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The Basics of Hazardous Locations and Lighting

Kurtzon Lighting

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Background

In this complicated world many workers are exposed daily to the danger of fire or explosion. Even ordinary people are regularly exposed to this type of hazard at the gas station, auto dealership or hospital. Protecting these areas from explosion are many organizations such as the American Gas Assoc. (AGA), Factory Mutual (FM), Occupational Safety and Health Act (OSHA) and above all, the National Fire Protection Association (NFPA). The NFPA publishes the nations most authoritative and comprehensive document on electrical safety, NFPA 70, National Electric Code (commonly called the "NEC"). The NEC is a part of the wide variety of safety documents the NFPA publishes. The NEC addresses in chapter five the requirements for electrical equipment and wiring used in locations where fire or explosion hazards may exist due to flammable gases or vapors, flammable liquids, combustible dusts or ignitable fibers, or flyings. Knowing when and what type of a hazardous location exists is the professional engineer's job as well as the "local authority with jurisdiction". The NEC contains the requirements needed to design the electrical system in a way that reduces the hazard in the location. The requirements for hazardous locations are found in article 500 through 505. (See Note 1)

Attributes of Some Class I Gases

Group	Gas	Flammable Range or Limits (Percent by Volume)		Auto Ignition Temp.(°F)	Density (Air = 1)
		Low Concentration	High Concentration		
A	Acetylene	2.5	100	580	0.9
B	Hydrogen	4.0	75	930	0.1
C	Hydrazine	2.9	98	70	1.1
D	Propane	2.1	9.5	840	1.6

This chart is offered only as an example of gases' hazardous properties. It is not to be used for determining the proper electrical equipment. For this consult your professional engineer. These values are based on standard temperature and pressure, when temperature is not a factor.

Defining Locations

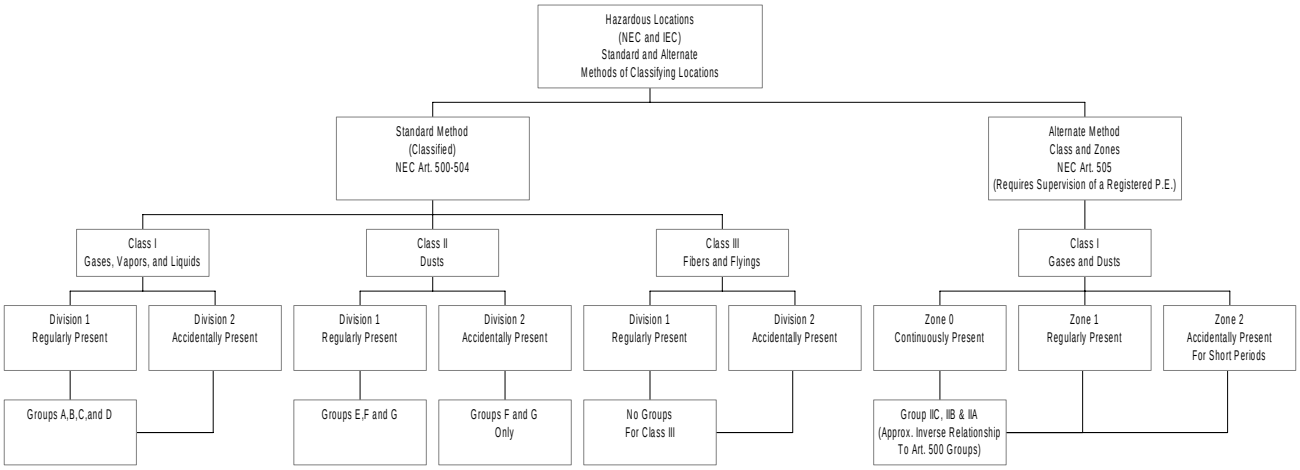
The specific difference between ordinary and hazardous locations is the presence of a combustible atmosphere.
The presence of a fuel in an environment where electric service is provided is the essence of any hazardous location. The term "presence" is important to define. There are many areas where fuel is or could be made available that are not considered hazardous locations. The determining factor is concentration. Most gaseous fuels have a range of concentration that is ignitable. Above or below this range, the atmosphere may not be ignitable. *(Keep in mind that we should always treat the "high concentration" as a hazard since it would be very easy to reduce the concentration into the hazardous conditions.)*
Most gases are heavier or lighter than air, so concentrations in a space may vary greatly throughout the room. A heavy vapor like propane will have a higher concentration near the floor and a lower concentration near the ceiling. Conversely, a lighter vapor like Hydrogen can have its highest concentration near the ceiling. The concentration is important to determine the hazard involved. For instance, natural gas has a flammable (explosive) limit of 5.0% lower and 15% for a higher limit.[2] When concentrations are below 5%, the mixture is too lean to burn and if it is above 15%, it is too rich to burn. Do not use the upper limit for a margin of safety because the mixture will go through the explosive range during an accidental spillage or release.

Another type of hazardous location is where combustible dusts are stored or handled. Combustible dusts are heavier than air and easily accumulate on the surfaces of electrical components, which can insulate them and thereby cause them to overheat. Dusts also can easily be temporarily suspended in an ignitable cloud when released or disturbed. Therefore, some Hazardous Locations are areas where the build up of a combustible dust or the generation of a dust cloud is possible. Similarly, other hazardous locations are areas where the build up of combustible fibers or flyings is possible. To summarize, the type of combustible atmosphere present in the environment, whether gas, dust or fiber is the key element in the classification and definition of the hazardous location.

Ignition

Ignition happens when the fuel, within the explosive range, in the presence of air, is exposed to an **ignition source** such as sparks, a flame, or to temperatures above its **Autoignition Temperature (AIT)**. The AIT is specific to a volatile mix. Assuming a concentration of natural gas in a normal air environment the AIT is 1000 degrees F. (See chart for other gases AIT values). If heated to this temperature it would ignite and burn without the addition of any other energy such as spark or

flame. The AIT is important to determine the type of equipment needed, where this kind of fuel is available. Using a margin of safety, authorities determine the required Maximum Operating Temperatures of heat generating devices such as lighting fixtures, motors, etc. with reference to the AIT. Since a hazardous fuel presence is expected the products intended for use in these environments must be assured of not providing the ignition energy. Electrical equipment must be designed to contain all sparks or flames generated during normal or abnormal conditions as well as not to exceed the maximum operating temperature required for this environment.



Once a hazardous location is defined and classified, its requirements must be matched to the correct electrical equipment for use in that environment. Only special electrical equipment is allowed into these environments , and a great deal of effort and expense by manufacturers is devoted to offering this equipment. Only certain organizations, such as UL, have developed standards and procedures, for designing and testing of this equipment for hazardous locations. This work is keyed to three important concepts: **Class, Division and Group**

Classes

The type of fuel involved determines classes. Class I is related to the gases like hydrogen or gasoline, Class II is associated with the dusts like coal and grain dusts. Class III encompasses fibers or flyings as found in the textile and woodworking industry though areas of wood dust are a Class II location.

Divisions

Divisions are the second category used to determine the extent of the hazard. Will the site be exposed to the fuel regularly or rarely due to containment or ventilation system failure? The answer to this question determines which division applies to this site.

Division 1 is the most severe environment. The hazardous atmosphere is always or is often present or may become present during frequent servicing or repair.

Division 2 is where the hazardous atmosphere is only available during accidental spillage or the like. These environments are usually storage or handling facilities where the element is kept in sealed containers or closed systems. This division can also be found adjacent to Div I areas where the fuel might occasionally be communicated. Also, Div II environments exist where ignitable concentrations of the fuel are normally prevented by mechanical positive ventilation, which could become hazardous upon failure or abnormal operation of the ventilation systems. Kurtzon offers many lighting products for Division 2, (Classes I, II & III).

Groups The last major category for specifying a hazardous location are groups. Hazardous materials are separated into groups based on their physical characteristics. Some of these characteristics are explosive energy, particle size and conductivity. The group designation further defines the type of hazard involved and the type of equipment needed to maintain safety. Class I groups are defined as letters A through D. The letter designation refers to the relative pressure generated during an explosion. It does not relate to the AIT, or the flammable range. Class I, Group A gases are capable of generating the highest explosion pressures. Where Group D gases generate the least pressure. Due to the higher explosive

energy involved, the equipment destined for Group A environments are more difficult to manufacture compared to the group D fixtures. Group designations for Class II areas refer to the type of dust involved. Group E dusts contain combustible metal dusts like aluminum, magnesium and others. Group F dusts contain carbon or carbonaceous dusts like coal and some other combustible dusts. Group G dust are the combustible dusts not found in groups E or F.

There are several ways to provide acceptable protection from electrical equipment in hazardous (classified) locations. Each class may require different methods to arrest the hazard. We provide this section to help you understand the physical differences between the products offered for each class or division.

Maximum Operating Temperatures

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

Taken from table 500-3d, NEC-96

explosive energy release is usually unexpected. The fixture is not sealed. The fixtures are purposely designed with special leak paths that allow for the safe exit of the expanding gases from an internal explosion. Concentric rings, special threads and/or machined joints are what leak the exhaust of the explosion. If these leaks were sealed, the fixture might rupture and ignite the surrounding atmosphere. The process of leaking hot gases from the enclosure is important. The escaping gases must be cooled well below the autoignition temperature of the surrounding atmosphere or the flame could spread. Once cooled by the flame front's close contact with the metal escape path, the exhaust is no longer a hazard. Explosion

Explosion Proof construction
Class I Div. 1 fluorescent Fixture.

Methods of Protection:

Explosion-Proof devices for Class I Div. 1 or 2.

A device, including its enclosure, that is designed to withstand an explosion from within, of a certain gas or vapor. The device and its enclosure also prevent the ignition of the same surrounding atmosphere by arresting sparks, flame, hot gases or flashes created within the fixture. In addition, the external operating temperature (hottest extended surface) will not ignite the surrounding hazardous gas or vapor. It is expected that an explosion will occur within the enclosure. Protection is only afforded by controlling the energy released from the enclosure. One of the key methods used to control the

Class I Div. 2 Hazardous Location Fixture
Kurtzon Lighting HL-A-1-40-1/OCT

proof devices are suitable for both Division 1 and Division 2 Class I environments.

Class I Div. 2

Protection for Class I Div. 2 devices are handled differently based on the device. You can use products listed for

Class I Div. 1 in these areas. You can also use many of the other methods of protection as found in the NEC. One of the more economical methods is to provide electrical devices that are **NRLT** listed to meet the specific features described by the NEC for Div. 2 installations. Fixtures, for instance, must be designed to contain all arcing and sparking. In addition to this other construction requirements, tests must be done to determine the maximum operating temperature of every surface of the fixture, inside or out. These fixtures are marked with the Maximum operating temperature or the Temperature Range Code and the maximum ambient temperature (room temperature). Products listed for this area are also marked with the Class, Division and Group. The NEC still allows "Enclosed and Gasketed" or what used to be called "Vaportight" fixtures for this area but regulatory agencies have all but eliminated this fixtures use in practice.

Purged and Pressurized

Another protection method is the purged and pressurized (P&P) system. This system is created using purged and pressurized enclosures in conjunction with a protective gas to reduce the classification of internal enclosure spaces to a new division II space or possibly a non-classified space. The protective gas must be supplied at a suitable pressure and flow to prevent the entrance of the hazardous element (gas, dust or fiber). In addition, protective measures must be taken to provide safeguards against pressure system failure.

There are three types of Purged and Pressurized systems: Type X, reduces the classification within the protected enclosure from Div I to non-classified (ordinary) locations. Type Y, Div I to Div II and Type Z, Div. II non-classified. For more information on P & P, see NFPA496-1993.

Intrinsically Safe: This is another recognized form of protection for hazardous locations. The protection comes from limiting the energy available to a level incapable of igniting the hazardous atmosphere even when in an overload or abnormal condition. This protection is usually used for control circuits and measurement equipment such as thermocouples, light emitting diodes (LED's) and pressure sensors. Nonincendive circuits and nonincendive components are permitted where approved for Class I, Div 2 locations and are similar to the intrinsically safe, in that they will not ignite the atmosphere.

Paint Spray Booths

This space has special requirements regarding lighting fixtures. Surface mounted fixtures installed inside must be rated for Class I or II, Div.1. Where recessed fixtures are in use in ceiling or walls the Division 2 products may in some conditions be applied if they are additionally listed for paint spray booths. The lens frame must provide for control of a interlock switch wired to disable the application process. This interlock would prevent the generation of the vapor if the fixture lens is not sealed. Another method of lighting these areas uses break resistant clear tempered glass panels separating the classified space from fixed mounted Division 2 listed fixtures or ordinary location fixtures (as required) installed outside of the booth. Fixture installation must be so that radiant or conductive heat will not create excess heat that may ignite residue or vapor on or near the glass panel. This allows the use of less expensive wiring methods and equipment as well. Consult Art. 516 for specifics regarding this application.

Hermetically Sealed: The last method of protection is the "Hermetically Sealed". A hermetically sealed device *permanently* excludes the hazardous environment. Typically used for switching devices, this method relies on the fusion seal between metals and or glass to maintain separation of environments. This method is only approved for use in certain Class I Div II locations.

Class II

Dust-ignition proof construction excludes dust from inside the enclosure and when properly installed will not permit arcs or sparks or heat to ignite an exterior accumulation or cloud of a specific dust on or near the enclosure.

The exclusion of dust from the inside of the enclosure and the effect of the dust blanket or dust build-up on external temperatures are two of the concerns addressed by Laboratory testing.

Class III

The methods of protection for this category are similar to the ones provided for Class II in that they relate to keeping the fibers out of the device and containing any arcs or sparks and avoiding overheating of the components.

Laboratory Testing

In the United States there are several nationally recognized testing laboratories that test and approve hazardous location products. The products that have approval are published in books or directories. These directories are available to local authorities to verify the suitability of a product for a certain application. One of these books is called the "Hazardous Location Equipment" Directory published by Underwriters Laboratories Inc. commonly called the UL Red book.

New Classification Methods

IEC Class and Zones

There is now an alternate method of classifying hazardous locations. The method is based on standards for area classification from the International Electrotechnical Commission (IEC). This classification scheme only covers the exposure of gases similar to Class I locations from Art. 500. There are three zones that are similar to the divisions of Art. 500 in that they are related to the likelihood of exposure.

Zone 0 is the area where there is a constant exposure in excess of 1000 hours per year of the hazardous atmosphere. It is not a good practice to use electrical equipment in this zone if it can be avoided. It is wise to use only products listed for this zone that are intrinsically safe systems.

Zone 1 is the area where the exposure is common under normal operating conditions or may exist during frequent repair or maintenance, typically less than 1000 hrs but greater than 10hrs per year.

Zone 2 is similar to Division 2 where the hazardous atmosphere is only available during accidental spillage or the like. These environments are usually storage or handling facilities where the element is kept in sealed containers or closed systems or exposure is limited to less than 10 hours per year. This zone can also be found adjacent to Zone I areas where the element might occasionally be communicated. Further information on this method of classification can be found in article 505 of the NEC-1996.

Class I Div. 2 Wet location listed surface mounted fixtures. WL-PSB, WL-D, WL-E Vega Series

Class I Div. 2 HID recessed and surface mounted fixtures. HL-S-3-541 or KL-G-3-541.

Class I Div. 2 Wet location listed surface mounted fixtures. WL-A, WL-AFV, WL-B, WL-C Vega Series

Class I and II, Div. 2 fluorescent recessed fixtures for grid or drywall ceilings. HL-G-3 or HL-F-3 series.

Glossary

Auto Ignition Temperature (AIT) - The temperature where burning may start without the presence of a flame, spark or arc.

Classes - Shown as I, II, or III. Distinctions made between the type of hazard involved regarding the kind of fuel in the environment.

Classified - Referring to areas or electric components that are or for hazardous location.

Concentration – Expressed in percentages of the subject fuel such as 25% hydrogen where the balance is air.

Density – Expressed as a factor usually referenced to air or water to help determine whether a fuel will rise or fall. (In this document it is referenced to air which equals 1.0)

Divisions- Shown as 1or 2. Distinctions made between the extent of the hazard involving the likelihood of the exposure to the hazard.

Explosion - The spontaneous violent burning of fuel.

Flash point - The temperature where a flammable liquid becomes a gas.

Flying – Small, light and thin polymeric materials typically the result of manufactureing processes.

Fuel - Chemical or molecular energy stored in many forms, liquid, gas or solid. They usually contain a form of hydrogen or carbon or both.

Groups – Shown as letters A through G. Further Distinctions made between the types of fuels and their specific explosive characteristics or particle size. Fuels are grouped together when they pose a similar hazard. Groups A through D are for Class I and include gases, liquids and vapors. Groups E, F & G are dusts for Class II locations. There are no groups for Class III locations.

Hermetically Sealed- (As it applies here) A seal that is created by the fusion of glass to metal or metal to metal

Ignition Source – The introduction of sufficient energy to cause burning

Listed – Referring to a product that has been tested or otherwise evaluated for safety by a nationally recognized testing laboratory.

Nonincendive – Low energy electrical systems or components designed to not ignite an atmosphere.

NRTL - A nationally recognized testing laboratory such as Underwriters Laboratories and Canadian Standards Assoc.

Temperature Code – An assigned designation referenced to a maximum operating temperature range for a heat generating device such as a motor or lighting fixture. (Not to be confused with autoignition temperature.)

Zones - A new method (NEC-96, art. 505) of describing locations that are hazardous due to the presence of fuels.

Notes:

For Informational Purposes Only:

None of the foregoing is to be construed in any way as a replacement for the guidance, advice or approval of a qualified professional engineer. As always, consult your local authority and all relevant standards.

1. *The NEC does not classify areas where ammunition, blasting powder or dynamite is used, made or stored. These areas are covered by other regulating authorities who may use classified products as part of their safety precautions, even though the products have not been evaluated for such service.*
2. *Values are referenced to standard temperatures and pressures. The lower limits are lower and the upper limits are higher when the temperature is increased.*

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