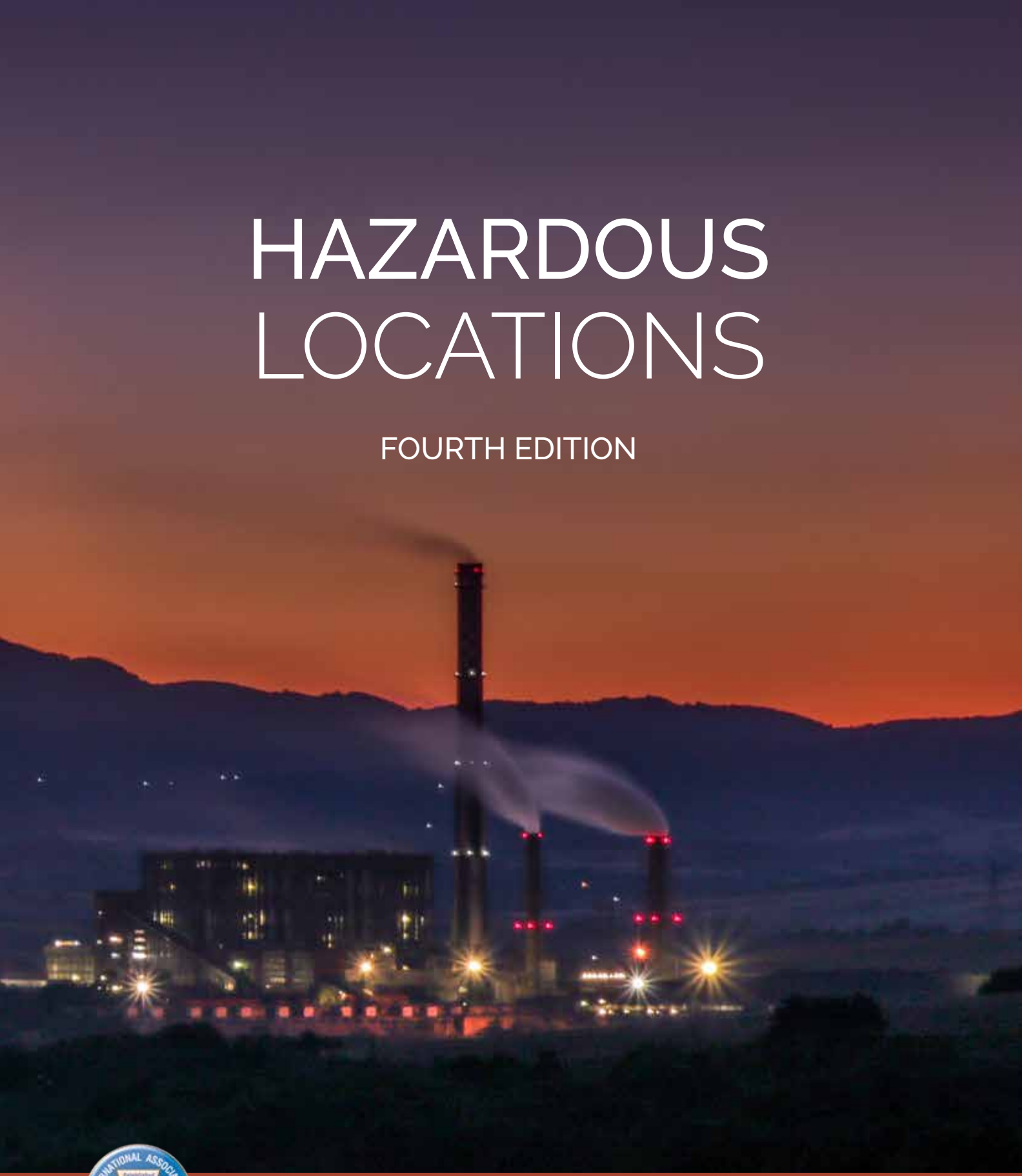
HAZARDOUS LOCATIONS

FOURTH EDITION



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Hazardous Locations

Fourth Edition

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CHAPTER ONE

CLASSIFICATION OF AREAS AND LOCATIONS

One of the most important actions associated with safe electrical installations in hazardous (classified) locations is to determine the area classification and the extent of such areas. Before electrical wiring and equipment are installed in a hazardous (classified) location, the hazardous area classification must be known. Some of these classified locations are clearly defined in the *National Electrical Code* (NFPA 70), while others require research and reference to other applicable codes and standards.

Area classification is often the result of a risk analysis of a particular location or area to determine the likelihood that an explosion hazard exists. Areas are generally hazardous (classified) locations if ignitible concentrations of flammable gases, flammable liquid-produced vapors, combustible liquid-produced vapors, combustible dust, or ignitible fibers/flyings, either in suspension in the air or other accumulations that present explosion or fire hazards, exist, or could exist.

DEGREE OF THE HAZARD

The degree of the hazard is usually determined by the particular gas, vapor, or other substance and the associated process that will produce, or is likely to produce, atmospheres or accumulations of these materials that can be ignited. Electricity presents an ignition source to these areas, and installations of electrical equipment and materials in these locations are much more restrictive and specific. This chapter provides some general insight into the various classified areas that are determined either under the Division system or the Zone system of classifying hazardous (classified) locations. The multiple levels of area classification and details of

each will be provided later in this chapter. Figure 1.01 shows a Class I, Division 1 area with a boundary against a Class I, Division 2 area that extends out to an unclassified area. Areas that are not classified as a hazardous location are defined as unclassified locations as defined in Article 100 of the *NEC* (see figure 1.01 and photo 1.01).

At this point, it is necessary to familiarize oneself with the common terms used in determining area classification. These are the terms used by the applicable standards. When discussions or planning related to area classification are taking place, it is vital to use a common language of communication, the language used in the applicable code or standard.

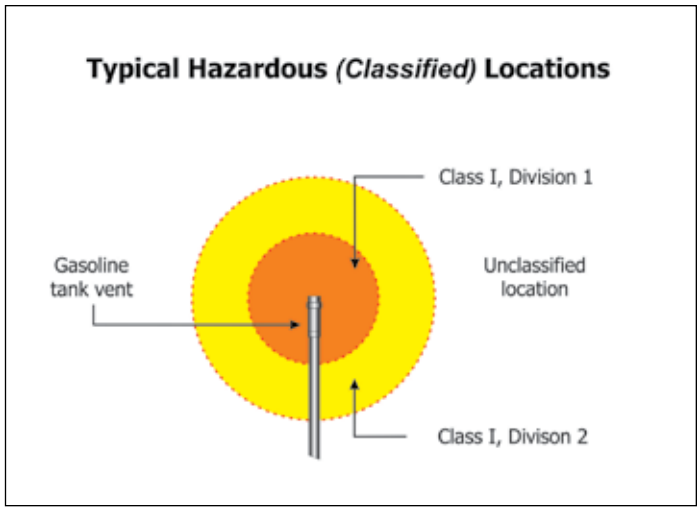

Figure 1.01 Typical Class I, Division 1 and Division 2 areas with a boundary against an unclassified area

Photo 1.01 Class I, Divisions 1 and 2 areas within determined distances from underground gasoline tank vents

DEFINITIONS

Flammable gases are those that will burn in air[1] and as gases that are ignitable at atmospheric temperature and pressure in a mixture of 13 percent or less (by volume) with air, or that has a flammable range with air of at least 12 percent, regardless of the lower limit.[2]

Flammable vapors are those given off from a flammable liquid at and above its flash point.[3]

Flammable liquids are defined as Class I liquids having a flash point below 22.8°C (73°F) and boiling point below 37.8°C (100°F) and having a vapor pressure not exceeding 40 psi at 37.8°C (100°F).[4]

Combustible liquids have a flash point at or above 37.8°C (100°F).[5] These liquids will form an ignitible mixture only when heated above their flash point.

Combustible dust is defined as dust particles that are 500 microns or smaller (material passing a U.S. No. 35 standard sieve as specified in ASTM E 11-09, *Standard Specification for Wire Cloth and Sieves for Testing Purposes*) and present a fire or explosion hazard when dispersed and ignited in air.

Easily ignitible fibers/flyings are not defined in any NFPA document or any other industry document. However, in Section 506.6, Group IIIA materials are defined as solid particles, including fibers, greater than 500 µm in nominal size, which could be suspended in air and could settle out of the atmosphere under their own weight.

Unclassified locations are "determined to be neither Class I, Division 1; Class I, Division 2; Class I, Zone 0; Class I, Zone 1; Class I, Zone 2; Class II, Division 1; Class II, Division 2; Class III, Division 1; Class III, Division 2; Zone 20; Zone 21; Zone 22; nor any combination thereof."[7]

Photo 1.02 Typical motor fuel dispensing facilities fall under the requirements of Article 514 of the *NEC; NFPA 30A is the associated standard.*

Predetermined Classification Areas

The *NEC* identifies several predetermined hazardous (classified) locations associated with various special occupancies and conditions. Where the area classification is already predetermined and provided in a code rule or standard, one can proceed with a design or installation with an understanding of the extent (boundaries) of the hazardous (classified) location. For example, in Article 514, there is a predetermined classified area at a motor fuel dispenser identified in Table 514.3(B)(1). This table indicates that the area extending up to 0.5 m (18 in.) above grade level within 6.0 m (20 ft) horizontally of an edge of the dispenser enclosure is a Class I, Division 2 location (see figure 1.02 and photo 1.02). With that information, the installer or design team can plan an electrical design or installation for the dispensing equipment. Electrical wiring and equipment installed in this classified location must be done with the appropriate wiring methods and equipment. Chapter five of this book provides more detailed information about the wiring methods permitted in hazardous (classified) locations. The above example is just one of many classified (hazardous) locations predetermined and delineated in *NEC* rules. Several other special occupancies with hazardous locations have well-defined boundaries identified in the *NEC,* such as aircraft hangars, commercial repair garages, and spray paint booths. Chapter six takes a more detailed look at these special occupancies and their associated requirements for the hazardous (classified) locations in each.

Risk Assessment and Analysis

Many other locations and conditions in the industry require a more analytical and careful approach to determining area classifications. For these areas not defined by a particular code or standard, the process of determining a classified area is more complicated. The first step of which is usually an assessment or risk analysis associated with the area in question. In addition to determining the likelihood that an ignitible concentration exists, the area classification provides an accurate and defined description of the material (gas, vapor, dust, and so forth) so that appropriate electrical systems and equipment can be selected for the design and installation. Determining who is responsible for risk analysis is a common question. More than one individual is often responsible for determining the area classification.

Note: For Zone area classifications, an EPL (or equipment protection level) may appear on the area classification drawing. EPLs are designated as G for gas, D for dust, or M for mining. The designation is then followed by a letter (a, b, or c) to give the user a better understanding as to whether the classified area is intended for equipment that provides either (a) a "very high," (b) a "high," or (c) an "enhanced" level of protection against ignition of an explosive atmosphere.

When it has been established that any flammable or combustible materials are present, then an assessment must determine if the material is likely

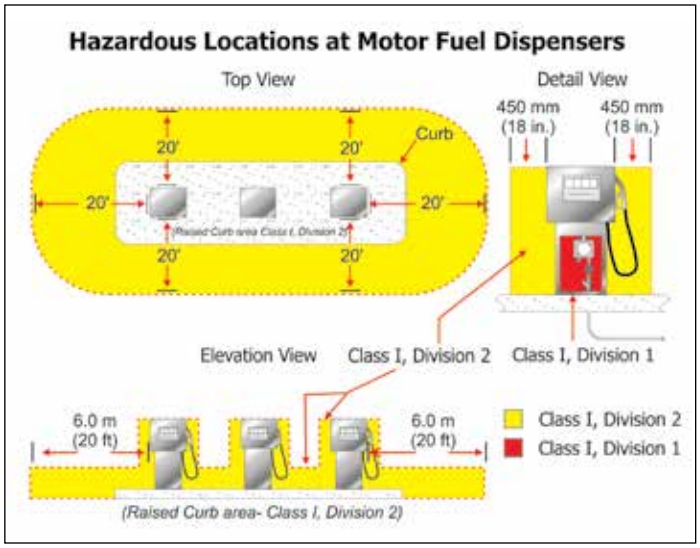

Figure 1.02 Motor fuel dispensing equipment showing the classification of the area and the extent (boundary) of the hazardous (classified) location as identified in Table 514.3(B)(1) in Article 514.

(1) to be released, and (2) to form an ignitible concentration with air (oxygen), and whether (3) an ignition source by the electrical system is a threat to persons and property. In some cases, this assessment process is simple in nature; and in others, it can be quite complex. It is important to carefully consider all possible situations that present ignition risks that might result in explosions and fire.

Documentation of Hazardous (Classified) Locations

The *NEC* requires, in 500.4(A), proper documentation of areas designated as hazardous (classified) locations. This documentation can be in several acceptable formats, but it must be acceptable to the approving authority (see the definition of *authority having jurisdiction* in Article 100). Usually, it is in the form of written documents, accompanied by blueprints or drawings that graphically show the area classification (see figure 1.03). This documentation must be available to those authorized to design, install, inspect, maintain, or operate electrical equipment at that location [*NEC* 500.4(A)]. This requirement and the general information provided in this chapter will assist readers and reinforce the understanding that risk analysis and determination of hazardous locations is not a process that should be performed in the field during installation.

The Design Team

Educated design and ingenuity are critical to making these determinations and, generally, include work by various professionals involved in this type of work. As all of the information and facts are gathered that relate to determining the extent of a hazardous location, it becomes evident that the process will likely involve more than just the electrical component of the facility design and installation. In many installations, it will require involvement from one or more of the following engineering or design professionals: chemical, process, mechanical, fire protection, civil, environmental, structural, architectural and electrical.

The owner has a responsibility to assist the design team by disclosing all pertinent information about the materials to be used and how they will assist in implementing an adequate design. Any change of design in any of these disciplines can impact the area classification. Communication and full disclosure is imperative in accurate determination of hazardous (classified) locations and the extent of those areas. It is also important that owners and operators of facilities that include hazardous (classified) locations be familiar with the hazards and the determined locations.

Important Design Reference Information

The process of determining a hazardous (classified) location involves identifying combustible or flammable materials. The following two references are essential to the process of area classification:

NFPA 497–2017, *Recommended Practice for the Classification of Flammable Liquids, Gases, or Vapors and of Hazardous (Classified) Locations for Electrical Installations in Chemical Process Areas.*

NFPA 499–2017, *Recommended Practice for the*

Classification of Combustible Dusts and of Hazardous (Classified) Locations for Electrical Installations in Chemical Process Areas.

Much of the information contained in these recommended practices has been extracted and inserted into other applicable and mandatory codes and standards. NFPA 497 and NFPA 499 serve as the primary basis of hazardous area classification. Many of the requirements in the *NEC* have been extracted from either NFPA 497 or 499 and inserted as rules. Where the *NEC* provides extracted information from other standards, brackets containing the standard and the section number of the standard from which it was derived will follow the rule.

Most who are involved in the electrical industry are usually familiar with *NEC* (NFPA 70) but are far less familiar with other standards applicable to hazardous locations. When dealing with hazardous (classified) locations, especially when it comes to determining area classification, one needs to be familiar with recorded industrial experience as well as with the other applicable standards of the National Fire Protection Association (NFPA), the American Petroleum Institute (API), the International Society of Automation (ISA), and Underwriters Laboratories Inc. (UL) that may be of use in the classification of various locations. Information about determining adequate ventilation and the various forms of protection against static electricity and lightning hazards, as well as other important protection methods and techniques, are also described in these standards [*NEC* 500.4(B) Informational Note 2].

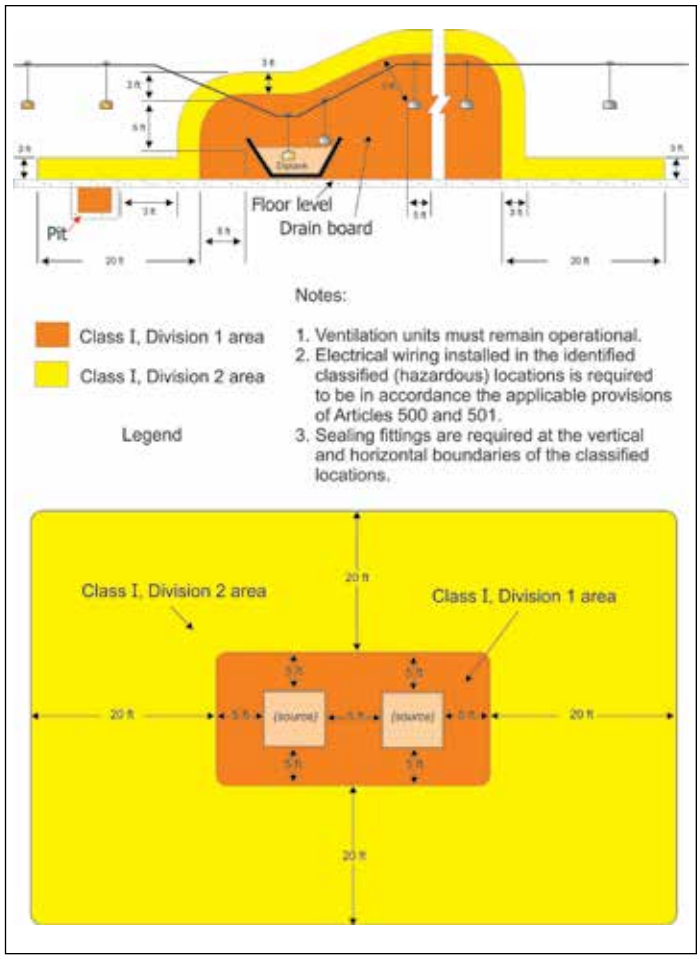

Figure 1.03 An example of typical documentation of a hazardous (classified) location as required by 500.4(A), showing a small schematic and a legend that provides information about the area classification. Documentation should provide material involved, autoignition temperature, gas group, and vapor density.

These two common primary NFPA references are useful in assisting in the determination of hazardous locations. Table 4.4.2 of NFPA 497 provides a fairly complete list of combustible and flammable liquids. Annex C to NFPA 497 gives several additional references that could also assist in judging materials for purposes of area classification because of flammable or combustible liquids. Table 5.2.3 of NFPA 499 presents an extensive list of common materials defined as combustible dusts. Annex B to NFPA 499 offers several additional references to assist in judging materials for purposes of area classification because of combustible dust [see Annex, Table A-01 that reproduces NFPA 497, Table 4.4.2 and Table A-02 that reproduces NFPA 499, Table 5.2.3].

The Fire Triangle

To develop an understanding of the hazards associated with the use of electricity in hazardous

locations, a review of the components (oxygen, heat or ignition, and fuel) of the fire triangle is in order. All three elements of the triangle must be present in specific ratios for ignition and explosion to occur (see figure 1.04). Vapor density will impact the likelihood that an ignitible concentration will develop; this will be covered in detail later in this chapter. Approximately 21 percent of the earth's atmosphere is oxygen. For the focus of this text, the heat or ignition source is the electrical system; although it could be open flame or other heat sources that exceed the ignition levels of the materials involved. The fuel leg of the triangle could be one or a combination of the various materials listed in the tables provided in NFPA 497 and 499.

Requirements in standards related to hazardous (classified) locations are based on *normal* atmospheric quantities of oxygen. It should be noted that these standard requirements have not considered situations involving oxygen-enriched or oxygen-deprived atmospheres. Identifying those conditions is part of the risk assessment and analysis process when determining area classification.

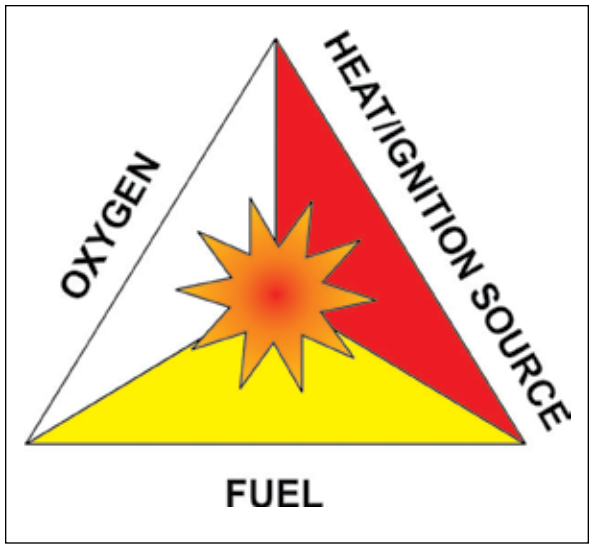

Figure 1.04 The fire triangle showing the three legs of the triangle: fuel, heat/ignition, and oxygen

Photo 1.03 A natural gas boiler with a sealed gas piping system

Other General Safety Concerns

Although the electrical system is the source of ignition considered by this text, those performing electrical work in hazardous (classified) locations must be aware that many non-electrical items that occur in an electrical installation (vehicle use, smoking, cutting and burning, mechanical sparks, welding, etc.) are also regulated in the codes, standards, and recommended practices developed by many industries that include hazardous (classified) locations. A thorough review of those requirements for working safely in hazardous (classified) locations must be made. An additional general statement applies to all locations where flammable and combustible materials are present: Catastrophic failures or discharges of the materials from containment have not been considered in the area classification of a facility. If catastrophic events—hurricanes, tornados, earthquakes, military or terrorist attacks, and so forth—occur, providing special electrical equipment would probably have little impact on the ignition of the material.

UNCLASSIFIED AREAS

As briefly discussed earlier in this chapter, *unclassified locations* are defined in Article 100 as "locations determined to be neither Class I, Division 1; Class I, Division 2; Class I, Zone 0; Class I, Zone 1; Class I, Zone 2; Class II, Division 1; Class II, Division 2; Class III, Division 1; Class III, Division 2; Zone 20, Zone 21, Zone 22; nor

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PROTECT YOURSELF AND YOUR TEAM!

This book provides training materials and resources to assist those involved with designing, installing, inspecting and maintaining electrical systems in hazardous (classified) locations.

Hazardous Locations includes information on:

- Area classification
- Methods of protection
- Interaction of protection techniques with specific types of electrical equipment
- Wiring requirements
- Specific occupancies and industries

Readers should be aware that approval of and design of electrical installations in hazardous location are two different tasks and responsibilities. The area classification of design would likely include a team of electrical, process, mechanical, fire protection and structural design contributors. That design should include proper documentation. Approval of the classification and design is the responsibility of the AHJ.

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