



Mining
Product
Capabilities

LEARN MORE: 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, oil sands, uranium, coal, precious metals, and other mining applications. Littelfuse products monitor and control systems by providing circuit protection for motors and pumps, mitigating arc flashes, confirming proper grounding of transformers and portable equipment, and detecting ground 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. Littelfuse industrial products come with a 5-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-grounding resistors (NGRs) are used to ground transformers or generators to eliminate transient overvoltages, significantly reduce the risk of arc flash, and limit the amount of ground-fault current to reduce point-of-fault damage.

- Limits point-of-fault damage during a ground fault

Neutral-grounding resistor monitors ensure the integrity of the resistor by continuously verifying neutral-to-ground continuity, measuring ground-fault current, and monitoring the neutral voltage to detect failed NGRs or ground faults.

- Monitors neutral-to-ground continuity to ensure proper system grounding



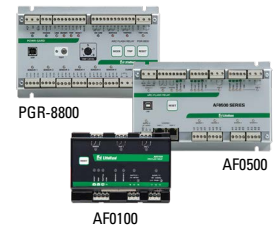
Ground-check monitors (also known as ground-check relays or pilot-wire monitors) are used to monitor the integrity of the grounding circuit external to the NGR. When electrical equipment is fed by portable trailing cables, the ground-check monitor is used to verify a continuous low-impedance ground path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

- Combination ground-fault and ground-check monitoring for cables up to 25 kV
- Ensures portable equipment is grounded to reduce hazardous ground-fault voltages
- Protects cables up to 10 km or 6 miles



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 both light and current (PGR-8800 model) for the fastest arc-flash detection—average less than 1 ms
- Reduces arc-flash energy and risk
- 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 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 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 protection, metering, and datalogging functions



Ground-fault relays are used to minimize the damage to electrical equipment when current flows back to the supply transformer through the ground-return path otherwise known as a ground- or low-level fault.

Ground-Fault Protection Relay

- Detects breakdown of insulation resistance caused by moisture, vibration, chemicals, or dust
- Microprocessor-based solutions with advanced digital harmonic filtering to prevent nuisance trips

AC/DC Sensitive Earth-Leakage Relay

- AC/DC ground-fault detection primarily used with variable frequency drives (VFDs)
- Detects faults down to 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



INDUSTRY SNAPSHOT

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

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

Source: Littelfuse 2014 Mining Survey

Ground-fault circuit interrupters (GFCIs) are used to protect personnel from electrical shock caused by ground faults.

- UL943C-certified as a 3-phase, industrial GFCI for 480 V and 600 V applications
- Human-level ground-fault protection for pumps, fans, and welders
- Ensures portable equipment is grounded to reduce hazardous ground-fault voltages



Fuses are designed to protect an electrical circuit from overcurrents (currents higher than the normal operating level) and are commonly used on transformers, control circuits, and other electrical equipment.

UL Class RK1 Fuses

- Superior overload and short-circuit protection
- Extremely current-limiting
- Indicating fuses and DIN-mount fuse holders available



Class CC Fuses

- Supplemental overcurrent protection
- Extremely current-limiting
- High interrupting capacity
- Fast-acting reliability



High-speed fuses are used to protect sensitive semiconductor devices and are becoming more common due to the increasing use of modern equipment such as soft starters and variable frequency drives (VFDs).

POWR-SPEED® High Speed Semiconductor Fuses

- Short-circuit protection
- Extremely current-limiting
- Superior cycling capability
- Designed to protect the power semiconductor devices found in VFDs, UPSs, Softstarts, and DC drive systems



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
- Ground-Fault Ground-Check Monitor
- Motor Protection
- Neutral-Grounding Resistor Monitor
- UL Fuses, Blocks, Holders

B Portable Power Center

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

- Arc-Flash Relay
- Ground-Fault Ground-Check Monitor
- Motor and Pump Protection
- Neutral-Grounding Resistor and NGR Monitor
- Feeder Protection
- UL Fuses, Blocks, Holders
- High-Speed Fuses

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
- Ground-Fault Ground-Check Monitor
- Motor and Pump Protection
- UL Fuses, Blocks, Holders

D Primary Power Center/Electrical House

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

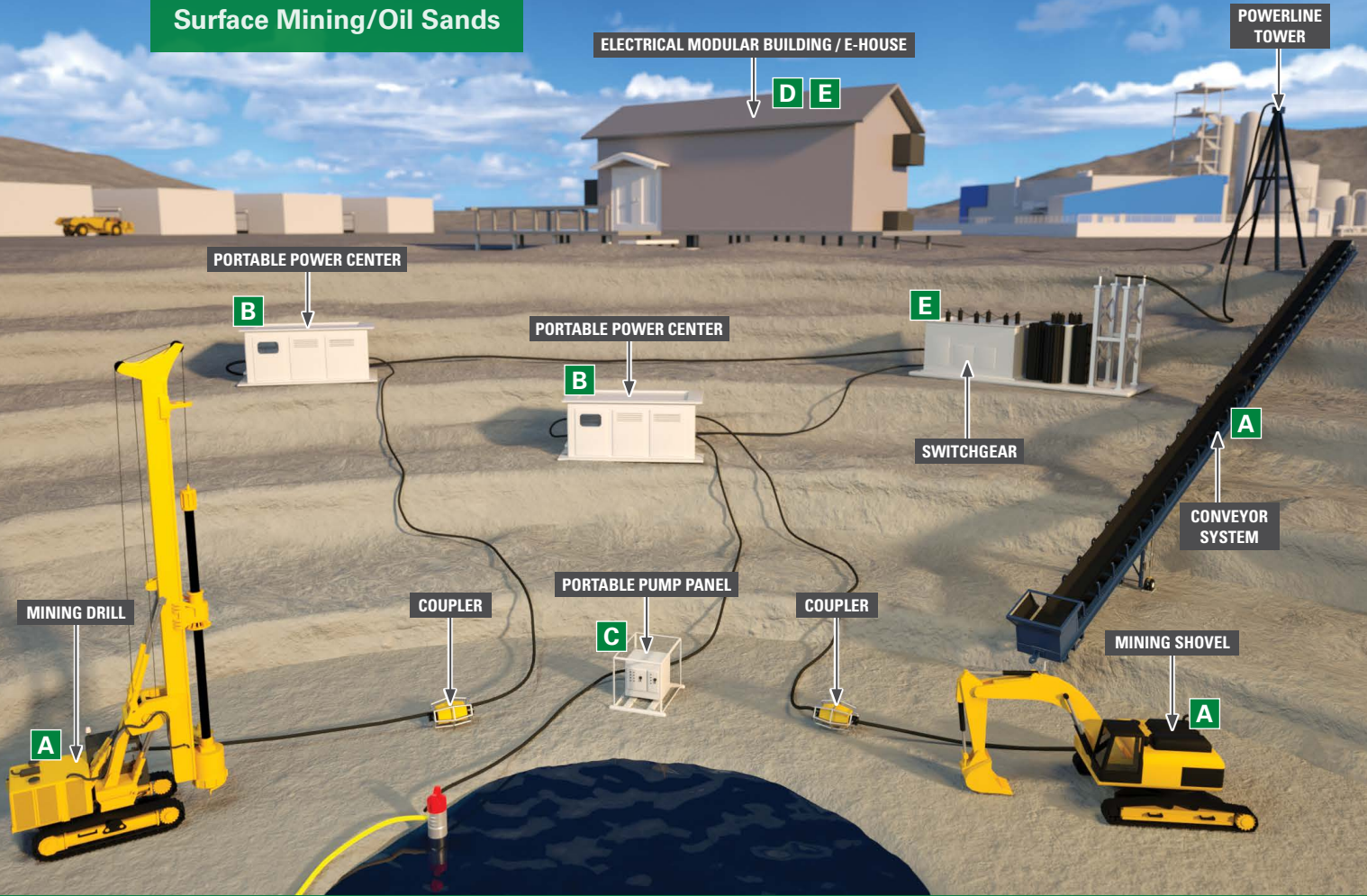
- Arc-Flash Relay
- Ground-Fault Protection
- Industrial Shock-Block
- Motor and Pump Protection
- UL Fuses, Blocks, Holders
- High-Speed Fuses

E Indoor or Outdoor Standard and Arc-Resistant Switchgear

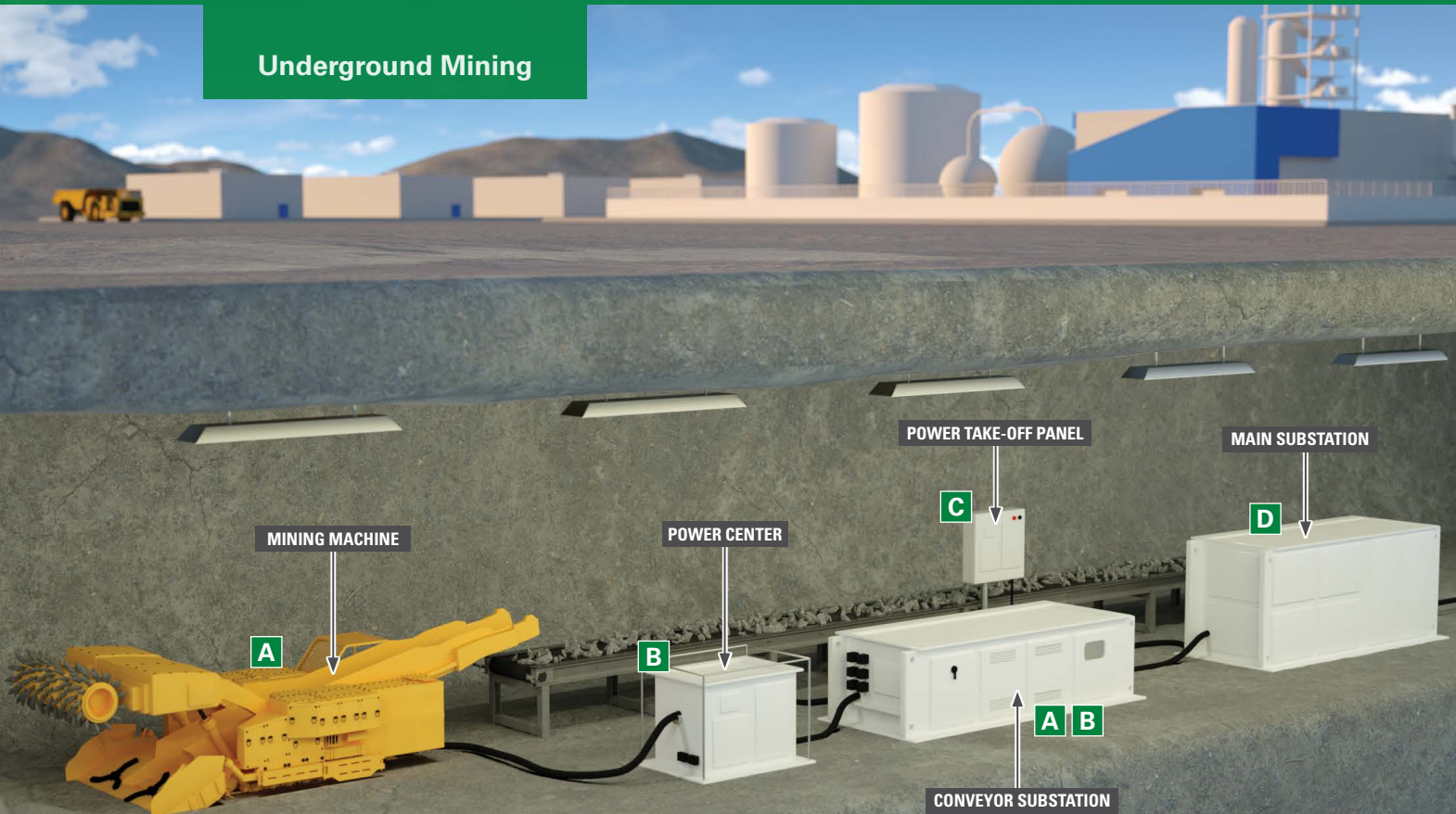
Used to isolate and protect high-voltage circuits underground, on the surface, and in surface substations

- Arc-Flash Relay
- Feeder Protection
- Ground-Fault Protection
- Neutral-Grounding Resistor Monitor
- Motor and Pump Protection
- UL Fuses, Blocks, Holders
- High-Speed Fuses

Surface Mining/Oil Sands



Underground Mining



Industrial GFCI

FIELD SUCCESS STORY

A large solution mining company has pump stations located near the water supply to provide water for processing. A filter is required to screen the water intake before it can be pumped into the mine. Even though a second filter is installed inside the pumping station, rocks, sand, and debris still get in. Typically, once a year, an employee must clean and remove the debris out of the sump with the help of a submersible pump. Having a submersible pump running while the employee is cleaning, puts them at risk for an electrical shock. To resolve the situation, our Industrial Shock-Block® SB6100 is mounted on the inside wall of the pumping station. Now when a worker goes into the pumping station to clean the sump they are protected.



INDUSTRY SNAPSHOT

Mining operations use pumps for dewatering. With long power cables and a wet environment, there is much concern regarding worker safety when pumps are re-positioned or trash screens are cleared.

61% of respondents surveyed **don't use GFCI protection on pumps** creating a higher risk for worker injury or death, fines, lawsuits, as well as downtime.

Source: Littelfuse 2014 Mining Survey

Ground Faults

Ground 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 ground faults. Being able to monitor, detect, and locate ground faults can make a big difference in the security and stability (up-time) of a facility.

When a ground 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-grounding resistor at the secondary of the movable substation transformer. The ground-fault voltage at the frame of the equipment is equal to the product of the fault current and the resistance of the ground wire. The person touching the frame of the trailing-cable-fed equipment will be exposed to the ground-fault voltage. Properly grounding the system and monitoring the health of the ground conductor is critical for safe operation.

INDUSTRY SNAPSHOT

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

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

Which Relay is Right for You?

| FEATURE | GROUND FAULT/ GROUND CHECK | | RESISTOR MONITOR | | GROUND FAULT | | | |
|---|-------------------------------|-------------------|------------------|--------------------------------|--------------|--------|--------|-------|
| | SE-105 SE-107 | SE-134C SE-135 | SE-325 | SE-330 SE-330AU SE-330HV | SE-701 | SE-704 | SE-703 | EL731 |
| DC Ground Fault (79G) ¹ | | | | | | | | ✓ |
| AC Ground Fault (50G/N, 51G/N) ² | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| RTD Temperature (38, 49) ³ | | | | | | | | ✓ |
| Neutral Overvoltage (59N) ⁴ | | | ✓ | ✓ | | | | |
| Checking or Interlocking Relay (3GC) ⁵ | ✓ | ✓ | ✓ | ✓ | | | | |
| Harmonic Filtering | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Lockout Relay (86) ⁶ | | | ✓ | ✓ | | | | |
| 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

**SE-330 and SE-HV models

¹ ANSI/IEEE 79G: AC-Reclosing Relay Ground Relay

² ANSI/IEEE 50G/N: Instantaneous Overcurrent Relay Ground Instantaneous Overcurrent/Neutral Instantaneous Overcurrent; ANSI/IEEE 51G/N: Overload Ground Time Overcurrent/Neutral Time Overcurrent

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

⁴ ANSI/IEEE 59N: Neutral Overvoltage

⁵ Ground Check Checking Relay

⁶ 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

AF0100

AF0500

3 Use high-resistance grounding (NGR) systems to improve the overall architecture of the electrical system and significantly reduce the opportunity for faults. Continuously monitor the neutral-to-ground path to verify the NGR is intact.

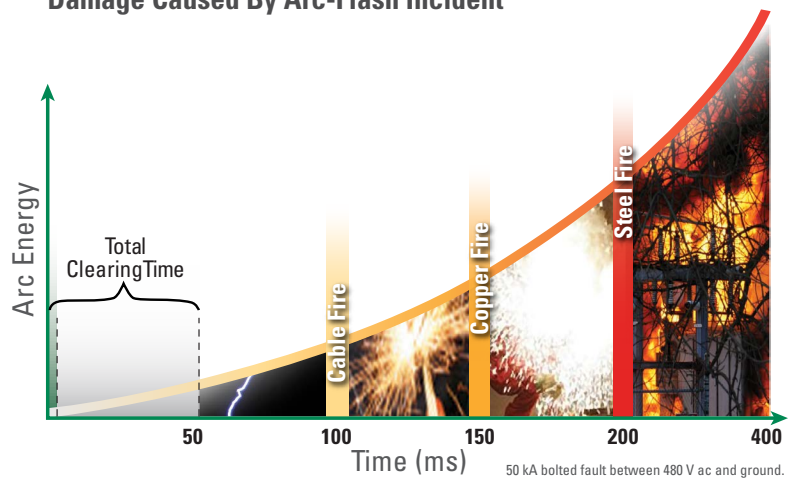


Neutral-Grounding Resistor

SE-330 Neutral-Grounding Resistor Monitor

Damage Caused By Arc-Flash Incident

The Littelfuse Arc-Flash Relays use a 125- μ s 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 milliseconds.



INDUSTRY SNAPSHOT

More than 50% of mining industry respondents surveyed **do not use arc-flash relay protection**. While the use of high-resistance grounding (HRG) eliminates the chance of an arc flash on a ground 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 does not require PC configuration, has a simple and flexible design, and whose wiring ports are clearly marked. Its inputs should accept both point sensors and fiber-optic sensors.

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

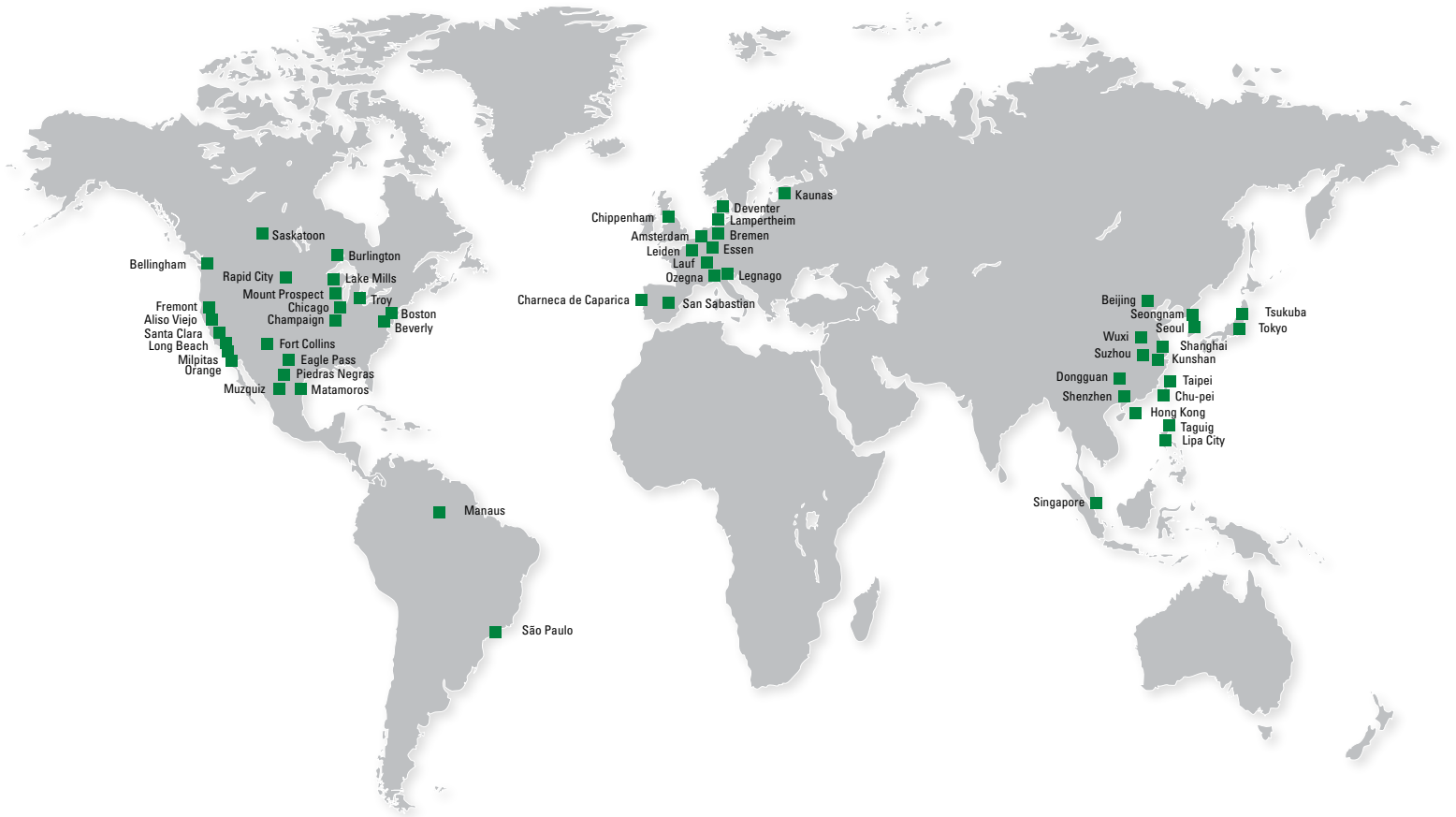
Some arc-flash relay designs allow for the interconnection of multiple relays with several sensors each. With this design you can even use a downstream arc-flash relay to trip the upstream circuit breaker.

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.

LOCAL RESOURCES FOR A **GLOBAL** MARKET



Littelfuse.com/Mining

For a comprehensive library of resources including datasheets, product manuals, white papers, application guides, demos, online design tools, catalogs, and more, visit www.Littelfuse.com/TechnicalResources.

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