February 2013

Are You Sure You Are Not In A Hazardous Location?

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Are You Sure You Are Not in a Hazardous Location?

What you may think is a hazardous location may not be what the *National Electrical Code®* (*NEC®*) considers a hazardous location. There is no way powdered sugar can create a hazardous location, right? Of course, this area is not a hazardous location because an explosive atmosphere is not present. If I were in a hazardous location, I would be required to wear special articles of clothing. An outdoor area cannot possibly be a classified location. If you were in a hazardous location you would know it, wouldn't you?

Sound familiar? Then you could be in a hazardous location without knowing it. Knowing that an area is hazardous is the only way to minimize the potential for an incident and the only way to know is by properly classifying the area. Proper classification provides not only a safety benefit but also an economic one because it will affect present and future electrical installations. An incorrect classification can be expensive in many ways. Two examples are the installation of expensive hazardous location equipment in an area that does not require it, or utilizing a protection technique not suitable for the location risking harm to critical equipment and people by the resultant explosion and loss of life. Only in an area correctly classified is it possible to employ the appropriate prevention techniques using the *NEC* requirements.

The *NEC* Classifications

The *NEC* recognizes two classification methods; the Division method and the Zone method. For the Division scheme, there are three classes of hazardous locations based on the type of material involved. Within each class are varying degrees of hazard, so each class is subdivided into divisions based on the likelihood the material will be present. Flammable gases, flammable liquid–produced vapors, and combustible liquid–produced vapors are separated into four Class I groups, and combustible dusts are separated into three Class II groups depending on their properties. Ignitible fibers and combustible flyings are not separated into groups.

Division Scheme

- Gases and vapors - Class I
  - Always or likely to be present - Division 1
  - Not likely to be present - Division 2
    - Groups A, B, C, and D
- Dusts - Class II
  - Division 1
  - Division 2
    - Groups E, F, and G
- Fibers/flyings - Class III
  - Division 1
  - Division 2
    - No groups

Gases and vapors are also Class I materials under the Zone scheme while there are no class designations for dusts or fibers. The likelihood of a material being present is designated as a zone. Flammable gases and vapors are separated into three Class I groups depending on their properties but again dust and fibers are not further delineated. Although this paper will use the terminology for the Division method, the information is adaptable for the Zone method.

Zone Scheme

- Gases and vapors - Class I
  - Always present - Zone 0
  - Likely to be present - Zone 1
  - Not likely to be present - Zone 2
    - Groups IIC, IIB, and IIA
- Dusts, fibers and flyings
  - Always present - Zone 20
  - Likely to be present - Zone 21
  - Not likely to be present - Zone 22
    - No groups

NEC Hazardous (Classified) Locations

The confined space in your facility may not be a *NEC* hazardous location. Confined spaces, toxic chemicals and radiation exposure are terms often associated with the words *hazardous location*. While these may qualify as a hazardous location with the presence of the right type of material, they are not necessarily hazardous locations as defined by the *NEC*. The *NEC* definition for classified locations contains the phrase "depending on the properties … and the likelihood that a flammable or combustible concentration or quantity is present." The definitions for the classification of gas, dust and fiber locations include terms such as *ignitible concentrations* or *quantities sufficient to produce explosive or ignitible mixtures*. For brevity, this paper will use the term *ignitible mixture* to refer to any ignitible, flammable, combustible or explosive atmosphere regardless of the type of material being present. Likewise, *material* will include chemicals, gases, vapors, liquids, dusts, fibers and flyings.

Is it a Hazardous Location?

The *Code* assumes the material is known to be ignitible at some concentration. A material that does not create an ignitible mixture under any condition is not a Class I, II or III material and does not create a hazardous location under the scope of the *NEC*. The *NEC* group's material together based on them exhibiting similar characteristics but does not provide a list of materials. If your facility will use ethylene glycol monobutyl ether acetate (herein called ethylene glycol) you know it is a Group C material because, as the *NEC* states, it has a minimum safe experimental gap value greater than 0.75 mm or a minimum igniting current ratio greater than 0.80. It is not actually necessary to know that but it is necessary to know that this ethylene glycol is a Group C material. NFPA recommended practices list evaluated materials by group.

The facility uses a Group C material; therefore there must be a hazardous location. This may or may not be true. Do you know what it takes to create an ignitible mixture with air? This is another parameter that the *Code* assumes you know. For a given vapor, the vapor-in-air ratio must be within the flammable limits to become a hazard. Many chemicals reach the lower limit of the flammable range within a few percent of vapor-to-air ratio. Many achieve this lower limit at less than 1% in air. The flammable range may be very narrow with the upper limit being within a few percent of the lower limit. It could also be very wide, such as for acetylene, which is flammable over a range of 2.5% to nearly 100%. Again, this information is provided in NFPA recommended practices. These show that ethylene glycol is flammable in the range of 0.9 to 8.5% vapor-in-air. Outside of this range the material does not present an ignitible mixture.

The facility uses ethylene glycol in an open vat so it has to be a hazardous location. Again, this may not be true. Other factors play a role in determining that an ignitible mixture is present. Before the area is classified under the scope of the *NEC*, it is necessary to consider all factors. The *Code* only requires classification where an ignitible mixture may be present. Maybe you decide to take a short cut and declare that if ethylene glycol is in an open vat then the entire room will be a hazardous location. Before you do this, you should be aware that deciding to classify a location as hazardous is not only a safety issue but an economic one. The incorrect classification could make an electrical installation needlessly very expensive at best and could cost lives at worst.

Finally, about the ethylene glycol used in this fictitious facility, it is assumed you know which one is being used. Although facility personnel may call the material *ethylene glycol*, the material here has been ethylene glycol monobutyl ether acetate. Are you sure the one used is not a different ethylene glycol compound such as monoethyl ether acetate, monobutyl ether, monomethyl ether or monoethyl ether. Each of these has different characteristics than the material presented. In fact, one compound is a Group D material not a Group C material. Anyone responsible for classifying the location would need to know this.

Class II and Class III Locations

So far, this paper has addressed Class I locations so a brief description of Class II and III locations is necessary. For dusts and fibers, housekeeping, settlement rates and air velocity are all factors in determining the extent of or need for a classification. Unlike vapors and gasses, it is the physical amount of dust or fibers present that often determines the classification. This is commonly accomplished by determining the thickness of the dust layer expected to settle out over a set period of time. Just as for Class I locations it assumed that you know what group the dust is in. Again, NFPA recommended practices have already separated evaluated materials into the appropriate group.

In response to the statement in the first paragraph, powdered sugar is a Class II, Group G combustible dust that can create hazardous location. There have been several incidents at facilities where personnel were not aware of this fact.

Division 1 or Division 2

Many have heard that a Division 1 area is where an ignitible mixture is always present or is present under normal conditions. They have also heard that if neither of these is true then it must be a Division 2 location. This could be a starting point for determining if you are in a hazardous location but it is not entirely correct. *Normal* does not necessarily mean that everything is operating properly. Frequent maintenance that releases combustible material would qualify as a potential Division 1 location not a Division 2 location. Also, Division 1 includes the area around equipment that could fail, release an ignitible mixture and simultaneously present an ignition source. Often this situation is mistaken to be a Division 2 condition where a hazard is determined under abnormal conditions. An area classified as hazardous may not always contain an ignitible mixture or may not appear to contain material that warranted a classification. How you know the area you are in is a hazardous location will be covered later.

Classifying a Hazardous Location

NFPA technical committees and the American Petroleum Institute (API), among other organizations with experience and expertise in working with flammable liquids, gases, vapors, dusts, fibers and flyings inherent to a process or present under abnormal conditions of operation, determine the parameters, distances, and degrees of hazard associated with classified locations. They provide requirements to achieve these and the basis for determining the classifications. Persons using these classifications without knowledge of the requirements may incorrectly determine the hazards for their installation.

In some facilities, an expert or team of experts, which may include a process engineer, mechanical engineer, safety engineer, chemist and operations personnel, will use the information developed in those standards. They apply that information to their specific equipment and process and, depending on the materials, physical equipment and locations (for example, possible leaks at flanges), determine the area classification. Those classifying a location are responsible to determine the proper use of the area classifications and any modifications based on the deviations from the original document conditions.

They must also evaluate onsite conditions that may alter a classification. Factors that could affect an actual location's classification include:

1) Pits and depressions - collect heavier than air material
2) Roofs and overhangs - collect lighter than air material
3) Prevailing wind - extent of area differs from a still air environment
4) Area grade - liquid spilled on unlevel ground behaves differently than level ground
5) Material process - temperature, pressure and volume impact the extent of the area

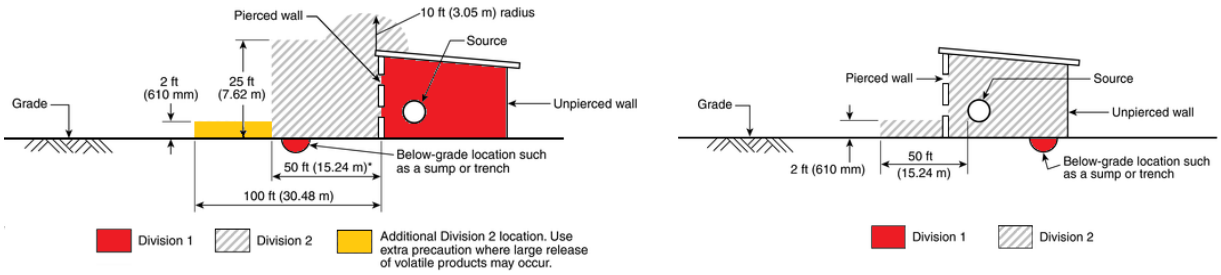
If different types of material — such as a flammable gas and a combustible dust — exist at a location, the area must be classified as both a Class I and a Class II location. Those responsible know that a reduction in ignition energy often results from the combination of materials and that the flammable gas need not be in the flammable range for this reduction to occur. Lastly, they will understand that it is not

possible to classify an area for one installation then use that classification for all similar installations. For example, the hazardous area around an oilrig in operation above the Arctic Circle will not be the same as for an identical rig operating in a Middle Eastern desert.

A Critical Document

After the decision that the area requires classification and the degree and extent of the area has been determined, the *NEC* requires proper documentation of that designation. This is often accomplished by showing the source of the material, process parameters (temperature, flow, pressure, etc), Division 1 boundary and/or Division 2 boundary, and any other pertinent information on a drawing. This document is critical to selecting and installing equipment. It is nearly impossible to install equipment properly without knowing the boundaries of the classification. The classification of a hazardous area is also not based on a transient nature and reclassification is only possible through modification of supporting documentation.

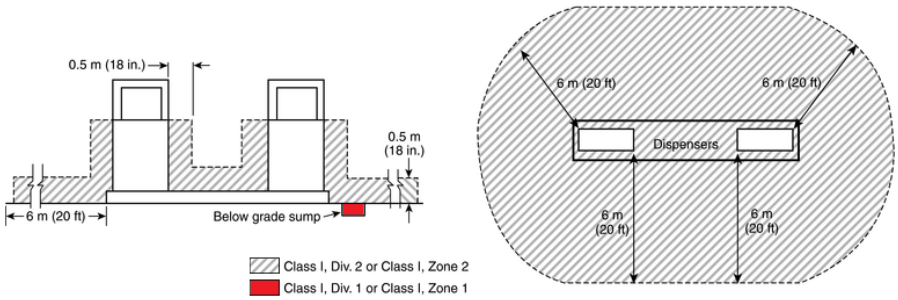
The following two figures illustrate the type of drawing provided to document the area classification by showing the extent of the hazardous location. These specific drawings are for a flammable liquid leak that occurs indoors and is adjacent to an opening in an exterior wall. The source is large process equipment operating under high pressure at a moderate flow rate. The only difference is the left figure does not have adequate ventilation while the figure on the right is provided with adequate ventilation. That simple design modification drastically alters the classification of the installation.



This type of drawing will tell you that you are in a hazardous location. For a completely classified room or building such as above, signage provided on entry points often indicates the potential hazard. The need for special clothing or protective gear is not based on the classification of the area by *NEC* requirements. The material's properties dictate the need for any special protection. Gas masks, oxygen tanks and haz-mat suits are not required by the *Code* because that concern is outside its scope.

The public interacts daily with a Class I location without incident. Not only is it without incident but often without their knowledge of being in such a location. These Class I locations involve the handling of a volatile flammable liquid or gas and are present in almost every city and town. These Class I locations are of course, gas stations and propane filling stations. You may have never considered this but now you are aware of why smoking, keeping a vehicle running and generating static electricity by getting back into the vehicle are all things to avoid. The extent of the classification around a gasoline dispenser

extends further than one would expect as the figure below depicts for the standard classification around dispensing units. This also illustrates that a location entirely outdoors is capable of being a hazardous location.



What Happens Next

If you are only responsible for classifying the location, your job is done when you provide proper documentation of the area. The *NEC* requires that this document be available to anyone designing, installing, maintaining or operating electrical equipment at that location. If you are one of the people responsible for any of those parts of the electrical installation, your job has just begun.

Safely installing electric equipment is nearly impossible without proper documentation. It is by using the document that you will know which protection techniques are allowed and where they are no longer required to be used. Does that elevator motor need to be explosionproof or is a standard motor allowed? Is it permissible to install a basic duplex receptacle on that wall or is it required to be interlocked? Will a wiring method pass through the hazardous location even though it does not connect to anything in the area? The only way to know is to look at the drawing.

Preventing Ignition of the Hazardous Location

It is frequently possible to locate much of the equipment in an unclassified location and, thus, to reduce the amount of special equipment required. If this is not practicable, equipment must be identified for the purpose and installed properly. The protection and wiring methods specified for a given classification are to minimize the potential of ignition. There are fifteen different protection techniques permitted by the *NEC* with some suitable for installation under one or both classification schemes. The protection techniques accomplish preventing ignition of the atmosphere by different means and the *Code*'s installation requirements may be different for each. Before selecting a protection method, consult the drawing to determine the classification of the location where the equipment will be installed.

Is the Right Equipment Being Installed

Protection techniques intended solely for Division 2 locations are generally not acceptable for Division 1 installations. Wiring passing through the hazardous location must use an appropriate protection technique for the portion in that area. Do you know the answer to these questions?

- Is there a difference between a flameproof enclosure and an explosionproof enclosure?
- Does Class I equipment convey a higher level of safety than Class II equipment?
- Is an enclosure suitable for Class I also suitable for Class III?
- How can gas detection be used for a hazardous location installation?

Knowing the answers to these questions is necessary to assure that equipment selected is appropriate for the location. To answer two of the questions, to protect against explosions in hazardous locations, all electrical equipment exposed to the hazardous atmosphere must be suitable for the location. Class I protection methods do not represent a higher level of safety than Class II methods. Equipment suitable for one class or group may not be suitable for any other class or group and protection techniques required for Class II locations are different from that required for Class I locations. Class I equipment is not necessarily suitable for a Class III location because the hazard contemplated in design is different.

The selection of an appropriate protection technique for equipment often also determines the wiring method permitted by the *NEC*. Part II of Articles 501, 502 and 503 covering wiring methods is the lengthiest part of each article. The wiring method often completes the equipment enclosure in addition to protecting the conductors. In order to accomplish this it is necessary to seal the wiring method. In addition, the wiring method may need to be sealed to prevent it from transmitting the material to other locations. Conduit is obviously capable of propagating an ignition and transmitting a material but the design of some cables also permits this to occur. Such a cable will require sealing even when installed in conduit. How to accomplish this sealing is dependent on the construction of the cable and on whether or not it is capable of transmitting material. Even cables and raceways used with intrinsically safe systems permitted by Article 504 may require the use of seals.

Selecting equipment by protection technique for a known hazardous location is not the only criterion that needs consideration. One aspect of selecting the equipment is not as generic; that is temperature. The type of protection employed does not provide this information. Equipment intended for installation in a hazardous location is evaluated for its maximum temperature regardless of the type of protection. In addition, the equipment operating temperature is not the only temperature needing consideration. Ambient temperature and material ignition temperatures also need to be known. Only when all factors are considered can a specific piece of equipment be considered suitable for the actual hazardous location.

Interaction of Code Articles

Users of Chapter 5 often forget to verify that the general *Code* requirements have also been met. Section 90.3 details the arrangement of the *NEC*. Chapters 1, 2, 3 and 4 apply to all installations while Chapter 5 supplements or modifies those general requirements. For example, Type MC cable has specific requirements when installed in a hazardous location but the general rules, such as not being used where subject to physical damage in Article 330, still apply.

Chapter 5 articles also rely on each other. Article 500 applies to all hazardous locations classified under the Division method. The occupancies in Articles 511 through 516 contain specific requirements for

those locations but the applicable provisions in Article 501, 502 and 503 apply. The requirement for grounding and bonding metal conduit in Class I locations is covered in Article 501 not in the specific occupancy articles. If Article 513 requires explosionproof protection then Article 501 provisions for sealing are necessary or if Article 516 allows dust-ignitionproof equipment then provisions of Article 502 apply. The applicable requirements of the entire *Code* are necessary to properly install any equipment.

Articles 505 and 506

Article 505 contains the requirements for installation in a gas or vapor location classified under the Zone method while Article 506 contains the requirements for those classified due to dust, fiber and flyings. These articles also apply to the locations in Articles 511 through 516 when classified under the Zone method.

Several regions of the world also use a zone method of classification and equipment from these other regions occasionally finds its way into a region that uses the *NEC*. Only Zone equipment evaluated against the American National Standards and marked *AEx* is permitted by the *NEC*. A product intended for zone installation and not marked with AEx is not to American National Standards. Installation of equipment that does not meet the appropriate standard may not be safe or compliant within the *NEC* requirements and its installation could compromise safety of the equipment and personnel.

Specific Hazardous Locations

Several hazardous locations are common or have been examined enough to warrant their own articles. These locations are addressed in Articles 511 though 516. Each article has the ability to modify not only the requirements from the first four chapters of the *NEC* but also the general hazardous location requirements in Articles 500 through 506. For example, Article 514 (motor fuel dispensing facilities) permits Type PVC conduit, in an underground location, without the concrete encasement required in Article 501 because gas stations have considerable experience with underground nonmetallic conduit. These articles provide guidance for some area classifications with information extracted from other documents. The extracted classifications are based on the construction and parameters of the area meeting specific criteria set forth in those other documents. Deviations from any aspect could affect the classification.

Minimizing the Potential of an Ignition

The *NEC* installation requirements are to minimize the risk of hazards arising from the use of electricity. When a hazardous location is involved this takes on an expanded meaning. The appropriate classification of the area with the extent of the hazard well documented is required to begin achieving this purpose. A considerable number of factors influence the classification and each must be addressed. Once the classification is competed then the appropriate equipment protection techniques can be employed. Again, several installation aspects affect the safety of the system so it is necessary to follow the *Code* requirements.

Knowing that you are in a hazardous location assumes that a qualified person or team has properly applied the requirements to determine that fact. Classifying an area as hazardous is a detailed project whose result will have an economic and safety impact. Only through proper classification is it possible to employ the proper prevention techniques for the electrical installation. Properly classifying the area will avoid the installation of unnecessary or inappropriate equipment and most importantly, minimize the potential for an explosion or loss of life. You want to be sure you are not a hazardous location, don't you?

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