Classifications and Protections of Hazardous Area

Hazardous area is an environment that consists of any concentration of flammable gases, vapours, mists or combustible dust. This kind of area needs classification and there are several types of protection techniques to operate in such areas to reduce risk of explosion and fire. This document gives a broad overview of classification and protection techniques of hazardous areas. The information should be used only for educational purposes and must not be used in governing documents or any other sources.

Classification of Hazardous Area:

Hazardous area has a potentially explosive atmosphere. It has a great possibility or risk of fire or explosion when an electrical equipment is used in it. It generally has presence of flammable gases, vapours, flammable liquids, combustible dusts, ignitable fibres and flyings. The area with the possibility or risk of fire or explosion is classified as a hazardous location or area. It is always at the risk of catching fire or explosion.

Hazardous area is chiefly classified using two systems: The Class/Division system and the Zone system. The Class/Division system is more popular in the United States and Canada. The Zone system is widely used in the rest of the world. Slowly the United States and Canada too have started embracing the Zone system.

What is the Class/Division System?

This system classifies hazardous locations as per the Class, Division and Group. It is classified based on the following parameters.

1. Class- General nature or properties of the hazardous material is defined by the class. It suggests that hazardous material may or may not be in sufficient quantities in the surrounding atmosphere. There are three subtypes of class.

    A. Class I- These locations consist of flammable gases or vapours which may or may not be sufficient enough to produce explosive or ignitable mixtures.

B. Class II- These locations consist of combustible dust either in suspension, intermittently or periodically which may or may not be sufficient enough to produce explosive or ignitable mixtures.

C. Class III- These locations consist of fibres which may or may not be sufficient enough to produce explosive or ignitable mixtures.

2. Division- How likely the hazardous material can produce explosive or ignitable mixture is defined by the division. There are two types of divisions.

A. Division 1- The hazardous material having high probability of producing an explosive or ignitable mixture is included in division 1. In such a situation, even under normal operating conditions, explosive or ignitable mixture is continuously, intermittently or periodically present from the equipment itself.

B. Division 2- The hazardous material having low probability of producing an explosive or ignitable mixture is included in Division 2. In such a situation, only during abnormal conditions, an explosive or ignitable mixture is present, that too for a short period of time.

3. Group- When the types of hazardous material are classified as per the surrounding atmosphere, it is defined as Group. For example, Group A, B, C and D indicate gases (Class I only). Group E, F and G indicate dusts and flyings. (Class II or III). There are chiefly seven groups.

A. Group A- Atmospheres which comprise acetylene are part of Group A.

B. Group B- Atmospheres which contain flammable gas, flammable liquid-produced vapour, combustible liquid-produced vapour with MESG lesser than 0.45 mm or MIC ratio lesser than 0.40 are part of Group B. It includes typical gases like hydrogen, butadiene, ethylene oxide, propylene oxide, and acrolein.

C. Group C- Atmospheres which comprise a flammable gas, flammable liquid-produced vapour, or combustible liquid-produced vapour with MESG greater than 0.45 mm but lesser than or equal to 0.75 mm or MIC ratio greater than 0.40 but lesser than or equal to 0.80 are

part of Group C. It includes typical gases include ethyl ether, ethylene, acetaldehyde, and cyclopropane.

D. Group D- Atmospheres which comprise a flammable gas, flammable liquid-produced vapour, or combustible liquid-produced vapour with MESG greater than 0.75 mm or MIC ration greater than 0.80 are part of Group D. It includes typical gases like acetone, ammonia, benzene, butane, ethanol, gasoline, methane, natural gas, naphtha, and propane.

E. Group E- Atmospheres which comprise combustible metal dusts like aluminium, magnesium and their commercial alloys are part of Group E.

F. Group F- Atmospheres which comprise combustible carbonaceous dusts such as carbon black, coal or coke dust with the proportion of trapped volatiles more than 8% are part of Group F.

G. Group G- Atmospheres which comprise combustible dusts that are not included in Group E or F are part of Group G. This generally includes flour, starch, grain, wood, plastic and chemicals.

What is the Zone System?

Zones are chiefly divided into two parts: Gas and dust. They are further divided into groups and subgroups. Zone defines how likely the hazardous material like gas or dust can produce explosive or ignitable mixtures on the basis of their quantities.

1. Gas

    a. Zone 0- If ignitable concentrations of flammable gases or vapours are present continuously or for long periods of time, the area is included in Zone 0.

    b. Zone 1- If there is some possibility of ignitable concentrations of flammable gases or vapours to occur under normal operating conditions, the area is included in Zone 1.

    c. Zone 2- If there is hardly any possibility of ignitable concentrations of flammable gases or vapours to occur under normal operating conditions, and even if they do, they occur only for a short duration then the area included in Zone 2.

2. Dust

a. Zone 20- If ignitable fibres and flyings are present continuously or for long periods of time, the area is included in Zone 20.

b. Zone 21- If there is some possibility of combustible dusts or ignitable fibres and flyings to occur under normal operating conditions, the area is included in Zone 21.

c. Zone 22- If there is hardly any possibility of combustible dusts or ignitable fibres and flyings to occur under normal operating conditions and even if they do, they occur only for a short duration, then the area is included in Zone 22.

In the hazardous area, electrical equipment too are divided into 3 groups.

Group I- In some mines, there is a natural presence of flammable mixture of gases. Group 1 includes equipment that are meant to be used in mines that are prone to firedamp.

Group II- Group II is further divided into three subgroups. It includes equipment that is used in places containing an explosive gas atmosphere excluding mines that are prone to firedamp.

Group IIA- This group includes atmospheres comprising propane, gases and vapours of equivalent hazard.

Group IIB- This group includes atmospheres comprising ethylene, gases and vapours of equivalent hazard.

Group IIC- This group includes atmospheres comprising acetylene or hydrogen, gases and vapours of equivalent hazard.

Group III- Just like Group II, Group III too is further divided into three subgroups. It includes equipment that is used in places having an explosive dust atmosphere.

-Group IIIA- It includes atmospheres comprising combustible flyings.

-Group IIIB- It includes atmospheres comprising non-conductive dust.

-Group IIIC- It includes atmospheres comprising conductive dust.

What are the effective protection techniques and methods?

In order to reduce or minimize potential risks or explosion or fire from electrical equipment in the hazardous area, people operating in these areas have to employ various protection techniques and methods. We have listed some methods here.

As per **Class/Division System**, there are four main protection techniques.

A. Explosion Proof: This protection uses an enclosure to prevent explosion. This enclosure is capable of withstanding explosive gas or vapour within it. It can further prevent ignition of an explosive gas or vapour surrounding it by operating at an external temperature that does not allow explosive gas or vapour to be ignited.

B. Intrinsically Safe: This protection disables electrical equipment to release sufficient electrical or thermal energy that can cause ignition under normal or abnormal conditions. It provides safety when a particular hazardous atmospheric mixture is in its most ignitable concentration.

C. Dust Ignition Proof: This provides protection from ignitable dust and also the amount of dust that might affect rating and performance of the equipment. When it is properly installed as per the original design, it stops arcs, sparks and heat which are generally generated or liberated inside the enclosure and might cause ignition of exterior accumulations or atmospheric suspensions of a specified dust.

D. Non-incendive: In this type of protection, under normal conditions, the equipment is incapable of causing ignition of a specified flammable gas or vapour -in-air mixture due to arcing or thermal effect.

As per **Zone system**, there are four main protection techniques.

The concepts mentioned in this document are high-level protection concepts. Each concept has sublevels. However, it may not apply to each type. In some equipment, multiple types of protections can be combined.

A. Flame-proof: This protection uses an enclosure that can withstand the pressure developed during an internal explosion of an explosive mixture. It prevents transmission of the explosion outside of the enclosure. It operates at an external temperature that does not allow explosive gas or vapour to be ignited. This type of protection is known as “Ex d”.

B. Intrinsically Safe: This protection disables electrical equipment to release sufficient electrical or thermal energy that can cause ignition under normal or abnormal conditions. It provides safety when a particular hazardous atmospheric mixture is in its most ignitable concentration. This type of protection is known as “Ex i”.

C. Increased Safety: Increased safety can be combined with flame-proof protection type. It ensures that probability of excessive temperatures and occurrence of arcs or sparks in the interior or external parts of electrical apparatus is reduced. It is known as “Ex e.”

D. Type n- This type of protection when fitted in electrical equipment ensures that in normal operation, it is unable to ignite the surrounding explosive atmosphere. It is generally referred to as “Ex n.”

E. Type t- In this type of protection, electrical equipment has an enclosure which provides dust ingress protection and limits surface temperatures. This type of protection is known as “Ex t.”

F. Type h- This type has three different types of protections.

1. Type in which constructional measures are applied in order to provide protection against potential ignition from hot surfaces, sparks and compressions that are generated by moving parts.

2. Second type includes ignition protection in which mechanical or electrical devices are used in combination with nonelectrical equipment either manually or automatically to reduce chances of potential ignition source converting into an effective ignition source.

3. This protection type makes potential sources of ignition ineffective or separates them from explosive atmosphere by either immersing them in a protective liquid or partially immersing them and continuously coating their active surfaces with a protective liquid in a way that the explosive atmosphere above the liquid or outside the equipment enclosure is incapable of being ignited. It is generally referred to as the “Ex h” protection method.

How are Equipment Protection Level (EPL) marked?

EPL marking indicates how protected the equipment is based on the level of protection given to it. It also considers the difference between explosive gas atmospheres, explosive dust atmospheres and the explosive atmospheres in mines prone to firedamp. There are methods of determining EPL.

Temperature Code (T Code):

When does a mixture of hazardous gases and air ignite? Normally, when it comes into contact with a hot surface. There are several conditions that will determine whether the hot surface is capable of igniting a gas or not. These include: surface area, temperature, concentration of the gas. The same applies to combustible dusts. T code of a product suggests a maximum temperature that a product will not exceed under a specified ambient temperature. Take for example a product has a T code of T63. It suggests that its maximum temperature will not exceed 200°C if it is operated under a normal temperature as suggested by the manufacturer.

Nomenclature

Class/Division system

The approved equipment will be marked as per the Class (I, II or III), Division (1 or 2), Group (A, B, C, D, E, F or G) and temperature code (T1 through T6) it is rated for. If the equipment is intrinsically safe, the equipment will contain “IS” on it. Have a look at some examples.

Temperature class

T-Class	Hazards which will not ignite at temperatures below:
T1	450℃
T2	300℃
T3	200℃
T4	135℃
T5	100℃
T6	85℃

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