



Expertise Applied | Answers Delivered

An aerial photograph of a large-scale open-pit mine. A dark, winding road cuts through the terraced rock walls of the mine. Several large yellow haul trucks are visible on the road, moving in different directions. The rock faces show various shades of grey, blue, and reddish-brown, indicating different geological layers. In the bottom left corner, there is a rectangular area covered with a grey, textured material, possibly a waste pile or a processing area.

## Mining Product Capabilities

LEARN MORE: [littelfuse.com/mining](http://littelfuse.com/mining)

# Our Mining Expertise Runs Deep

Since 1975, Littelfuse has been designing robust products that stand up to the hazardous conditions found in underground and surface mining environments. Innovative engineering, years of experience, and field usage learnings contribute to Littelfuse being the leading manufacturer of mining protection components used by top companies worldwide.



Our **quality products** help customers safely control and distribute electrical power in potash, coal, oil sands, uranium, precious metals, and other mining applications. Littelfuse products monitor and control electrical systems by providing circuit protection for motors and pumps, mitigating arc flashes, confirming proper earthing of transformers and portable equipment, and detecting earth faults.

With Littelfuse cost-effective, **industry-respected** circuit-protection products, customers can eliminate hazards, reduce downtime, and increase the operational life of mining equipment to create a higher return on investment. Most Littelfuse industrial products come with either a 5-year or 10-year warranty, and are locally available through our extensive distributor network. By monitoring and protecting expensive mining equipment, customers can keep costs down, their business running, and ensure a safe work environment.



### FIELD SUCCESS STORY

When the world's largest fertilizer company is mining for potash 1,000 m (3,300 ft) below the surface, they come to Littelfuse for quality products and engineering expertise. Littelfuse products are an integral part of their electrical systems that power and protect critical applications in the harshest underground and surface-mining environments. The world's top mining companies trust Littelfuse for fuses, monitors, and protection relays.



### INDUSTRY SNAPSHOT

**70%** of those surveyed estimate that hidden costs such as repairs, downtime, and late deliveries are not included in their Total Cost of Ownership (TCO). These hidden costs can add an additional 10-30% to the TCO of equipment.

**40%** stated that downtime costs were "important" or "very important" when considering new equipment.

Source: Littelfuse 2014 Mining Survey

## Products and Benefits

The Littelfuse portfolio includes a comprehensive line of monitors, protection relays, and fuses to minimize electrical safety hazards, limit equipment damage, and improve productivity.

**Neutral-earthing resistor (NER) monitors** ensure the integrity of the resistor by continuously verifying neutral-to-earth continuity, measuring earth-fault current, and monitoring the neutral voltage to detect failed NERs or earth faults.

- Monitors neutral-to-earth continuity to ensure proper system earthing
- SE-330AU is compliant with AS/NZS 2081.3:2002



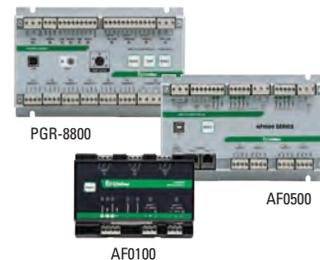
**Earth-continuity monitors** (also known as ground-check relays or pilot-wire monitors) are used to monitor the integrity of the earthing circuit external to the NER. When electrical equipment is fed by portable trailing cables, the earth-continuity monitor is used to verify a continuous low-impedance earth path from the equipment frame to the source, eliminating the possibility of hazardous earth-fault touch potential. They also detect potentially hazardous conditions such as an open cable coupler or receptacle, a shorted pilot wire to earth (damage to the cable), and initiating a trip (de-energizing the system) if a coupler becomes uncoupled under load.

- Combination earth-fault and earth-continuity monitoring for cables up to 25 kV and 10 km long
- Ensures portable equipment is earthed to reduce hazardous earth-fault voltages



**Arc-flash protection relays** limit damage by detecting the light and/or current from an arc flash and rapidly tripping an upstream breaker in milliseconds.

- Utilizes light (and current optional) for fast arc-flash detection and annunciation in under 1 ms
- Reduces arc-flash energy and risk to personnel and equipment
- Fail-safe design with innovative, continuous self-monitoring



**Motor and pump overload protection relays** protect expensive motors or pumps and are commonly used in critical mining operations such as production, mine ventilation, dewatering, and material handling. Monitoring the operating conditions of motor windings, bearings, supply or load can extend the life of the machines to increase ROI and reduce or even prevent downtime and their associated costs.

- Extends motor life
- Provides metering, datalogging, and network communications
- Helps eliminate costly machine replacement or system downtime



**Feeder protection relays** monitor current, voltage, and temperature to help prevent feeder application faults. They offer inverse-time characteristics, integrated breaker or contactor control, data logging, and metering.

- FPS Feeder Protection System provides current, voltage, and temperature protection
- FPU-32 Feeder Protection Unit provides integrated current based protection, metering, and data-logging functions



**Earth-fault relays** are used to minimize the damage to electrical equipment when current flows back to the supply transformer through the earth-return path, otherwise known as earth leakage or an earth fault.

#### Earth-Fault Protection Relay

- Detects leakage current resulting from breakdown of insulation resistance caused by moisture, vibration, chemicals, or dust
- Microprocessor-based solutions with advanced digital harmonic filtering to prevent nuisance trips
- SE-703 is AS/NZS 2081:2011 compliant

#### AC/DC Sensitive Earth-Leakage Relay

- AC/DC earth-fault detection often used with variable frequency drives (VFDs)
- Detects DC faults (0 Hz)
- Provides two adjustable setpoints (one for warning and one for shutdown) for ranges between 30 mA and 5 A
- Three programmable output relays
- EL731 is AS/NZS 2081:2011 compliant



## INDUSTRY SNAPSHOT

To lower energy costs, mining operations are switching to VFDs to control motors. **76%** of mining engineers surveyed **used built-in VFD earth-fault protection, while 16% do not use earth-fault protection at all.**

NOTE: Not all VFD built-in earth-fault protection settings are sensitive enough to work in high-resistance ground systems.

Source: Littelfuse 2014 Mining Survey

# Littelfuse Designs and Supplies Critical Electrical Products that Ensure Safe and Reliable Distribution of Electrical Power in Mines

## Surface Mining/Oil Sands

Littelfuse engineers and manufactures vital components that safeguard electrical systems, motors, and pumps used in field-mining applications. The diagram to the right shows the electrical and dewatering systems in a typical surface-mining operation and illustrates the critical job Littelfuse products perform for the power and safety of the mine.

## Underground Mining

Littelfuse designs and supplies critical products that ensures safe and reliable distribution of power in mines. The diagram to the right shows the complex electrical system in a typical underground mine and indicates the vital role that Littelfuse plays in powering and protecting the mine.

### **A** Mining Machine & Conveyor System Controls

Used to operate the equipment and includes protection relays

- Arc-Flash Relay
- Earth-Fault Earth-Continuity Monitor
- Motor Protection
- Neutral-Earthing Resistor Monitor

### **B** Portable Power Center

Provides power to mining machines, pumps, fans, motors, etc.

- Arc-Flash Relay
- Earth-Fault Earth-Continuity Monitor
- Motor and Pump Protection
- Neutral-Earthing Resistor and NER Monitor
- Feeder Protection

### **C** Custom Electrical Panels

Power-take-off or starter panels protect and isolate trailing-cable-fed equipment such as pumps, jumbos, drills, and electric machines

- Arc-Flash Relay
- Earth-Fault Earth-Continuity Monitor
- Motor and Pump Protection

### **D** Primary Power Center/Electrical House

Provides local power for lighting, conveyors, pumps, fans, and other equipment

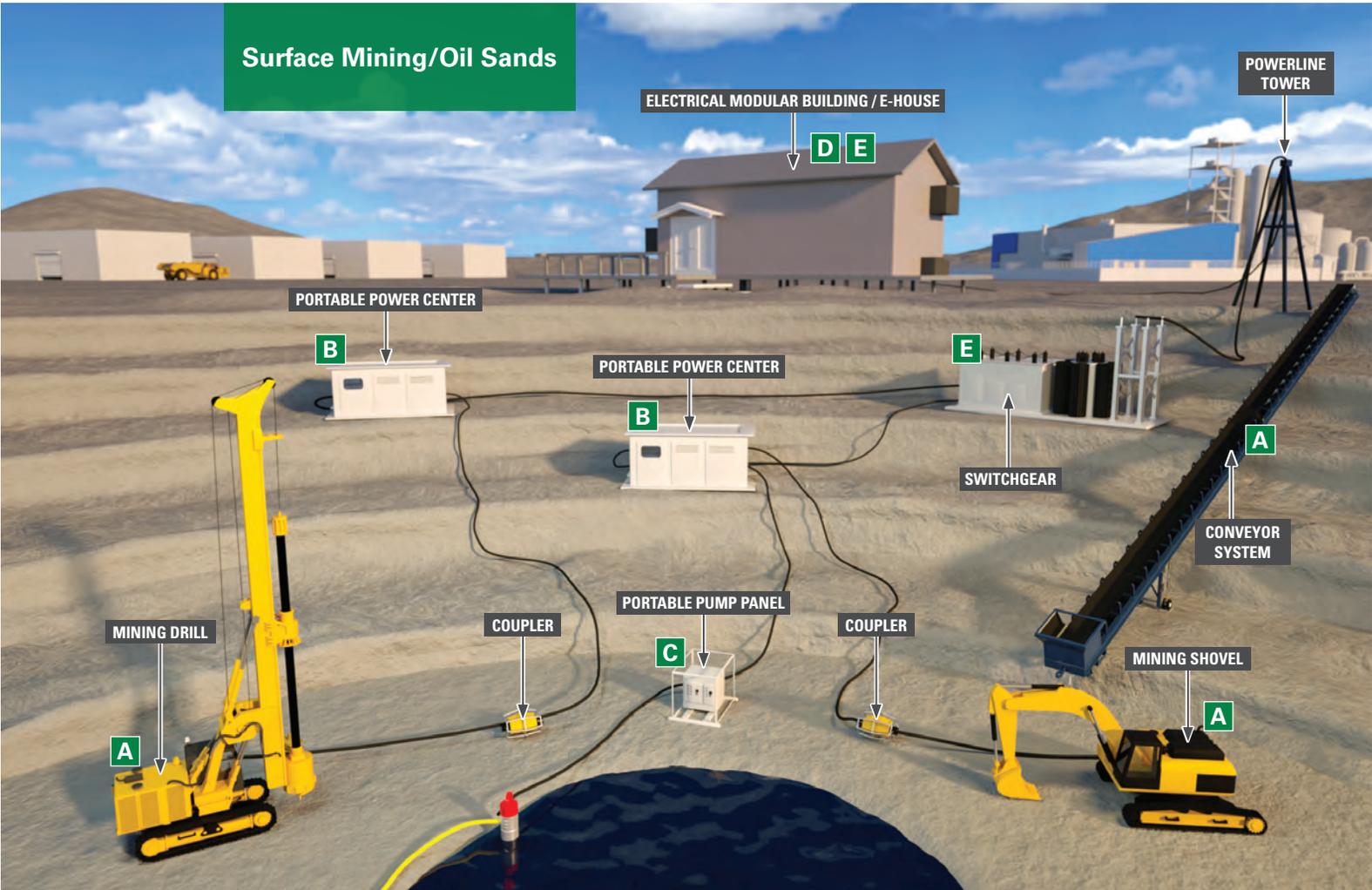
- Arc-Flash Relay
- Earth-Fault Protection
- Industrial Shock-Block
- Motor and Pump Protection

### **E** Indoor or Outdoor Standard and Arc-Resistant Switchgear

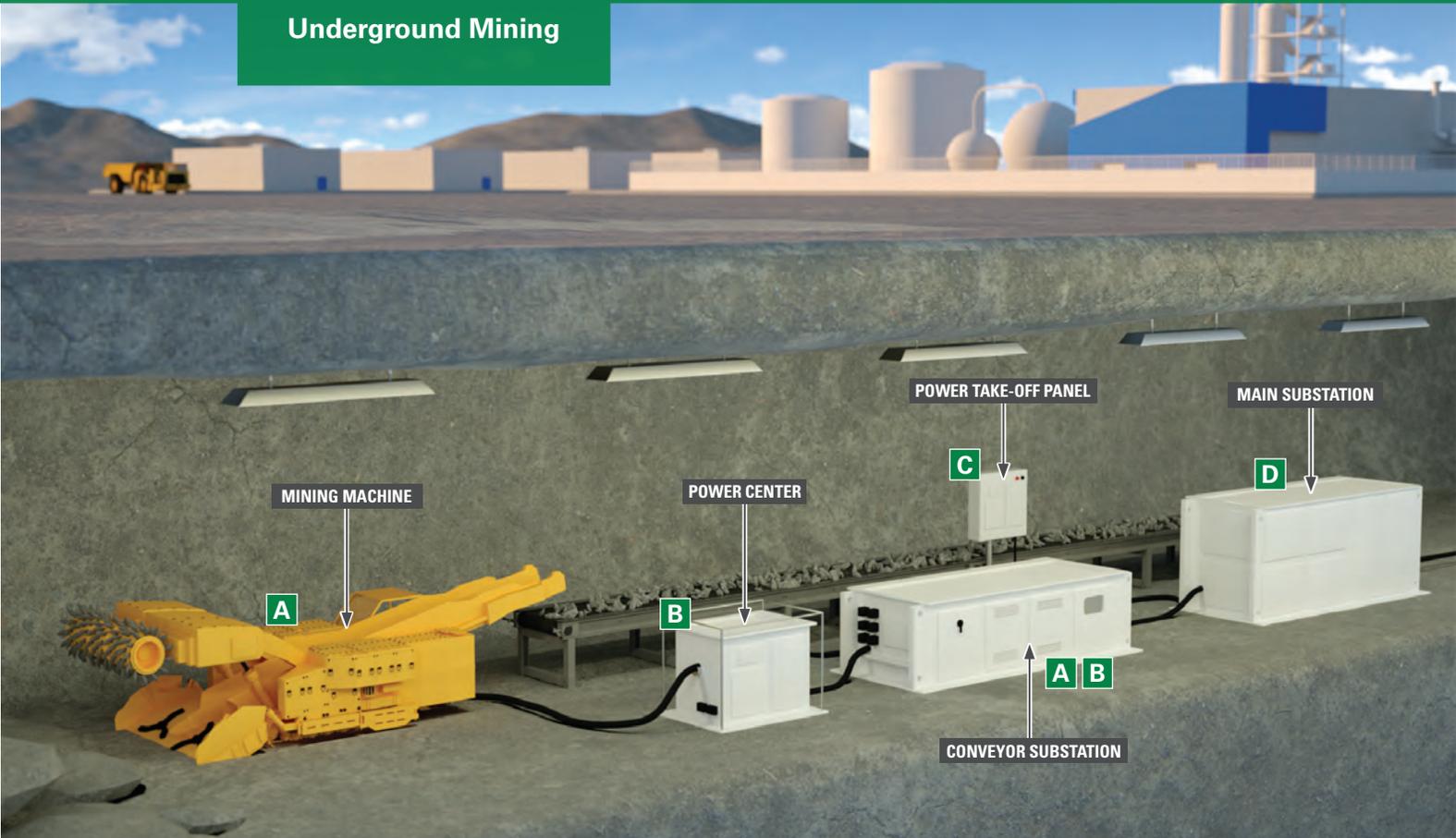
Used to isolate and protect high-voltage circuits underground, on the surface, and in surface substations

- Arc-Flash Relay
- Feeder Protection
- Earth-Fault Protection
- Neutral-Earthing Resistor Monitor
- Motor and Pump Protection

## Surface Mining/Oil Sands



## Underground Mining



### Earth Faults

Earth faults are the most common type of electrical fault and the majority of these happen at low-voltage levels which can cause major damage. Facilities that have electrical problems may have issues with earth faults. Being able to monitor, detect, and locate earth faults can make a big difference in the security and stability (up-time) of a facility.

When a earth fault occurs on portable trailing-cable-fed equipment, the maximum prospective fault current that will flow is defined by the let-through-current rating of the neutral-earthing resistor at the secondary of the movable substation transformer, and the resistance of the earth-return path. The earth-fault voltage at the frame of the equipment is equal to the product of the fault current and the resistance of the earth wire. The person touching the frame of the trailing-cable-fed equipment will be exposed to the earth-fault voltage. Properly earthing the system and monitoring the health of the earth conductor is critical for safe operation.

#### INDUSTRY SNAPSHOT

**95% of all faults on electrical systems are earth faults, with the most common type of earth fault being the arcing type.**

Source: CSE Magazine "Grounding and Bonding in Commercial Buildings" 8/5/12



# Which Relay is Right for You?

FEATURE	EARTH FAULT/ EARTH CHECK		RESISTOR MONITOR		EARTH FAULT			
	SE-105 SE-107	SE-134C SE-135	SE-330	SE-330AU	SE-701	SE-704	SE-703	EL731
DC Earth Fault (76G) <sup>1</sup>				AS/NZS 2018.3				✓
AC Earth Fault (50G/N, 51G/N) <sup>2</sup>	✓	✓	✓	✓	✓	✓	✓	✓
RTD Temperature (38, 49) <sup>3</sup>								✓
Neutral Overvoltage (59N) <sup>4</sup>			✓	✓				
Checking or Interlocking Relay (3GC) <sup>5</sup>	✓	✓	✓	✓				
Harmonic Filtering	✓	✓	✓	✓	✓	✓	✓	✓
Lockout Relay (86) <sup>6</sup>			✓	✓				
Adjustable Pickup	✓	✓	✓	✓	✓	✓	✓	✓
Adjustable Time Delay	✓	✓	✓	✓	✓	✓	✓	✓
CT Loop Monitoring		✓		✓	✓	✓	✓	✓
Analog Output			✓	✓	✓	✓	✓	✓
Pulsing			✓					
Data Logging			✓	✓				✓
Communications		*	✓	✓				*
5-Year Warranty	✓	✓	✓	✓	✓	✓	✓	✓
Standard Conformal Coating	✓	✓	✓	✓	*	*	✓	✓
UL	✓	✓	✓	✓	✓	✓	✓	✓
CSA	✓	✓	✓	✓	✓	✓	✓	✓
CE		✓	✓	✓	✓	✓	✓	✓
RCM	✓	✓	✓	✓	✓	✓	✓	✓

\*Optional

<sup>1</sup> ANSI/IEEE 76G: DC Earth Overcurrent Relay

<sup>2</sup> ANSI/IEEE 50G/N: Instantaneous Overcurrent Relay Earth Instantaneous Overcurrent/Neutral Instantaneous Overcurrent; ANSI/IEEE 51G/N: Overload Earth Time Overcurrent/Neutral Time Overcurrent

<sup>3</sup> ANSI/IEEE 38: Bearing Protective Device/Bearing Rtd; ANSI/IEEE 49: Machine or Transformer Thermal Relay/Thermal Overload

<sup>4</sup> ANSI/IEEE 59N: Neutral Overvoltage

<sup>5</sup> Earth Check Checking Relay

<sup>6</sup> ANSI/IEEE 86: Lock-Out Relay, Master Trip Relay

## How to Mitigate an Arc Flash

**1** Use current-limiting fuses to reduce incident energy levels.



UL Listed Fuses

**2** Use arc-flash relays to protect critical panels and detect an arc flash in milliseconds and trip the breaker.



PGR-8800

AF0500

AF0100

**3** Use high-resistance earthing systems to improve the overall architecture of the electrical system and significantly reduce the opportunity for faults. Continuously monitor the neutral-to-earth path to verify the NER is intact.

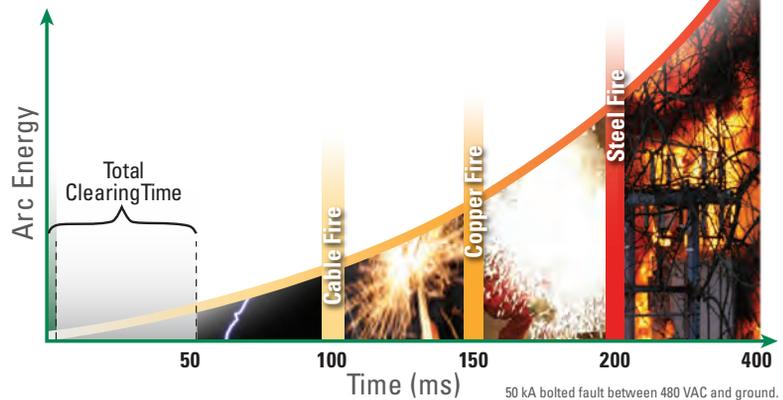


Neutral-Earthing Resistor

SE-330 Neutral-Earthing Resistor Monitor

### Damage Caused By Arc-Flash Incident

The Littelfuse Arc-Flash Relays use a high-speed light-sampling scheme in combination with an ultra-fast IGBT output to be able to detect a developing arc flash and send a trip signal to a circuit breaker in under a millisecond.



#### INDUSTRY SNAPSHOT

**More than 50%** of mining industry respondents surveyed **do not use arc-flash relay protection**. While the use of high-resistance earthing (HRE) eliminates the chance of an arc flash on an earth fault, it cannot stop an arc flash caused by phase-to-phase faults. Littelfuse arc-flash protection relays detect an arc flash in milliseconds and trip a circuit breaker reducing the energy available during the fault.

Source: Littelfuse 2014 Mining Survey

## 7 Selection Criteria to Use When Evaluating Arc-Flash Relays

### 1. Reaction Time

This is the most significant characteristic when selecting an arc-flash relay. It is important to think about the timing of events that can happen during an arcing fault.

### 2. Trip Reliability

Trip reliability ensures mitigation of an arcing fault. Trip redundancy and system-health monitoring are the two most important points to consider.

### 3. Avoidance of Nuisance Tripping

Arc-flash relays use light sensors with detection thresholds between 3,000 and 30,000 lux. At levels below 9,000 lux, there is a risk of nuisance trips from headlamps, small flashlights, and other light sources. Choose an arc-flash relay that will not trip below 9,000 lux or that has an adjustable sensitivity that can be set within a reasonable range for your application.

### 4. Ease of Installation

Choose an arc-flash relay that has a simple and flexible design, and whose wiring ports are clearly marked. Its inputs should accept both point sensors and fiber-optic sensors, and automatically recognize when a sensor is connected (after recognition, disconnection should result in an alarm).

### 5. Software

Using arc-flash relays that have software with event logging allows you to track trends in the system's performance. Some arc-flash relays also have communication interfaces that can be used to configure the units.

### 6. Sensor Design

Use enough sensors to ensure coverage of all areas when the desire is to improve safety and reduce equipment damage and incident energy. Most installations require multiple sensors in the cabinet and near vertical and horizontal bus bars where arcing faults are apt to occur in feeder switchgear in the cabinets. Electrical sensor connections can make installation, extension, or splicing easier than pure fiber connections.

### 7. Scalability and Flexibility

Some arc-flash relay designs allow for the interconnection of multiple relays with several sensors each. With this design you can even use a downstream arc-flash relay to trip the upstream circuit breaker.

Learn more at [Littelfuse.com/ArcFlash](https://www.littelfuse.com/ArcFlash)

### FIELD SUCCESS STORY

*Evans Enterprises needed to reduce the hazardous risk category for one of their level-four panels so workers could approach the panel if it was opened. Our PGR-8800 arc-flash relay detects an arc and sends a trip signal to the breaker in less than one millisecond. Less than a week after installation, Evans had an arc-flash incident. Not only did the relay protect the company, equipment, and employees, it saved them up to \$1 million in damages and the plant was down for less than 24 hours.*



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