

# Classification of Hazardous Atmospheres

The following pages contain excerpts for your convenience. If more comprehensive information is required, consult with your Western Technology representative.

## **HAZARDOUS LOCATION CLASSIFICATION**

The classification of a given area as to Class, Division, and Group is solely the judgment of THE OWNERS, INSURANCE COMPANY AND THE AUTHORITY HAVING JURISDICTION.

## **A. Definitions**

The definitions below are extracted from the 7990 National Electrical Code. These definitions are included to define and clarify the meaning and intent when terms such as 'Explosionproof' and 'Dust-ignitionproof' are used in this publication.

"Explosionproof Apparatus": Apparatus enclosed in a case which is capable of withstanding an explosion of a specified gas or vapor which may occur within it and of preventing the ignition of a specified gas or vapor surrounding the enclosure by sparks, flashes, or explosion of the gas or vapor within, and which operates at such an external temperature that a surrounding flammable atmosphere will not be ignited thereby.

'Dust-ignitionproof,' as used in this Article, shall mean enclosed in a manner which will exclude ignitable amounts of dusts or amounts which might affect performance or rating and that where installed and protected in accordance with this Code, will not permit arcs, sparks or heat otherwise generated or liberated inside of the enclosure, to cause ignition of exterior accumulations or atmospheric suspensions of a specified dust on or

in the vicinity of the enclosure. The National Electrical Code, which is widely used for classification purposes, divides atmospheric explosion hazards into three broad classes; they are summarized in Table 1. However, it must be understood that considerable skill and judgment must be applied when deciding to what degree an area contains hazardous concentrations of vapors, combustible dusts or easily ignitable fibers and flyings. Many factors, such as temperature, barometric pressure, quantity of release, humidity, ventilation, distance from the vapor source, etc. must be considered. When information on all factors concerned is properly evaluated, a consistent classification for the selection and location of electrical equipment can be developed.

**For a more complete list of flammable liquids, gases, and solids, see Classification of Gases, Vapor and Dusts for Electrical Equipment in Hazardous (Classified) Locations, NFPA 497M-1986\*.**

\* Denotes revision

**B. The National Electrical Code® and Underwriters Laboratories Inc.®**

The NEC® is considered the definitive classification tool and contains explanatory data about flammable gases and combustible dusts as it may apply to storage areas, garages or gasoline stations. Specific installation practices have been set up for heavier-than-air vapors. However, there is no such specific data for acetylene, whose vapor density is very near that of air. In the case of hydrogen which has a low vapor density and is used indoors, the most hazardous concentrations are likely to be in the upper portion of the room.

Many states, municipalities and public service companies use the NEC as a requirement for their Inspectors.

Underwriters Laboratories, inc. (UL) is a not-for-profit. Independent organization testing for public safety. Its function is to determine whether or not devices and equipment submitted to it are safe and can be used in the NEC category for which they were designed. To do this, it maintains extensive laboratory and testing facilities.

UL's function does not include actual enforcement of the National Electrical Code. However, as previously indicated, inspection authorities use UL's listing as criteria in carrying out their inspections of hazardous areas.

**C. Class I Atmospheric Hazards.**

Class 1 atmospheric hazards are divided not only into the four groups shown in Table I, but also into two divisions.

Division 1 covers locations where flammable gases or vapors may exist under normal operating conditions, under frequent repair or maintenance operations, or where breakdown or faulty operation of process equipment might also cause simultaneous failure of electrical equipment.

Division 2 covers locations where flammable gases, vapors or volatile liquids are handled either in a closed system, or confined within suitable enclosures, or where hazardous concentrations are normally prevented by positive mechanical ventilation. Areas adjacent to Division 1 locations, into which gases might occasionally flow, would also belong in Division 2

**D. Class II Atmospheric Hazards.**

Class II atmospheric hazards cover three groups of combustible dusts. The groupings are based on the resistivity of the dusts. Group E is always Division 1. Group F, depending on the resistivity, and Group G may be either Division 1 or 2.

**E. Class III Atmospheric Hazards.**

Class III atmospheric hazards cover locations where combustible fibers or flyings are present but not likely to be in suspension in air in quantities sufficient to produce ignitable mixtures (Division 1) and locations in which easily ignitable fibers are stored or handled (Division 2).

| CLASS 1 TEMPERATURE MARKING    |     |   |
|--------------------------------|-----|---|
| Maximum Operating Temperature° |     | Temperature Code or Identification Number |
| °C                             | °F  |   |
| 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                                       |
| 160                            | 320 | T3C                                       |
| 135                            | 275 | T4  |
| 120                            | 248 | T4A                                       |
| 100                            | 212 | T5  |
| 85                             | 185 | T6  |

°Based on a 40°C (104°F) ambient

| Class                       | Division                       | Group | Typical atmosphere/Ignition Temps.   | Devices Covered   | Temperature Measured   | Limiting Value  |
|-----------------------------|--------------------------------|-------|--|---|--|---|
| I.<br>Gases,<br>vapors      | 1<br>Normally<br>hazardous     | A     | acetylene (305°C, 581°F)   | All<br>electrical<br>devices<br>and wiring  | Maximum<br>external<br>temperature in<br>40°C ambient  | See Sect. 500-3 of<br>NEC   |
|                             |                                | B     | 1,3-Butadiene1 (420°C, 788°F)<br>Ethylene Oxide2 (429°C, 804°F)<br>Hydrogen (520°C, 968°F)<br>Manufactured Gases containing<br>more than 30% hydrogen (by volume)<br>Propylene Oxide2 (449°C, 840°F)   |   |  |   |
|                             |                                | C     | Acetaldehyde (175°C, 347°F)<br>Diethyl Ether (160°C, 320°F)<br>Ethylene (450°C, 842°F)<br>Unsymmetrical Dimethyl Hydrazine (UDMH)<br>(249°C, 480°F)  |   |  |   |
|                             |                                | D     | Acetone (465°C, 869°F)<br>Acrylonitrile (481°C, 898°F)<br>Ammonia3 (498°C, 928°F)<br>Benzene (498°C, 928°F)<br>Butane (288°C, 550°F)<br>1-Butanol (343°C, 650°F)<br>2-Butanol (405°C, 761°F)<br>n-Butyl Acetate (421°C, 790°F)<br>Cyclopropane (503°C, 938°F)<br>Ethane (472°C, 882°F)<br>Ethanol (363°C, 685°F)<br>Ethyl Acetate (427°C, 800°F)<br>Ethylene Dichloride (413°C, 775°F)<br>Gasoline (280-471°C, 536-880°F)<br>Heptane (204°C, 399°F)<br>Hexane (225°C, 437°F)<br>Isoamyl Alcohol (350°C, 662°F)<br>Isoprene (220qC,428°F)<br>Methane (630°C, 999°F)<br>Methanol (385°C, 725°F)<br>Methyl Ethyl Ketone (404°C, 759°F)<br>Methyl Isobutyl Ketone (440°C, 840°F)<br>2-Methyl-1-Propanol (416°C, 780°F)<br>2-Methyl-2-Propanol (478°C, 892T)<br>Naptha (petroleum); (288°C, 650°F)<br>Octane (206°C, 403°F)<br>Pentane (243°C, 470°F)<br>1-Pentanol (300°C, 572°F)<br>Propane (450°C, 842°F)<br>1-Propanol (413°C, 775°F)<br>2-Propanol (399°C, 750°F)<br>Propylene (455°C, 851°F)<br>Styrene (490°C, 914°F)<br>Toluene (480°C 896°F)<br>Vinyl Acetate (402°C, 756°F)<br>Vinyl Chloride (472°C,882°F)<br>Xylenes (464-529°C, 867-984°F) |   |  |   |
| I.<br>Gases,<br>vapors      | 2<br>Not normally<br>hazardous | A     | Same as Division 1   | Lamps,<br>resistors,<br>coils, etc.,<br>other than<br>arcing<br>devices.<br>(See Div.<br>1) | Max. internal or<br>external temp,<br>not to exceed<br>the Ignition<br>temperature in<br>degrees Celsius<br>(°C) of the<br>gas or vapor<br>involved. | See Sect. 500-3   |
|                             |                                | B     | Same as Division 1   |   |  |   |
|                             |                                | C     | Same as Division 1   |   |  |   |
|                             |                                | D     | Same as Division 1   |   |  |   |
| II.<br>Combustible<br>dusts | 1<br>Normally<br>hazardous     | E     | Atmospheres containing combustible metal<br>dusts regardless of resistivity, or other<br>combustible dusts of similarly hazardous<br>characteristics having resistivity of less than 10 <sup>2</sup><br>ohm-centimeter   | Devices<br>not<br>subject to<br>overloads<br>(switches,<br>meters)                          | Max external<br>temp. in 40°C<br>ambient with a<br>dust blanket  | Shall be less than<br>Ignition temperature<br>of dust but not more<br>than: |

| Class  | Division                       | Group | Typical atmosphere/Ignition Temps.  | Devices Covered                                    | Temperature Measured                        | Limiting Value   |
|--|--------------------------------|-------|---|--|---|--|
| II.<br>Combustible<br>dusts                          | 1<br>Normally<br>hazardous     | F     | Atmospheres containing carbonaceous dusts having resistivity between $10^2$ and $10^8$ ohm-centimeter | Devices subject to overload (motors, transformers) |   | No overload:<br>E-200°C (392°F)<br>F-200°C (392°F)<br>G-165°C (329°F)  |
|  |                                | G     | Atmospheres containing combustible dusts having resistivity of $10^8$ ohm-centimeter or greater       |  |   | Possible overload In operation: Normal<br>E-200°C<br>F-200°C (392°F)<br>G-120°C (248°F)<br>Abnormal<br>E-200°C (392°F)<br>F-200°C (392°F)<br>G-165°C (329°F) |
| II.<br>Combustible<br>dusts                          | 2<br>Not normally<br>hazardous | F     | Atmospheres containing carbonaceous dusts having resistivity of $10^5$ ohm-centimeter or greater      | Lighting fixtures                                  | Max. external temp. under conditions of use | Same as Division 1   |
|  |                                | G     | Same as Division 1  |  |   |  |
| III.<br>Easily<br>ignitable<br>fibers and<br>flyings | 1 & 2                          |       |   | Lighting fixtures                                  | Max. external temp. under conditions of use | 165°C (329°F)  |

<sup>1</sup> Group D equipment may be used for this atmosphere if such equipment is isolated in accordance with Section 501-5(a) by sealing all conduit 1/2-inch size or larger.

<sup>2</sup> Group C equipment may be used for this atmosphere if such equipment is isolated in accordance with Section 501-5(a) by sealing all conduit 1/2-inch size or larger.

<sup>3</sup> For Classification of areas involving ammonia atmosphere, see Safety Code for Mechanical Refrigeration (ANSI/ASHRAE IS-1978) and Safety Requirements for the Storage and Handling of Anhydrous Ammonia 64/VS7/CG/4 G-2. 1-1981\*.

<sup>4</sup> A saturated hydrocarbon mixture boiling in the range 20-135°C (68-275°F). Also known by the synonyms benzine, ligroin, petroleum ether or naphtha.

† For a more complete list of flammable liquids, gases, and solids, see classification of Gases, Vapors and Dusts for Electrical Equipment In Hazardous (Classified) Locations, NFPA 497M-1986\*.

| <b>SUMMARY OF CLASSIFICATION CHART</b> |   |   |
|--|---|---|
| <b>CLASS</b>                           | <b>DIVISION</b>   | <b>GROUP</b>  |
| <b>I. GAS</b>                          | <b>1. HAZARD EXISTS</b><br>Always Present In<br>Atmosphere    | <b>A. Acetylene</b>   |
|  |   | <b>B. Hydrogen &amp; Manufactured Gases containing Hydrogen</b> |
|  |   | <b>C. Petrochemicals</b>  |
|  |   | <b>D. Petrochemicals</b>  |
|  | <b>2. POTENTIAL HAZARD</b><br>May Be Present In<br>Atmosphere | <b>A. Acetylene</b>   |
|  |   | <b>B. Hydrogen &amp; Manufactured Gases containing Hydrogen</b> |
|  |   | <b>C. Petrochemicals</b>  |
|  |   | <b>D. Petrochemicals</b>  |
| <b>II. DUST</b>                        | <b>1. HAZARD EXISTS</b><br>Always Present In<br>Atmosphere    | <b>E. Conductive &amp; Combustible Metal Dust</b>               |
|  |   | <b>F. Combustible Carbon Dust</b>                               |
|  |   | <b>G. Non-Conductive Combustible Dust</b>                       |
|  | <b>2. POTENTIAL HAZARD</b><br>May Be Present In<br>Atmosphere | <b>E. Conductive &amp; Combustible Metal Dust</b>               |
|  |   | <b>F. Combustible Carbon Dust</b>                               |
|  |   | <b>G. Non-Conductive Combustible Dust</b>                       |
| <b>III. FIBERS</b>                     | <b>1. PRODUCTION AREAS</b>                                    | <b>Combustible</b>  |
|  | <b>2. HANDLING OR STORAGE AREAS</b>                           | <b>Combustible</b>  |

# HAZARDOUS LOCATION - OSHA DEFINITIONS

(29 CFR, STANDARD NUMBER 1910.399)

## 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 locations include:**

### **Class I, Division 1 - A Class I, Division 1 location is a location:**

- (i) In which ignitable concentrations of flammable gases or vapors may exist under normal operating conditions; or
- (ii) In which ignitable concentrations of such gases or vapors may exist frequently because of repair or maintenance operations or because of leakage; or
- (iii) In which breakdown or faulty operation of equipment or processes might release ignitable concentrations of flammable gases or vapors, and might also cause simultaneous failure of electric equipment.

**Note to the definition of "Class I, Division 1:"** This classification usually includes locations where volatile flammable liquids or liquefied flammable gases are transferred from one container to another; interiors of spray booths and areas in the vicinity of spraying and painting operations where volatile flammable solvents are used; locations containing open tanks or vats of volatile flammable liquids; drying rooms or compartments for the evaporation of flammable solvents; locations containing fat and oil extraction equipment using volatile flammable solvents; portions of cleaning and dyeing plants where flammable liquids are used; gas generator rooms and other portions of gas manufacturing plants where flammable gas may escape; inadequately ventilated pump rooms for flammable gas or for volatile flammable liquids; the interiors of refrigerators and freezers in which volatile flammable materials are stored in open, lightly stoppered, or easily ruptured containers; and all other locations where ignitable concentrations of flammable vapors or gases are likely to occur in the course of normal operations.

### **Class I, Division 2 - A Class I, Division 2 location is a location:**

- (i) In which volatile flammable liquids or flammable gases are handled, processed, or used, but in which the hazardous liquids, vapors, or gases will normally be confined within closed containers or closed systems from which they can escape only in the event of accidental rupture or breakdown of such containers or systems, or as a result of abnormal operation of equipment; or
- (ii) In which ignitable concentrations of gases or vapors are normally prevented by positive mechanical ventilation, and which might become hazardous through failure or abnormal operations of the ventilating equipment; or
- (iii) That is adjacent to a Class I, Division 1 location, and to which ignitable concentrations of gases or vapors might occasionally be communicated unless such communication is prevented by adequate positive-pressure ventilation from a source of clean air, and effective safeguards against ventilation failure are provided.

**Note to the definition of "Class I, Division 2:"** This classification usually includes locations where volatile flammable liquids or flammable gases or vapors are used, but which would become hazardous only in case of an accident or of some unusual operating condition. The quantity of flammable material that might escape in case of accident, the adequacy of ventilating equipment, the total area involved, and the record of the industry or business with respect to explosions or fires are all factors that merit consideration in determining the classification and extent of each location. Piping without valves, checks, meters, and similar devices would not ordinarily introduce a hazardous condition even though used for flammable liquids or gases. Locations used for the storage of flammable liquids or liquefied or compressed gases in sealed containers would not normally be considered hazardous unless also subject to other hazardous conditions.

Electrical conduits and their associated enclosures separated from process fluids by a single seal or barrier are classed as a Division 2 location if the outside of the conduit and enclosures is a nonhazardous location.

## **Class II locations**

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

**Class II locations include:**

### ***Class II, Division 1 - A Class II, Division 1 location is a location:***

- (i) In which combustible dust is or may be in suspension in the air under normal operating conditions, in quantities sufficient to produce explosive or ignitable mixtures; or
- (ii) Where mechanical failure or abnormal operation of machinery or equipment might cause such explosive or ignitable mixtures to be produced, and might also provide a source of ignition through simultaneous failure of electric equipment, through operation of protection devices, or from other causes; or
- (iii) In which combustible dusts of an electrically conductive nature may be present.

**Note to the definition of "Class II, Division 1:"** This classification may include areas of grain handling and processing plants, starch plants, sugar-pulverizing plants, malting plants, hay-grinding plants, coal pulverizing plants, areas where metal dusts and powders are produced or processed, and other similar locations that contain dust producing machinery and equipment (except where the equipment is dust-tight or vented to the outside). These areas would have combustible dust in the air, under normal operating conditions, in quantities sufficient to produce explosive or ignitable mixtures. Combustible dusts that 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 wood flour, oil meal from beans and seed, dried hay, and other organic materials which may produce combustible dusts when processed or handled. Dusts containing magnesium or aluminum are particularly hazardous, and the use of extreme caution is necessary to avoid ignition and explosion.

### ***Class II, Division 2 - A Class II, Division 2 location is a location where:***

- (i) Combustible dust will not normally be in suspension in the air in quantities sufficient to produce explosive or ignitable mixtures, and dust accumulations will normally be insufficient to interfere with the normal operation of electric equipment or other apparatus, but combustible dust may be in suspension in the air as a result of infrequent malfunctioning of handling or processing equipment; and
- (ii) Resulting combustible dust accumulations on, in, or in the vicinity of the electric equipment may be sufficient to interfere with the safe dissipation of heat from electric equipment or may be ignitable by abnormal operation or failure of electric equipment.

**Note to the definition of "Class II, Division 2:"** This classification includes locations where dangerous concentrations of suspended dust would not be likely, but where dust accumulations might form on or in the vicinity of electric equipment. These areas may contain equipment from which appreciable quantities of dust would escape under abnormal operating conditions or be adjacent to a Class II Division 1 location, as described above, into which an explosive or ignitable concentration of dust may be put into suspension under abnormal operating conditions.

## **Class III locations**

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

### ***Class III, Division 1***

A Class III, Division 1 location is a location in which easily ignitable fibers or materials producing combustible flyings are handled, manufactured, or used.

**Note to the definition of "Class III, Division 1:"** Such locations usually include some parts of rayon, cotton, and other textile mills; combustible fiber manufacturing and processing plants; cotton gins and cotton-seed mills; flax-processing plants; clothing manufacturing plants; woodworking plants, and establishments; and industries involving similar hazardous processes or conditions. Easily ignitable fibers and flyings include rayon, cotton (including cotton linters and cotton waste), sisal or henequen, istle, jute, hemp, tow, cocoa fiber, oakum, baled waste kapok, Spanish moss, excelsior, and other materials of similar nature.

### ***Class III, Division 2***

A Class III, Division 2 location is a location in which easily ignitable fibers are stored or handled, other than in the process of manufacture.