

Basics of Explosion Protection

HAZARDOUS LOCATIONS

Hazardous locations are defined as premises, buildings or parts thereof where fire or explosion hazards may exist due to the presence of flammable gases or vapors, flammable liquids, combustible dusts, or easily ignitable fibers or flyings.

Although, flammable gases, vapors and combustible dusts exist almost everywhere, fortunately, they are present only in minute quantities. Simply because flammable gases or vapors, or combustible dusts are present, there is not necessarily a hazardous location. The quantities or concentrations must be sufficient to present a potential explosion hazard.

The electrical codes that deal with these types of hazardous locations areas do not deal with materials such as high explosives, such as dynamite, munitions, or fireworks. Other rules and regulations deal with areas involving these materials.

Understanding “Global” Hazardous Location Requirements

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 occurrence or risk of fire or explosion that the material presents. While Canada has traditionally been a country with a Class, Division system like the US; Canada has adopted the Class Zone system for new construction projects, the Class, Division system still exist in facilities previously built under this system.

In other parts of the world, areas containing explosive atmospheres are dealt with using the “Zone System”. Zones are based predominantly on the International Electrotechnical Commission (IEC) and European Committee for Electrotechnical Standardization (CENELEC) standards. Whereas North America deals with multiple types of hazardous atmospheres.

HAZARDOUS LOCATION BASICS

In North America, hazardous locations are separated into three “Classes” or types based on the explosive characteristics of the materials. The Classes or type of material is further separated into “Divisions” or “Zones” based on the release of the flammable material. The Zone system has three levels of hazard versus the Division System’s two levels.

Hazardous Materials	Class/Division System	Class/Zone System
Gases or Vapors ①	Class I, Division 1	Class I, Zone 0, Zone 1
	Class I, Division 2	Class I, Zone 2
Combustible Dusts ②	Class II, Division 1	Class I, Zone 20 Zone 21
	Class II, Division 2	Class I, Zone 22
Fibers or Flyings	Class III, Division 1	Class I, Zone 20 Zone 21
	Class III, Division 2	Class I, Zone 22

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

② Zones 20, 21 and 22 for Dust are adopted by Europe and the U.S. but not by Canada.

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 ignitable mixtures. The terms, “gases or vapors” differentiates between materials that are in a gaseous state under normal atmospheric conditions, such as hydrogen or methane, and a vapor that is flashed off from a liquid, under normal atmospheric conditions, such as gasoline.

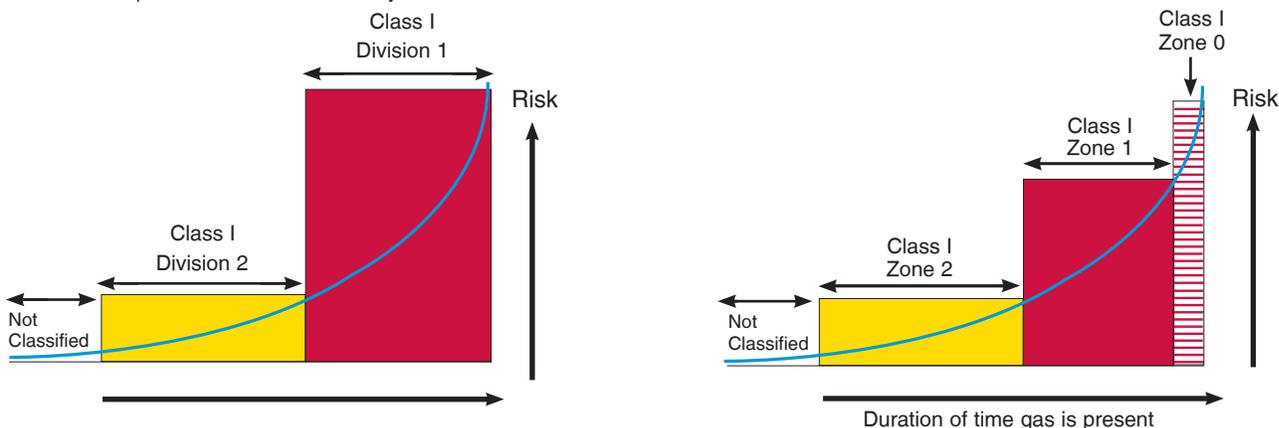
The subdivision of Class I, locations into “Divisions” or “Zones” is based on the probability that an explosive gas atmosphere may be present in a location. If the risk is extremely low, the location is considered unclassified. A good example of a low risk area is a single family home with natural gas or propane furnace for heating. The gas could, and does on extremely rare occasions, leak into the home, encounter an ignition source and an explosion occurs, usually with devastating results. However, since the risk is so low, because of the safety systems built into the gas supply and heating equipment, these areas are not “hazardous (classified) locations”.

Recent editions of the NEC® (National Electrical Code) and CEC® (Canadian Electrical Code) have incorporated the international definitions for “Zones” for Class I, locations. The two codes continue to address the “Division” system although the methods are somewhat different.

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

Frequency of Occurrence	Division System	Class/Zone System
Continuous	Class I, Division 1	Class I, Zone 0
Intermittent Periodically		Class I, Zone 1
Abnormal Condition	Class I, Division 2	Class I, Zone 2

The charts below compare the Division and Zone systems in terms of risk assessment.



The abnormal conditions of occurrence, or lower risk areas, in the Zone and Division system are basically identical. However, in areas where a hazard is expected to occur in normal operation, the Zone system deals with highest risk areas separately, and risk associated with the remaining location 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	Class, 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

①The 1-hour per year used in API RP505 is considered to be high by some industry experts. Conservative estimates of this figure should be 0.01 hours per year.

Class I Locations, continued

Class I locations are further divided into Groups based on the explosive properties of the materials present. North America under the Class & Div. System uses four Gas groups while the IEC/CENELEC and the U.S. and Canada under the Zone System use three.

The chart below compares the two systems.

Typical Gas	Class/Division Gas Groups	Class I, Zone Gas Groups
Acetylene	A	II C
Hydrogen	B	
Ethylene	C	II B
Propane	D	II A

(The US has added a "IIB + hydrogen" group to address certain construction limitations.)

Class II Locations

Class II locations are those which are hazardous due to the presence of combustible or electrically conductive dusts. 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.

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.

Groups	Type of Material	Examples
E	Metal Dusts	Powdered Metals such as Aluminum or Magnesium
F	Carbonaceous Dusts	Carbon Black, Coal Dust or Coke Dust
G	Agricultural Dusts	Grain, Flour, Sugars, Spices and certain Polymers

(The IEC and NEC 506 have developed Zones for atmospheres containing combustible dusts, which again separates areas in to three Zones 20, 21 and 22.)

Zone 20, 21 and 22 Locations

The IEC/CENELEC and the U.S. introduced the three-Zone system for combustible dust locations. These have not been included in the CEC yet. The definitions are as follows:

Zone 20 - an area in which a combustible dust, as a cloud, is present continuously or frequently during normal operations in sufficient quantities to produce an explosive mixture.

Zone 21 - an area in which a combustible dust, as a cloud, is likely to occur during normal operations in sufficient quantities to produce an explosive mixture.

Zone 22 - an area in which combustible dust clouds may occur infrequently and persist for only short periods of time or in which accumulations or layers may be present under abnormal conditions.

Class III Locations

Class III locations are those which are hazardous due to the presence of easily ignitable fibers or flyings. However, the material is not suspended in the air in quantities sufficient to produce ignitable mixtures.

Easily ignitable fibers and flyings present a serious fire risk, not normally an explosion hazard. The greater danger with Class III materials is that if a layer forms throughout a facility, an ignition will cause a flash fire which moves at near explosive speeds.

In the Zone System fibers and flyings are treated under Zone 20, 21 and 22.

TEMPERATURE CLASSES

Ignition temperature or auto-ignition temperature (AIT) is the minimum temperature of a surface at which an explosive atmosphere ignites. Flammable vapors and gases can be classified into temperature classes according to their ignition temperature. The maximum temperature of a piece of equipment must always be lower than the ignition temperature of the gas - air mixture or vapor - air mixture in which it is placed. Equipment shall be marked to show the operating temperature or temperature class referenced to a +40°C (+104°F) ambient. The temperature class (T code) is indicated on the manufacturers nameplate and is based on the table below.

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. The standard temperature range for equipment design in the Zone system is -20°C to +40°C; and in the Class and Division System -25°C to +40°C for this ranges no ambient temperature marking is required on the product. Electrical equipment that is designed for use in a range of ambient temperature other than stated, the actual ambient temperature range shall be marked on the equipment nameplate.

The R. STAHL product lines, in most cases, exceed the above mentioned temperature requirements. Refer to the appropriate catalog pages for the product-specific "Ambient Temperature Range". Any ranges outside of the above stated ranges are marked on the product nameplate.

North American Temperature Code	IEC/CENELEC/NEC 505 Temperature Classes	Maximum Temperature	
		°C	°F
T1	T1	450°C	842°F
T2	T2	300°C	572°F
T2A	-	280°C	536°F
T2B	-	260°C	500°F
T2C	-	230°C	446°F
T2D	-	215°C	419°F
T3	T3	200°C	392°F
T3A	-	180°C	356°F
T3B	-	165°C	329°F
T3C	-	160°C	320°F
T4	T4	135°C	275°F
T4A	-	120°C	248°F
T5	T5	100°C	212°F
T6	T6	85°C	185°F

Applications requiring product with extreme ambient temperature ranges outside those standard ranges stated under the heading "Ambient Temperature Range" are specified under the heading of "Special Ambient Temperature Range". Only products with this additional catalog information can be customized for extreme temperature applications. Please consult factory for your special needs.

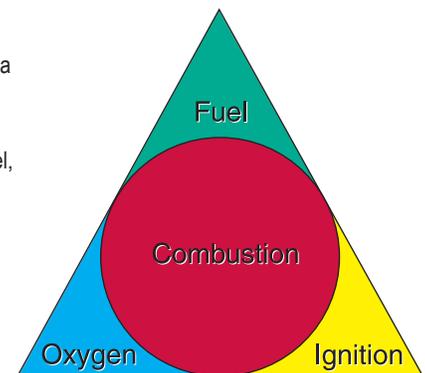
EXPLOSIVE GAS PROTECTION METHODS

There are a number of methods of protecting electrical equipment, which prevent an explosion when used in a flammable gas atmosphere.

Three elements are required for an explosion to occur - fuel, oxygen and a heat or ignition source must be present. 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 the "Lower Explosive Limit" (LEL) and the "Upper Explosive Limit" (UEL).

Each method of protection addresses the Fire Triangle in some manner. Either by containing an internal explosion or eliminating one or more of the components necessary for an explosion to occur.

The most common North American methods of protection are explosionproof equipment for Class I locations, and dust-ignition proof equipment for Class II locations. R. STAHL produces a wide range of equipment for use in hazardous locations using various methods of protection.



Methods of Protection (Gas)

Flameproof Type of Protection "d" - or Explosionproof Equipment



Although the North American term "explosionproof" and IEC term "flameproof" are SIMILAR concepts, the requirements in the product standards are different. Explosionproof is a Div. 1 technology which can be used in a NEC or CEC defined Zone 1 environment. Flameproof is a Zone 1 technology and can not be used in a Div. 1 environment.

Since flammable gases and vapors are expected inside an enclosure, the equipment must be capable of withstanding an explosion caused by sparking contacts of devices, high temperatures, 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 escape through the joints of the unit.

In addition, the external surfaces of the enclosure must not become hot enough to ignite the surrounding atmosphere due to heat energy within the unit. This heat energy may be the result of normal operation of heat-producing equipment, or the result of an electrical arc to the enclosure from an arcing ground fault. Safety factors are applied to all testing of this type of enclosure to ensure the unit will not rupture as a result of an internal explosion.