide a degree of protection against rain, sleet; and damage from external ice formation.

Type 3S Enclosures

Type 3S Enclosures are 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

Type 4 Enclosures are 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
Type 4X Enclosures are 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
Type 5 Enclosures are intended for indoor use primary to provide a degree of protection against settling airborne dust, falling dirt, and dripping noncorrosive liquids.

Type 6 Enclosures
Type 6 Enclosures are intended for indoor or outdoor use primarily to provide a degree of protection against hose directed water, the entry of water during occasional temporary submersion at a limited depth; and damage from external ice formation.

Type 6P Enclosures
Type 6P Enclosures are intended for indoor or outdoor use primarily to provide a degree of protection against hose-directed water, the entry of water during prolonged submersion at a limited depth; and damage from external ice formation.

Type 12 Enclosures
Type 12 Enclosures are intended for indoor use primarily to provide a degree of protection against circulating dust, falling dirt, and dripping noncorrosive liquids.

Type 12K Enclosures
Type 12K Enclosures with knockouts are intended for indoor use primarily to provide a degree of protection against circulating dust, falling dirt, and dripping noncorrosive liquids.

Type 13 Enclosures
Type 13 Enclosures are intended for indoor use primarily to provide a degree of protection against dust, spraying of water, oil, and noncorrosive coolant.

DEFINITIONS PERTAINING TO HAZARDOUS (CLASSIFIED) LOCATIONS

The following NEMA type enclosures occasionally appear on specifications and product literature however, they are not used by CSA. These NEMA types are specific to the US only.

Type 7 Enclosures
Type 7 Enclosures are intended for indoor use in locations classified as Class I, Groups A, B, C, or D, as defined in the NEC®.

Type 8 Enclosures
Type 8 Enclosures are for indoor or outdoor use in locations classified as Class I, Groups A, B, C, or D, as defined in the NEC®

Type 9 Enclosures
Type 9 Enclosures are intended for indoor use in locations classified as Class II, Groups E, F, and G, as defined in the NEC®

Type 10 Enclosures
Type 10 Enclosures are constructed to meet the applicable requirements of the Mine Safety and Health Administration (MSHA).

- *Refer to NEMA Standards Publication No. 250 Enclosures for Electrical Equipment (1000 Volts Maximum) or other third party certification standards for specific requirements for product construction, testing and performance such as Underwriters Laboratories Inc.®, Standard UL 50 “Standard for Enclosures for Electrical Equipment”, and UL 886 “Outlet Boxes and Fittings for use in Hazardous (Classified) Locations”.*

COMPARISON OF SPECIFIC APPLICATIONS OF ENCLOSURES FOR INDOOR NONHAZARDOUS LOCATIONS

PROVIDES A DEGREE OF PROTECTION AGAINST THE FOLLOWING ENVIRONMENTAL CONDITIONS	TYPE OF ENCLOSURE									
	1*	2*	4	4X	5	6	6P	12	12K	13
Incidental contact with the enclosed equipment	X	X	X	X	X	X	X	X	X	X
Falling dirt	X	X	X	X	X	X	X	X	X	X
Falling liquids and light splashing	—	X	X	X	X	X	X	X	X	X
Circulating dust, lint, fibers, and flyings**	—	—	X	X	—	X	X	X	X	X
Settling airborne dust, lint, fibers, and flyings**	—	—	X	X	X	X	X	X	X	X
Hosedown and splashing water	—	—	X	X	—	X	X	—	—	—
Oil and coolant seepage	—	—	—	—	—	—	—	X	X	X
Oil and coolant spraying and splashing	—	—	—	—	—	—	—	—	—	X
Corrosive agents	—	—	—	X	—	—	—	—	—	—
Occasional temporary submersion	—	—	—	—	—	X	X	—	—	—
Occasional prolonged submersion	—	—	—	—	—	—	—	—	—	—

** These enclosures may be ventilated. However, Type 1 may not provide protection against small particles of falling dirt when ventilation is provided in the enclosure top.*
*** These fibers and flyings are nonhazardous materials and are not considered as Class III type ignitable fibers or combustible flyings. For Class III type ignitable fibers or combustible flyings see the National Electrical Code®, Article 500.*

COMPARISON OF SPECIFIC APPLICATIONS OF ENCLOSURES FOR OUTDOOR NONHAZARDOUS LOCATIONS

PROVIDES A DEGREE OF PROTECTION AGAINST THE FOLLOWING ENVIRONMENTAL CONDITIONS	TYPE OF ENCLOSURE						
	3	3R***	3S	4	4X	6	6P
Incidental contact with the enclosed equipment	X	X	X	X	X	X	X
Rain, snow, sleet*	X	X	X	X	X	X	X
Sleet**	—	—	X	—	—	—	—
Windblown dust	X	—	X	X	X	X	X
Hosedown	—	—	—	X	X	X	X
Corrosive agents	—	—	—	—	X	—	X
Occasional temporary submersion	—	—	—	—	—	X	X
Occasional prolonged submersion	—	—	—	—	—	—	X

** External operating mechanisms are not required to operate when the enclosure is ice covered.*
*** External operating mechanisms are operable when the enclosure is ice covered.*
**** These enclosures may be ventilated.*

COMPARISON OF SPECIFIC APPLICATIONS OF ENCLOSURES FOR INDOOR HAZARDOUS (CLASSIFIED) LOCATIONS

PROVIDES A DEGREE OF PROTECTION AGAINST ATMOSPHERES TYPICALLY CONTAINING HAZARDOUS GASES, VAPORS, AND DUSTS***	TYPE OF ENCLOSURE NEMA 7 & 8, CLASS I GROUPS**					TYPE OF ENCLOSURE NEMA 9 & 10, CLASS II GROUPS**			
	Class	A	B	C	D	E	F	G	10
Acetylene	I	X	—	—	—	—	—	—	—
Hydrogen, manufactured gases	I	—	X	—	—	—	—	—	—
Diethyl ether, ethylene, cyclopropane	I	—	—	X	—	—	—	—	—
Gasoline, hexane, butane, naptha, propane, acetone									
Toluene, isoprene	I	—	—	—	X	—	—	—	—
Metal dusts	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

** Due to the characteristics of the gas, vapor, or dust, a product suitable for one Class or Group may not be suitable for another Class or Group unless so marked on the product.*
*** For Class III type ignitable fibers or combustible flyings refer to the National Electrical Code® Article 500.*
**** For a complete listing of flammable liquids, gases, or vapors refer to NFPA 497 - 1997 (Recommended Practice for the Classification of Flammable Liquids, Gases, or Vapors and of Hazardous (Classified) Locations for Electrical Installations in Chemical Process Areas and NFPA 325 - 1994 (Fire Hazard Properties of Flammable Liquids, Gases, and Volatile Solids). Reference also NFPA 499 – 1997 Classifications of Combustible Dusts and of Hazardous (Classified) Locations for Electrical Installations in Chemical Process Areas.*

PROTECTION CLASSES OF ENCLOSURES (IP CODE)

The IEC uses the term “Ingress Protection” to identify the environmental protection of an enclosure.

This is defined in IEC Standard 529 and is referenced by the CEC®. IP Codes are comparable to NEMA Enclosure Types.

The IP classification system designates, by means of a number, the degree of protection provided by an enclosure and the electrical equipment against physical contact, foreign bodies and water ingress.

The protection classes for electrical equipment in respect of:

I. Protection of persons against contact with live or moving parts. (Physical contact protection)
II. Protection against ingress of solid foreign bodies. (Foreign body protection)
III. Protection against ingress of water. (Water protection)

Structure and use of the IP Code:

I. If a code digit does not have to be given it should be replaced with the letter “X”.
II. Additional and/or supplementary letters may be omitted without substitute letters.
III. If more than one supplementary letter is required, alphabetical order should be followed.

The numbering system and degree of protection follows:

The additional (optional) letter concerns protection of persons and refers to information about protection against access to dangerous parts by:

I. Back of the hand	letter A
II. Finger	letter B
III. Tool	letter C
IV. Wire	letter O

The supplemental (optional) letter concerns protection of the equipment and provides supplementary information specially for:

I. High voltage equipment	letter H
II. Water-proofing during operation	letter M
III. Water-proofing during standstill	letter S
IV. Weather conditions	letter W

IP CODE: NUMBERING SYSTEM

IP 5 4 C S

- IP — Code letters
- 5 — First Digit 0 to 6: contact and foreign body protection
- 4 — Second Digit 0 to 8: water protection
- C — Additional letters A, B, C, O (optional)
- S — Supplementary letter H, M, S, W (optional)

DIGIT	FIRST DIGIT PHYSICAL PROTECTION	FOREIGN BODY PROTECTION	SECOND DIGIT WATER PROTECTION
0	Non-protected	Non-protected	Non-protected
1	Protection against back of hand contact.	Protected against solid objects greater than 50 mm (1.97 in.).	Protected against water dripping vertically.
2	Protection against finger contact.	Protected against solid objects greater than 12 mm (0.47 in.).	Protected against vertically dripping water when tilted up to 15, degrees.
3	Protection against contact from a wire or tools.	Protected against solid objects greater the 2.5 mm (0.098 in.).	Protected against spraying water at an angle up to 60° degrees from the vertical.
4	Protection against contact with a wire or strip of thickness greater than 1.0 mm (0.039 in.).	Protected against solid objects greater the 1.0 mm (0.039 in.).	Protected from splashing water from any direction.
5	Protection against contact with a wire.	Dust-protected prevents ingress of dust in sufficient quantity to interfere with operation of equipment.	Protected against water jets from any direction.
6	Protected against contact with a wire.	Dust-tight no dust ingress.	Protected against heavy seas or powerful jets of water and prevents ingress sufficient to cause harm.
7			Protected against the effects of immersion between a depth of 150 mm to 1 meter.
8			Protected against submersion, suitable for continuous immersion in water under conditions specified by the manufacture.

Refer to IEC Standards Publication 529 (Classification of Degrees of Protection Provided by Enclosures) for complete descriptions and test requirements.

NEMA ENCLOSURE TYPES VS. IEC CLASSIFICATION DESIGNATION

NEMA ENCLOSURE TYPE NUMBER	IEC ENCLOSURE CLASSIFICATION
1	IP 23
2	IP 30
3	IP 64
3R	IP 32
3S	IP 54
4 and 4X	IP 66
5	IP 52
6 and 6P	IP 67
12 and 12K	IP 55
13	IP 65

EQUIPMENT CERTIFICATION

United States and Canada

In most cases, equipment for use in hazardous locations must be certified to an appropriate National Standard and marked as such by an accredited third party testing organization. Follow-up inspection to ensure conformance is usually part of the program. Products may carry multiple markings for multiple countries.

The specific requirements for product certification vary from country to country. While CSA, UL and FM are similar in their approach, subtle differences still exist. CSA, UL and FM accept component listing of products. This means that selected products may be offered in modular form, which the customer may assemble without effecting the listing.

European Countries

The countries belonging to the European Union EU, who develop products based upon the standards of the European Committee for Electrotechnical Standardization (CENELEC), have requirements differing in many, but not all respects, from U.S. requirements established by the NEC® and American National Standards Institute. These CENELEC standards were developed based on IEC 60079, and are called Euronorms. The CENELEC standards for electrical equipment for hazardous locations are numbered EN60079-1 through EN60079-31.

IEC Ex Scheme. The Scheme is a global conformity assessment program administered by the International Electrotechnical Commission (IEC). This certification scheme is based upon IEC Standards as the basis for participating countries' certification of electrical equipment for hazardous locations. The goal of the IEC Ex Scheme is a series of IEC Standards Acceptable to all participating countries that will be used by any member Certification Body to issue a certification that will be acceptable to any member country.

MARKING

Typical North American marking

Class I,	Divisions 1 & 2	Groups A, B, C, and D, T6
Class I,	Zones 1 & 2	Groups IIC, IIB, IIA, T6
Class II,	Divisions 1 & 2	Groups E, F, and G
Class III		
NEMA 3, 4, 4X		

United States "AEx" marking requires Class and Zone suitability (Class I, Zone 1, AEx e IIC T5)

ATEX DIRECTIVE

This directive applies to electrical and non-electrical components and protective systems intended for use in potentially explosive atmospheres. Compliance with the requirements of this new directive will become mandatory on July 1, 2003 when the old approach directives will be repealed. Certificates of Conformity issued under the old approach directives will remain valid until June 30, 2003, after this date all products will need to comply with the requirements outlined under the "New Approach" or ATEX Directive (94/9/EC).

The ATEX Directive relates to electrical and mechanical equipment and includes items such as:

- All equipment and protective systems intended for use in potentially explosive atmospheres within the European Union are covered and must have the CE marking along with specific type of explosion protection markings.

- Explosive atmospheres caused by the presence of gas, vapors and mists.

- Existing, previously certified products must be re-examined to determine compliance with the new directives.

- Mining (Group I) and surface (Group II) non-mining is addressed. (Group I) applies to equipment intended for use in underground parts of mines, and to those parts of surface installations of such mines, likely to be endangered by firedamp and/or combustible dusts. (Group II) non-mining applies to equipment intended for use in other surface industrial and offshore locations likely to be endangered by explosive atmospheres.

- Equipment categories defining the required levels of protection are introduced. Category 1 covers equipment having a very high level of protection. Category 2 covers equipment having a high level of protection, and Category 3 covers equipment having a normal level of protection.

- Harmonized European standards are no longer listed in the directive. Instead, a set of electrical health and safety requirements is specified. CEN and CENELEC, the European standards making bodies have been charged with the responsibility of preparing standards in support of these essential health and safety requirements (EHSR's).

- Technical requirements for equipment and protective systems where the risk arises from combustible dusts, gases, vapors and mist are covered by the Essential Health and Safety Requirements.

- There is more emphasis placed upon the continued compliance of certified products. Conformity assessment addresses both the design and production phases. There is an option to adopt a quality systems approach to cover the production phase for some equipment. The quality system will be based on the ISO 9000 series of standards but augmented for this purpose.

- The requirements for surveillance are addressed in more detail and are not therefore open to differing interpretations of the requirements.

All manufacturers of products covered by these new directives must prepare a declaration of conformity containing details about the product, its intended use and how it complies with the requirements. In most cases, this will entail the involvement of a Notified Body in the Conformity Assessment Procedure.

DIVISION, ZONE, CATEGORY RISK ASSESSMENT

	FLAMMABLE GAS ALWAYS PRESENT >1000 HRS./YEAR	FLAMMABLE GAS NORMALLY PRESENT 10-1000 HRS./YEAR	FLAMMABLE GAS NOT NORMALLY PRESENT <10 HRS./YEAR
U.S. — NEC 500	Division 1	Division 1	Division 2
U.S. — NEC 505	Zone 0	Zone 1	Zone 2
CENELEC/IEC	Zone 0	Zone 1	Zone 2
ATEX	Category 1G (Gas)	Category 2G (Gas)	Category 3G (Gas)

PROTECTION METHODS

METHOD OF PROTECTION	SYMBOL	PERMITTED ZONE IEC	PERMITTED ZONE US (NEC 505)	ATEX CATEGORY
Flameproof	d	1 & 2	1 & 2	2
Enclosed Break	nC	2	2	3
Powder Filled	q	1 & 2	1 & 2	2
Increased Safety	e	1 & 2	1 & 2	2
Non-Sparking	nA	2	2	3
Intrinsic Safety	ia	0, 1 & 2	0, 1 & 2	1
	ib	1 & 2	1 & 2	2
	ic	2	—	3
Energy Limitation	nL	2	2	3
Pressurized	px	1 & 2	1 & 2	2
	py	1 & 2	1 & 2	2
	pz	2	2	3
Encapsulation	ma	0, 1 & 2	0, 1 & 2	1
	mb	1 & 2	1 & 2	2
Oil Immersion	o	1 & 2	1 & 2	2
Restricted Breathing	nR	2	2	3
Special	s (1)	—	—	1

(1) Must be marked suitable for Zone 0

EXPANDED MARKINGS
U.S. (NEC 500)

Class I Div. 1 Groups A, B, C, D T5

Permitted Class
Permitted Division
Gas Group
Temperature Class

U. S. (NEC 505)

Class I Zone 1 A Ex e IIC T5

Permitted Class
Permitted Zone
American National Standards Institute (ANSI)
Explosion Protected
Method of Protection
Gas Group
Temperature Class

IEC Ex MARKING

Ex e IIC T5

Explosion Protected
Method of Protection
Equipment Group
Temperature Class

ATEX MARKING
CE MARKING

CE 0000 Ex II 2 G

CE Marking
Notified Body number
Explosion Protected
Equipment Group
Category
Suitable for Gas

ADDITIONAL MARKING

Ex ia IIC T4

Explosion Protected
Method of Protection
Equipment Group
Temperature Rating

HUBBELL
KILLARK®