A Guide to Hazardous Location Classifications

Timothy Stevens, Product Marketing Manager, Kenall

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Sugar dust explosion at Imperial Sugar in Port Wentworth, GA. Combustible dust is in Class 2.

Personal and property safety in hazardous locations and explosive atmospheres might not sound like a common concern for most people, but it is more critical than most people know. The number of hazardous locations in the US numbers in the hundreds of thousands and includes places we visit or drive by every day: retail gas stations, grain elevators, food processors, distilleries, chemical plants, refineries, paint and surface coating application and storage areas, power generation and waste treatment plants are all considered hazardous to some degree.

There are a number of organizations that work diligently to prevent accidental fires and explosions: the Underwriters Laboratories (UL), Occupational Safety and Health Act (OSHA), and the National Fire Protection Association (NFPA) lead these efforts. As part of this endeavor, the NFPA publishes a comprehensive document on electrical safety, the NFPA 70, National Electric Code (commonly called the NEC). The NEC outlines the requirements for electrical system design and equipment located in hazardous location/explosive atmosphere locations.

What Makes a Location Hazardous?

What makes a location hazardous? The simple explanation is that it is the presence of a specific concentration of fuel in an environment where electric service is also available.

Flammable Gases and Liquids

Most flammable gases have an ignitable range of concentration, but above or below this range, the fuel may not ignite. (Note: a concentration of fuel above the specified range is still considered a hazard, since it is possible to reduce the concentration until it is once again in the ignitable range.) Because most gases are either heavier or lighter than air, concentrations can vary greatly throughout a space, and can either sink or float. The infamous Texas City, Texas Refinery explosion in 2005 was caused by the accidental release of hydrocarbons (fuel spill), which vaporized and then the cloud was accidentally ignited by a running vehicle parked nearby. Examples of other flammable gases include acetylene, propane, carbon monoxide, butane, ammonia, methane, ammonia, hydrogen, and ethylene.

Dust / Fibers and Flyings

Combustible dusts pose two challenges: they can either form an explosive cloud when mixed with air, or they can accumulate on the surfaces of electrical components, insulating them and causing them to overheat. According to a 2014 New York Times editorial, combustible dust explosions alone killed 29 people and injured 161 in the four-year period between 2008 and 2012, including a series of sugar dust explosions in Georgia in 2008 (pictured above right) and three combustible dust accidents in 2011 at the Hoeganaes metal powder plant in Gallatin, Tennessee.

Potentially combustible/explosive dusts are separated in to six categories: agricultural products, such as egg white, powdered milk, starches, sugars and wood flour; agricultural dusts, including many grains (dust and flour), coffee, cotton, grass and spices; carbonaceous dusts, such as coal, charcoal, petroleum coke, cork and cellulose; chemical dusts, including methyl-cellulose, lactose and sulfur; metal dusts, including aluminum, magnesium and zinc; and numerous types of plastics, including melamine and several types of vinyl.

Preventing Ignition

There are two ways that fuel is ignited: when a fuel is in its explosive range and exposed to air and an ignition source, such as sparks or an open flame, or when it reaches its Auto Ignition Temperature (AIT). The AIT is the temperature at which a fuel will, if heated, ignite and burn without the addition of sparks or flame. Authorities use factors such as AIT to determine the required maximum operating temperatures of heat-generating devices, such as luminaires and equipment motors. These devices must be designed to contain all sparks or flames generated during normal or abnormal conditions, and must not exceed the maximum operating temperature required for this environment.

Companies, such as UL®, have developed standards and procedures for designing and testing equipment for use in hazardous locations. These standards and procedures are determined by their classification, division and group, which are established primarily by the NEC and its Canadian counterpart, the Canadian Standards Association (CSA) Canadian Electrical Code (CEC).

NEC Classification Systems

Classes

- Class 1: flammable gases and liquids
- Class 2: dust
- Class 3: fibers or flyings as found in the textile and woodworking industries (with the exception of wood dust, which is Class 2).

Divisions

- Division I is the most severe environment: the hazardous atmosphere is always or often present, or becomes present during frequent servicing/repair.
- Division II: the hazardous atmosphere is only available infrequently, for instance in the case of an accidental spill or the failure of a mechanical positive ventilation system. It includes storage/handling facilities, where the fuel is kept in sealed containers or closed systems. This division can also be found adjacent to Division I areas, where the fuel might occasionally be communicated.

Groups

Hazardous materials are separated into groups based on physical characteristics, such as explosive energy, particle size and conductivity.

- Class I groups are gases and are designated with the letters A through D. Class I, group A gases generate the highest explosive pressures (acetylene) and group D gases (propane) generate the lowest. Due to the higher explosive energy involved, the equipment destined for group A environments is most difficult to manufacture.
- Class II groups are dusts: group E contains conductive or metal dusts like magnesium; group F contains carbonaceous dusts, such as coal; group G dusts are non-conductive dusts including grain, wood and plastic.

Hazardous Location Classifications and Device Types

Protection Classifications

There are several ways to provide acceptable protection from electrical equipment in hazardous (classified) locations.

Division II (Classes I, II & III)

Explosion proof devices

Explosion proof devices and enclosures are designed to withstand a gas or vapor explosion from within, and prevent the ignition of the surrounding atmosphere by arresting any sparks, flame, hot gases or flashes created inside the fixture. In addition, the external operating temperature (hottest extended surface) will not ignite the surrounding hazardous gas or vapor.

The expectation when designing an explosion-proof device is that an explosion will take place inside the enclosure. Protection comes from controlling the energy released from the enclosure. Surprisingly, the fixtures are not sealed, rather, they are designed with special leak paths (in the form of concentric rings, special threads and/or machined joints) that allow for the safe exit of expanding gases from an internal explosion. The process of leaking hot gases from the enclosure is important, because if these leaks were sealed, the fixture could rupture and ignite the surrounding atmosphere. The escaping gases are cooled by the flame front's close contact with the metal escape path, and the exhaust is no longer hazardous. Explosion proof devices are suitable for both Division I and Division II Class I environments.

Class I Div. II devices

Protection for Class I Div. II devices are handled differently based on the device. Acceptable devices include:

- Products listed for Class I Division I
- Nationally Recognized Testing Laboratory (NRTL)-listed devices that meet the specific features described by the NEC for Div II installations. For instance, fixtures must be designed to contain arcing and sparking. Also, other construction requirements/tests must be done to determine the maximum operating temperature of every surface of the fixture, inside and out, and then the fixtures must be labeled with the maximum operating temperature or the Temperature Range Code and the maximum ambient temperature (room temperature).
- The NEC still allows "enclosed and gasketed" or "vapor tight" fixtures, but regulatory agencies have all but eliminated this in practice.

Purged and Pressurized

This system is created using purged and pressurized enclosures* in conjunction with a protective gas to reduce the classification of internal enclosure spaces to Division II or possibly a non-classified space. The protective gas must be supplied at a suitable pressure and flow to prevent the entrance of fuel (gas, dust or fiber). In addition, protective measures must be taken to prevent pressure system failure. There are three types of purged and pressurized systems:

- Type X reduces the classification within the protected enclosure from Division I to non-classified
- Type Y reduces the classification from Division I to Division II
- Type Z reduces the classification from Division II to non-classified

* For more information on P&P see NFPA 49608

Intrinsically Safe

Intrinsically safe devices limit the energy available so that they are is incapable of igniting the hazardous atmosphere, even when in an overload or abnormal condition. This protection is usually used for control circuits and measurement equipment, such as thermocouples, LEDs and pressure sensors. A similar type of component or circuit, called nonincendive, is permitted where approved for Class I, Division II locations.

Class II

Class II devices exclude dust from the enclosure's interior. When properly installed, a Class II device will not permit arcs, sparks or heat to ignite dust (or a dust cloud) on or near the enclosure.

Class III

Class III devices exclude flyings and fiber from the enclosure's interior. A Class III device will not permit arcs, sparks or heat to ignite this type of fuel on or near the enclosure.

Paint Spray Booths

Paint spray booths have special lighting fixture requirements. Surface mounted fixtures installed inside a booth must be rated for Class I or II, Division I. Fixtures that are recessed, certified Division II and specifically listed for paint spray booths may also be used. However, the lens frame must provide for an interlock switch, wired to disable the application process. This interlock would prevent the generation of vapor if the fixture lens is not sealed.

Another more budget-friendly method of lighting paint spray booths involves installing break-resistant, clear, tempered glass panels between the classified space and the mounted Division II-listed fixtures. Fixture installation must be done so that radiant or conductive heat will not accumulate and ignite residue or vapor on or near the glass panels. (Consult NFPA Article 516 for specifics regarding this application.)

Laboratory Testing

In the United States there are several nationally recognized testing laboratories that test and approve hazardous location products, and provide directories so that local authorities can verify the suitability of a product for a particular application. One such directory is called the "Hazardous Location Equipment Directory," published by Underwriters Laboratories Inc.®, commonly referred to as the UL Red Book®.

For further information about this subject, visit www. Xxxx.com.

Hazardous Location Fixtures

HBMA
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HES Series
Fluorescent

CSEDO Series
(HSEDO Series)
LED

CSESO Series
(HSESO Series)
LED

10200 55th Street
Kenosha, WI 53144
262-891-9700
www.kenall.com

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