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Area Classification- A Tool for Risk Assessment

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Abstract- Gases, vapours, mists and dusts can all form explosive atmospheres with air. Hazardous area classification is used to identify places where, because of the potential for an explosive atmosphere, special precautions over sources of ignition are needed to prevent fires and explosions.

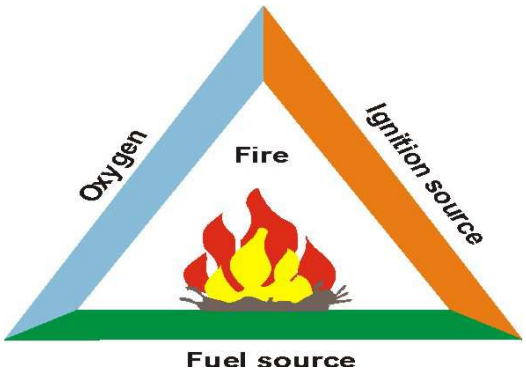
Hazardous area classification should be carried out as an integral part of the risk assessment to identify places where controls over ignition sources are needed (hazardous places) and also those places where they are not (non hazardous places). Hazardous places are further classified in Zones which distinguish between places that have a high chance of an explosive atmosphere occurring and those places where an explosive atmosphere may only occur occasionally or in abnormal circumstances. The definitions of the Zones also recognize that the chance of a fire or explosion depends on the likelihood of an explosive atmosphere occurring at the same time as an ignition source becomes active.

The methods used to classify an installation can vary depending upon which part of the world it is located, but generally there are two main types of classification. In countries that have adopted the IEC (International Electro technical Commission) philosophy this is referred to as Zoning whilst in North American installations are classified by Classes, Divisions and Groups to ascertain the level of safety required.

Keywords : *Atmosphere, explosive, flammable, Hazard, zones.*

1. INTRODUCTION

A “hazardous area” is defined as an area in which the atmosphere contains, or may contain in sufficient quantities, flammable or explosive gases, dusts or vapours. In such an atmosphere a fire or explosion is possible when three basic conditions are met. This is often referred to as the “hazardous area” or “combustion” triangle.



When electrical equipment is used in, around, or near an atmosphere that has flammable gases or vapours, flammable liquids, combustible dusts, ignitable fibres or flyings, there is always a possibility or risk that a fire or explosion might occur. Those areas where the possibility or risk of fire or explosion might occur due to an explosive atmosphere and/or mixture is often calleda hazardous (or classified) location/area. Currently there are two systems used to classify these hazardous areas, viz.:- the Class/Division system and the Zone system. The Class/Division system is used predominately in the United States and Canada, whereas the rest of the world generally uses the Zone system.

The *National Electrical Code* (NEC) defines hazardous locations as those areas "where fire or explosion hazards may exist due to flammable gases or vapours, flammable liquids, combustible dust or ignitable fibres or flyings."

A substantial part of the NEC is devoted to the discussion of hazardous locations. That's because electrical equipment can become a source of ignition in these volatile areas.

Hazardous locations are classified in three ways by the *National Electrical Code*:
TYPE, CONDITION, and NATURE.

1. HAZARDOUS LOCATION TYPES

Class/ Division System

Hazardous locations as per the Class/ Division system are classified according to the Class, Division and Group.

1. *Class* – The Class defines the general nature (or properties) of the hazardous material in the surrounding atmosphere which may or may not be in sufficient quantities.

Class/ Division System

Class-I-Locations

According to the NEC, there are three types of hazardous locations. The first type of hazard is one which is created by the presence of flammable gases or vapours in the air, such as natural gas or gasoline vapour. When these materials are found in the atmosphere, a potential for explosion exists, which could be ignited if an electrical or other source of ignition is present. The Code writers have referred to this first type of hazard as Class I. So, a Class I Hazardous Location is one in which flammable gases or vapours may be present in the air in sufficient quantities to be explosive or ignitable. Some typical Class I locations are:

- Petroleum refineries, and gasoline storage and dispensing areas;
- Dry cleaning plants where vapours from cleaning fluids can be present;
- Spray finishing areas;
- Aircraft hangars and fuel servicing areas; and
- Utility gas plants, and operations involving storage and handling of liquified petroleum gas or natural gas.
- All of these are Class I . . . gas or vapour . . . hazardous locations. All require special Class I hazardous location equipment.

Class-II-Locations

The second type of hazard listed by the National Electrical Code are those areas made hazardous by the presence of combustible dust. These are referred to in the Code as "Class II Locations." Finely pulverized material, suspended in the atmosphere, can cause as powerful an explosion as one occurring at a petroleum refinery. Some typical Class II locations are:

- Grain elevators;
- Flour and feed mills;
- Plants that manufacture, use or store magnesium or aluminium powders;
- Producers of plastics, medicines and fireworks;
- Producers of starch or candies;
- Spice-grinding plants, sugar plants and cocoa plants; and
- Coal preparation plants and other carbon handling or processing areas.

Class-III-Locations

Class III hazardous locations, according to the NEC, are areas where there are easily-ignitable fibers or flyings present, due to the types of materials being handled, stored, or processed. The fibers and flyings are not likely to be suspended in the air, but can collect around machinery or on lighting fixtures and where heat, a spark or hot metal can ignite them. Some typical Class III locations are:

- Textile mills, cotton gins;
- Cotton seed mills, flax processing plants; and
- Plants that shape, pulverize or cut wood and create sawdust or flyings.

2. HAZARDOUS LOCATION CONDITIONS/DIVISION

Division—The Division defines the probability of the hazardous material being able to produce an explosive or ignitable mixture based upon its presence.

a. Division 1 indicates that the hazardous material has a high probability of producing an explosive or ignitable mixture due to it being present continuously, intermittently, or periodically or from the equipment itself under normal operating conditions.

b. Division 2 indicates that the hazardous material has a low probability of producing an explosive or ignitable mixture and is present only during abnormal conditions for a short period of time.

Good examples of Class I, Division 1 locations would be the areas near open dome loading facilities or adjacent to relief valves in a petroleum refinery, because the hazardous material would be present during *normal* plant operations.

Closed storage drums containing flammable liquids in an inside storage room would not normally allow the hazardous vapours to escape into the atmosphere. But, what happens if one of the containers is leaking? You've got a Division 2 -abnormal - condition . . . a Class I, Division 2 hazardous location.

3. NATURE OF HAZARDOUS SUBSTANCES/GROUP

The gases and vapours of Class I locations are broken into four groups by the Code: A, B, C, and D. These materials are grouped according to the ignition

temperature of the substance, its explosion pressure, and other flammable characteristics.

The only substance in Group A is acetylene. Acetylene makes up only a very small percentage of hazardous locations. Consequently, little equipment is available for this type of location. Acetylene is a gas with extremely high explosion pressures.

Group B is another relatively small segment of classified areas. This group includes hydrogen and other materials with similar characteristics. If you follow certain specific restrictions in the Code, some of these Group B locations, other than hydrogen, can actually be satisfied with Group C and Group D equipment.

Group C and Group D are by far the most usual Class I groups. They comprise the greatest percentage of all Class I hazardous locations. Found in Group D are many of the most common flammable substances such as butane, gasoline, natural gas and propane.

In Class II - dust locations - we find the hazardous materials in Groups E, F, and G. These groups are classified according to the ignition temperature and the conductivity of the hazardous substance. Conductivity is an important consideration in Class II locations, especially with metal dusts.

Metal dusts are categorized in the Code as Group E. Included here are aluminium and magnesium dusts and other metal dusts of similar nature.

Group F atmospheres contain such materials as carbon black, charcoal dust, coal and coke dust.

In Group G we have grain dusts, flour, starch, cocoa, and similar types of materials.

Zone System

Hazardous locations per the Zone system are classified according to its Zone which can be gas or dust. For gas atmospheres electrical equipment is further divided into Groups and Subgroups.

Zone—The Zone defines the probability of the hazardous material, gas or dust, being present in sufficient quantities to produce explosive or ignitable mixtures.

1. Gas

a. Zone 0—Ignitable concentrations of flammable gases or vapours which are present continuously or for long periods of time.

b. Zone 1—Ignitable concentrations of flammable gases or vapours which are likely to occur under normal operating conditions.

c. Zone 2—Ignitable concentrations of flammable gases or vapours which are not likely to occur under normal operating conditions and do so only for a short period of time.

Group—Electrical equipment used in gas atmospheres is divided into two groups.

- Group I—Equipment used in mines with atmospheres containing methane or gases and vapours of equivalent hazard.
- Group II—All other equipment; which is further subdivided into three subgroups.
  - Group IIA—Atmospheres containing propane, or gases and vapours of equivalent hazard.
  - Group IIB—Atmospheres containing ethylene, or gases and vapours of equivalent hazard.
  - Group IIC—Atmospheres containing acetylene or hydrogen, or gases and vapours of equivalent hazard.

2. Dust

a. Zone 20—An area where combustible dusts or ignitable fibres and flyings are present continuously or for long periods of time.

b. Zone 21—An area where combustible dusts or ignitable fibres and flyings are likely to occur under normal operating conditions.

c. Zone 22—An area where combustible dusts or ignitable fibres and flyings are not likely to occur under normal operating conditions and do so only for a short period of time.

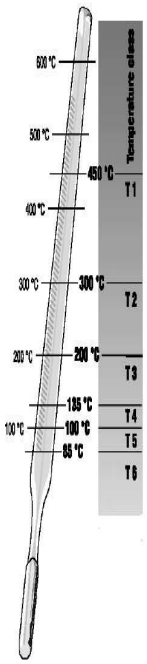
Classification Table

Summary of Class I, II, III Hazardous Locations			
CLASSES	GROUPS	DIVISIONS	
		1	2
I Gases, vapors, and liquids (Art. 501)	A: Acetylene B: Hydrogen, etc. C: Ether, etc. D: Hydrocarbons, fuels, solvents, etc.	Normally explosive and hazardous	Not normally present in an explosive concentration (but may accidentally exist)
II Dusts (Art. 502)	E: Metal dusts (conductive,* and explosive) F: Carbon dusts (some are conductive,* and all are explosive) G: Flour, starch, grain, combustible plastic or chemical dust (explosive)	Ignitable quantities of dust normally are or may be in suspension, or conductive dust may be present	Dust not normally suspended in an ignitable concentration (but may accidentally exist). Dust layers are present.
III Fibers and flyings (Art. 503)	Textiles, wood-working, etc. (easily ignitable, but not likely to be explosive)	Handled or used in manufacturing	Stored or handled in storage (exclusive of manufacturing)

Temperature Class Definition

The temperature classes are used to designate the maximum operating temperatures on the surface of the equipment which should not exceed the ignition temperature of the surrounding atmosphere. Ignition temperature is the minimum temperature required, at normal atmospheric pressure in the absence of a spark or flame, to set afire or cause self-sustained combustion independently of the heating or heated element.

Class I temperature marking shall not exceed the ignition temperature of the specific gas or vapour to be encountered as specified in NEC section 500-5(d).



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

Marking The rules for marking the electrical equipment are uniformly laid down in the standards relating to general technical requirements. The equipment must be distinctively marked in accordance to the classified area in which it can be installed.

The minimal marking must indicate the following:

- Class
- Division
- Group
- The maximum safe operating temperature or temperature range, based on a 40□C ambient.
- Any special conditions that have to be observed (such as NEC section 500-5(d))

- **EXECUTION TO NEC/CEC STANDARDS**

Type of Flammable Substance

Class I
Class I — Approved for the strictest Class, therefore all Classes
- Class I — Flammable gas, vapours, and liquids
- Class II — Combustible dusts
- Class III — Ignitable fibres and flyings

Area Classification

Division 1 — Approved for the strictest Division, therefore both Divisions
- Division 1 — Flammable substances are continually present or are likely to exist under normal operating conditions
- Division 2 — Flammable substances are not likely to exist under normal operating conditions

Gas Group

Group B — Approved for Group B; therefore also approved for Groups C and D, but not Group A. If no Groups are listed, approved for all Groups.
The gases are grouped according to certain physical characteristics on their explosive behaviour.

Temperature Code

If no temperature code is listed, meets strictest temperature code **(T6).** This is the maximum temperature that the equipment is allowed to emit without causing an explosion/fire.

- **PROTECTION TECHNIQUES AND METHODS**

Various protection techniques and methods have been developed and employed, thus reducing or minimizing the potential risks of explosion or fire from electrical equipment located in hazardous locations. Not all methods are listed.

Class/Division system

Explosion-proof—A type of protection that utilizes an enclosure that is capable of withstanding an explosive gas or vapour within it and or preventing the ignition of an explosive gas or vapour that may surround it and that operates at such an external temperature that a surrounding explosive gas or vapour will not be ignited thereby._ Intrinsically Safe—A type of protection in which the electrical equipment under normal or abnormal conditions is incapable of releasing sufficient electrical or thermal energy to cause ignition of a specific hazardous atmospheric mixture in its most easily ignitable concentration. _ Dust Ignition-proof—A type of protection that excludes ignitable amounts of dust or amounts that might affect performance or rating and that, when installed and protected in accordance with the original design intent, will not allow arcs, sparks or heat otherwise generated or liberated inside the enclosure to cause ignition of exterior accumulations or atmospheric suspensions of a specified dust. _ Non-incendive—A type of protection in which the equipment is incapable, under normal conditions, of causing ignition of a specified flammable gas or vapour-in-air mixture due to arcing or thermal effect.

Zone system

Flame-proof—A type of protection in which an enclosure can withstand the pressure developed during an internal explosion of an explosive mixture and that prevents the transmission of the explosion to the explosive atmosphere surrounding the enclosure and that operates at such an external temperature that a surrounding explosive gas or vapour will not be ignited there. This type of protection is referred to as "Ex d".

Intrinsically Safe—A type of protection in which the electrical equipment under normal or abnormal conditions is incapable of releasing sufficient electrical or thermal energy to cause ignition of a specific hazardous atmospheric mixture in its most easily ignitable concentrations. This type of protection is referred to as "Ex i".

Increase Safety

A type of protection in which various measures are applied to reduce the probability of excessive temperatures and the occurrence of arcs or sparks in the interior and on the external parts of electrical apparatus that do not produce them in normal service. Increased safety

may be used with flame-proof type of protection. This type of protection is referred to as “Ex e”. _

Type n

A type of protection applied to electrical equipment such that in normal operation it is not capable of igniting a surrounding explosive atmosphere. This type of protection is referred to as “Ex n”.

▪ CONCLUSION

In order to protect installations from a potential explosion a method of analyzing and classifying a potentially hazardous area is required. The purpose of this is to ensure the correct selection and installation of equipment to ultimately prevent an explosion and to ensure safety of life.

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