



PDH-Pro.com

## NEC Area Classification

**Course Number:** EE-02-601

**PDH:** 2

**Approved for:** AK, AL, AR, DE, FL, GA, IA, ID, IL, IN, KS, KY, LA, MD, ME, MI, MN, MO, MS, MT, NC, ND, NE, NH, NJ, NM, NV, NY, OH, OK, OR, PA, SC, SD, TN, TX, UT, VA, VT, WI, WV, and WY

### State Board Approvals

Florida Provider # 0009553 License #868

Indiana Continuing Education Provider #CE21800088

Maryland Approved Provider of Continuing Professional Competency

New Jersey Professional Competency Approval #24GP00025600

North Carolina Approved Sponsor #S-0695

NYSED Sponsor #274

### How Our Written Courses Work

This document is the course text. You may review this material at your leisure before or after you purchase the course.

After the course has been purchased, review the technical material and then complete the quiz at your convenience.

A Certificate of Completion is available once you pass the exam (70% or greater).

If a passing grade is not obtained, you may take the quiz as many times as necessary until a passing grade is obtained).

If you have any questions or technical difficulties, please call (508) 298-4787 or email us at [admin@PDH Pro.com](mailto:admin@PDH Pro.com).





## Module 1: Introduction

### Learning Objectives

By the end of this section, you will be able to:

- **Identify** the regulatory definitions of hazardous locations according to OSHA, NEC, and CEC standards.
- **Evaluate** the necessity of specialized electrical equipment based on environmental risk factors.

*Executive Summary:* Hazardous locations are strictly defined areas where flammable substances exist in sufficient quantities to produce an explosion or fire, requiring specialized equipment and installation techniques to mitigate risk.

### Design Fundamentals for Hazardous Environments

A primary objective in industrial safety is the prevention of fires and explosions. This field receives extensive focus through rigorous codes, standards, and engineering design practices.

### Regulatory Framework

Regulatory bodies establish systems to classify locations based on the specific degree of hazard presented:

- **OSHA Publication 3073:** Defines these areas as locations where flammable liquids, gases, vapors, or combustible dusts exist in quantities sufficient to cause an explosion or fire.
- **NEC and CEC:** Define these areas as locations where a potential hazard may exist under either normal or abnormal conditions due to the presence of flammable gases, vapors, combustible dusts, or ignitable fibers/flyings.

### Application of Engineering Judgment

Hazardous locations often involve environments where electrical equipment is installed in the presence of volatile elements. While some substances are unavoidable—such as methane or coal dust in mining operations—the engineer must ensure safe system operation through proper selection and installation.

**⚠ Safety Constraint:** In any area defined as a hazardous location, you must utilize specially designed equipment and specific installation techniques to protect against explosive potential.

**💡 Design Tip:** Understanding the specific environment is critical. Proper selection of components like push buttons and pilot lights ensures the integrity of the safe operating system.

**Industry Expansion** While chemical and petrochemical industries remain primary users of explosion-protected equipment, the application has expanded into modern sectors:

- Waste disposal facilities.



- Landfill operations.
- Bio-gas utilization plants.

---

*Checkpoint Quiz*

---

**1. According to the NEC and CEC, a hazardous area is defined by the potential for hazard under which conditions?**

- a) Only under normal operating conditions.
- b) Only during equipment failure or abnormal conditions.
- c) Under both normal and abnormal conditions.
- d) Only when oxygen-enriched atmospheres are present.

**Answer:** (c). The code accounts for hazards present during routine operation as well as those resulting from leaks or failures.

**2. Which regulatory body defines a hazardous location specifically as an area where flammable substances exist in "sufficient quantities" to produce a fire or explosion?**

- a) IEEE
- b) OSHA
- c) NEMA
- d) ASTM

**Answer:** (b). This specific "sufficient quantities" phrasing is found in OSHA Publication 3073.

**3. Which of the following is cited as a modern field where focus on explosion-protected electrical equipment has expanded?**

- a) Residential HVAC systems.
- b) Commercial aerospace manufacturing.
- c) Landfills and bio-gas utilization.
- d) Automotive assembly lines.

**Answer:** (c). The text explicitly mentions these as new fields for hazardous location safety application.

## Module 2: Basic Requirements for an Explosion

### Learning Objectives

By the end of this section, you will be able to:

- **Evaluate** the three fundamental components of the ignition triangle required for a combustion event.
- **Differentiate** between the hazards posed by flammable gases, liquids, and combustible solids.
- **Analyze** the variables that influence the minimum ignition energy and flammability limits of hazardous substances.

*Executive Summary:* An explosion is a rapid physical or chemical decay involving significant increases in temperature and pressure; preventing such events requires the deliberate elimination of at least one element of the ignition triangle: fuel, oxidizer, or ignition source.

### The Mechanism of an Explosion

An explosion is defined as a sudden reaction involving rapid physical or chemical decay accompanied by an increase in temperature or pressure, or both. Most industrial explosions occur when flammable gases, vapors, or dust react with the oxygen contained in the surrounding air.

### The Ignition Triangle

For an explosion to occur in atmospheric air, three basic requirements must exist simultaneously:

- **Flammable Substance:** This must be present in sufficient quantity to produce an ignitable or explosive mixture.
- **Oxidizer:** Typically air (O<sub>2</sub>), which must be present in sufficient quantity in combination with the fuel.
- **Source of Ignition:** A spark or high heat must be present to initiate the reaction.

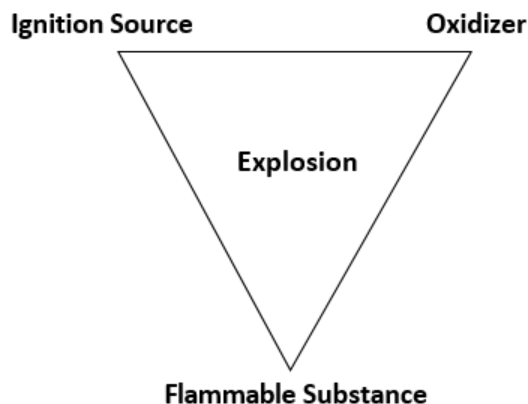



Figure 1.

## Characteristics of Flammable Substances

Flammable materials are categorized into three primary subgroups based on their physical state and reactive properties.

**Table A.**

| Flammable Substance       | Examples  | Description  |
|---------------------------|---|--|
| Flammable Gas             | Hydrogen, etc.  | <ul style="list-style-type: none"> <li>Often compounds of hydrogen and carbon that require very little to react with atmospheric oxygen.</li> </ul>  |
| Flammable Liquids/ Vapors | Hydrocarbons such as ether, acetone, lighter fluids, etc. | <ul style="list-style-type: none"> <li>Even at room temperature, sufficient quantities of these hydrocarbons can evaporate to form a potentially explosive atmosphere at their surface. Other liquids require higher temperature for this to occur.</li> <li>The flash point of a flammable liquid is the lowest temperature at which a sufficient quantity of vapor will arise to permit ignition under laboratory conditions. This is an important factor in the classification of hazardous areas.</li> <li>Flammable liquids with a high flash point are less hazardous than liquids with a low flash point.</li> </ul>  |
| Flammable Solids          | Dust, fibers, and flying's                                | <ul style="list-style-type: none"> <li>The cumulative nature of the dust hazard is the most significant difference between a gas/vapor hazard and the dust hazard.</li> <li>A dust cloud will settle on nearby surfaces if it is not ignited. Unless removed, layers of dust can build up and will serve as fuel for subsequent ignition.</li> <li>The typical dust explosion starts with the ignition of a small dust cloud resulting in relatively small damages.</li> <li>Pressure waves of the small initial explosion are the most damaging part of the dust explosions.</li> </ul> <p>These pressure waves release dust layers from surrounding vertical or horizontal surfaces to produce a larger cloud which is ignited by the burning particles of the initial cloud.</p> <p>In this way, the small initial explosion can produce a much larger explosion. In some cases, a series of explosions occur, each stronger than the previous.</p> |

 **Calculation Note:** Every gas or vapor has specific **lower flammability limits (LFL)** and **upper flammability limits (UFL)**. If the concentration is outside this range, a flame will not propagate even if ignition occurs.

## The Role of the Oxidizer

The standard oxidizer in hazardous location engineering is air at normal atmospheric conditions.

- **Equilibrium:** Explosions are most violent when oxygen and fuel are in equilibrium.
- **Dilution:** Hazards can be mitigated by diluting flammable substances with air or by preventing air ingress (inerting).



- **Enriched Atmospheres:** Oxygen-enriched environments or pressurized enclosures alter ignition conditions and require special containment studies.

### Sources of Ignition

The energy required for ignition depends on the concentration of the substance, its explosive characteristics, and the volume of the location.

Table B.

| Ignition Sources (Industrial Electrical Equipment) | Examples  |
|--|---|
| Hot Surfaces                                       | Surfaces heated by coils, resistors, lamps, brakes, or hot bearings. Hot surface ignition can occur at the Auto-Ignition Temperature (AIT) or spontaneous ignition temperature at which a hazardous substance will spontaneously ignite without further energy. |
| Electrical Sparks                                  | Occurs when circuits are broken or static discharge takes place. In low voltage circuits, arcs are often created through the making and breaking of electrical contacts.  |
| Friction and Impact Sparks                         | When casings or enclosures are struck.  |

**⚠ Safety Constraint:** The design of explosion-proof electrical equipment must eliminate these sources of ignition, which is verified through mandatory testing and certification.

### Explosion Control and Mitigation

Reduction of hazards is not absolute; there is no "absolute safety". The primary objective is to reduce the risk to an **acceptable level** where the probability of an explosion is not significantly increased by the presence of electrical apparatus.

### Hierarchy of Control

1. **Location:** The most certain method of prevention is locating electrical equipment outside of hazardous areas whenever possible.
2. **Inhibition:** If relocation is not practical, use installation techniques and enclosures that eliminate one or more elements of the ignition triangle.



Purchase this course to  
see the remainder of  
the technical materials.