SPECIAL REPORT

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ELECTRICAL SAFETY

Compelled to Stay Safe in Confined Spaces

by Matt Crouse, UL EHS Sustainability

The final years of the Obama administration have seen several changes to OSHA regulations in an agency not known for its ability to quickly promulgate standards. In 2015, OSHA released a new subpart to the 1926 construction standard. Subpart AA, also noted as part 1201, is the Permit Required Confined Space for construction standard.

"Interesting," you may say, "but I am not in construction. Why should I be concerned with construction confined-space standards?" It's important to remember that the activity you are performing, not the industry classification, determines whether you follow 1910 General Industry standards or 1926 Construction standards. "Construction work" means work for construction, alteration, and/or repair, including painting and decorating (see **http://plnt.sv/1606-OSHA** for an August 1994 OSHA memorandum on "construction vs. maintenance"). Short of routine cleaning and component replacement, your activities could be considered construction activities in the eyes of a compliance officer.

Work in and around electrical vaults presents unique hazards for workers. The obvious hazard is electrical, and most companies have done their due diligence in reducing exposure. But are you evaluating whether the vault is a permit-required confined space (PRCS)? According to the new standards, a space will now be considered confined when it meets the following construction industry definition:

1. It is large enough and so configured that an employee can bodily enter it (notice the difference from the general industry standard in that it drops the "and perform assigned work" wording),
2. It has limited or restricted means for entry and exit, AND
3. It is not designed for continuous occupancy.

By the OSHA definition above, you are most likely entering a confined space when you enter an electrical vault. Further, a confined space is a PRCS if it contains any other recognized hazard. Until you verify that all electrical hazard exposures are at a zero-energy state, you are entering a PRCS when going into an electrical vault. In practice, rarely can all energy be at a zero state in the entire vault. Because of that, any entry into an electrical vault is a PRCS entry requiring that all permit procedures be followed. It is not feasible to use alternative methods and nearly impossible to maintain a zero-energy state.

The solution: Upgrade your current confined-space program to one based on the requirements found in 29CFR1926 Subpart AA. OSHA stated in the preamble to its new standard that compliance with the construction standard will meet compliance with the general industry standard. However, given the greater prescriptive nature of the construction standard, the reverse isn't also true.

So what does such an upgrade look like? To start, you'll need a "competent person" who can assess PRCS requirements on a regular – or possibly daily – basis. Be selective when choosing a candidate for this position rather than making it an arbitrary assignment. You will need documentation of the person's competency – in some cases of noncompliance, this person can be held criminally liable. If you select an untrained hourly worker, you are not only setting everyone up for failure, but also you're telling a compliance officer that you did not take this responsibility seriously.

After making a wise choice, be sure to empower your PRCS expert with the authority to start and stop entries as well as provide him or her with ongoing education and certification. Your investment in this role will pay additional dividends in an actively engaged employee who sees value in this responsibility.

Next, your PRCS expert should evaluate and re-evaluate your spaces depending on the activity performed there. Unless you are cleaning, troubleshooting, or making in-kind exact replacements in your electrical vault, you could be viewed as performing construction activities in your PRCS.

You will also want to revisit your rescue program. Calling 911 is not a rescue plan. OSHA requires rescuers to be familiar with and practice actual rescues at least once per year. It's unrealistic to assume your local fire department can train all potential responders to practice rescue within your spaces every year.

Lastly, the new subpart requires that if you are relying on the local fire department for a rescue, the department must notify you if it is not going to be available to assist in your rescue. If your entries are planned and infrequent, it may not be cost-effective to train and maintain rescue crews. Consider performing only entries that can be self-rescue or nonentry rescue. Note, too, that an increasing number of companies perform confined-space rescue services on demand.

Next, upgrade your equipment to include ventilation failure and engulfment monitoring. Don't forget to train and document employees expected to use this equipment. Record daily or frequent bump tests to prove your equipment is in good working order and ready for service. If you can, get extras of the exact same model of monitors, because this equipment can and will fail. The similarity of like models will prevent the need for any additional training, documentation, and calibration. You may not need all of this equipment for all your entries, but you will be ready for any construction entry.

Train, maintain, and document. Soon the new standard will become the new norm. It is only a matter of time before the general industry confined-space requirements found in 29CFR1910.146 will be replaced by the requirements found in the construction industry standard 29CFR1926.1201. Given the speed with which this agency is beginning to move, that may happen sooner rather than later.

Upgrading your program to the new subpart AA of the construction standard will ensure compliance regardless of the activity. Of more importance, the review of your PRCS program itself will improve your safety program. These complicated changes might seem onerous at first, but remember their ultimate purpose. They will help keep your workers safe, and that's the most important thing for any employer to do.

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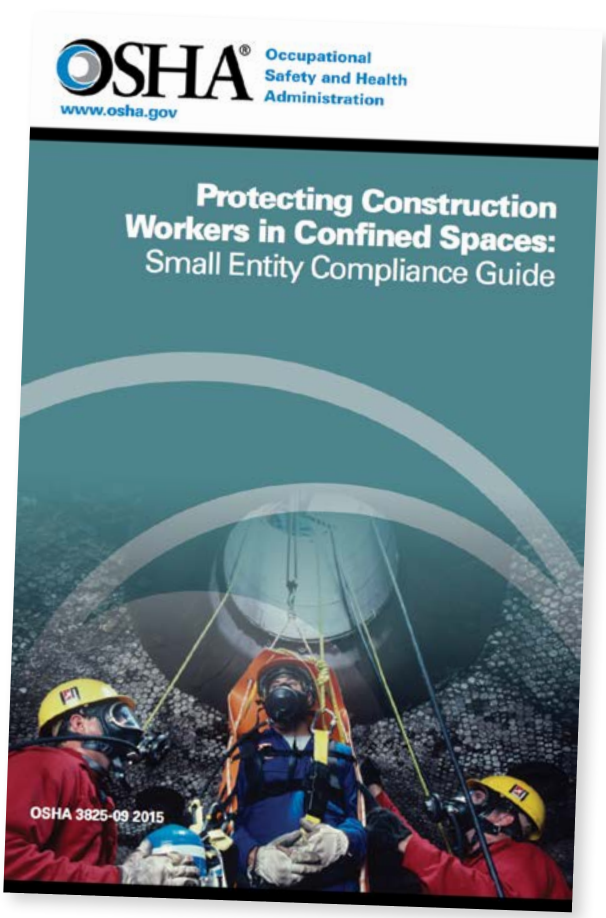
Protecting Construction Workers in Confined Spaces

The following is excerpted from OSHA's 2015 "Protecting Construction Workers in Confined Spaces:Small Entity Compliance Guide." For the full guide, please visit www.osha.gov/Publications/OSHA3825.pdf.

A confined space is a space whose configuration and/or contents may present special dangers not found in normal work areas. Confined spaces may be poorly ventilated and, as a result, contain insufficient oxygen or hazardous levels of toxic gases. Working in a tight space can prevent a worker from keeping a safe distance from mechanical and electrical hazards in the space. Fumes from a flammable liquid that is used in a poorly ventilated area can reach explosive levels. Such hazards endanger both the workers in the confined space and others who become exposed to the hazards when they attempt to rescue injured workers.



A space has a limited or restricted means of exit if a person could not readily escape from the space in an emergency. Any of the following factors indicate that a work space has a limited or restricted means of exit:

- The need to use a ladder or movable stairs, or stairs that are narrow or twisted;
- A door that is difficult to open or a doorway that is too small to exit while walking upright;
- Obstructions such as pipes, conduits, ducts, or materials that a worker would need to crawl over or under or squeeze around;
- The need to travel a long distance to a point of safety.

Before any worker works in a permit space, the entry employer must train authorized entrants, attendants, entry supervisors, and other employees with duties under the standard (such as persons who test and monitor the atmosphere in a permit space) to understand the hazards in the permit space and the methods used to protect against those hazards. If a worker is not authorized to perform entry rescues, the training must include the dangers of attempting such rescues.
All training must be provided at no cost to workers. After the training, the employer must ensure that the workers have the understanding, knowledge and skills necessary to safely perform their assigned duties.

The required training must be provided:

- In both a language and vocabulary that the worker can understand;
- Before the worker is first assigned duties under this standard and before there is a change in the worker's assigned duties;
- Whenever there is a change in permit space entry operations that presents a new hazard about which the worker has not previously been trained;
- Whenever the worker's actions show inadequacies in the worker's knowledge or use of entry procedures.

The employer must keep a record showing that the required worker training has been completed. The record must contain the worker's name, the trainer's signature or initials and the dates of the training. The employer must make the record available for inspection by workers and their authorized representatives.

For additional information, see these compliance assistance resources at osha.gov:

Confined Spaces in Construction: Final Rule
www.osha.gov/FedReg_osha_pdf/FED20150504.pdf

Reader-friendly version of 29CFR1926 Subpart AA
www.osha.gov/confinedspaces/1926_subpart_aa.pdf

"Is 911 Your Confined Space Rescue Plan?"
www.osha.gov/Publications/OSHA3849.pdf

Permit-Required Confined Spaces in General Industry (OSHA QuickCards, also available in Spanish)
www.osha.gov/Publications/3214-10N-05-english-06-27-2007.html

How the IIoT is Changing Electrical Safety

by Sheila Kennedy, Contributing Editor

Most maintenance teams and environment, health, and safety (EHS) officers consistently look for ways to improve team safety. While it's often hard to justify changing existing practices and tools, when it comes to electrical safety, there's a clear exception. Noncontact tools have measurably improved electrical safety, but new opportunities afforded by the Industrial Internet of Things (IIoT) heighten their potential.

Wireless tools are an example. Because they place greater distance between technicians and potential hazards, the changeover to wireless tools that began several years ago is likely to accelerate as more tools become wireless. They usually don't cost any more than regular models do, and they are no more complex to use.

Electrical safety technology providers are also adding cloud connectivity to their tool catalogs. For instance, certain multimeters, clamp meters, power quality meters, and infrared cameras are IIoT-enabled by a radio that connects to a smartphone via a smartphone app. The test tool live-streams its readings to the app, from which the user can read the measurement in safer surroundings as well as tag and save the measurement to a cloud database for later reference by the entire maintenance team.

Early adoption of IIoT-enabled tools reflects a company's risk profile and how heavily regulated it is, suggests reliability specialist Paul Dufresne, CMRP, CRL. "The nuclear and pharmaceutical industries tend to be more advanced in the technologies they employ, such as safety tools tied back into the DCS through smart controllers and things like that."

Not every company is at that point. Dufresne said that to date he has used a kaleidoscope of tools for electrical safety – grounding systems, electrical motor testing, partial discharge testing, and infrared testing among them – but they all were standalone. No IIoT-enabled tools have yet been used by his team, and there was no live, active tracking of electrical safety system monitoring results.

Corporate security policies also influence tool decisions. "As a rule, we don't use any outside Internet vehicles such as the cloud," says Russell Flagg, CBM program owner at Duke Energy's Smith Energy Complex (www.duke-energy.com). "We are a regulated utility that must comply with the NERC/CIP network security requirements, so that pretty much rules out that method of data transfer and review."

The Smith Energy Complex is instead leveraging the IIoT by installing continuous motor monitoring sensors on all of its medium-voltage switchgear so the gear can be monitored 24/7. This eliminates having to open energized switchgear and attaching clamps on meters. "The continuous motor monitoring will be fed into our SmartGen program and will be part of our M&D center monitoring regimen," says Flagg.

At The J.M. Smucker Company, ultrasound, infrared, and motor circuit analysis are among the most useful tools for monitoring and maintaining electrical safety, says Joe Anderson, CMRP, CRL, and a former reliability leader at Smucker who joined the Schwan Food Co. as senior reliability manager earlier this year. Anderson predicts that all such tools soon will be IIoT-enabled. "This will be driven by customer demand and to help them maintain a competitive advantage," he says.

Contact Sheila Kennedy, CMRP, at sheila@addcomm.com.

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Arc-flash relay FAQ

Know your facts about this increasingly key component of a best-in-class electrical safety program

By Dean Katsiris, B.E., B.Sc.

There are several strategies for reducing the risk of arc flash in a plant. As more plant engineers and maintenance managers have become aware of arc-flash protection relays as one possible solution, they have a lot of questions. This article answers some of the most frequently asked questions.

CAN THE ARC FLASH RELAY BE USED IN LOW VOLTAGE SYSTEMS? WILL A LOW VOLTAGE BREAKER CLOSING OR OPENING CAUSE A TRIP?

When a low-voltage breaker is closing there is often a large inrush current that, depending on the configuration of the arc flash relay, could be sufficient to allow a high-intensity light source other than an arc flash to cause a trip. While low-voltage breakers often produce an arc when they are opening, closing the breaker does not normally produce an arc, so the arc flash relay should not operate unintentionally.

When opening the breaker, an arc is typically present as part of normal operation of the breaker. If light sensors are placed such that the breaker arcing is visible then it is recommended to also use current supervision. The breaker arcing during normal opening will cause a reduction in current because of the increased impedance and the relay with current supervision will not operate.

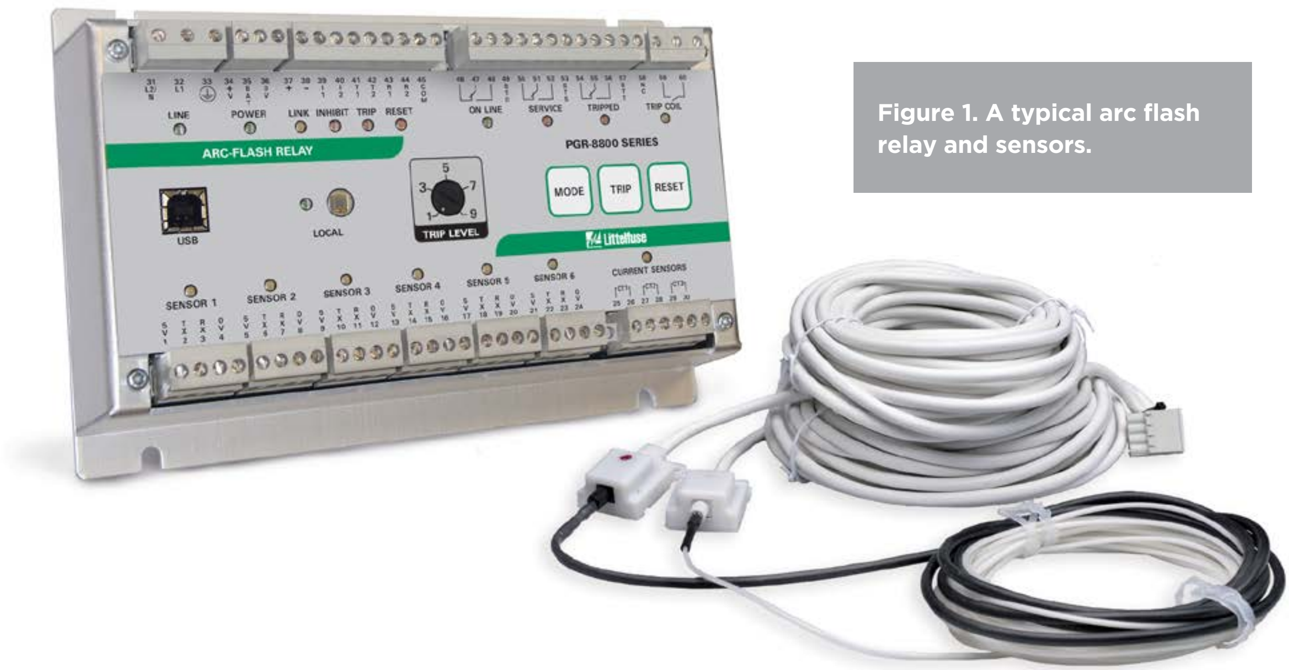

Figure 1. A typical arc flash relay and sensors.

CAN WE LOWER THE REQUIRED LEVEL OF PERSONAL PROTECTIVE EQUIPMENT (PPE) IF WE INSTALL ARC FLASH RELAYS?

The level of PPE is based on the level of arc flash hazard, which in turn is based on the potential incident energy of an arc flash event. To lower the incident energy, reduce the fault current or reduce the clearing time.

- Reducing the current can be achieved by using current-limiting fuses and – for single-phase faults – resistance grounding.

- Reducing the clearing time typically is not possible when using overcurrent protection due to system coordination requirements. Current-based protection must have sufficient delay to prevent unnecessary tripping on momentary overload or current spikes, thus losing valuable reaction time. Arc flash relays resolve this issue by detecting light, which allows for fast reaction time, sometimes <1 ms, which is much faster than using standard protection and circuit breakers alone (see Figure 1).

HOW DO ARC FLASH RELAYS COORDINATE WITH OTHER PROTECTION RELAYS?

Power system analysis software programs can be used to help with system coordination. Some arc flash relays have two definite time settings (for example, 10-1000% full-load current and 1ms–20s time delay) that can be used for coordination; however, both control one set of output trip contact. One setpoint can be used for detecting a low-level arcing condition, and the other can be used for detecting high-level arcing condition. If either condition is met, a trip signal is sent to the circuit breaker.

Coordination for arc flash protection is not practical due to the reaction time required and utilizing light as a fault detection method.

HOW DO ARC-FLASH RELAYS COMPARE TO ZONE SELECTIVE INTERLOCKING PROTECTION (ZSIP) AND BUS DIFFERENTIAL?

These are different technologies that detect and quickly clear faults. ZSIP will detect a fault and block an upstream protective device from operating until the local protective device has a chance to clear the fault. If not, the upstream device attempts to clear it. This takes valuable time (100ms for detection only) and may be difficult to retrofit.

Bus differential measures the difference of current going into and out of a device, such as switchgear. If the current supplied by the source travels through the switchgear to the load, all is well. If a fault occurs within the switchgear, the current going in does not equal the current going to the load. This detection method is much quicker (33ms for detection only) and may be more difficult and/or expensive to retrofit, depending on the number of current transformers (CTs).

DO ARC-FLASH RELAYS PROVIDE ZONE IDENTIFICATION?

Yes, an arc-flash relay has multiple sensors that can be installed in each cubicle, compartment, or bucket. With some models, each sensor has an on-board LED as well as an LED on the relay that provides feedback identifying which zone caused the fault. The arc flash relay has one set of contacts to trip the main circuit breaker. Protection zones can be implemented by connecting multiple arc flash relays to separate breakers, or by using an arc flash relay with multiple, configurable zones.

If individual circuit protection is desired, the built-in light sensor on the front of the relay can be utilized. Simply install the arc flash relay in each cubicle and connect to the associated feeder circuit breaker.

WHAT ARE TYPICAL INSTALLATION GUIDELINES FOR THE SENSORS?

An arc-flash relay and sensors are easily installed in retrofit projects and new switchgear with little or no re-configuration (see Figure 2). Some relays have built-in USB interface software that makes it easy to configure even elaborate systems with multiple power sources.

Generally, it is recommended to mount one or two sensors per cubicle to cover all horizontal and vertical bus bars, breaker compartments, drawers, and anywhere that there is potential for an arc-fault. Threading a fiber-optic sen-

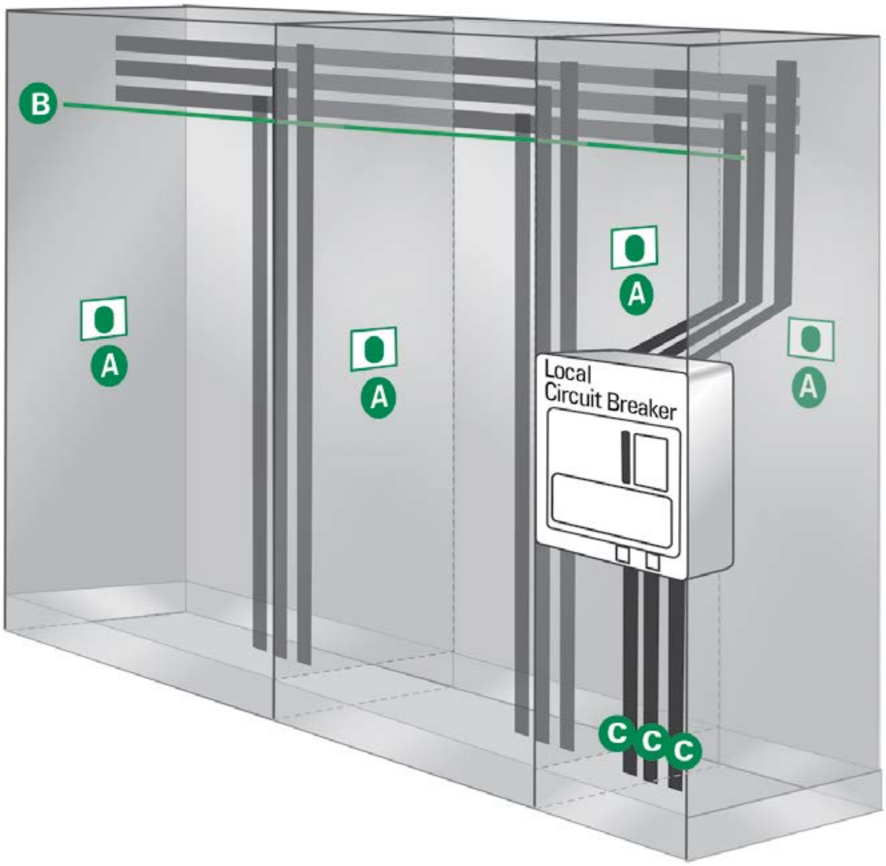

Figure 2. Typical arc flash sensor installation, including (a) point sensors, (b) fiber-optic sensors, and (c) phase current transformers.

sor through the cabinets and in areas where point-sensor coverage is uncertain results in complete coverage and an added level of redundancy. Even if policy is to work on only de-energized systems, all maintenance areas should be monitored to prevent potential damage and additional cost. At least one sensor should have visibility of an arc fault if a person blocks the other sensor(s).

A. Point Sensor – Line-of-sight light sensor and cable. Some models feature a built-in LED to indicate sensor health or trip state.
B. Fiber-Optic Sensor – A 360° fiber-optic sensor detects light along the entire length of the cable. Some models feature a built-in LED to indicate sensor health or trip state. Recommended installation is along bus bars as well as in challenging spaces that have many compartments.
C. Phase Current Transformers (CTs) – Phase CTs are required to detect phase currents. When retrofitting systems, existing CTs with a 5-A secondary can be used.

Below are some additional guidelines:

- First determine sensor placement, then consider zones.
- Ensure that sensors and cables are not blocked by objects, either fixed or movable.
- Do not place sensors or fiber cable on live or energized components.

- Chose a location that will minimize collection of foreign debris and easy access for maintenance, if needed.
- Use care when handling, pulling, and securing cables.
- Avoid sharp bends (<2cm) and high temperature (>80°C).
- Consider placements around air-magnetic circuit breakers.
- Consider movable parts and area accessible to personnel for commissioning, testing, inspecting, etc.
- Even though the sensors and cables have no exposed live parts are fully insulated, the placement and routing must comply with industry standard requirements on over-surface (creep) and through-air (clearance).

IS THERE A MAINTENANCE SCHEDULE FOR THE SENSORS?

With some arc-flash relays, each sensor has an internal health LED. Its purpose is to verify the continuity of the sensor cabling and the internal sensor circuitry. This “health check” circuit will not detect dust buildup on the sensor.

There are several ways to mitigate dust buildup. A sensor mounted at the top of an enclosure looking down is optimal. This configuration will not collect much dust in most cabinet installations, due to the light intensity of an arc combined with the reflections off the metal walls (even a dirty sensor will collect a great deal of light).

Sensors must be cleaned in order to maintain consistent sensitivity. Sensor cleaning should be part of regular maintenance and should be performed via compressed air or dry wipe down. A maintenance routine can be implemented to clean sensors at a set interval that is aligned with industry standard recommendations, such as NFPA 70B, Recommended Practice for Equipment Maintenance.

A more proactive approach could also be used by putting the relay into “service” mode and shining a bright light on each sensor. If the relay light isn’t indicating a trip, then cleaning is necessary.

DURING MAINTENANCE, WE USE INSTANTANEOUS SETTINGS AT THE FEEDER BREAKER RELAY. ISN’T THAT PROTECTION AS GOOD AS AN ARC FLASH RELAY?

Not with some fault conditions. According to IEEE 1584, the arcing current can be as low as 38% of the available bolted fault current. If the instantaneous trip setting of the circuit breaker is greater than the arcing current, the breaker could take seconds or minutes to open, thus creating a potentially dangerous arc flash condition. In contrast, an arc flash relay can react very quickly regardless of the fault current, and initiate the tripping signal to open the breaker and clear the fault within 30 ms, lowering the arc-flash incident energy to a minimum.

HOW DO YOU TEST THE SENSORS? ARE THEY FAIL SAFE?

In some arc flash relays, a sensor-check circuit tests the sensor once per second to verify that the sensor assembly is functioning correctly and that is connected. The signal is sent from the relay along the cable to the sensor which activates an internal LED. A failure in the sensor circuitry or cable would result in a loss of check signal. The relay recognizes this signal loss as a loss of sensor and will indicate an error condition on the sensor and on the relay, and the online output will change state. The user can decide what to do with this relay output and whether it will trip the system or simply signal an alarm. The fiber-optic sensor works the same way except that the signal travels through the length of the fiber-optic cable so a break or crimp in that cable is detected.

Sensors can be tested individually by putting the relay into "service" mode and shining a bright light source on the sensor. A trip will be indicated if the sensor is able to detect the light but a trip signal will not be sent to the breaker. A high-power flashlight can serve to verify the sensors are properly detecting light. The power required on the flashlight is difficult to quantify because of the way the light is spread and focused, but a 3-million candle-power flashlight has proven sufficient for use on point sensors.

HOW DO THE CURRENT INPUTS HELP THE PERFORMANCE OF THE RELAY?

The CT inputs provide optional current measurement, protection, and restraint. In applications with indoor lighting and no high-intensity light sources (e.g., welding, direct sunlight) nearby, current measurement may not be of benefit to the relay aside from high-level overcurrent protection. However, for applications where high intensity light could be mistaken for an arc on an arc flash sensor, the current measurement ability acts as a second-level verification in addition to light. If there is intense light on the sensor but the current is normal, the relay can be configured to ignore the light. If there is higher than normal current and there is also intense light as from an arc flash, then the relay will trip. The current effectively supervises the operation of the light-tripping mechanism and allows nuisance-free operation of the relay in applications with optical noise.

IF ONE WAS TO USE THIS ARC FLASH RELAY AS THE ONLY METHOD TO PROTECT PERSONNEL FROM ARC FLASH, SHOULDN'T THE ARC-FLASH RELAYS BE TESTED AND HAVE A SAFETY INTEGRITY LEVEL (SIL)?

We don't recommend that an arc flash relay be used as the only method to protect personnel from arc-flash. Adequate PPE should be worn based on the results of an arc-flash study. Resistance grounding is highly recommended to eliminate single phase-to-ground arc flashes. Current-limiting fuses and relays with maintenance mode settings or dual set-point groups are also highly recommended.

WOULD CAMERA FLASH LIGHTS TRIGGER THE ARC FLASH RELAYS?

It depends on the sensitivity of the relay and sensors. Typically, a compact camera's flash does not present enough intensity to cause a trip, except at very close proximity to the sensor. More advanced cameras with larger flashes can trip the relay from a greater distance. In applications where this is a concern, it is recommended to use CTs so that non-arc flash light with no corresponding increase in current above normal operating conditions does not cause a trip. Where current supervision is used, both high current and intense light are required to have an arc flash trip. Some arc flash relays also allow for time and light sensitivity adjustment to reduce this risk.

HOW DO YOU MODEL ARC FLASH RELAYS IN POWER SYSTEM ANALYSIS SOFTWARE, SUCH SKM AND ETAP, AS THE RELAY IS DETECTING LIGHT INSTEAD OF CURRENT?

You must add the arc-flash trip time (1ms for example) to the breaker shunt-trip operating or clearing time. The result will be a horizontal line (definite-time) that shows the same response time regardless of the current. This demonstrates the advantage of using light for arc flash detection.

Dean Katsiris is product manager for protection relays at Littelfuse and holds bachelor's degrees in Electrical Engineering and Computer Science from the University of Saskatchewan. Over the past decade, he has worked in a variety of roles at Littelfuse including research & development and sales. Dean is a member of the IEEE, and be contacted at dkatsiris@littelfuse.com.

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Small Labels, Big Safety Message

Learn what you need to do to comply with the latest NFPA 70E safety labeling rules

by Antony Parsons, Schneider Electric Engineering Services

Complying with the requirements of NFPA 70E®, the National Fire Protection Association's Standard for Electrical Safety in the Workplace, is a multi-faceted process and is the responsibility of the facility owner.

An arc-flash risk assessment is required for any electrical equipment operating at 50V or greater that may require inspections, adjustment, servicing, or maintenance while energized. Equipment that falls into this category is required to have the field marking (label) in place.

An assessment also required even if it is a company's practice to work only on de-energized equipment. Why? Because until the circuit is verified dead, it is considered energized. To approach the circuit to test it, the worker must be outfitted in the appropriate level of personal protective equipment (PPE); this level is specified on the label.

Arc-flash labeling requirements were first introduced in the National Electrical Code® (NEC®) in 2002 and subsequently appeared in NFPA 70E in 2009. While both standards require arc-flash labels, there are some differences in their specific requirements.

NEC LABELING REQUIREMENTS

NEC Section 110.16 requires labeling that provides a general warning against arc-flash hazards. Changes to the NEC labeling standard have been made with subsequent revision cycles (2005, 2008, 2011, and 2014). NEC labels should contain “signal” words, colors, and symbols and should comply with ANSI Z535, which has been adopted by OSHA. Messaging should include specific details on:

- The nature of the hazard
- The consequences of the hazard
- Avoidance procedures

NEC labeling requirements also are referenced in Section 110.21(B). Because NEC labels do not contain circuit-specific information, they can be either field- or factory-applied.

Figure 1. Example “Danger” label meeting NEC requirements.

NFPA 70E LABELING REQUIREMENTS

NFPA 70E labels provide detailed, site-specific information on the arc-flash hazard present; this is useful for PPE selection. NFPA 70E labeling requirements, found in Section 130.5(D) of the standard, state that equipment that is likely to be examined, adjusted, serviced, or maintained while energized shall be field-marked with a label containing all of the following information:

1) At least one of the following:
- Available incident energy or required PPE category
- Minimum arc rating of clothing
- Site-specific level of PPE

2) Nominal system voltage

3) Arc-flash boundary

As a recommended best practice, consider adding information such as date, calculation method, references to standards, an engineering contact, and shock boundary information.

NFPA 70E LABELING OPTIONS

NFPA 70E-2015 Section 130.5(D) gives facilities choices in ways to communicate the incident energy level and/or required PPE. Whichever labeling option a facility selects, consistency in using it is key.

1. MINIMUM ARC RATING OF CLOTHING

This option potentially allows for development of a simplified arc-flash PPE approach in the facility.

For example, consider the PPE system defined in NFPA 70E, Annex H, where arc-rated clothing recommendations are provided for locations that have available incident energy less than 1.2 cal/cm2, between 1.2 and 12 cal/cm2, and between 12 and 40 cal/cm2. Under such a system, a worker at a location with a calculated incident energy level of 4.5 cal/cm2 would wear clothing rated for up to 12 cal/cm2.

When utilizing this approach, workers in some cases might have to wear more PPE than would be absolutely necessary, as there could be arc-rated clothing available that exceeded the actual incident energy level but that did not meet the defined minimum arc rating. The advantages of such a system include:

- Simplified arc-flash PPE system using a standardized two- or three-level PPE approach.
- Increased efficiency and fewer errors in label application, thanks to the use of fewer unique labels.

Finally, because the actual incident energy levels are not shown at each location but are essentially "rounded up" to the next-higher standard value, minor changes in the system would not invalidate the labels nearly as often as they otherwise might. For example, if a change in the utility system meant that the calculated 4.5 cal/cm2 incident energy value rose to 5.2 cal/cm2, the same 12 cal/cm2 minimum arc rating would still apply.

Arc Flash Information

Use this information in accordance with applicable OSHA standards, NFPA 70E-2015 and other required safe electrical work practices.

12 cal/cm² Incident Energy at a Working Distance of 1 ft 6 in.
4 ft 9 in. Arc Flash Boundary

208 V Shock hazard when cover is open
3 ft 6 in. Limited Approach
1 ft 0 in. Restricted Approach

Q2C: 12345678 Date: 09/10/14

Values produced by a Schneider Electric engineering analysis. Any system modification, adjustment of protective device settings, or failure to properly maintain equipment will invalidated this label. For more information, contact Schneider Electric at 1-888-778-2733.

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Figure 2. Example "Arc Flash Information" label meeting NFPA 70E requirements, and showing minimum arc rating of clothing.

2. AVAILABLE INCIDENT ENERGY OR ARC FLASH PPE CATEGORY

With this option, the equipment is labeled with either the available incident energy level calculated in an arc-flash study or PPE category determined using NFPA 70E Tables.

Arc Flash Information

Use this information in accordance with applicable OSHA standards, NFPA 70E-2015 and other required safe electrical work practices.

1.71 cal/cm² Incident Energy at a Working Distance of 1 ft 6 in.
1 ft 10 in. Arc Flash Boundary

208 V Shock hazard when cover is open
3 ft 6 in. Limited Approach
1 ft 0 in. Restricted Approach

Eqpt Name: L1A

Q2C: 12345678 Date: 09/10/14

Values produced by a Schneider Electric engineering analysis. Any system modification, adjustment of protective device settings, or failure to properly maintain equipment will invalidated this label. For more information, contact Schneider Electric at 1-888-778-2733.

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Figure 3. Example "Arc Flash Information" label meeting NFPA 70E requirements, and showing available incident energy.

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3. Site-specific level of PPE

NFPA 70E also allows for labels to show required "site-specific" levels of PPE. Site-specific levels are not defined in NFPA 70E but are intended to be developed by end users who wish to implement a site-specific PPE system to ensure that:

- The labels they affix to their equipment are consistent with their overall Electrical Safety Program and worker training, or
- The labels define specific PPE requirements for the facility.

A site-specific label also could be used to closely match "legacy" labels generated under previous versions of NFPA 70E. Though NFPA 70E does not provide further guidance on defining the site-specific options, Schneider Electric recommends that any such labels align with the facility's written Electrical Safety Program and that workers be trained to read, interpret, and properly apply the information contained on the labels.

Arc Flash Information	
PPE LEVEL - Site-Specific **2**	**Use this information in accordance with applicable OSHA standards, NFPA 70E-2015 and other required safe electrical work practices.**
8 cal/cm² Incident Energy at a Working Distance of 1 ft 6 in. 4 ft 9 in. Arc Flash Boundary	
208 V Shock hazard when cover is open 3 ft 6 in. Limited Approach 1 ft 0 in. Restricted Approach	
Q2C: 1234578	**Date 12/01/14**
Values produced by a Schneider Electric engineering analysis. Any system modification, adjustment of protective device settings, or failure to properly maintain equipment will invalidated this label. **For more information, contact Schneider Electric at 1-888-778-2733.** Copyright 2014 Schneider Electric. All rights reserved.	

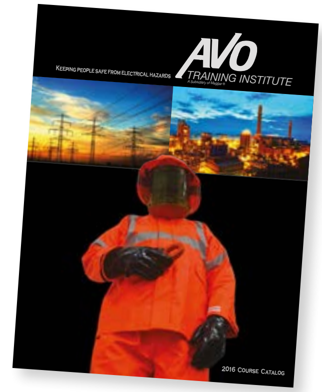
Figure 4. Example "Arc Flash Information" label meeting NFPA 70E requirements, and showing site-specific information.

Figure 4. Example "Arc Flash Information" label meeting NFPA 70E requirements, and showing site-specific information.

It is critical that the labeling approach, the employee training program, and the Electrical Safe Work Practices policy and documentation all align. The ultimate goal of arc-flash labeling is to allow a qualified employee to correctly understand, interpret and apply the information on the arc-flash labels. Schneider Electric's current practice is to provide two labels – the "Danger" label to comply with NEC, along with the NFPA 70E "Arc Flash Information" label. Together, the two labels constitute an effective labeling system that meets the requirements of both standards.

Antony Parsons is a senior staff engineer for Schneider Electric Engineering Services. He earned a BSEE from the University of Houston, and an MS and PhD in electrical engineering from the University of Texas at Austin. He has 15 years' industry experience, and is a member the IEEE P1584 Working Group on Arc Flash Hazard Calculations.

AVO® Training Institute, a Megger® subsidiary, celebrates over 50 years keeping people safe from electrical hazards. From electrical maintenance safety procedures to safe work practices, engineering services including arc flash studies, AVO is the complete one-stop electrical training resource. Courses are offered at our locations nationwide or on-site at your facility.



https://www.plantservices.com/assets/Media/1605/avo-course-catalog.pdf

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High temperatures cause over 50% of electronic equipment failures, according to a study by the US Air Force Avionics Integrity Program. Vibration and humidity each contribute an additional 20% of failure says the same study. According to the Weather Channel, in the last four decades we have seen average temperatures increase by 2.0°F to 3.6°F in many locations with more extreme temperatures during the summer months. To prevent loss of productivity it is important to take preventative action to address thermal management of electrical components, electronics, control systems and VFDs.


Electronic Equipment Failures: Cause, Effect and Resolution

https://www.plantservices.com/assets/Media/1605/electronic-equipment-failures.PDF

What's Your Arc-Flash Risk?

Access our on-line incident energy reduction calculator to determine your risk and how installing a Littelfuse Arc Flash Relay can help lower that risk. An arc-flash relay is an integral component of an arc-flash protection scheme that can minimize damage and save money, time, and lives. A minimal investment of just a few thousand dollars can save tremendous costs in lost equipment, downtime and production, not to mention the risk of employee injury or fatality. Don't rely on PPE alone to protect workers. A proactive strategy is recommended when it comes to protecting critical assets and employee safety.

http://www.Littelfuse.com/arcflashcalculator