

• Guide
• For
• Proper Use
• of



• Intrinsically Safe
Fire Protection Devices

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Foreword

The need for safety in potentially explosive atmospheres where electrical devices are used has increased substantially over the past several years. Today, applications for intrinsic safety abound in virtually every industry.

The purpose of this guide is to provide general information on intrinsic safety and fire protection in hazardous areas.

Intrinsically safe devices can provide protection of life and property even in hazardous (classified) locations. However, because equipment from different manufacturers varies in specifications and listings, *the information in this guide should not be used as a substitute for manufacturers' recommendations or code requirements.*

Glossary

AHJ

Authority Having Jurisdiction. Individual or organization vested with the power to approve of fire alarm systems.

BARRIER

The device that is capable of limiting the voltage and current into a hazardous area. The barrier contains redundant electrical components to ensure safety in the event of failure.

CENELEC

European Committee for Electrotechnical Standardization. A committee charged with the responsibility of harmonizing the electrical standards of all its member nations.

DIVISION

Method used in United States for classifying a hazardous area in terms of the likelihood of flammable gases being present.

EXPLOSION

A violent expansion that is caused by a sudden release of energy from a very rapid chemical reaction.

EXPLOSIONPROOF

Sometimes referred to as flameproof, a method of enclosing a non-intrinsically safe device so that if an explosion occurs within the enclosure, it will be contained within the enclosure and not spread to the surrounding atmosphere.

HAZARDOUS AREA

A region which has been classified according to standards agencies as containing flammable gases or dusts of various concentrations.

IGNITION CURVE

A graph which shows the amount of current, voltage, capacitance, or inductance required to ignite various gases.

INTRINSIC SAFETY

The process whereby a circuit or other electrical apparatus is rendered incapable of producing the energy required to ignite a flammable atmosphere.

SAFE AREA

A region where flammable or explosive atmospheres do not exist.

ZONE

Method which is traditionally used outside United States for classifying a hazardous area.

SECTION I

Introduction

ORIGIN OF INTRINSIC SAFETY

A tiny spark from a piece of equipment in a grain silo... or a paint factory... or an oil rig -- and the atmosphere ignites. A bang, a whoosh, catastrophe.

The hazard created by an electrical-explosive atmosphere was first recognized in Germany before 1900 in experimental work by the coal mining industry on the ignition of methane, but it took a disaster at the Senghenydd Colliery in 1913 to bring the hazard into prominence. The subsequent investigation revealed the explosion had been caused by a spark from a cell feeding a bell signal. This discovery resulted in new regulations for the testing and approval of signaling apparatus in coal mines. Since that time, researchers have been continuously untangling the complex mechanism of ignition by weak sparks.

Today, virtually every industry worldwide is subject to some risk of explosion. At the same time, industries have never enjoyed greater peace of mind. New materials, methods and applications have helped make the prevention of industrial explosions more effective and less expensive than ever before.

EVER INCREASING HAZARDS

While explosion detection and prevention continues to improve, the range of industries subject to hazard keeps growing. Sometimes just the increase in the size of an organization is enough to create a new hazard. Examples of industries, materials and processes that require explosion protection include:

Industries, Materials And Processes Requiring Explosion Protection

- Acetylene, ethylene or methanol derivatives
- Ammonium sulfate
- Brewing
- Coal tar products
- Cosmetics
- Distillers
- Dry cleaning
- Dyestuffs
- Electric furnace
- Fatty acids, hardened oil and glycerine
- Fermentation
- Flammable gas
- Grain
- Gum products
- Insecticides and germicides
- Munitions
- Oil refining
- Paint spray booths
- Paints
- Perfumes and cosmetics
- Petrochemical
- Pharmaceutical
- Photographic
- Printing
- Processed paper
- Soda manufacturing
- Synthetic fibers
- Synthetic resins and plastics
- Utilities
- Vegetable oil
- Waste water
- Wood dry distillation

CAUSES OF EXPLOSIONS

Three conditions must be present for an explosion to occur:

1. Combustible material (gas, vapors, dust, etc.)
2. Oxygen
3. Electrical or thermal energy (of sufficient value)

If any one of these conditions is *not* present, the explosion *cannot* occur.

Each method of hazardous area protection prevents a different condition from being present. Intrinsic safety prevents sufficient electrical or thermal energy from being present.

WHAT IS INTRINSIC SAFETY?

Intrinsically safe means *inherently* safe.

Intrinsic safety is an explosion-prevention technique applied to the design of electrical equipment as well as the wiring of hazardous locations where flammable or combustible material is present. The technique limits electrical and thermal energy levels below what is required to ignite a specific atmospheric hazard.

Intrinsically safe wiring is *incapable* of releasing sufficient electrical or thermal energy under normal or *abnormal* conditions to cause ignition to a specific flammable or combustible atmospheric mixture in its most easily ignitable concentration.

The first step is to define the Class and Group for which the proposed intrinsically safe electrical circuits are to be installed (*see section IV*). Since intrinsic safety is a technique for the most hazardous locations, consideration of the Division is not necessary.

Intrinsic safety maintains energy levels below those required to ignite specific hazardous mixtures. Consequently, it's important to determine the energy allowances for operational and safety considerations.

The *1990 National Electric Code* (NEC®), Article 504, introduced intrinsically safe systems as an acceptable wiring system. Careful examination of the code will help provide safe installations that are free from hazard.

OTHER METHODS OF PROTECTION

The three most popular methods of protection are:

1. Explosionproofing
2. Pressurization
3. Intrinsic safety

Two other methods, powder filling and 'increased safety,' are used less extensively but are briefly discussed in this section.

EXPLOSIONPROOFING

The best-known and oldest electrical safety technique, explosionproofed equipment, can withstand an internal explosion without transmitting it to the surrounding atmosphere. Explosionproof enclosures withstand four times the explosion pressure produced during ignition. Normally, explosion or fire will not occur due to lack of air, but, if an explosion does occur, it will be small enough to be contained by the enclosure. The technique uses wide metal-to-metal flanges between equipment covers and labyrinth flamepaths around spindles and shafts to rapidly cool flame before it can cause ignition. Explosionproof enclosures must be properly installed, with tight tolerances; they must also be flamtight, with joints and flanges held within narrow tolerances to allow for rapid cooling of

explosion-related gases. Best used for heavy equipment, such as motors and transformers, explosion-proof equipment tends to be big and bulky, and requires heavy conduits and seals (which may add to a perception of safety). Unlike intrinsically safe design, explosionproof equipment operates at normal power levels, which makes it ideally suited for applications where circuits have high power requirements. In hazardous areas (Class I, Division 1 and 2), arcing devices such as switches, contactor and motor starters must be enclosed in an explosionproof enclosure. Enclosures for Class II locations must be dust-ignitionproof. Explosionproofing of smaller items, such as small motors, lamps and telephones, present limitations. The technique can be avoided, in part, by locating such equipment outside the building, by moving toward open-air construction or by eliminating the side walls of a building.

Advantages

- May be used with high power electrical devices such as contactors, transformers, motors, etc.

Disadvantages

- Size and weight are restrictive.
- All bolts must be installed to be safe (threaded covers must be tight where appropriate).
- Explosionproof conduit and appropriate seals must also be installed.
- Power must be disconnected before cover may be removed. Improper opening and closing of an explosionproof enclosure will compromise its integrity.

PRESSURIZATION

Widely used for process analysis equipment, and for solving difficult on-off applications, pressurization separates an explosive gas mixture and a source of ignition by means of a pressure barrier and/or continuous dilution. Pressurization, also known as 'Purged Enclosures,' keeps the enclosure filled with a positive pressure of air or an inert gas. As long as the inside pressure is greater than the outside pressure, explosive gases cannot enter the enclosure.

BASEEFA now certifies equipment to the CENELEC standard and can, under certain well-defined circumstances, offer approval to equipment not included in the standard. While these upgraded standards have reduced the acceptability of many local installations, certified systems and equipment are generally available. Most pressurization equipment is intrinsically safe.

Advantages

- May be used with high power electrical devices such as contactors, transformers, etc.

Disadvantages

- Separate air/gas supply is necessary.
- Mechanical/electrical interlocking is required when opening and closing enclosure doors.
- Air/gas supply must be able to compensate for leakage through the enclosure.

POWDER FILLING

Formerly called sand filling, this technique is defined in the CENELEC standard as: 'A type of protection which is achieved by filling the enclosure with a material in a finely granular state so that in the intended conditions of service any arc occurring within the enclosure of an apparatus will not ignite any external explosive atmosphere. Ignition shall not be caused by flame or by excessive temperature of the surface of the enclosure. Powder filling has not found ready acceptance except in highly specialized applications.'

INCREASED SAFETY

This technique is applied only to electrical equipment that does not contain arcing or sparking devices, or hot surfaces that might cause ignition. Measures are applied to reduce the possibility of failure in normally non-sparking parts. These measures include the use of temperature de-rated insu-

lation materials, enhanced creepage and clearance distances, particular attention to terminal design, protection against the ingress of solids and liquids, impact test requirements for the enclosure, and control of maximum temperatures (especially in motors).

INTRINSIC SAFETY

This method of protection limits the energy passing into the hazardous area by means of safety barriers mounted in the safe area. Regardless of the fault in the hazardous area, sufficient energy cannot be released to ignite the explosive atmosphere because of the energy limitation.

Advantages

- Explosionproof enclosure and conduit are unnecessary.
- Failure to replace enclosure covers or bolts will not degrade protection.
- Field instruments may be maintained and calibrated with power applied.
- Intrinsic safety is approved for all Classes, Divisions, and Groups.

Disadvantages

- Since Intrinsic safety operates with low power, only low-power instruments may be utilized in the hazardous area.

ADVANTAGES OF INTRINSICALLY SAFE EQUIPMENT

1 No explosion can occur under any operating condition.

Intrinsic-safety equipment operates on lower power levels so there is no shock hazard due to excess thermal energy and arcing. Safety barriers are grounded to be effective under fault conditions; intrinsic safety is provided through voltage and current limiters. Zener diodes and resistors that provide this limiting are usually mounted away from hazardous areas. Failure to replace enclosure covers or bolts will not imperil protection.

2 Small, inexpensive, easy to install.

Intrinsically safe systems tend to be small and do not require expensive, bulky accessories such as explosionproof enclosures, seals and rigid metallic conduits, a design that generally makes easy handling and installation. Explosionproof enclosures and conduit are no longer necessary, so labor and material costs are lower. Safety 'hot' permits are not required.

3 Less maintenance and downtime.

Equipment can be calibrated and maintained without disconnecting power, which means easier maintenance and decreased down time. Field instruments may be maintained and calibrated with power applied, thereby minimizing downtime.

4 Less liability insurance.

Since properly installed intrinsic-safety circuits and equipment reduce the probability of explosion to practically zero, insurance rates tend to be lower, especially where local ordinance requires hazardous facilities to carry special liability insurance.

5 Enhanced reliability.

All components and assemblies are tested for reliability before being certified and labeled intrinsically safe. Surge suppression circuitry is often used to prevent spikes and transients.

6 Worldwide recognition.

Intrinsic safety standards, procedures and tests are recognized worldwide; products are suitable for all Classes, Divisions and Groups defined by the National Electrical Code (NEC®).

SECTION II

PRINCIPLES OF INTRINSICALLY SAFE DETECTION

The principles of intrinsically safe detection are virtually identical to the principles of 'regular' detection.

TYPES OF DETECTORS

Two basic types of smoke detectors are commonly used today: ionization and photoelectric. The sensing chambers of these detectors use different principles of operation to assess the visible or invisible particles of combustion given off in developing fires.

IONIZATION SMOKE DETECTORS

A typical ionization chamber consists of two electrically charged plates and a radioactive source (typically Americium 241) for ionizing the air between the plates. The radioactive source emits particles that collide with the air molecules and dislodge their electrons. As molecules lose electrons, they become positively charged ions. As other molecules gain electrons, they become negatively charged ions. Equal numbers of positive and negative ions are created. The positively charged ions are attracted to the negatively charged electrical plate, while the negatively charged ions are attracted to the positively charged plate. This creates a small ionization current that can be measured by electronic circuitry connected to the plates.

Particles of combustion are much larger than the ionized air molecules. As particles of combustion enter an ionization chamber, ionized air molecules collide and combine with them. As these relatively large particles continue to combine with many other ions, they become recombination centers, and the total number of ionized particles in the chamber is reduced. This reduction in the ionized particles results in a decrease in the chamber current that is sensed by electronic circuitry monitoring the chamber. When the current is reduced by a predetermined amount, a threshold is crossed and alarm condition is established.

PHOTOELECTRIC SMOKE DETECTORS

Smoke produced by a fire affects the intensity of a light beam passing through air. The smoke can block or obscure the beam. It can also cause the light to scatter due to reflection off the smoke particles. Photoelectric smoke detectors are designed to sense smoke by utilizing the effects of smoke on light.

PHOTOELECTRIC LIGHT OBSCURATION SMOKE DETECTOR. One basic type of photoelectric detector, the light obscuration detector, employs a light source and a photo sensitive receiving device, such as a photodiode. When smoke particles partially block the light beam, the reduction in light reaching the photosensitive device alters its output. The change in output is sensed by the detector's circuitry, and when the threshold is crossed, an alarm is initiated. Obscuration type detectors are usually the protected beam type where the light source projects across a large area.

PHOTOELECTRIC LIGHT SCATTERING SMOKE DETECTOR. Most photoelectric smoke detectors are of the spot type and operate on the light-scattering principal. A light-emitting diode (LED) is beamed into an area not normally 'seen' by a photosensitive element, generally a photodiode. When smoke particles enter the light path, light strikes the particles and is reflected onto the photosensitive device causing the detector to respond.

SITUATIONS WHERE OTHER TYPES OF DETECTORS MAY BE USED

In certain circumstances where smoke detectors are unsuitable, special-purpose detectors, such as flame detectors, heat detectors, and other detection devices may be suitable.

The application of these special types of detectors should be based on an engineering survey and used in accordance with the manufacturer's installation instructions.

A NOTE ABOUT PROPER DETECTOR PLACEMENT

Although the operation and coverage of intrinsically safe detectors is likely to be similar to that of ordinary detectors, the AHJ (Authority Having Jurisdiction over fire codes) may require different spacing depending on the nature of the hazardous environment. Check with the AHJ prior to the design of the system for your application.

SECTION III

INSTALLATION OF INTRINSICALLY SAFE DETECTORS

Intrinsically safe detectors are used in hazardous locations where explosive levels of gas or vapors are normally or potentially present. The circuit power levels are limited so the potential to ignite an explosive atmosphere is eliminated.

Intrinsically safe detectors must be compatible with fire alarm control panels for proper ground fault detection. Conventional 2-wire detector capability must include the barrier, panel, and detector. Consult the appropriate listing agency for further information about the use of intrinsically safe products. A barrier must also be used in all intrinsically safe applications and can be purchased separately. Where applicable, BASEEFA or FM must approve the barrier used with the system. Intrinsically safe detectors are designed to provide protection and be used with compatible UL listed control panels.

INSTALLATION

Intrinsic safety can be compromised after initial installation due to improper maintenance or repair. Intrinsically safe circuits must be separated physically from non-intrinsically safe circuits by at least two inches, since induced voltages could defeat the purpose and concept of intrinsic safety. These systems must be designed and installed in precise accordance with the control drawings. Additionally, all equipment must be marked with the control drawing number. Induced voltages could defeat the concept of intrinsically safe systems, but carefully following these guidelines will help prevent corruption of the integrity of the system.

NEC® Section 504-1 covers intrinsically safe apparatus and wiring in Class I, II, and III locations and not intrinsically safe systems that are located in a classified area. Generally, intrinsically safe systems may be permitted using any wiring methods suitable for classified locations. However, sealing shall be provided in accordance with NEC® section 504-70 and separation of intrinsically safe systems shall be provided in accordance with NEC® section 504-30.

WIRING METHODS

General wiring is permitted. Intrinsically safe systems are designed to always fail in the safe position, even in the event of a crushed or cut wire or cable. Installation usually requires metal raceways to protect intrinsically safe conductors and prevent costly accidental shutdowns and operational stoppages.

SEALING

NEC® Section 504-70 requires that conduits and cables be sealed in accordance with the hazardous location in which they are installed. Sealing of intrinsically safe systems must be provided as specified in Section 501-5. Sealing is also required for flammable or combustible dust, as specified in NEC® Section 502-5. Seals are not required for enclosures that contain only intrinsically safe apparatus.

WIRING IDENTIFICATION

Strict marking identification is required in both hazardous and non-hazardous locations to prevent inadvertently mixing other systems with intrinsically safe systems, both during the initial installation and at a later date. At intervals of no more than 25 feet apart, permanent identification stating 'Intrinsic safety wiring' must be used at all terminals and throughout the entire length of the wiring method and support system. While industry practice has been to additionally identify the wiring system with a light blue color for the cable systems, color coding is generally not required by law, and is only permitted where no other conductors are light blue in color. For specific requirements, see NEC® Section 504-80 (a) and (b).

ELECTRICAL AND MECHANICAL SEPARATION

Separate wiring compartments or physical barriers are preferred by most designers. Intrinsically safe conductors are not placed in the same raceway, cables tray, or cable with circuits of other non-intrinsically safe systems, although exceptions to this rule can be found in NEC® Section 504-30(a)(1) and (2). Open wiring of conductors and cables is permitted but must be separated from non-intrinsically safe circuits by at least 50 mm and secured. Intrinsically safe circuits must be separated from other intrinsically safe circuits by being placed in separate cables or with a grounded metal shield or by a minimum of 0.01 inches of insulation.

GROUNDING

Grounding is required for all intrinsically safe systems, including apparatus, enclosures, raceways, and cable shields. Control drawings may also require supplementary bonding to the grounding electrode or some associated apparatus such as intrinsic safety barriers.

SECTION IV

HAZARDOUS AREA CLASSIFICATIONS

INTRINSIC SAFETY APPROVAL AUTHORITIES

Normally, governments and insurance carriers require that intrinsic safety systems be approved, and hazardous areas classified by a recognized approval authority. The AHJ (Authority Having Jurisdiction) will vary with the locale and industry. The AHJ could be a fire marshal, or a representative of the insurance underwriters, or a municipal electrical inspector, or sometimes even a member of a corporate safety organization.

Although the professionals who classify locations may 'live by the code,' this approach may not be enough to ensure a correct classification of a hazardous area. Many factors will not be so obvious to an inspector who is trained by textbook only. Examples of such factors that can influence the classification of a hazardous area include air currents and ventilation, temperatures, and topography. Unfortunately, an incorrect classification can result in fires, explosions, loss of life, and loss of property. Obviously, the role of the inspector is crucial, and it's a difficult job. Inspectors must keep up with a multitude of code requirements and a variety of location conditions. Their evaluations must be based not only on technical knowledge, but experience.

AMERICAN VS. EUROPEAN CLASSIFICATION SYSTEMS

The National Electric Code (NEC®) first addressed the installation of equipment for use in hazardous locations in 1920, followed by UL's first published standard in 1930. Over the years these U.S. requirements evolved into a single area classification system known as the Division system which today addresses the design, manufacture, installation, maintenance and inspection of hazardous areas and the equipment and wiring used in them.

Meanwhile, European countries were independently developing their own area classification systems to address hazardous locations safety issues. The resulting classification development is based on the International Electrotechnical Commission (IEC) Zone system, with deviations to meet each country's national codes. While other countries do accept and use the Division system (most notably Canada and Mexico), the majority of the world's hazardous locations are classified using the concepts of the IEC Zone system.

With North America using the Division system and Europe using the Zone system, much confusion has ensued, especially as the global marketplace has become reality. Understanding the similarities and differences between these two systems is therefore very important. While both systems share many similarities, there are significant differences that impact the ability of manufacturers to sell, and users to install the same products in various hazardous locations around world. It is often difficult for a product or installation to comply with both systems.

U. S. ADOPTION OF THE IEC SYSTEM

As a result of these Division/Zone differences, internationally oriented manufacturers and users found it increasingly more difficult to conduct business in the emerging world market. This global business challenge made it critical for the United States to examine the Zone system closer and find a way to integrate it into its codes. In 1995, the United States completed this review and adopted the IEC Zone system for the 1996 edition of the NEC®. As a result, the United States has joined Asia, Australia, Europe and South America in accepting the Zone system -- in applications from on-shore refineries to off-shore oil rigs. This acceptance has significantly increased the potential for global marketability of a common product and installation design.

A new article 505 in the 1996 edition of the NEC® allows for a second, parallel classification system to the traditional U.S. Class I Division system -- the new U.S. Class I Zone system. This new Zone system for United States is based on the IEC Zone system, with U.S. national deviations. While it was necessary for the U.S. Zone system to deviate from the IEC's own system (as is done by most countries), the key concepts of the IEC system have been incorporated into the new U.S. system -- including area classification, gas grouping, temperature codes, protection methods, and markings.

These U.S. national deviations were primarily necessary to ensure compliance with the NEC® because the IEC installation requirements allow markings, wiring methods, and grounding constructions that do not comply with the NEC®. In addition to deviations in the NEC®, deviations that ensure compliance with the U.S. fire or electric shock hazard equipment requirements are necessary. This is because the IEC equipment requirements only address the risk of explosion associated with its own equipment, and do not address such issues as insulation properties, electrical spacings, and overload endurance capabilities for all equipment.

In the U.S., intrinsic safety standards are written by the National Fire Protection Agency (NFPA) in NEC® Article 504. Typically, intrinsically safe products are tested and approved or listed by Factory Mutual Research Corporation (FM) or Underwriters Laboratories, Inc. (UL). The Canadian Standards Association (CSA) is the predominant approval authority of Canada.

There are many international standards for intrinsic safety in use around the world, but the most important standards are those set by the European Committee for Electrotechnical Standardization (CENELEC). The CENELEC standards are a single set of standards agreed upon by all of the member nations, mainly comprised of the European Community nations of Western Europe. Several test laboratories are authorized to issue approvals of intrinsic safety equipment to the CENELEC standards. A CENELEC approval issued by any authorized test laboratory is valid in all of the CENELEC member nations.

Although the approval and certification process required for intrinsically safe devices provides a degree of safety, careful planning, design, and engineering remain critical.

AMERICAN SYSTEM HAZARDOUS AREA CLASSIFICATIONS

In the United States, hazardous areas are classified in three categories: Classes, Divisions, and Groups.

TABLE 1

Class: Defines the type of hazard	I Flammable gases or vapors II Combustible dusts III Ignitable fibers
Division: Defines how the hazard is present	1 Hazard exists under normal operating conditions 2 Hazard exists under abnormal operating conditions
Group: Defines the substance	A, B, C, D – gases E, F, G -- dusts

HOW THE DIVISION AND ZONE SYSTEMS DIFFER

While the U.S. Division and Zone area classification systems are independent, their apparent differences actually reflect an overall similarity in the way hazardous locations are addressed throughout the world. Most of the differences between the two systems are organizational. The following tables provide side-by-side comparisons.

TABLE 2

CLASS I AREA CLASSIFICATION COMPARISON

Division 1:	
Where ignitable concentrations of flammable gases, vapors or liquids <u>can exist</u> all of the time or some of the time under normal operating conditions.	<p>Zone 0: Where ignitable concentrations of flammable gases, vapors or liquids <u>can exist all of the time or for long periods of time</u> under normal operating conditions.</p> <p>Zone 1: Where ignitable concentrations of flammable gases, vapors or liquids <u>can exist some of the time</u> under normal operating conditions.</p>
Division 2:	
Where ignitable concentrations of flammable gases, vapors or liquids <u>are not likely</u> to exist under normal operating conditions.	<p>Zone 2: Where ignitable concentrations of flammable gases, vapors or liquids <u>are not likely to exist</u> under normal operating conditions.</p>

TABLE 3

CLASS I GAS GROUP COMPARISON

Divisions 1 and 2	Zones 0, 1 and 2
A (acetylene)	IIC (acetylene)
B (hydrogen)	IIC (hydrogen)
C (ethylene)	IIB (ethylene)
D (propane)	IIA (propane)

TABLE 4

CLASS I TEMPERATURE CODE COMPARISON

Divisions 1 and 2	Zones 0, 1 and 2
T1 ($\leq 450^{\circ}\text{C}$)	T1 ($\leq 450^{\circ}\text{C}$)
T2 ($\leq 300^{\circ}\text{C}$)	T1 ($\leq 300^{\circ}\text{C}$)
T2A, B, C, D ($\leq 280, 260, 230, 215^{\circ}\text{C}$)	---
T3 ($\leq 200^{\circ}\text{C}$)	T3 ($\leq 200^{\circ}\text{C}$)
T3A, B, C ($\leq 180, 165, 160^{\circ}\text{C}$)	---
T4 ($\leq 135^{\circ}\text{C}$)	T4 ($\leq 135^{\circ}\text{C}$)
T4A ($\leq 120^{\circ}\text{C}$)	---
T5 ($\leq 100^{\circ}\text{C}$)	T5 ($\leq 100^{\circ}\text{C}$)
T6 ($\leq 85^{\circ}\text{C}$)	T6 ($\leq 85^{\circ}\text{C}$)

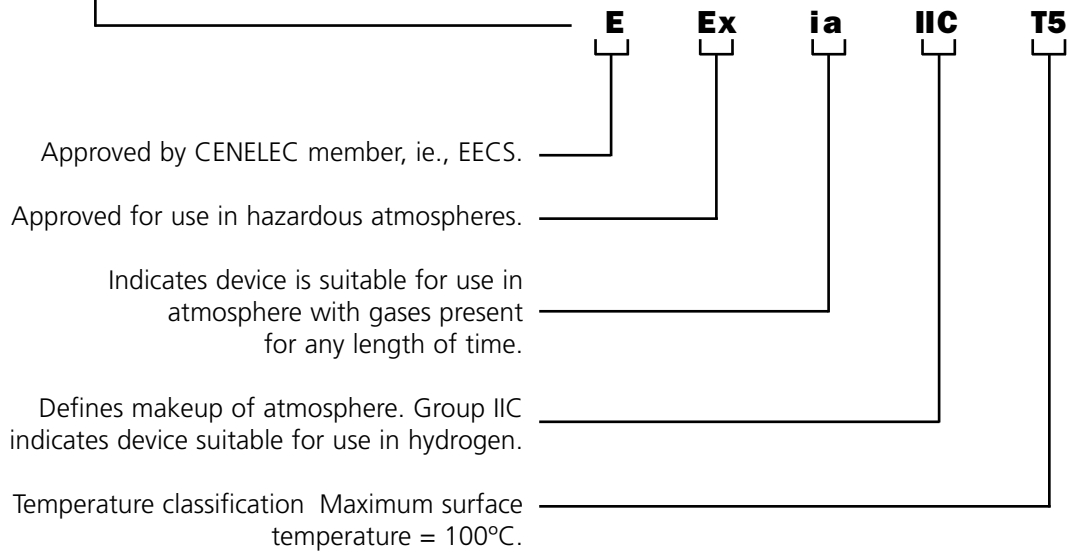
TABLE 5

CLASS I AREA PROTECTION METHOD COMPARISON

Area	Division Protection Methods:	Area	Zone Protection Methods:
Division 1:	Explosionproof Intrinsically safe (2 fault) Purged/pressurized (Type X or Y)	Zone 0	Intrinsically Safe, 'ia' (2 fault) Class I, Div. 1 Intrinsically safe (2 fault)
		Zone 1	Encapsulation, 'm' Flameproof, 'd' Increased safety, 'e' Intrinsically safe, 'ib' (1 fault) Oil immersion, 'o' Powder filling, 'q' Purged/pressurized, 'p' Any Class I, Zone 0 method Any Class I, Div. 1 method
Division 2:	Hermetically sealed Nonincendive Non-sparking Oil immersion Purged/pressurized (Type Z) Sealed device Any Class 1, Div. 1 method	Zone 2	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, Div. 1 or 2 method



**TABLE 6
WHAT DO THE MARKINGS ON THE DETECTOR MEAN?**

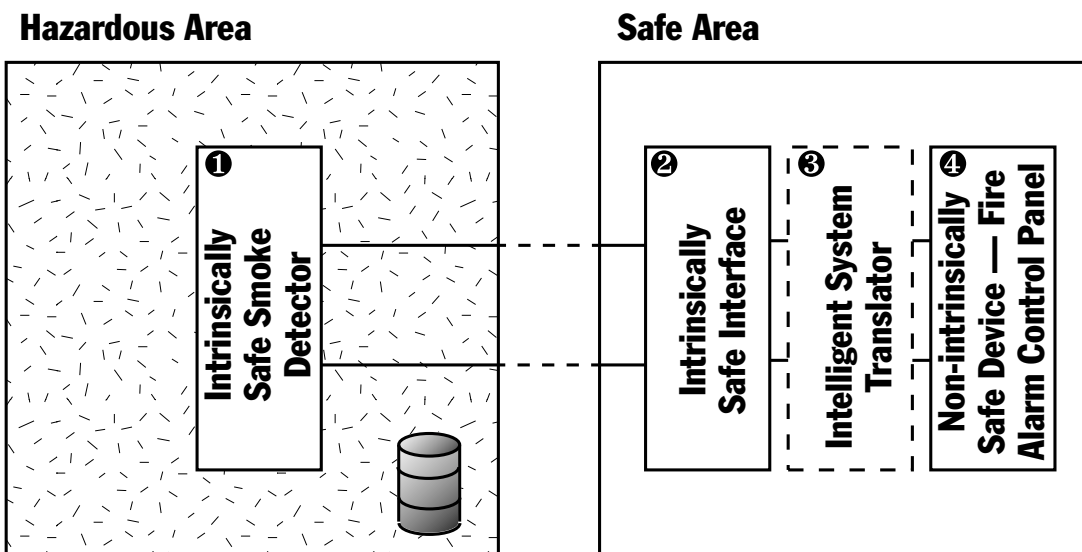


SECTION V

SYSTEM CONFIGURATION

SYSTEM BLOCK DIAGRAMS

Figure 1 **BLOCK DIAGRAM**



❶ Intrinsic safe smoke detector: a device approved by one or more agencies recognized as having the authority to list devices for use in hazardous (classified) environments.

❷ Intrinsic safe interface: a device which limits the energy into the hazardous area, usually a barrier in fire protection applications.

❸ Intelligent system translator: a module which enables an intelligent smoke detector to communicate to the fire alarm control panel through the barrier.

❹ Non-intrinsic safe device (fire alarm control panel): a listed, compatible control device for use with the smoke detector, barrier, and translator.

ZENER BARRIERS

Zener barriers limit the energy to the hazardous area to a level below that which could ignite a specific gas/air mixture. This is accomplished by protecting against the following faults:

1. Shorting of the wires connected to the hazardous area side of the barrier.
2. Grounding of the wires connected to the hazardous area side of the barrier.
3. Misconnection or failure of the power supply allowing an unsafe voltage to be applied to the safe area side of the barrier. The barrier will prevent this unsafe level of voltage from passing into the hazardous area.

Figure 2 is a schematic diagram of a shunt zener diode barrier. This is a single-channel positive polarity type.

This barrier contains:

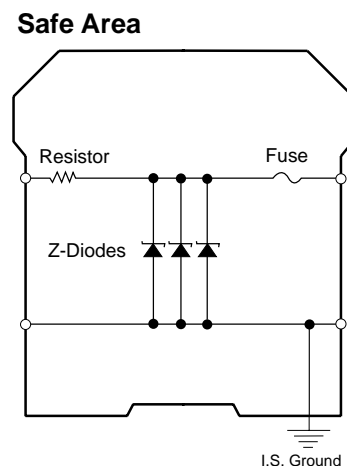
1. A resistor which limits the current to the hazardous area.
2. A fuse which will open if excessive current passes through the barrier.
3. Redundant zener diodes which limit the voltage to a safe level even though an unsafe level is applied to the safe area side of the barrier. Only one zener diode is necessary, however, redundancy plays a large role in intrinsic safety. Therefore, approval agencies require more than one in case of a failure.

GROUNDING ZENER BARRIERS

All shunt zener diode barriers must be connected to a high-integrity intrinsic safety grounds. This system must have a dedicated ground conductor separate from the power system so the power system ground current will not flow through it. The ground conductors must be No. 12AWG or larger and be reliably connected to a ground electrode in accordance with Article 509 of the NEC (NFPA 70) or Section 10 of the CEC Part I, CSA 22.1.

Barriers must have the appropriate electrical parameters (current and power output) for the application. Barriers must also be certified for the application by the appropriate approvals body.

Figure 2 **SHUNT ZENER DIODE BARRIER**
Schematic diagram of a shunt zener diode barrier showing resistor (for current limiting), a fuse (which opens in the case of excessive current), and redundant zener diodes (which limit the voltage to a safe level).



WHERE TO PURCHASE BARRIERS

Measurement Technology Ltd.

MTL Incorporated
Sales Headquarters
P.O. Box 1690
Manassas, VA 20108-1690
or
8576 Wellington Road
Manassas, VA 20109
Tel: +1 703 361 0111
Fax: +1 703 368 1029
Email: mtlincdrl@attmail.com

Pepperl+Fuchs Inc.

Headquarters, North and Central America
1600 Enterprise Parkway
Twinsburg, Ohio 44087
Tel.: (330) 425-3555
Fax: (330) 425-4607
Email: sales@us.pepperl-fuchs.com
HomePage: <http://www.pepperl-fuchs.com>

REFERENCES

1. *Intrinsic Safety, the safe use electronics in hazardous locations*, R. J. Redding, McGraw-Hill, London, 1971.
2. *Hazardous Classified Locations: Electrical Designs and Installation*, Richard E. Loyd, Delmar Publishers, Albany, NY, 1997.
3. *Application Note AN9003, A user's guide to intrinsic safety*, Measurement Technology Ltd., March 1989.
4. "The manufacture and utilisation of electrical equipment for use in potentially explosive atmospheres," B. Hill, Electrical and Mechanical Executive Engineer, May/June 1982.
5. "Intrinsic Safety Vs. Explosionproof Design," Sam Khalilieh, Consulting and Specifying Engineer, August 1995, pp. 28-30.
6. "Defining hazardous locations on a global scale," Paul Kelly, On the Mark, Fall 1997.
7. "Intrinsic safety in the 1990's," L.C. Towle, Process Industry Journal, October 1988.
8. "Fire detection in hazardous areas," Mike O'Neill, Control and Instrumentation, November 1986.
9. "Intrinsic safety -- its widening horizons," L.C. Towle, TP1099, MTL Instruments Group plc, March 1991.
10. "Intrinsically safe installations on ships and offshore structures," L.C. Towle, Institute of Marine Engineers' Meeting, London, October 21, 1985.
11. *Intrinsic Safety Catalog*, North American Edition 1996, Pepperl + Fuchs.

STANDARDS AND AGENCIES

TESTING LABORATORIES

Testing laboratories test smoke detectors, control panels, and other components of fire alarm systems to verify conformance with NFPA requirements and their own standards. Equipment that passes their tests are identified by a label.

Underwriters Laboratories, Inc. (UL)

333 Pfingsten Rd.
Northbrook, IL 60062
Ph: (847) 272-8800
Fax: (847) 272-8129

Underwriters Laboratories, Inc. (UL)

1655 Scott Boulevard
Santa Clara, CA 95050

Underwriters Laboratories, Inc. (UL)

1285 Walt Whitman Road
Melville, NY 11747

Underwriters Laboratories, Inc. (UL)

12 Laboratory Drive
P.O. Box 13995
Research Triangle Park, NC

UL publishes an annual report listing fire protection equipment which bear the UL label. Its standards which apply to smoke detectors are:

UL 217 -- Single and Multiple Station Smoke Detectors

UL 268 -- Smoke Detectors for Fire Protection Signaling Systems

UL 268A -- Smoke Detectors for Duct Applications

UL 864 -- Standard for Control Units for Fire Protective Signaling Systems

Factory Mutual Research (FM)

1151 Boston-Providence Turnpike
P.O. Box 9102
Norwood, MA 02062-9102
Ph: (781) 762-4300 Fax: (781) 762-9375

FM publishes an annual report listing fire protection equipment which bears its label.

Electrical Equipment Certification Service (EECS)

In 1987, the Mining Equipment Certification Service (MECS) and the British Approvals Service for Electrical Equipment in Flammable Atmospheres (BASEEFA) were brought together to form EECS.

Electrical Equipment Certification Service

Health and Safety Executive
Harpur Hill, Buxton, Derbyshire, SK17 9JN, United Kingdom
Ph: 01298 28000 Fax: 01298 28244

EECS standards which applied to intrinsic safety are BS5501 -- Electrical Apparatus for Potentially Explosive Atmospheres.

Loss Prevention Certification Board

Melrose Avenue
Borehamwood Hertfordshire WD6 ZBJ
Ph: 081 207 2345 Fax: 081 207 630

SYSTEM SENSOR SERVICES

THE SYSTEM SENSOR WARRANTY

System Sensor smoke detectors are covered under the following Three-year Limited Warranty:

“System Sensor warrants its System Smoke Detectors to be free from defects in materials and workmanship under normal use and service for a period of three years from the date of manufacture as indicated by the date code stamped on each product. System Sensor makes or assumes no other express Warranty, obligation or liability for its system smoke detectors. No agent representative, dealer, or the employee of the Company has the authority to increase or alter the obligations of this Warranty. The Company’s obligation under this Warranty shall be limited to repair or replacement of any part of the detector which is found to be defective in materials or workmanship under normal use and service during the three year period commencing with the date of manufacture. After phoning System Sensor (1-800-SENSOR2) for a return authorization number, send defective units postage prepaid to System Sensor, Repair Department, 3825 Ohio Avenue, St. Charles, IL 60174. The Company shall not be obligated to repair or replace units which are found to be defective because of damage, unreasonable use, modification, or alterations occurring after the date manufacture, or units that are not properly maintained. The duration of any implied warranty, including that of merchantability or fitness for any particular purpose, shall be limited to a period of three years commencing with the date of manufacture. In no case shall the Company be liable for any consequential damages for breach of this or any other warranty, express or implied whatsoever, even if the loss or damage is caused by the Company’s negligence or fault.

Customer shall be solely responsible for determining suitability for use, including compatibility with other equipment. System Sensor shall in no event be liable in this respect. Customer agrees that if the products sold hereunder are resold, customer will include in the contract for resale, provisions which limit recoveries against System Sensor in accordance with this section.”

UL LISTING AND OTHER AGENCY APPROVALS

System Sensor Smoke Detectors are submitted for approval by Underwriters Laboratories, Inc. (UL), Underwriters Laboratories of Canada (ULC), the California State Fire Marshal (CSFM), and Factory Mutual (FM).

CUSTOMER SERVICE CENTERS

Detectors needing cleaning, testing, repair, or replacement can be sent to the addresses listed below after calling the Customer Service Department for a Return Authorization Number:

System Sensor
Repair Department
RA # _____
3825 Ohio Avenue
St. Charles, IL 60174
Toll-free: 1-800-SENSOR2
Telephone: (630) 377-6363
Fax: (630) 377-6495

or, in Canada to:
System Sensor Canada
6581 Kitimat Road, Unit #7
Mississauga, Ontario
Canada L5N 3T5
Toll-free: 1-800-SENSOR2
Fax: (905) 812-0771

OTHER SYSTEM SENSOR SERVICES

- System Sensor Field Sales Engineers can provide technical support from the factory.
- System Sensor Customer Service Department provides cleaning and calibration of smoke detectors.

