# Hazardous Area Classifications

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# ABSTRACT


In the chemical industry, flammable gases or vapors, flammable liquids, combustible dusts, ignitable fibers or flyings are manufactured, stored, or handled often. A location or area that could contain an explosive atmosphere or mixture of one or more of these materials is referred to as a hazardous or classified area. When electrical equipment is used in or around these hazardous areas, the risk of a fire or explosion is present. To make sure the electrical equipment being used in these hazardous areas are designed to protect against this risk, systems to classify the hazard in the area were developed.

This paper will explain why areas need to be classified in greater detail, the different classification systems used globally, and the differences between them.

# WHY ARE HAZARDOUS AREA CLASSIFICATIONS REQUIRED?

Before explaining the different classification systems, it is important to understand why areas need to be classified as hazardous. A hazardous area is defined as any location where a fuel source exists and mix with oxygen from the ambient air at a concentration between the lower flammability limit (LFL) and upper flammability limit (UFL) of the fuel.

This fuel source could be a flammable gas, flammable or combustible vapors produced by a liquid, combustible dust, combustible fiber, or some combination of these. The fuel and oxygen combine for two of the three required legs for a fire, as represented below as the Fire Triangle in Figure 1. Figure 2 represents the Dust Explosion Pentagon, which requires two additional legs for an explosion specific for dust. For simplicity, the Fire Triangle will be used in the rest of the explanation. See the other BSI Tech Tip 'The Dust Explosion Pentagon' for more detailed information on that subject.

Since the fuel is necessary to the process and the oxygen is present in ambient air, the only leg remaining is the ignition source. Ignition can come from many sources, but two easily generated sources are a hot surface or spark from electrical equipment. When electrical equipment is placed in these hazardous locations, it needs to be designed properly to protect against generating any ignition source. Since different potential fuels would interact with electrical equipment differently, the location the fuel is being manufactured, stored, or handled needs to be properly classified so the equipment can be designed with the required protection layers.

Depending on where in the world the hazardous location is, two different hazardous area classification (HAC) systems are used:

- In North America (United States and Canada), the Class/Division classification system is used
- In Europe and the rest of the world, the Zone classification system is used

Figure 1

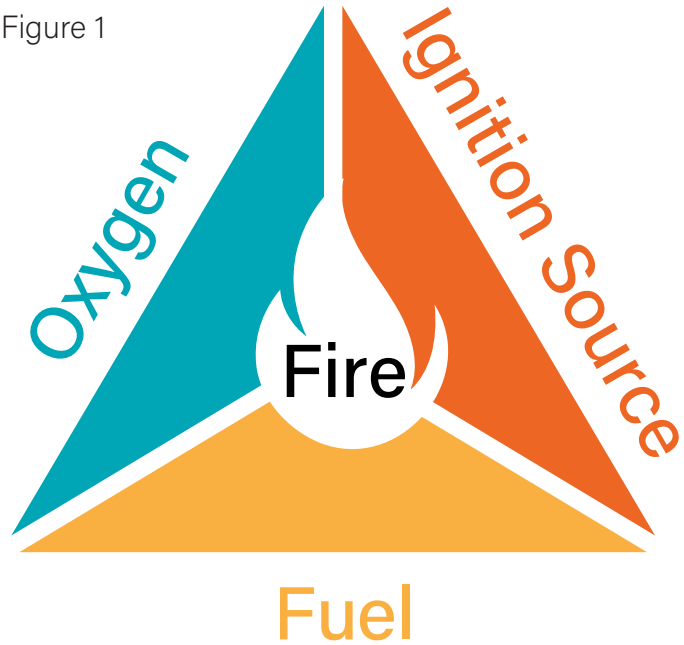
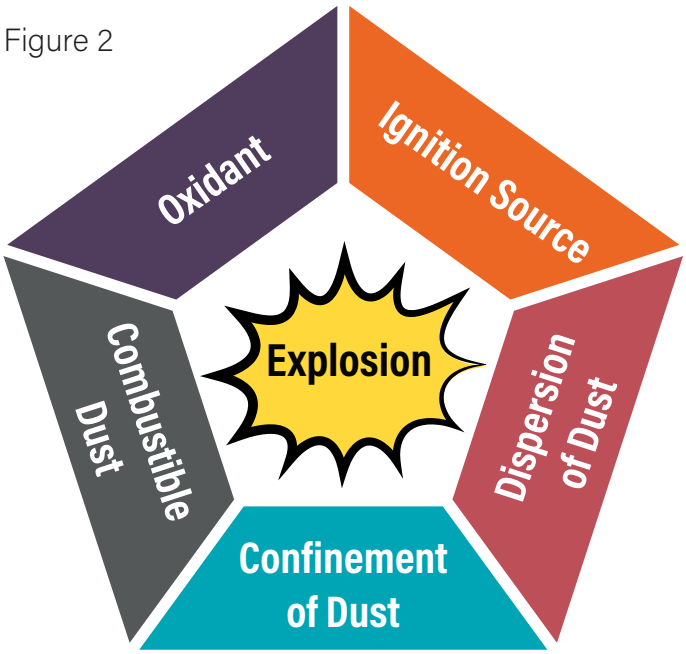



Figure 2



# CLASS/DIVISION SYSTEM

The most used system for HAC in the United States and Canada is the Class/Division system. The definitions and structure of the system is outlined in the National Fire Protection Association (NFPA) Publication 70 and National Electrical Code (NEC) Article 500. It is divided into three categories to describe the hazardous area:

- **Class:** Describes the overall nature of the hazardous material in the area.
- **Division:** Describes the probability that the hazardous material is present
- **Group:** Describes the type of material, more specifically than the class.

The below tables define what each Class/Division/Group is:

**Class:** describes the overall nature of the hazardous material in the area.

| Class | Definition |
|---|---|
| Class I | Hazardous since flammable vapors or gases are (or have the potential to be) present in the area in a quantity such that it exists as an explosive or ignitable mixture |
| Class II | Hazardous since combustible or conductive dusts are (or have the potential to be) present in the area in a quantity such that it exists as an explosive or ignitable mixture |
| Class III | Hazardous since ignitable fibers or flyings are (or have the potential to be) present in the area in a quantity such that it exists as an explosive or ignitable mixture |

**Division:** Describes the probability that the hazardous material is present.

| Division | Definition |
|---|---|
| Division I | Hazardous material defined by the Class has a high probability of creating an ignitable mixture due to it being present during normal operation. |
| Division II | Hazardous material defined by the Class has a low probability of creating an ignitable mixture due to it being present only in abnormal conditions for a short period of time. |

**Group:** Describes the type of material, more specifically than the class.

| Group (Applicable Class) | Definition |
|---|---|
| Group A (Class I) | Atmosphere containing **acetylene**. |
| Group B (Class I) | Atmospheres containing a flammable gas, flammable liquid-produced vapor, or combustible liquid-produced vapor whose Maximum Experimental Safe Gap (MESG) is less than 0.45 mm or Minimum Igniting Current Ratio (MIC ratio) is less than 0.40.<br>**Ex: hydrogen, butadiene, ethylene oxide, propylene oxide, and acrolein** |
| Group C (Class I) | Atmospheres containing a flammable gas, flammable liquid-produced vapor, or combustible liquid-produced vapor whose MESG is greater than 0.45 mm but less than or equal to 0.75 mm or MIC ratio is greater than 0.40 but less than or equal to 0.80.<br>**Ex: ethyl ether, ethylene, acetaldehyde, and cyclopropane** |
| Group D (Class I) | Atmospheres containing a flammable gas, flammable liquid-produced vapor, or combustible liquid-produced vapor whose MESG is greater than 0.75 mm or MIC ration is greater than 0.80.<br>**Ex: acetone, ammonia, benzene, butane, ethanol, gasoline, methane, natural gas, naphtha, and propane** |
| Group E (Class II and III) | Atmospheres containing combustible metal dusts.<br>**Ex: aluminum, magnesium, and their commercial alloys** |
| Group F (Class II and III) | Atmospheres containing combustible carbonaceous dusts with 8% or more trapped volatiles.<br>**Ex: carbon black, coal, or coke dust** |
| Group G (Class II and III) | Atmospheres containing combustible dusts not included in Group E or Group F.<br>**Ex: flour, starch, grain, wood, plastic, and chemicals** |

As listed above, Groups A, B, C and D are only applicable to gases and vapors (Class I) while Groups E, F, and G are reserved for dusts and flyings (Class II and III).

Definitions:

- **Maximum Experiment Safe Gap (MESG):** the maximum gap between two flat surfaces that prevents an ignition of a flammable gas and air mixture propagating from an inner chamber through a path to a secondary chamber under specific test conditions
- **Minimum Igniting Current (MIC) Ratio:** The ratio of the minimum current required from an inductive spark discharge to ignite the most easily ignitable mixture of a gas or vapor, divided by the minimum current required from an inductive spark discharge to ignite methane under the same test conditions

# ZONE SYSTEM

While the Class/Division classification is widely used in North America, the most common system in Europe and the rest of world is the Zone system. The Zone system is being used more and more in North America but still is not the industry standard. This system follows a similar structure to the Class/Division system but combines the Class/Division categories into one called the 'Zone.'

- **Zone:** describes the overall nature of the hazardous material in the area and describes the probability that the hazardous material is present
- **Group:** describes the type of material, more specifically than the Zone, and to an extent the location of the area

The below tables define the Zones and Groups covered by this classification system:

**Zone:** Describes the overall nature of the hazardous material in the area and describes the probability that the hazardous material is present.

| Zone | Definition |
|---|---|
| **Zones for flammable gases or vapors** | |
| Zone 0 | Ignitable concentrations of flammable gases or vapors which are present continuously or for long periods of time |
| Zone 1 | Ignitable concentrations of flammable gases or vapors which are likely to occur under normal operating conditions |
| Zone 2 | Ignitable concentrations of flammable gases or vapors which are not likely to be present under normal operating conditions and do so only for a short period of time |
| **Zones for combustible dusts or ignitable fibers and flyings** | |
| Zone 20 | An area where combustible dusts or ignitable fibers and flyings are present continuously or for long periods of time |
| Zone 21 | An area where combustible dusts or ignitable fibers and flyings are likely to occur under normal operating conditions |
| Zone 22 | An area where combustible dusts or ignitable fibers and flyings are not likely to be present under normal operating conditions and do so only for a short period of time |

## ZONE SYSTEM (Continued)

**Group:** Describes the type of material, more specifically than the Zone, and to an extent the location of the area.

| Group | Sub-Group | Definition |
|---|---|---|
| Group I | Atmospheres in **mines** susceptible to firedamp (naturally occurring flammable gas mixtures that are present in mines) | |
| Group II | Atmospheres with an **explosive gas** other than mines susceptible to firedamp. Further divided into 3 sub-group: | |
| | A | Atmospheres containing propane, acetone, benzene, butane, methane, petrol, hexane, paint solvents or gases and vapors of equivalent hazard |
| | B | Atmospheres containing ethylene, propylene oxide, ethylene oxide, butadiene, cyclopropane, ethyl ether, or gases and vapors of equivalent hazard |
| | C | Atmospheres containing acetylene, hydrogen, carbon disulfide or gases and vapors of equivalent hazard |
| Group III | Atmospheres containing an explosive dust. Further divided into 3 sub-groups: | |
| | A | Atmospheres containing combustible flyings |
| | B | Atmospheres containing non-conductive dusts |
| | C | Atmospheres containing conductive dusts |

# FREQUENTLY ASKED QUESTIONS

**Can a Class 1 rated piece of equipment be used in a Class 2 environment? What about a Zone 0 rated piece of equipment in a Zone 20 environment?**

- Not always. Class 1/Zone 0 rated equipment is designed to protect against gases and vapors, while Class 2/Zone 20 are designed to protect against dust.
- Check with the equipment's manufacturer to verify its hazardous area classification certification

**Can a Division 1 rated piece of equipment be used in a Division 2 environment? Zone 0 in Zone 1? What about the other way around?**

- Equipment rated for Division 1 can be used in Division 2, but not the other way around.
- The same applies for the Zone system- Zone 0 can be used in Zones 1 and 2 but Zone 1 or 2 could not be used in Zone 0.
- Equipment designed for a more hazardous service can be used in a less hazardous service provided the correct Class and Group is used

**How do I find out what group my hazardous chemical would be in?**

- A more comprehensive list of hazardous chemicals and their groups beyond what is listed above can be found in NEC Article 500 and NFPA 497.

**What is the NEMA rating listed on my equipment?**

- NEMA is the National Electrical Manufactures Association.
- Their rating refers to an equipment's protection against incidental dirt or water from entering the equipment.
- The NEMA rating does not cover protection against fire and explosions caused by flammable gases or vapors, combustible dusts, or ignitable fibers and flyings

**Where can I learn more?**

- To learn more about Hazardous Area Classifications, read NFPA Publication 70, NEC Article 500 (Class/Division system), or NEC Article 505-506 (Zone system)
- Or call us at 513-201-3100 and one of our experienced engineers can answer any questions you have

# SUMMARY

The correct precautions must always be taken when dealing with hazardous materials, especially while being used with electrical equipment. Sparks and hot surfaces generated from electrical equipment can provide an ignition source, leading to a fire or explosion. Properly classifying the areas that these materials are present in ensures the electrical equipment being used are appropriately designed for the hazard present.

Understanding the hazards that the material being used is key to maintaining a safe work environment. By utilizing either the Class/ Division or Zone systems to classify the hazardous area, the correct electrical equipment can be installed to help prevent a fire or explosion.

# THANK YOU

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