

Hazardous locations are those areas where a potential for explosion and fire exist because of flammable gases, vapors or finely pulverized dusts in the atmosphere, or because of the presence of easily ignitable fibers or flyings. Hazardous locations may result from the normal processing of certain volatile chemicals, gases, grains, etc., or it may result from accidental failure of storage systems for these materials. It is also possible that a hazardous location may be created when volatile solvents or fluids used in a normal maintenance routine vaporize to form an explosive atmosphere.

Regardless of the cause of a hazardous location it is necessary that every precaution be taken to guard against ignition of the atmosphere. Certainly no open flames would be permitted in these locations, but what about other sources of ignition?

## **ELECTRICAL SOURCES OF IGNITION**

A source of ignition is simply the energy required to touch off an explosion in a hazardous location atmosphere.

Electrical equipment, can be a source of this ignition energy. The normal operation of switches, circuit breakers, motor starters, contactors and plugs, and receptacles release this energy in the form of arcs and sparks as contacts open and close; making and breaking circuits.

Electrical equipment such as lighting fixtures and motors, is classified as "heat producing" and it will become a source of ignition if it reaches a surface temperature which exceeds the ignition temperature of the particular gas, vapor or dust in the atmosphere.

It is also possible that an abnormality or failure in an electrical system could provide a source of ignition. A loose termination in a splice box or a loose lamp in a socket can be the source of both arcing and heat. The failure of insulation from cuts, nicks or aging can also act as an ignition source again from sparking, arcing and heat.

## **HAZARDOUS LOCATIONS AND THE NATIONAL ELECTRICAL CODE**

The National Electrical Code treats installations in hazardous locations in articles 500 through 517.

Each hazardous location can be classified by the definitions in the NEC, and following are interpretations of these classifications and applications.

### **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.

#### **CLASS I, DIVISION 1**

These are Class I locations where the hazardous atmosphere is expected to be present during normal operations. It may be present continuously, intermittently, periodically or during normal repair or maintenance operations. Division 1 locations are also those locations where a breakdown in the operation of processing equipment results in the release of hazardous vapors and the simultaneous failure of electrical equipment.

### **CLASS I, DIVISION 2**

These are Class I locations in which volatile flammable liquids or gases are handled, processed or used, but in which they will normally be confined within closed containers or closed systems from which they can escape only in the case of accidental rupture or breakdown of the containers or systems. The hazardous conditions will occur only under abnormal conditions.

### **CLASS II LOCATIONS**

Class II locations are those that are hazardous because of the presence of combustible dusts.

#### **CLASS II, DIVISION 1**

These are Class II locations where combustible dust may be in suspension in the air under normal conditions in sufficient quantities to produce explosive or ignitable mixtures. This may occur continuously, intermittently or periodically. Division 1 locations also exist where failure or malfunction of machinery or equipment might cause a hazardous location to exist while providing a source of ignition with the simultaneous failure of electrical equipment. Included also, are locations in which combustible dust of an electrically conductive nature may be present.

#### **CLASS II, DIVISION 2**

A Class II, Division 2 location is one in which combustible dust will not normally be in suspension in the air and normal operations will not put the dust in suspension, but where accumulation of the dust may interfere with the safe dissipation of heat from electrical equipment or where accumulations near electrical equipment may be ignited by arcs, sparks or burning material from the equipment.

### **CLASS III LOCATIONS**

Class III locations are those that are hazardous because of the presence of easily ignitable fibers or flyings, but in which the fibers or flyings are not likely to be in suspension in the air in quantities sufficient to produce ignitable mixtures.

#### **CLASS III, DIVISION 1**

These are locations in which easily ignitable fibers or materials producing combustible flyings are handled, manufactured or used.

#### **CLASS III, DIVISION 2**

These locations are where easily ignitable fibers are stored or handled.

## EQUIPMENT FOR CLASS I LOCATIONS

Devices for Class I locations are housed in enclosures which are designed strong enough to contain an explosion if the hazardous vapors enter the enclosure and are ignited. These enclosures then cool and vent the products of combustion in such a way that the surrounding atmosphere is not ignited.

Heat producing equipment for hazardous locations, such as lighting fixtures, must not only contain the explosion and vent the cooled products of combustion, but must also be designed to operate with surface temperatures below the ignition temperatures of the hazardous atmosphere.

Since the different vapors and gases making up hazardous atmospheres have varying properties, they have been placed in groups based on a common range of ignition temperatures and explosion pressures. These groups are designated A, B, C, and D, and the equipment selected must be suitable for the group of the specific hazardous gas or vapor.

Reference to the National Electrical Code will indicate that most of the equipment used for Class I, Division 2 applications is the same as that used for Division 1 applications. However, in certain instances, standard location equipment may be used for some of the Class I, Division 2 applications if the appropriate restrictions are followed. The National Electrical Code contains the specific rules.

## EQUIPMENT FOR CLASS II LOCATIONS

The enclosures used to house devices in Class II locations are designed to seal out dust. Contact between the hazardous atmosphere and the source of ignition has been eliminated and no explosion can occur within the enclosure.

As in Class I equipment, heat producing equipment must be designed to operate below the ignition temperature of the hazardous atmosphere. However, in Class II equipment, additional consideration must be given to the heat buildup which may result from the layer of dust which will settle on the equipment.

Dusts have also been placed in Groups designated E, F, & G, based on their particular hazardous characteristics and the dusts' electrical resistivity. Group E includes metal dusts and other combustible dusts with resistivity less than  $10^6$  ohm-centimeter, and Group G includes combustible dusts with resistivity greater than  $10^6$  ohm-centimeter. Group F includes atmospheres containing carbon black, charcoal, coal or coke dusts, which have more than 8% total volatile material, (Carbon black per ASTM D1620; charcoal, coal and coke dusts per ASTM D271) or atmospheres containing these dusts sensitized by other materials so that they present an explosion and hazard, and having resistivity greater than  $10^2$  ohm-centimeters but equal to or less than  $10^6$  ohm-centimeters.

Flexibility, similar to that described for Class I, Division 2 applications, is also permitted in the selection of equipment and wiring methods used for Class II, Division 2 applications. The National Electrical Code contains the specific rules.

## EQUIPMENT FOR CLASS III LOCATIONS

Class III locations require equipment which is designed to minimize the entrance of fibers and flyings, prevent the escape of sparks or burning material and operate at a temperature below the point of combustion.

## APPLICATIONS FOR HAZARDOUS LOCATION EQUIPMENT

Hazardous location equipment may be required in any area where the presence of flammable gases, vapors or finely pulverized dusts in the atmosphere is sufficient to create a threat of explosion or fire. It may also be required where easily ignitable fibers or flyings are present. The following is a representative (but not complete) list of the types of locations and operations requiring hazardous location equipment in at least certain areas.

### CLASS I LOCATIONS

Petroleum refining facilities.

Dip tanks containing flammable or combustible liquids.

Dry cleaning plants.

Plants manufacturing organic coatings.

Spray finishing areas (residue must be considered).

Petroleum dispensing areas.

Solvent extraction plants.

Plants manufacturing or using pyroxylin (nitro-cellulose) type and other plastics (Class II also).

Locations where inhalation anesthetics are used.

Utility gas plants, operations involving storage and handling of liquefied petroleum and natural gas.

Aircraft hangers and fuel servicing areas.

### CLASS II LOCATIONS

Grain elevators and bulk handling facilities.

Manufacture and storage of magnesium.

Manufacture and storage of starch.

Fireworks manufacture and storage.

Flour and feed mills.

Areas for packaging and handling of pulverized sugar and cocoa.

Facilities for the manufacture of magnesium and aluminum powder.

Some coal preparation plants & coal handling facilities.

Spice grinding plants.

Confectionary manufacturing plants.

### CLASS III LOCATIONS

Wood working plants.

Textile mills.

Cotton gins and cotton seed mills.

Flax producing plants.

**GAS**

**GROUP A — ATMOSPHERES**

acetylene

**GROUP B — ATMOSPHERES**

acrolein (inhibited) (2)  
arsine butadiene (1)  
ethylene oxide (2)  
formaldehyde (gas)  
hydrogen manufactured gasses containing more than 30% hydrogen (by volume)  
propylene oxide (2)  
propyl nitrate

**GROUP C — ATMOSPHERES**

acetaldehyde  
allyl alcohol  
butyl mercaptan  
n-butylaldehyde  
carbon monoxide  
crotonaldehyde  
cyclopropane  
dicyclopentadiene  
diethyl ether  
diethylamine  
di-isopropylamine  
dimethylamine  
1,4-dioxane  
di-n-propylamine  
epichlorohydrin  
ethylene  
ethylenimine  
ethyl mercaptan  
n-ethyl morpholine  
ethyl sulphide  
hydrogen cyanide  
hydrogen selenide

hydrogen sulfide  
isobutyraldehyde  
isopropyl glycidyl ether  
methylacetylene  
methylacetylene-propadiene (stabilized)  
methyl ether  
methyl formal  
methyl mercaptan  
monomethyl hydrazine  
morpholine nitroethane  
nitromethane  
2-nitropropane propionaldehyde  
n-propyl ether  
tetrahydrofuran  
triethylamine  
unsymmetrical dimethylhydrazine (UDMH 1,1-dimethyl hydrazine)  
valeraldehyde

**GROUP D — ATMOSPHERES**

acetic acid (glacial)  
acetone  
acetonitrile  
acrylonitrile  
allyl chloride  
ammonia (3)  
n-amyl acetate  
sec-amyl acetate  
benzene  
butane  
1-butanol (butyl alcohol)  
2-butanol (secondary butyl alcohol)  
n-butyl acetate  
sec-butyl acetate  
butylamine  
butylene  
chlorobenzene  
chloroprene  
cyclohexane  
cyclohexene  
cyclopropane

1,2-dichlorethylene  
1,3-dichloropropene  
di-isobutylene  
ethane  
ethanol (ethyl alcohol)  
ethyl acetate  
ethyl acrylate (inhibited)  
ethylamine  
ethyl benzene  
ethyl chloride  
ethylenediamine (anhydrous)  
ethylene dichloride  
ethylene glycol monomethyl ether  
ethyl formate  
gasoline  
heptane  
heptene  
hexane  
2-hexanone  
hexenes  
isoamyl acetate  
isoamyl alcohol

**GROUP D (Cont.)**

isobutyl acrylate  
isoprene  
isopropyl acetate  
isopropylamine  
isopropyl ether  
liquefied petroleum gas  
mesityl oxide  
methane (natural gas)  
methanol (methyl alcohol)  
methyl acetate  
methyl acrylate  
methylamine  
methylcyclohexane  
methyl ethyl ketone  
methyl formate  
methyl isobutyl ketone  
methyl isocyanate  
methyl methacrylate  
2-methyl-1-propanol (isobutyl alcohol)  
2-methyl-2-propanol (tertiary butyl alcohol)  
naphtha (petroleum)  
nonane

nonene  
octane  
octene  
pentane  
1-pentanol (amyl alcohol)  
2-pentanone  
1-pentene  
petroleum naphtha (4)  
propane  
1-propanol (propyl alcohol)  
2-propanol (isopropyl alcohol)  
n-propyl acetate  
propylene  
propylene dichloride  
propylene oxide (2)  
pyridine  
styrene  
toluene  
tripropylamine  
turpentine  
vinyl acetate  
vinyl chloride  
vinylidene chloride  
xylenes

**DUST**

**GROUP E — ATMOSPHERES** Containing combustible metal dusts regardless of resistivity, or other combustible dusts of similarly hazardous characteristics having resistivity of less than 10 3/4 ohm-centimeter.

**GROUP F — ATMOSPHERES** Containing carbon black, charcoal, coal or coke dusts which have more than 8 percent total volatile material (carbon black per ASTM D1620; charcoal, coal and coke dusts, per ASTM D271) or atmospheres containing these dusts sensitized by other materials so that they present an explosion hazard, and having resistivity greater than 10 ohm-centimeter but equal or less than 10<sup>9</sup> ohm-centimeter.

**GROUP G — ATMOSPHERES** Containing combustible dusts having resistivity of 105 ohm-centimeter or greater.

- (1) Group D equipment shall be permitted for this atmosphere if such equipment is isolated in accordance with Section 501-5(a) by sealing all conduit 1/2-inch or larger.
- (2) Group C equipment shall be permitted for this atmosphere if such equipment is isolated in accordance with Section 501-5(a) by sealing all conduit 1/2-inch or larger.
- (3) For classification of areas involving ammonia atmosphere see Safety Code for Mechanical Refrigeration (ANSI/ASHRAE 15-1978) and Safety Requirements for the Storage and Handling of Anhydrous Ammonia (ANSI/CGA G2, 1-1972).
- (4) Petroleum Naphtha is a saturated hydrocarbon mixture whose boiling range is 20° to 135°C. It is also known as benzine, ligroin, petroleum ether, and naphtha.

Certain chemicals may have characteristics that require safeguards beyond those required for any of the above groups. Carbon disulfide is one of the chemicals because of its low auto-ignition temperature and the small joint clearance to arrest its flame propagation.

For additional information from NFPA reference:

Flammable and  
Combustible Liquids  
Code (NFPA 30-1996)

Drycleaning Plants (NFPA 31-1997)

Manufacture of Organic Coatings (NFPA 35-1995 [ANSI])

Solvent Extraction Plants (NFPA 36-1997 [ANSI])

Storage and Handling of Liquefied Petroleum Gases (NFPA 58-1998)

Storage and Handling of Liquefied Petroleum Gases at Utility Gas Plants (NFPA 59-1998)

Classification of Class I Hazardous Locations for Electrical Installations in Chemical Plants (NFPA 497-1997 [ANSI])

Certain metal dusts may have characteristics that require safeguards beyond those required for atmospheres containing the dusts of aluminum magnesium, and their commercial alloys. For example, zirconium, thorium and uranium dusts have extremely low ignition temperatures [as low as 20°C (68°F)], and minimum ignition energies lower than any material classified in any of the Class I or Class II Groups.

Certain dusts may require additional precautions due to chemical phenomena that can result in the generation of ignitable gases. See National Electrical Safety Code (ANSI C2-1981). Section 127A-Coal Handling Areas.

Combustible dusts which are electrically nonconductive include dusts produced in the handling and processing of grain and grain products, pulverized sugar and cocoa, dried egg and milk powders, pulverized spices, starch and pastes, potato and woodflour, oil meal from beans and seed, dried hay, and other organic materials which may produce combustible dusts when processed or handled. Electrically conductive dusts are dusts with a resistivity less than  $10^5$  ohm-centimeter. Dusts containing magnesium or aluminum are particularly hazardous and the use of extreme caution will be necessary to avoid ignition and explosion.

Dust that is carbonized or excessively dry is highly susceptible to spontaneous ignition.

Equipment and wiring of the type defined in Article 100 as explosion-proof shall not be required and shall not be acceptable in Class II locations unless approved for such locations.

Where Class II, Group E dusts having a resistivity less than  $10^5$  ohm-centimeter are present in hazardous quantities, there are only Division 1 locations.

