



The Challenge

Gases, petroleum products, and airborne dusts tend, by their very nature, to be explosive if sources of sparks or excess heat are present. Over the years, these hazards have led to some catastrophic losses of life and property. In response to this hazardous potential, regulatory bodies around the world, including Underwriters Laboratories, Inc., have worked to establish and refine a standard that will minimize the hazards associated with these working environments. UL 913, which was originally issued in 1971, establishes the standard for “Intrinsically Safe Apparatus and Associated Apparatus for Use in Class I, II, and III, Division 1, Hazardous (Classified) Locations.”

The purpose of this standard is to specify requirements for the construction and testing of electrical apparatus, or parts of such apparatus, having circuits that are not capable of causing ignition in Division 1 Hazardous (Classified) Locations as defined in Article 500 of the National Electrical Code, ANSI/NFPA 70. Limiting exposure to high surface temperatures and requirements for dust-tight enclosures are key aspects of the UL913 standard.

Hazardous Locations and Intrinsic Safety Overview

Intrinsically safe apparatus have been developed to prevent hazardous substances from coming into contact with sources of ignition in two ways:

- Energy limitation – To limit the spark energy
- Temperature limitation – To limit the surface temperature

For Class I hazardous locations, flammable gases or vapors can be ignited by sparks caused by electronic switching, arcing or high surface temperature of the apparatus devices. For Class II and III hazardous locations, the greatest area of concern is the

apparatus surface temperature, which may trigger an explosion if the temperature is higher than the ignition point of the combustible dusts. For example, if the surface temperature of the apparatus does not exceed 120°C (under normal operating conditions) and 165°C (under fault conditions), a device is considered safe because it is not capable of causing ignition due to high surface temperature.

Today, the use of devices that are certified to be Intrinsically Safe (IS) is a requirement of operating electronic equipment in a potentially explosive areas, as shown in *Figure 1*.

Typical Hazardous Area Applications in which the UL 913 Standard Applies

Almost every industry related to energy or basic materials production has potentially hazardous locations, such as:

- Energy production: Oil/gas production/refining/storage/transportation, mining, etc.
- Materials processing: Chemicals manufacturing, semiconductor fabrication, tank farms, etc.
- Food production: Grain milling, baking, brewing, distilling, etc.
- Others: Pharmaceutical manufacturing, cosmetics manufacturing, pumping stations (gas, oil, sewage, etc.)

Table 1. UL 913 hazardous locations

Category of Hazard	Degree of Hazard
Class I: Location with flammable gases or vapors	Division 1: Ignitable concentration of flammable gases, vapors, or liquids can exist all the time or some of the time
Class II: Location with combustible dusts	
Class III: Location with ignitable fibers or flyings	

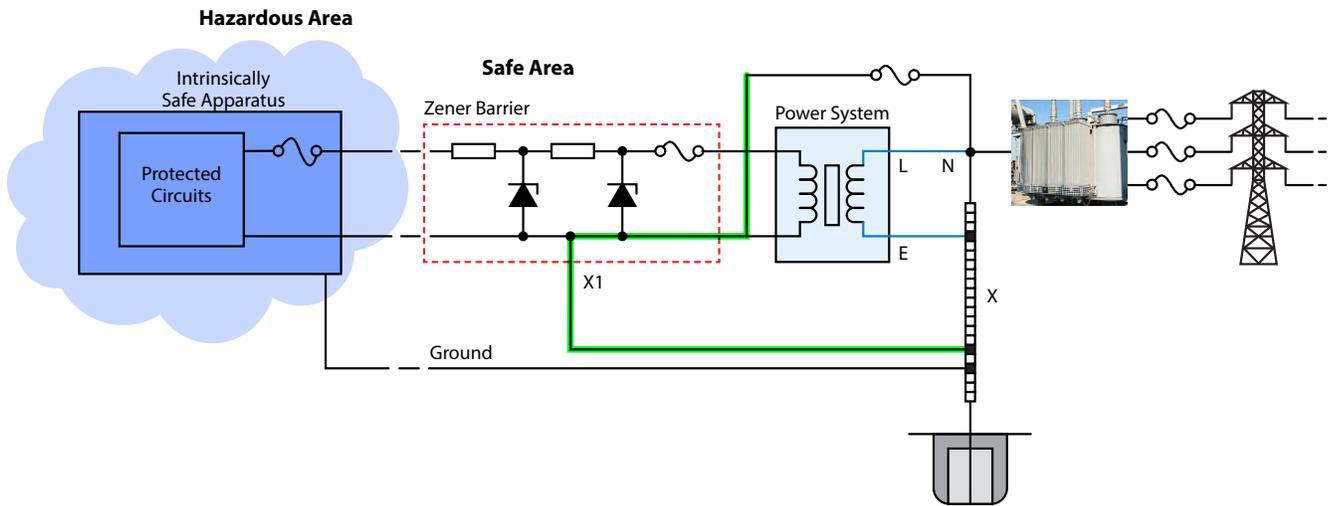


Figure 1. Hazardous vs. non-hazardous environments.

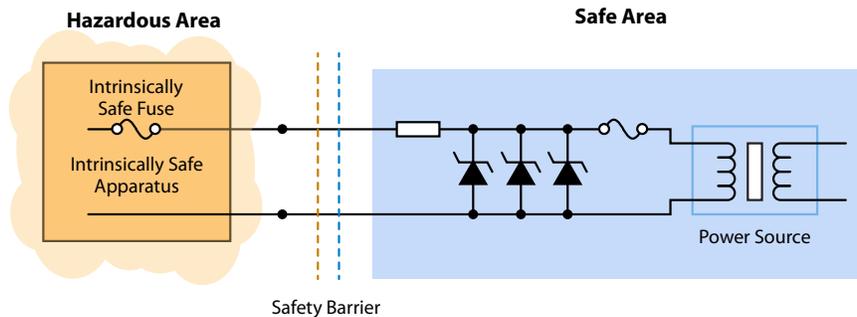


Figure 2. Example of a Fuse used in an intrinsically safe application.

An IS certified device is one that's designed in such a way that it's incapable of generating sufficient heat or spark to trigger any explosive event. Industrial computers, mobile phones, and other portable electronics are all examples of IS certified devices. Intrinsic safety standards are applicable to the signal and control circuits that can operate with low currents and voltages. It does not apply to high-powered circuits such as electric motors.

Basic Principles of Fuse Operation

When an abnormal condition (such as a capacitor failure, IC short, etc.) occurs in an electronic circuit, it creates an electrical fault that, if not controlled quickly, can cause thermal runaway. The result may be the generation of a spark or a component that reaches a high temperature, both of which are very hazardous, particularly in environments filled with potentially explosive gases, fuels, or dust. The solution is to use a fuse (*Figure 3*), which is an intentionally weak link designed to open the faulty circuit, thereby limiting the spark energy and surface temperature.

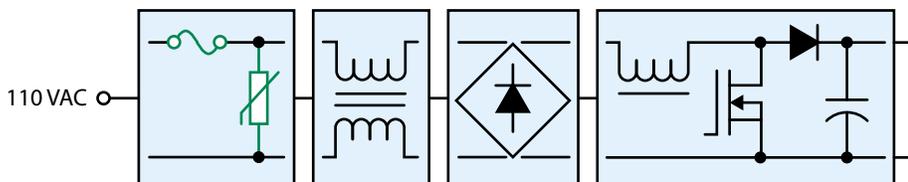


Figure 3. Fuse operation

Intrinsically Safe Products Require Intrinsically Safe Fuses

Within a hazardous area, a variety of electronic devices (*Figure 4*) are often used for production or maintenance activities.

These types of products include:

- Motor controllers
- Lighting
- Communication handsets
- Flow meters
- Process control and automation
- Sensors

Under normal operation, these types of apparatus can generate tiny internal sparks from components such as motor brushes, switch contacts, and connectors. To use this type of apparatus safely in a hazardous location, the energy of such sparks must be contained to avoid igniting explosive materials in the environment. An intrinsically safe certified fuse is necessary to limit the current under any abnormal condition to ensure that the circuit will open without generating a spark capable of causing ignition. Arcing can occur when the fuse opens, which must be contained within the fuse's encapsulation. The surface temperature of the fuse also must be kept below the temperature that could ignite explosive gases or dust.



Figure 4. A variety of electronic products are designed for safe use in hazardous locations.

Another aspect of intrinsic safety is the necessity of preventing the temperature of a component inside apparatus such as gauges, meters, and valves from rising to an unsafe level. Under fault conditions, the temperature of an internal component such as an IC or capacitor can rise much higher than under normal conditions. An intrinsically safe fuse, or current limiting resistor, is required to ensure that no

component in the circuit can reach a temperature that could ignite an explosion. Intrinsic safety standards increase overall safety of the apparatus, which increases the level of protection of human life in these hazardous operating environments.

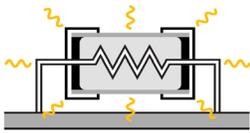
Designing Intrinsically Safe Circuits with PICO[®] 259-UL913 Series Fuses

The PICO[®] 259-UL913 Series Intrinsically Safe Fuse from Littelfuse (*Figure 5*) is a range of encapsulated fuses approved under the UL 913 standard for Intrinsically Safe Electrical Equipment to operate in hazardous locations. In fact, it is the only fuse sold that is certified to meet this standard. In the past, apparatus manufacturers have traditionally been forced to send fuses to a third-party supplier or create their own secondary process to encapsulate the entire fuse to meet the requirements of the UL 913 standard. Now, the PICO[®] 259-UL913 fuse can help reduce total product cost. This sealed fuse, available with ratings ranging from 62mA to 5A, is ideal for applications in the oil, gas, mining, chemical, and pharmaceutical industries because it is designed to operate within environments where there is danger of gas explosion from faulty circuits. In addition to UL 913 certification, these fuses meet ATEX (EN 60079-0:2009 & EN 60079-11:2007), IECEx (IEC 60079-0:2007 & IEC 60079-11:2006), and Baseefa requirements.

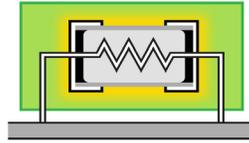


Figure 5. PICO[®] 259-UL913 Series Fuse from Littelfuse

The fuse design and its encapsulation (*Figure 6*) are suitable for use in intrinsically safe apparatus for applications with voltages up to 125Vrms (190V peak). The fuse's encapsulation is >1mm thick, so the fuse can also be used in Class I areas where flammable gases or vapors are present. This eliminates the need for an added conformal coating of the PCB where the fuse is placed. The fuse encapsulation limits the temperature and energy that is exposed to the hazardous gases in the environment and prevents particles from entering the fuse body. The encapsulation also limits the surface temperature of the fuse during operation, which allows it to be used in Class II and III environments where flammable dust particles are a concern.



Normal Fuse
(used in non-hazardous
environments)



PICO 259-UL913
Intrinsically Safe Fuse
with Encapsulant

Figure 6. The >1mm-thick encapsulant surrounding 259-UL913 Series fuses keeps them sealed, limiting the energy and temperature generated during fuse operation. It also prevents dust from entering the fuse body, which makes it ideal for use in hazardous environments.

For more information on designing circuits using the PICO[®] 259-UL913 Series Intrinsically Safe Fuse, including detailed specs, ampere ratings, package dimensions, etc., [consult the datasheet](#) available on the Littelfuse website. For assistance in choosing the right amperage PICO[®] 259-UL913 fuse for the application, consult our online step-by-step guide, [Fuseology: Fuse Characteristics, Terms and Consideration Factors](#).

Littelfuse, Inc.

8755 West Higgins Road, Suite 500
Chicago, IL 60631 USA
Phone: (773) 628-1000
Littelfuse.com