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Application Note:
Enhancing Workplace Safety in Hazardous Locations
with PICO® 259-UL913 and 305 Series Intrinsic Safety Fuses

The Challenge

Combustible gases, vapors, and airborne dusts tend, by their very nature, to be explosive if present in the right concentrations along with sources of sparks or excess heat. 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 electrical equipment for use in these environments. UL 913, which was originally issued in 1971, is a U.S. national 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 sources of electrical spark energy and high surface temperatures and maintaining separation distances are key aspects of the UL 913 standard.

Hazardous Locations and Intrinsic Safety Overview

Intrinsically safe apparatus have been developed to prevent electrical equipment from becoming sources of ignition of explosive atmospheres 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 or arcing or by high surface temperature of parts exposed to the explosive atmospheres. For Class II and III hazardous locations, one of the greatest areas 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 from a thermal ignition standpoint because it is not capable of causing ignition due to high surface temperature.

Today, the installation, use, and maintenance of devices within potentially explosive areas requires that theses devices be certified to provide protection against ignition. Intrinsic Safety (IS) is a practical method of achieving such protection. ***Figures 1*** and ***2*** show examples of common intrinsic safety systems.

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.

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	

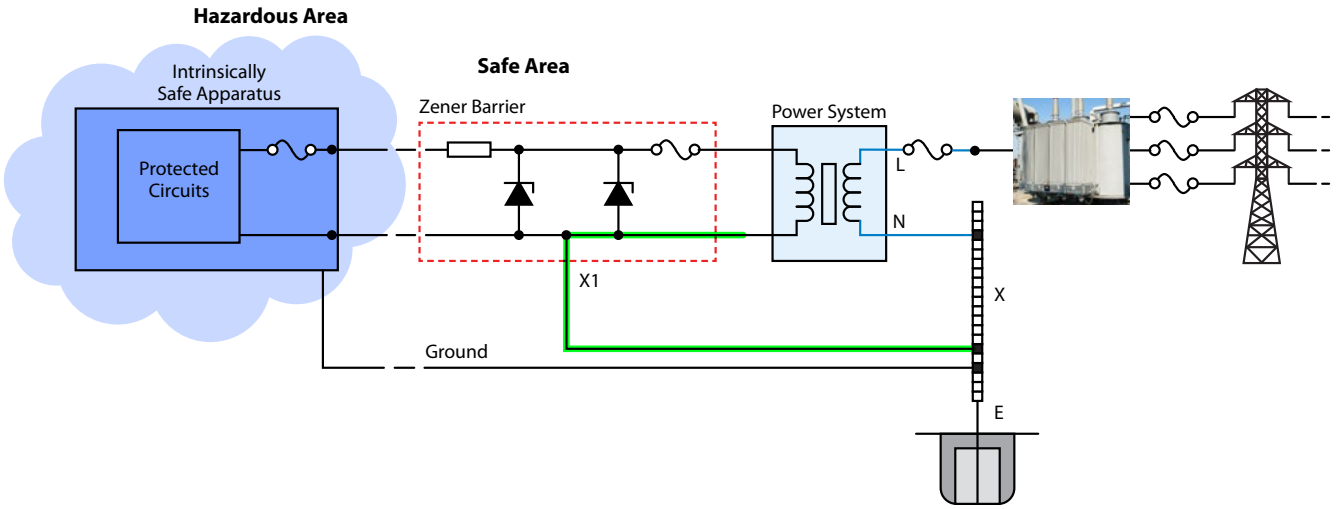

Figure 1. Intrinsic safety system using zener barrier.

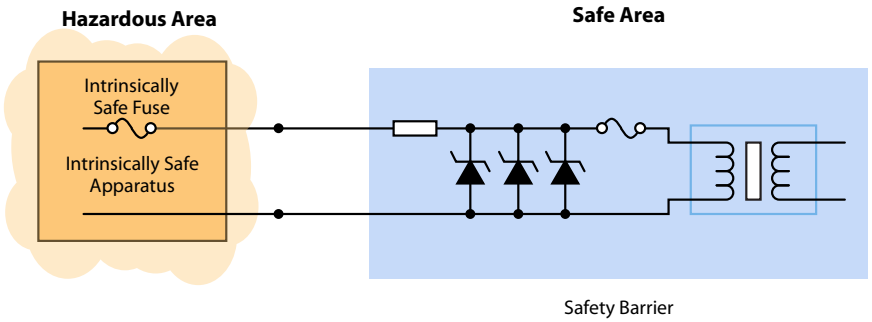

Figure 2. Intrinsic safety system using galvanic isolator.

- Food production: Grain milling, baking, brewing, distilling, etc.
- Others: Pharmaceutical manufacturing, cosmetics manufacturing, pumping stations (gas, oil, sewage, etc.)

An IS certified device is one that's designed in such a way that it's incapable of generating sufficient heat or spark energy 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 power, 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. This may result in a component that reaches a high temperature, which is very hazardous, particularly in environments filled with potentially explosive gases, fuels, or dust. The solution is to use a fuse, which is an intentionally weak link designed to open the faulty circuit, thereby limiting the spark energy and surface temperature.

Intrinsically Safe Products Require Intrinsically Safe Fuses

Within a hazardous area, a variety of electronic devices (*Figure 3*) 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

To use this type of apparatus safely in a hazardous location, the available energy must be limited to avoid igniting explosive materials in the environment. An intrinsically safe certified fuse is useful in limiting the current under abnormal conditions 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 3. 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 resistor 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 and 305 Series Fuses

Both the PICO® 259-UL913 and PICO® 305 Series Intrinsically Safe Fuses from Littelfuse *(Figure 4*) are encapsulated fuses approved under the UL 913 standard for Intrinsic Safety of Electrical Equipment to operate in hazardous locations. These two series fuses, rated at 125V and 277V respectively, are the only fuses sold that are 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 and PICO® 305 Series can help reduce total product cost. These sealed fuses, available with ratings ranging from 62mA to 5A, and ratings up to 750mA, respectively, are ideal for applications in the oil, gas, mining, chemical, and pharmaceutical industries because they are designed to operate within environments where there is danger of explosion from faulty circuits. In addition to UL 913 certification, these fuses meet ATEX (EN 60079-0 & EN 60079-11) and IECEx (IEC 60079-0 & IEC60079-11) requirements.

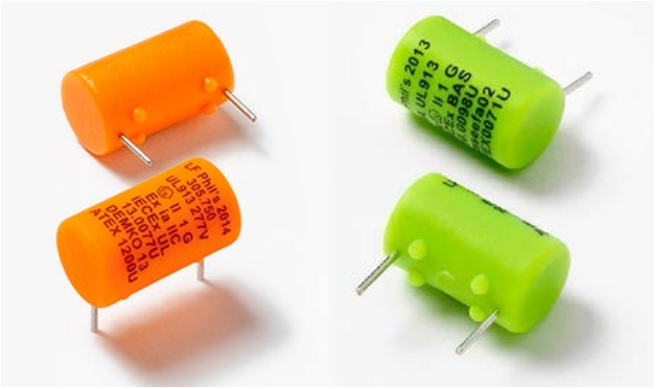

Figure 4. PICO® 305 Series and 259-UL913 Series Fuses from Littelfuse.

The PICO® 259-UL913 (green colored) fuse design and its encapsulation (*Figure 5*) are suitable for use in intrinsically safe apparatus and associated apparatus for applications with voltages up to 125Vrms (190V peak). The PICO® 305 Series (orange colored) fuse is rated for applications up to 277V. The fuse's encapsulation is >1mm thick and thus eliminates the need for an added encapsulation process or conformal coating of the PCB where the fuse is placed. The fuse encapsulation limits the temperature and energy that is exposed to the hazardous environment and prevents particles from entering the fuse body.

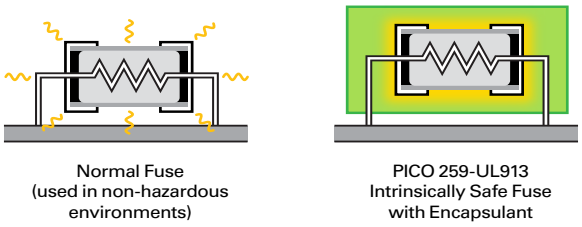

Figure 5. The >1mm-thick encapsulant surrounding 259-UL913 Series fuses keeps them sealed, limiting the energy and temperature exposed to the explosive atmosphere during fuse operation. It also prevents gases, dusts, and fibers from entering the fuse body, which makes it ideal for use in hazardous environments.

For more information on designing circuits using the PICO® 259-UL913 and PICO® 305 Series Intrinsic Safety Fuses, including detailed specs, ampere ratings, package dimensions, etc., consult the 259-UL913 and 305 Series datasheets available on the Littelfuse website. For assistance in choosing the right amperage PICO® 259-UL913 or PICO® 305 Series fuse for the application, consult our online step-by-step guide, Fuseology: Fuse Characteristics, Terms and Consideration Factors.

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