Allen-Bradley

Zone Hazardous Location

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Introduction

A major safety concern in industrial plants is the occurrence of fires and explosions. No other aspect of industrial safety receives more attention in the form of codes, standards, technical papers, and engineering design. Regulatory bodies like the Occupational Safety and Health Administration (OSHA) have established systems that classify locations which exhibit potentially dangerous conditions to the degree of hazard presented.

OSHA Publication 3073 defines a hazardous location as follows:

Hazardous locations are areas where flammable liquids, gases or vapors or combustible dusts exist in sufficient quantities to produce an explosion or fire. In hazardous locations, specially designed equipment and special installation techniques must be used to protect against the explosive and flammable potential of these substances.

Hazardous locations can also be described as those locations where electrical equipment might be installed and which, by their nature, might present a condition which could become explosive if the elements for ignition are present. Unfortunately, flammable substances are not always avoidable, e.g., methane and coal dust in mines. Therefore, it is of great importance that a user of electrical equipment, such as push buttons and pilot lights, be aware of the environment in which these products will be installed. The user's understanding of the hazard will help ensure that the electrical equipment is properly selected, installed, and operated to provide a safe operating system.

There are a great variety of applications, especially in the chemical and petrochemical industries, that require explosion protected equipment. As a result, there have been principles and technologies developed to allow electrical instrumentation and control devices to be used even in environments where there is a danger of explosion. However, focus on explosion protected electrical equipment is not limited to utilization and processing of oil and natural gas. It has expanded into new fields such as waste disposal, landfills, and the utilization of bio-gas.

Basic Requirements for an Explosion

What is 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.

When will an explosion occur?

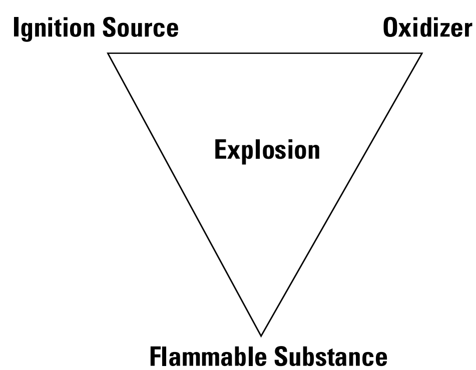
The most common types of reaction are between flammable gases, vapors, or dust with oxygen contained in the surrounding air.

As a rule, three basic requirements must be met for an explosion to take place in atmospheric air:

1. Flammable substance — needs to be present in sufficient quantity to produce an ignitable or explosive mixture.
2. Oxidizer — must be present in sufficient quantity in combination with the flammable substance to produce an explosive mixture. Most common is air (O_2).
3. Source of ignition — a spark or high heat must be present.

The presence of these three elements make up the sides of the ignition triangle. If any one of the three elements is missing, an explosion will not occur. All three elements must exist simultaneously for an explosion to occur.

Figure 1.



Flammable Substance

Flammable substances can be divided into three subgroups:

- Flammable gas
- Flammable liquids/vapors
- Flammable solids

Table A.

Flammable Substance	Examples	Description
Flammable Gas	Hydrogen, etc.	Often compounds of hydrogen and carbon that require very little to react with atmospheric oxygen.
Flammable Liquids/ Vapors	Hydrocarbons such as ether, acetone, lighter fluids, etc.	• 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. • 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. • Flammable liquids with a high flash point are less hazardous than liquids with a low flash point.
Flammable Solids	Dust, fibers, and flyings	• The cumulative nature of the dust hazard is the most significant difference between a gas/vapor hazard and the dust hazard. • 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. • The typical dust explosion starts with the ignition of a small dust cloud resulting in relatively small damages. • Pressure waves of the small initial explosion are the most damaging part of the dust explosions. 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. 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.

Note: Every flammable gas or vapor has specific lower and upper flammability limits. If the substance or concentration in the oxidizer is either below a specific value (lower flammability limit) or above a specific value (upper flammability limit), ignition might occur; however, a flame will not propagate.

If a flammable gas or vapor cloud is released and ignited, all the material may be consumed in one explosion. If the flammable gas or vapor cloud is not ignited, convection and diffusion will eventually disperse the flammable cloud, the immediate danger passes, and the particular fuel source is lost.

Oxidizer

The oxidizer referred to in all common hazardous location standards and explosion-proof equipment is air at normal atmospheric conditions. The oxygen in the air is only enough for the combustion of a certain quantity of flammable material. Air must be present in sufficient volume to propagate a flame before the air-fuel mixture becomes a hazard. When the amount of available atmospheric oxygen is more or less in equilibrium with the quantity of flammable material, the effect of an explosion — both temperature and pressure — is most violent. If the quantity of flammable material is too small, combustion will spread with difficulty or cease altogether. The same applies if the quantity of flammable material is too great for the available oxygen.

Each flammable material has an upper and lower explosion limit above or below which no explosion will take place. This can be exploited by diluting the flammable substances with air or preventing the ingress of air/oxygen. The latter option is ruled out in environments where people work regularly and is feasible only in a chemical plant where there are no human beings.

The presence of an oxygen-enriched atmosphere or a pressurized enclosure alters the conditions for ignition and dictates the use of special means for prevention and containment of explosions. No means of explosion protection considered safe for atmospheric mixtures should be used in either oxygen-enriched or pressurized situations without careful study.

Ignition Source

The amount of energy required to cause ignition is dependent upon these factors:

- The concentration of the hazardous substance within its specific flammability limits.
- The explosive characteristics of the particular hazardous substance.
- The volume of the location in which the hazardous substance is present.

Ignition may occur from sources such as the following:

- Open flames
- Hot gas
- Chemical reactions or biological processes which occur spontaneously at certain oxygen levels or temperatures
- Lightning
- Intense electromagnetic radiation
- Ionizing radiation
- Adiabatic compression and shock waves
- Static electricity
- Sparks or arcs from electrical equipment or wiring
- Hot surfaces of electrical equipment or wiring

Further classification of sources of ignition in industrial electrical equipment are as follows:

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	Occur 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.

The design of explosion-proof electrical equipment eliminates these sources of ignition and this is confirmed by testing and certification.

Where do explosions most frequently occur?

Typically exists in chemical plants, refineries, paint shops, cleaning facilities, mills, flour silos, tanks, and loading facilities for flammable gases, liquids, and solids.

How is the explosion controlled?

Reduction of hazards is not absolute. There is no absolute safety. Removing one of the elements from the ignition triangle can provide explosion protection and preclude unwanted, uncontrolled, and often disastrous explosions. If one of the three elements of the ignition triangle is missing, ignition will not occur. Since flammable substance and oxidizers cannot be frequently eliminated with certainty, inhibiting ignition of a potentially explosive atmosphere can eliminate danger at the source.

The objective of selecting an electrical apparatus and the means of installation is to reduce the hazard of the electrical apparatus to an acceptable level. An acceptable level might be defined as selecting protective measures and installation means to ensure that the probability of an explosion is not significantly greater due to the presence of electrical apparatus than it would have been had there been no electrical apparatus present.

The most certain method of preventing an explosion is to locate electrical equipment outside of hazardous (classified) areas whenever possible. In situations where this is not practical, installation techniques and enclosures are available which meet the requirements for locating electrical equipment in such areas. These methods of reducing hazards are based on the elimination of one or more of the elements of the ignition triangle discussed earlier.

Principles for Ensuring that Electrical Equipment Does Not Become a Source of Ignition

Four principles ensure that electrical equipment does not become a source of ignition. The basic point is to ensure that parts to which a potentially explosive atmosphere has free access do not become hot enough to ignite an explosive mixture.

Table C.

No.	Principles	Protection Method
1	Explosive mixtures can penetrate the electrical equipment and be ignited. Measures are taken to ensure that the explosion cannot spread to the surrounding atmosphere	Confine the Explosion • Flame-proof enclosure • Powder-filled enclosure
2	The equipment is provided with an enclosure that prevents the ingress of a potentially explosive mixture and/or contact with sources of ignition arising from the functioning of the equipment	Isolate the Hazard • Pressurized enclosure • Oil-filled enclosure • Potted enclosure
3	Potentially explosive mixtures can penetrate the enclosure but must not be ignited. Sparks and temperatures capable of causing ignition must be prevented.	Increased safety
4	Potentially explosive mixtures can penetrate the enclosure but must not be ignited. Sparks and raised temperatures must only occur within certain limits.	Limit the Energy • Intrinsically safe

Note: It is important that operators of hazardous location plants ensure that their personnel know when explosions are likely to happen and how to prevent it. A joint effort by the manufacturers of explosion-proof electrical equipment and the constructors and operators of industrial plants can help ensure the safe operation of electrical equipment in hazardous locations.

Design Regulations for Explosion-Proof Electrical Equipment

Explosion hazards arising from the handling of flammable gases, vapors, and dust are attributable to normal chemical and physical processes. Regulation on hazardous location by means of the Zone system have now been formulated by the International Electrotechnical Commission (IEC), the European Committee for Electrotechnical Standardization (CENELEC), the British Standards Institution (BSI), Deutsches Institut für Normung (DIN), and Association Française de Normalisation (AFNOR). The 1999 U.S. National Electrical Code (NEC) and the 1998 Canadian Electrical Code (CEC) now recognize the use of the Zone system for classification of hazardous areas. NEC has created an Americanized version of the IEC/CENELEC Zone system in a stand-alone article (Article 505). It uses the familiar Class/Division system and adapts the IEC/CENELEC Zones into it while maintaining NEC wiring methods and protection techniques. CEC, on the other hand, have made changes to the CEC section 18 to reflect the Zone standards while maintaining the standard for the Class/Division in an appendix.

Adherence to these regulations is required by manufacturers and operators of equipment and is monitored by accredited Test Houses. These standards allow the design of electrical equipment that eliminates the risk of explosion hazards. These standards enable manufacturers to design safe, explosion-protected electrical equipment that is tested with uniform and binding tests at test centers. On successful completion of tests, these centers issue confirmations, i.e., conformity certificates, which state that the required uniform safety standards for explosion protected electrical equipment have been met, the prerequisite for the equipment to go into production.

There are advantages to products specifically designed for use in the Zone designated areas since it is the dominant method used throughout the world, aside from the U.S. An understanding of the Zone system is very important. This paper is dedicated to help with the explaining of the application in Zone designated areas.

Definitions

Area Classification

Area classification methods provide a succinct description of the hazardous material that may be present, and the probability that it is present, so that the appropriate equipment may be selected and safe installation practices may be followed. It is intended that each room, section, or area of a facility shall be considered individually in determining its classification. Actually determining the classification of a specific location requires a thorough understanding of the particular site. An exhaustive study of the site must be undertaken before a decision can be made as to what Class, Zone, and Group is to be assigned. It is beyond the scope of this paper to engage in a detailed discussion of how a location is actually classified. The local inspection authority has the responsibility for defining a Class, Zone, and Group classification for specific areas.

Class Definition

The National Fire Protection Association (NFPA) Publication 70, NEC defines the type of hazardous substance that is or may be present in the air in quantities sufficient to produce explosive or ignitable mixtures.

- Class I locations are those in which flammable vapors and gases may be present
- Class II locations are those in which combustible dust may be found

The Class definitions only apply to applications in the U.S. The Zone standard classify the types of flammable substances present as such:

- Zone 0, Zone 1, and Zone 2 are zones where hazardous vapors and gases are present
- Zone 20, Zone 21, and Zone 22 are zones where hazardous dusts or fibers are present

The rest of this paper will concentrate mainly on locations where flammable gases or vapors are present.

Zone Definition

The hazardous location areas are defined by taking into account the different dangers presented by potentially explosive atmospheres. This enables protective measures to be taken which account for both cost and safety factors.

The IEC classification system, used throughout much of the world outside of North America, varies from the traditional NEC Class/Division system in that it recognizes three levels of probability that a flammable concentration of material might be present. These levels of probability are known as Zone 0, Zone 1, and Zone 2. The Zone designations replace the Divisions found in the NEC system. No exact correlation can be made between the Zone and Division designations.

Table D.

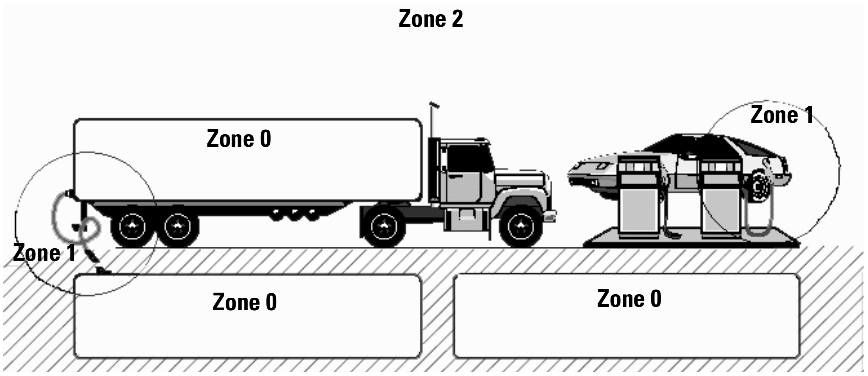
Zone	Definitions ❶
Zone 0	In which ignitable concentrations of flammable gases or vapors are: • Present continuously • Present for long periods of time
Zone 1	In which ignitable concentrations of flammable gases or vapors are: • Likely to exist under normal operating conditions • May exist frequently because of repair, maintenance operations, or leakage
Zone 2	In which ignitable concentrations of flammable gases or vapors are: • Not likely to occur in normal operation • Occur for only a short period of time • Become hazardous only in case of an accident or some unusual operating condition.

❶ Per NEC article 505-9, CEC Section 18, EN60079-10, IEC 60079-10

Figure 2 provides a graphical illustration to help with the understanding of the Zone definitions.

The installation requirements for Zone1 locations are more stringent than for Zone 2 locations, and installation requirements for Zone 0 are more stringent than Zone 1 locations.

Figure 2. Zone Definitions



This graphic is for illustration purposes only.

Group Definition

The explosive characteristics of the air mixtures of gases, vapors, or dusts vary with the specific material involved. Materials have been placed in groups based on their ignition temperatures and explosion pressures. Electrical apparatus for potentially explosive atmospheres is divided into 2 groups per EN 50014:

- Group I — Electrical apparatus for mines susceptible to firedamp (for use underground)
- Group II — Electrical apparatus for places with a potentially explosive atmosphere, other than mines susceptible to firedamp

Electrical apparatus of Group II may be subdivided according to the nature of the potentially explosive atmosphere for which it is intended. The subdivision is based on the maximum experimental safe gap (MESG) for flame-proof enclosures or the minimum ignition current (MIC) for intrinsically safe electrical apparatus as required in the specific European Standards as shown:

Table E.

Group	Flammable Material (Gases and Vapors)	Maximum Experimental Safe Gap (MESG) ❶	Minimum Igniting Current Ratio (MIC) ❶
IIA	• Propane • Acetone • Benzene • Butane • Methane • Petrol • Hexane • Paint Solvents	> 0.9 mm	> 0.8
IIB	• Ehtylene • Propylene Oxide • Ethylene Oxide • Butadiene • Cyclopropane • Ethyl Ether	0.5…0.9 mm	0.45…0.8
IIC	• Hydrogen • Acetylene • Carbon Disulphide	< 0.5 mm	< 0.45

❶ IEC 60079-12 provides an overview of classification by MESG and MIC procedures.

Ignition Temperature — Temperature Class

Ignition temperature is influenced by various factors such as the size, shape, type, and composition of a surface. This is the minimum temperature required, at normal atmospheric pressures in the absence of spark or flame, to set afire — that is, to cause self sustained combustion independently of the heating or heated element.

In IEC 60079-4, NEC, CENELEC, and other standards the authorities have agreed on a procedure for the determination of ignition temperature which comes close to giving the lowest practical value. This involves dividing the gases and vapors into temperature classes. In accordance with these temperature classes, electrical and other technological equipment is rated for surface temperature in such a way that the possibility of surface temperature ignition is excluded. The standards state in each case the extent to which these standard values may be exceeded and the required safety margins.

Figure 3.

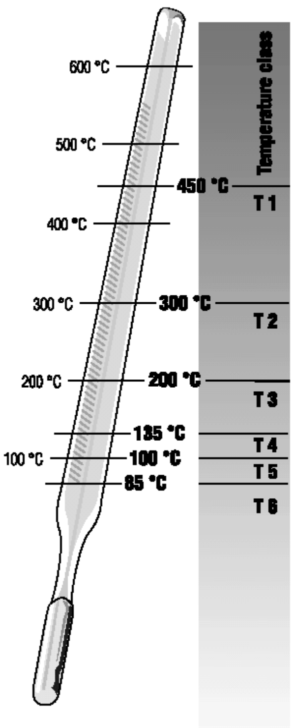


Table F.

Maximum Surface Temperature of Electrical Equipment		Temperature Class
450°C	842°F	T1
300°C	572°F	T2
200°C	392°F	T3
135°C	275°F	T4
100°C	212°F	T5
85°C	185°F	T6

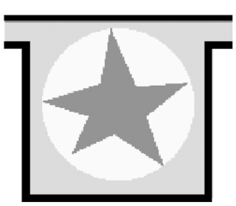
Protection Methods

Under the Zone system, equipment is tested and marked in accordance with the type of protection used by the equipment and not the area in which it can be used, such as the Class/Division system. It is the responsibility of the user or designer to select and apply the proper protection for each Zone. However, under the new approach, directive 94/9/EC requires that additional markings to specify exactly which categories and Zones the product may be used in.

For all protection methods, the rule applies that parts to which the potentially explosive atmosphere has unhindered access must not attain unacceptable temperatures. The temperatures must fall within the temperature class that applies to the particular potentially explosive atmosphere.

IEC 60079-1 — Flame-Proof Enclosure
Marking "EEx d" in Accordance with EN 50 014 and 50 018

Figure 4.



Principle

Type of protection in which components that could ignite a potentially explosive atmosphere are fitted in an enclosure that will contain the pressure of an explosion, preventing ignition of flammable gas outside the enclosure. Technically unavoidable gaps in the enclosure are so small and their lengths are restricted so that any hot gas released through them will have lost its power to cause ignition. If such gaps are only required by the production process they may be sealed with adhesive or gasket.

Important Design Parameters

- Mechanical strength to withstand the pressure of explosion in accordance with a stipulated safety factor.

  The following guideline may be used: a pressure of approximately 0.8 MPa (8 bar) is produced within a sphere; for this sphere to be classified as an EEx d enclosure it would have to withstand a pressure of 1.2 MPa (12 bar).

- Gaps between two parts of an enclosure must be so small and their lengths restricted so that any hot gas released is unable to ignite a potentially explosive atmosphere that may be present in the hazardous area.

  The parameters for the spark ignition gap with regard to width and length are different in the explosion hazard subgroups IIA, IIB, and IIC. The most stringent requirements apply to enclosures in subgroup IIC.

Applications

Equipment whose operation normally involves sparks or arcing and/or hot surfaces such as switchgear, slip rings, collectors, rheostats, fuses, lamps, or heating cartridges.

IEC 60079-2 — Pressurized Enclosure Marking "EEx p" in Accordance with EN 50 014 and EN 50 016

Figure 5.

Principle

The enclosure is filled with a pressurized gas (air, inert gas, or other suitable gas) in order to prevent the ingress of a surrounding atmosphere. The pressure within the enclosure is maintained with or without constant flushing of protective gas.

Important Design Parameters

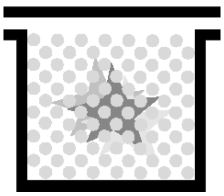
- Strength of the enclosure. The enclosure must be able to withstand 1.5 times the pressure of the gas inside it.
- The enclosure must be purged before the electrical equipment is energized.
- Shut-down or alarm in the event of the flow of the protective gas or the overpressure failing.

Applications

Electrical equipment whose normal operation involves sparks, arcing, or hot components and complex industrial standard equipment (controllers) whose protection type enables them to be operated in hazardous areas. Large machines, slip ring or collector motors, switchgear and control gear cabinets, and analysis devices.

IEC 60079-5 — Powder-Filled Enclosure
Marking "EEx q" in Accordance with EN 50 014 and EN 50 017

Figure 6.



Principle

The enclosure is filled with a fine powder to prevent arcing inside the enclosure from igniting a potentially explosive atmosphere outside the enclosure. There must be no risk of ignition by flame or the surface heat of the enclosure.

Important Design Parameters

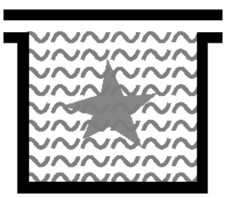
The filling, which may be sand, glass beads, or similar, is subject to special requirements, as is the design of the enclosure. The filling must not leak out of the enclosure, either during normal operation or as a result of arcing or other events inside the enclosure.

Applications

Capacitors, electronic sub-assemblies, or transformers used in hazardous areas. A wide variety of components whose operation involves sparks or hot surfaces but is not impeded by the powder filling.

IEC 60079-6 — Oil-Filled Enclosure
Marking "EEx o" in Accordance with EN 50 014 and EN 50 015

Figure 7.



Principle

Parts that could ignite a potentially explosive atmosphere are immersed in oil or another non-combustible, insulating liquid to an extent that gas or vapor above the liquid or outside the enclosure cannot be ignited by arcing, sparks, hot components (such as resistors) or hot residual gases from switching operations beneath the surface of the liquid.

Important Design Parameters

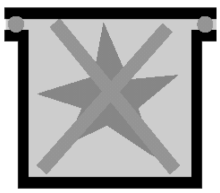
- Stipulated insulating liquids (e.g., oil)
- Assurance that the liquid remains in good condition with regard to dirt and viscosity
- Assurance and possibility of checking on safe oil level
  - On heating and cooling
  - Leak detection
- Restriction to non-portable equipment

Applications

Large transformers, switchgear, starting resistors, and complete starting controllers.

IEC 60079-7 — Increased Safety
Marking "EEx e" in Accordance with EN 50 014 and EN 50 019

Figure 8.



Principle

Additional measures are taken to achieve a higher degree of safety. This ensures reliable prevention of unacceptably high temperatures, sparks, or arcing, both on the inside and outside parts of electrical equipment whose normal operation does not involve unacceptably high temperatures, sparks, or arcing.

Important Design Parameters

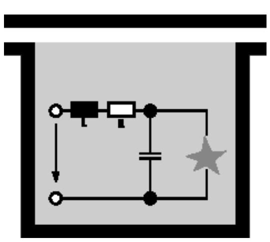
- Uninsulated, live components are subject to special protective requirements. Air and creepage gaps are wider than is generally the case in industry. Special conditions apply to the required IP enclosure protection.
- More stringent requirements apply to windings; mechanical strength, insulation, and resistance to high temperatures. Minimum cross sections are stipulated for winding wire, the impregnation and reinforcement of coils, and thermal monitoring devices.

Applications

Installation material such as Marshalling and junction boxes, terminal compartments for heating systems, batteries, transformers, ballast, and squirrel cage motors.

IEC 60079-11 — Intrinsically Safe
Marking "EEx i" in Accordance with EN 50 014 and EN 50 020

Figure 9.



Principle

Intrinsically safe electrical equipment contains only circuits that meet the requirements of intrinsically safe circuits. Intrinsically safe circuits do not allow spark or thermal effect to occur under the test conditions of the potentially explosive atmosphere of subgroup IIA, IIB, or IIC. The test conditions cover normal operation and certain fault conditions stipulated in the standard.

Important Design Parameters

- Use of certain components for electrical and electronic circuits
- Lower permitted load on the components than in ordinary industrial applications with regard to:
  - Voltage with regard to electric strength
  - Current with regard to heat

Voltage and current, including a safety margin, are kept so low that no impermissible temperatures can occur. Sparks and arcing (in the event of open circuit or short-circuit), posses so little energy that they are unable to ignite a potentially explosive atmosphere.

An impression of this protection type is provided by the fact that potentially explosive atmospheres of subgroup IIA require only a few hundred µW and those of subgroup IIC only 10 µW for ignition.

Applications

- Instrumentation and control
- Sensors working on physical, chemical, or mechanical principles
- Actuators working on optical, acoustic, and, to a certain extent, mechanical principles

IEC 60079 — Encapsulation
Marking "EEx m" in Accordance with EN 50 014 and EN 50 028

Figure 10.

Principle

Parts that could ignite a potentially explosive atmosphere by means of sparks or heat are potted so as to prevent ignition. This is done by encapsulating the components in a compound which is proof against physical — especially electrical, thermal, and mechanical — and chemical influences.

Important Design Parameters

- Encapsulation:
  - Breakdown strength
  - Low water absorption
  - Resistance to various influences
  - Potting must be of stipulated thickness all round
  - Cavities are only permitted to a limited extent
  - Potting is only penetrated by cable entries
- Load on components is limited or reduced.
- Increased clearance between live parts.

Applications

Static coils in ballast, solenoid valves or motors, relays and other control gear of limited power, and complete PCBs with electronic circuits.

IEC 60079-0 — General Technical Requirements

Principle

All generalized requirements applicable to the electrical equipment are summarized in this standard. The standards relating to the different types of protection may supplement these requirements.

Protection requirements relating to other sources of ignition are to be added.

The general temperature range for the use of explosion protected electrical equipment is given as –20…+40°C. Permissible extensions or restrictions of the temperature range are to be indicated.

Marking

The rules for marking the electrical equipment are uniformly laid down in the standards relating to general technical requirements.

The marking must indicate the following:

- The manufacturer who has put the item of electrical equipment on the market and who must be able to identify it.
- The type or types of protection the item of electrical equipment conforms to.
- The temperature class for which it is suitable.
- The explosion hazard group or subgroup applicable to the item of electrical equipment.
- The test center issuing the test certificate.
- Any special conditions that have to be observed.
- The standard or revision of the standard applicable to the item of electrical equipment.

Execution to EN Standards

Under the Zone System, equipment is marked as such:

i.e., Class I, Zone 1 AEx d IIC T6

Depending on the country certifications, slight variations to the marking is shown in the table below.

Table G.

	U.S	Canada	IEC	Europe
Class	Class I	Class I (optional)	—	—
Zone	Zone 0, 1, or 2	Zone 0, 1, or 2 (optional)	Zone 0, 1, or 2	Zone 0, 1, or 2
Explosion Protection Symbol	AEx	Ex	Ex	EEx
Protection Method Symbol(s)	i.e., d = flame-proof	i.e., d = flame-proof	i.e., d = flame-proof	i.e., d = flame-proof
Gas Group	IIA, IIB, or IIC	IIA, IIB, or IIC	IIA, IIB, or IIC	IIA, IIB, or IIC
Temperature Class	T1…T6	T1…T6	T1…T6	T1…T6

Within the European Community it has been agreed to formulate uniform requirements and introduce uniform assessment and marking to include devices, systems, and components other than electrical equipment. This is laid down in directive 94/9/EC on "Devices and protective systems for use in hazardous areas" (based on Article 100a of the Treaty of Rome and also known as "ATEX 100a"). As this directive includes electrical equipment, the markings are prefixed by additional symbols. The markings on all devices and protective systems for hazardous areas must indicate the areas of their designated use.

Future markings in accordance with EC directive 94/9/EC designating products will look as follows:

i.e., CE 0032 ⟨Ex⟩ II2G EEx d IIC T6, PTB 01 ATEX 1040, Allen-Bradley, Milwaukee, WI

Table H.

Symbol	Description
CE	CE marking
0032	Notified body identifier/TUV Nord
⟨Ex⟩ II2G	Epsilon-x is a designation for electrical certified by an EC testing station followed by: • Equipment group (I = underground mines, II = surface) • Zone (1 = Zone 0, 2 = Zone 1, 3 = Zone 2) • Category (G = gas, D = dust)
EEx d IIC T6	Symbol for electrical apparatus built to: • EEx = European standard • AEx = American standards • Ex = IEC and Canada standards Followed by: • Protection method • Gas group • Temperature class
PTB 01 ATEX 1040	Test house, certificate number: year of publication, reference to EC directive, continuous number
Allen-Bradley	Manufacturer name
Milwaukee, WI	Manufacturer address

Comparisons Between the Zone vs. Class/Division System

The Zone standard discussed in this paper is not the only standard that exists for hazardous location applications. There is another standard known as the Class/Division standard which is predominantly used in North America.

The comparisons between these two systems are not easily accomplished. Both systems are good and are developed independently from each other. They each have their own approach to area classification and each has its own advocates and approval organizations. Not one system is better than the other as neither has been proven to be safer than the other. Each has its own merits. Which system is preferred depends on the user preference, how the areas are classified, and the wiring system used in the facility. Currently the Zone system has wider use throughout the world in the chemical and petrochemical industries.

The Class/Division method is the dominant method used in the North America with requirements set by NEC/CEC. This method is very straightforward, with little interpretation as to the classification and what electrical materials can or cannot be used. On the other hand, the Zone method offers more choices as how to handle a particular application which may make it seem more complicated. This is because the Division equipment for hazardous location are marked in accordance to the area that it is classified to use, whereas equipment within the Zone method is marked in accordance with the type of protection used by the equipment. It is then the responsibility of the user to apply the proper method of protection in each Zone. However, under the new approach, directive 94/9/EC requires additional markings to specify exactly which categories and Zones the product may be used in. Both methods are meant to serve all hazardous areas from oil to sewage treatment to paint spray to everyday gas stations, as deemed appropriate by the user.

Standards for electrical installations have been established and are governed by a variety of organizations throughout the world to ensure safe electrical systems in hazardous locations. The NEC and the CEC govern the North American Standards. In Europe, the CENELEC has developed standards called EuroNorm (EN) Standards to which many European countries work. Other countries either work to their standards based on the international standards governed by the IEC or accept products and systems certified to European and/or North American Standards.

For a simplified side-by-side comparison between the NEC (Class/Division) standard and IEC (Zone), NEC (Class/Zone), CEC section 18 Zone standards, please refer to Appendix A of this publication. Please reference Publication 800-WP003A-EN-P for more detailed information on Class/Division applications.

Appendix A

Comparing IEC, NEC, and CEC Zone Standards with NEC/CEC Class/Division Standards

Table I. Class I Area Classification Comparison

<table>
<tr><th>Zone 0</th><th>Zone 1</th><th>Zone 2</th></tr>
<tr><td>Where ignitable concentrations of flammable gases, vapors, or liquids are present continuously or for long periods of time under normal operating conditions.</td><td>Where ignitable concentrations of flammable gases, vapors, or liquids:
• Are likely to exist under normal operating conditions
• May exist frequently because of repair, maintenance operations, or leakage</td><td>Where ignitable concentrations of flammable gases, vapors, or liquids:
• Are not likely to exist under normal operating conditions
• Occur for only a short period of time
• Become hazardous only in case of an accident or some unusual operating condition</td></tr>
<tr><th colspan="2">Division 1</th><th>Division 2</th></tr>
<tr><td colspan="2">Where ignitable concentrations of flammable gases, vapors, or liquids:
• Are likely to exist under normal operating conditions
• Exist frequently because of maintenance/repair work or frequent equipment failure</td><td>Where ignitable concentrations of flammable gases, vapors, or liquids:
• Are not likely to exist under normal operating conditions
• Are normally in closed containers where the hazard can only escape through accidental rupture or breakdown of such containers or in case of abnormal operation of equipment</td></tr>
</table>

Note: Per NEC Article 505-10(b)(1), a Division classified product may be installed in a Zone classified location but the reverse is not true. Typically, Zone classified product provides protection utilizing a protection method not available in the Class/Division scheme.

Table J. Class 1 Group Comparison

Zone	Class/Division
IIC — Acetylene and Hydrogen	A — Acetylene
	B — Hydrogen
IIB — Ethylene	C — Ethylene
IIA — Propane	D — Propane

Table K. Class 1 Protection Method Comparison

Zone 0	Zone 1	Zone 2
• Intrinsically safe (2 fault) • Intrinsically safe, "ia" (2 fault) Class I, Division 1 (U.S. only)	• Encapsulation, "m" • Flame-proof, "d" • Increased safety, "e" • Intrinsically safe, "ib" (1 fault) • Oil Immersion, "o" • Powder-filled, "q" • Purged/Pressurized, "p" • Any Class I, Zone 0 method • Any Class I, Division I method (U.S. only)	• Energy limited, "nC" • Hermetically sealed, "nC' • Nonincendive, "nC" • Non-sparking, "nA" • Restricted breathing, "nR" • Sealed device, "nC" • Any Class I, Zone 0 or 1 method • Any Class I, Division 1 or 2 method (U.S. only)

Division 1	Division 2
• Explosion-proof • Intrinsically safe (2 fault) • Purged/Pressurized (Type X or Y)	• Hermetically sealed • Nonincendive • Non-sparking • Oil immersion • Sealed device • Purged/Pressurized (Type Z) • Any Class I, Zone 1 or 2 method (U.S. only) • Any Class I, Division 1 method

Table L. Class 1 Temperature Class Comparison

Zone 0, 1, and 2	Division 1 and 2	Maximum Temperature
T1	T1	450°C (842°F)
T2	T2	300°C (572°F)
	T2A	280°C (536°F)
	T2B	260°C (500°F)
	T2C	230°C (446°F)
	T2D	215°C (419°F)
T3	T3	200°C (392°F)
	T3A	180°C (356°F)
	T3B	165°C (329°F)
	T3C	160°C (320°F)
T4	T4	135°C (275°F)
	T4A	120°C (248°F)
T5	T5	100°C (212°F)
T6	T6	85°C (185°F)