Be aware of best practices that avoid arc flash

- Mitigate arc-flash risk, p.2
- Practice safety first because arc flash has become ubiquitous, p.7
- The electrical barrier, p.9
There are effective tactics for reducing risk, but most attack the problem in a piecemeal fashion: a fuse here, a relay there, at equipment all over the building. Many electrical professionals are seeing the limitations of traditional protections, and they're considering a systemic approach that prevents phase-to-ground arc flash from forming anywhere in the system.

Resistance grounding systems are getting a fresh look; their use is increasing 23% a year. If a phase faults to ground, the resistance limits current to just a few amps, not enough to cause downtime by tripping the overcurrent protection device, and not enough to produce an arc flash.

Electrical professionals must consider many things when converting the facility’s solidly grounded system or ungrounded system to a resistance-grounded system. That’s why it’s important to know about resistance grounding, how to implement it, where it can be used and where it isn’t appropriate.

Ungrounded systems
Some older plants use ungrounded electrical systems, with a delta-connected transformer (Figure 1). Their advantage is they can continue to operate if one phase faults to ground, which is particularly important if continuity of power is critical. For example, chemical plants or refineries involving processes that can’t be interrupted without extensive dollar or product loss might have ungrounded systems. However, ungrounded systems have major problems, including transient overvoltages — a series of arcing ground faults can increase overall system voltage relative to ground to several times its normal value — and difficulty locating ground faults. For these reasons, many have been replaced by grounded systems.

Mitigate arc-flash risk
High-resistance grounding can reduce the chances of arc-flash hazard and downtime

Figure 1. Ungrounded systems can continue to operate if one phase faults to ground but can be subject to transient overvoltages and difficulty locating ground faults.
Solidly grounded systems A grounded system (Figure 2) is wye-connected, with the neutral — the center of the wye — solidly connected to ground. Three-phase loads are connected to three phases and single-phase loads are connected either to phase-to-neutral or phase-to-phase. It’s straightforward, and everyone understands how it works. But it also has some drawbacks.

The main drawback has to do with ground faults. If a phase conductor shorts solidly to ground, the overcurrent protective device will operate and shut off the affected phase. The other phases might not shut down immediately as well, which can mean that some motor loads might single-phase for a while. In either case, the loads connected to the affected phase get shut down, and production is disrupted.

But the ground fault might not be a solid short to ground; it might be an arc, and not draw enough current to trip the overcurrent protective device. In addition, the arc can initiate a dangerous arc flash, which is why power panels are required to have warning labels, and anyone working on an energized power panel must wear personal protective equipment (PPE).

The severity of an arc flash depends on system voltage and, more importantly, the available current, which can reach 100,000 A. Current-limiting fuses allow only a certain amount of energy to pass before they open the circuit, but they respond best to a solid short circuit, a so-called bolted fault.

**There has to be a better way**

Another way to ground a plant power system allows it to continue operating even if one phase faults to

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**Figure 2.** A grounded system is wye-connected, with the neutral solidly connected to ground. While it is simple, ground faults can shut it down and allows severe arc-flash hazards.

**Figure 3.** In a high resistance grounding system the neutral point of the wye transformer is connected to ground through a high-value neutral grounding resistor, which normally carries little or no current.
ground, while getting around the drawbacks of the ungrounded system. Overcurrent protective devices won’t trip, loads continue to operate and maintenance personnel can schedule an outage when it’s convenient rather than having to rush repairs because production has stopped. This grounding method also helps to eliminate the danger of arc flash, and it protects against transient overvoltages. We’re talking about a high-resistance grounding (HRG) system, also known as a resistance grounded (RG) system, high-impedance grounded neutral system, or a neutral grounding resistor (NGR) system. HRG systems aren’t new; in fact they’ve been mandatory for power wiring in mines for years, and they’re widely used in the petrochemical industry, but only now are they being considered for general industrial use. HRG systems are most often used on systems at or below 600 Vac, which the National Electrical Code (NEC), NFPA 70, article 250.36 permits.

**How an HRG system works**

In an HRG system, the neutral point of the wye transformer connects to ground through a high-value neutral grounding resistor (Figure 3), which normally carries little or no current. An ungrouded system with a delta-connected transformer uses a zig-zag transformer to produce an artificial neutral, which is then connected to ground through the NGR (Figure 4). This transformer carries very little current, so it need not be large or expensive.

During normal operation, the neutral point stays at nearly zero volts; any residual voltage is the result of small differences among the distributed capacitances of the three-phase feeders (Figure 5). The NGR will also limit transient overvoltages to safe values.

During a phase-to-ground fault, the neutral point assumes the phase-to-neutral voltage (277 V on a 480-V system), while the phase-to-ground voltage in the faulted phase will collapse to about zero. The current flowing through the NGR will be the voltage at the neutral point divided by its resistance, which is chosen to keep the current to a few amperes (usually 5 A). This current is too small to trip the system’s overcurrent protective devices and is too small to produce an arc flash. However, it’s important to remember that while resistance grounding prevents arc flash from phase-to-ground shorts, it has no effect on phase-to-phase shorts. Anyone working on an energized panel will still be required to use the appropriate PPE.

**Drawbacks and precautions with HRG systems**

Some electrical systems have both three-phase and single-phase loads. Facility systems — in office buildings, for example — generally use a system neutral for the 277-V circuits for lighting and HVAC blowers. The NEC doesn’t allow that neutral to be distributed, which makes it necessary to convert from a neutral running throughout the facility to isolation transformers. If single-phase loads must be powered from the system, they must be connected through a 1:1 isolation transformer or converted to line-to-line loads.

In industrial faculties, some three-phase loads — variable-frequency drives, for example — have filters on their input lines. These filters must be rated to withstand the elevated neutral point voltage that occurs during a ground fault. The filters on many or most modern VFDs are rated to handle this voltage, but it’s still a good idea to verify this fact.

If the grounding resistor opens — by accident, by
mistake, or even by someone stealing the grounding wire — the system will become ungrounded. A neutral grounding monitor can detect this and provide an alarm.

**Converting to an HRG system**

The first step is to determine the current that will flow through the NGR during a ground fault. This current must be greater than the distributed capacitance charging current for all three phases.

There are three ways to find the charging current: estimate it, calculate it, or measure it. For a 277/480 V system, the system capacitive charging current is usually less than 3.6 A, so 5 A has become the standard. Another way to estimate it is to assume 1.0 A per 1,000 kVA of transformer capacity for systems less than 600 V. If necessary, the capacitive charging current also can be measured during the commissioning phase, which might include deliberately grounding one phase.

After choosing the NGR current, it's a simple matter to find the required resistance. When a phase is faulted to ground, the neutral point rises to the system's phase-to-neutral voltage, 277 V in the case of a 480 V system. Assuming that the desired neutral grounding current during a phase-to-ground fault is 5 A, choose the tap on the NGR closest to about 55.4 Ohms. The NGR should be capable of dissipating more than 1.4 kW continuously.

Install the NGR between earth ground and the neutral point of the transformer — the center of the wye (if converting a grounded system) or the center of the zig-zag transformer (if converting an ungrounded system). Install an HRG relay in series with the NGR. This unit can be a neutral-grounding monitor, which measures the current and voltage in the neutral-to-ground connection and the continuity of the NGR, or a resistance grounded relay, which detects a ground fault and monitors the neutral-to-ground connection, and includes a pulsing contactor for use in locating ground faults.

**Finding a phase-to-ground fault in an HRG system**

Phase-to-ground faults might be either continuous or intermittent. There are two ways to detect the former: a pulsing contactor plus a portable zero-sequence meter (a meter with a current transformer through which three phases pass), or an HRG relay on each feed. A pulsing contactor, also called a shorting contactor, periodically shorts out half the grounding resistor, causing the ground fault current to double at about 1-sec intervals. With the pulsing contactor operating, a zero sequence meter shows a current variation at 1-sec intervals (the exact value of the current is unimportant; the variation is the key). Follow the feeds through the system, taking frequent readings; the 1-sec pulsing will be present upstream of the ground fault but disappear downstream.

The other way to detect a continuous ground fault is to install an HRG relay and a relay on each feed. The HRG relay tells that the ground fault exists, and the relays in the feeders identify the affected phase.

Intermittent ground faults can be difficult to locate.
Sometimes, for example, the ground fault isn’t in a feeder, but in a load that doesn’t operate continuously — one phase winding of a motor, for example. When the motor isn’t running, the ground fault disappears. In this admittedly simple case, the search can be as straightforward as having one person with a two-way radio or cell phone watch the HRG relay output while another walks around the factory looking for something that turns on and off in time with the problem.

Often the problem is more subtle. A good approach is to use the data logging capability found in some HRG relays. Using internal software, these HRG relays monitor and trend system ground current over time and can be used to match against equipment running time to locate the ground fault.

**Phase-to-ground-to-phase faults**

One advantage of an HRG system is that it can continue to operate with a ground fault on one phase. What happens if there’s a second ground fault before the first one is corrected? The main overcurrent device should trip, but a phase-to-ground-to-phase fault generally will have more resistance than a phase-to-ground fault. It might not draw enough current to trip the overcurrent device on the affected feeder, or might take a significant length of time to trip it. If the second fault has even greater resistance — an arcing fault, for example — it’s even less likely to cause a rapid trip.

On the other hand, if the second fault draws enough current, it might cause the main breaker to trip and shut down the plant. This is even more likely if the second fault isn’t phase-to-ground but phase-to-phase.

**Ground faults might be lurking in your variable-frequency drive systems**

By Ross George and Mervin Savostianik, Littelfuse, Inc.

Connecting a VFD to a high-resistance grounding system introduces electrical problems because the VFD’s built-in ground fault protection was designed for a solid ground. The fault current might not reach the VFD’s threshold trigger point. The solution is inserting a ground fault relay between the VFD and the grounding system. Ground fault relays also warn of problems before equipment is damaged, an event that would cost much more than the ground fault relay.

**Arc flash hazard Experts Answer Your Questions**

In March of 2011, Patrick Ostrenga, compliance assistance specialist, U.S. Department of Labor-OSHA (www.osha.gov), Dennis Neitzel, C.P.E., director emeritus, AVO Training Institute (www.avotraining.com), and Rick Maday, marketing specialist, Fluke (www.fluke.com), participated in the Plant Services Arc Flash Hazard Webinar and discussed what companies are doing to mitigate the hazard of arc flash. This webinar identifies best practices and demonstrates the technologies companies are using to determine a path toward a safer work environment.

**Arc Flash Webinar Follow-up**

Because of the overwhelming participation in that webinar, the panelists were unable to answer all of the audience questions in the allotted time. But, the link will take you to the answers to these questions, which include:

- Is adoption of NFPA 70E standards an option?
- Can one calculate the blast pressure resistance of an IR window?
- Does an IR window need any periodic maintenance?

There are several solutions. If the subsidiary feeders have their own zero-sequence current transformers and HRG relays, their time response characteristics can be coordinated with that of the main HRG relay and programmed to trip under this condition. A high-resistance grounding system can reduce unnecessary downtime and reduce the likelihood of arc-flash incidents, but it’s not a panacea. It requires both engineering effort to implement and trained maintenance personnel to use and maintain it. Most companies that installed such systems find they’re worth the effort. A more detailed treatment of many of the points in this article can be found in the IEEE paper “Advancements in Technology Create Safer & Smarter HRG Systems,” by the author and Mark S. Scarborough, P.E., of DuPont.

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It’s been facebooked, tweeted, youtubed, linked in and wikipediaed. And yet, despite its global name recognition, an electrical accident in the workplace kills a worker every 28 hours. According to an IEEE study involving more than 120,000 workers, arc flash was the culprit in more than 75% of those accidents. Electrical accidents represent a statistically small percentage of work-related incidents, often occurring even in facilities that have passed formal inspections within recent months, but they’re disproportionately fatal. In a seven-year study conducted by the U.S. Department of Labor’s Bureau of Labor Statistics, 2,576 U.S. workers died and another 32,807 sustained lost-time injuries, losing an average of 13 days away from work, because of electrical shock or burn injuries.

The Internet is brimming with information about arc flash: 364,000 hits on Google, 11.2 million hits on usa.gov and even 445 chilling videos on YouTube. So, why are U.S. workers still getting killed on an almost-daily basis?

**Arc flash: The element of surprise**

The problem is that an arc flash incident can occur, without warning, nearly anywhere high voltage is used.

“There are no crystal balls that are 100% foolproof when it comes to detecting arc flash hazards.”

Incidents can even occur in facilities that have been rigorously inspected, like data centers, manufacturing plants, commercial buildings, convention and hospitality centers, power generation and distribution infrastructure, retail space or other facilities where high levels of electrical power are needed.

But just as law enforcement officials can only attempt to preempt terrorist attacks by increasing surveillance, training those on the front lines on what to look for, investing in protective infrastructure and so on — facility operators haven’t historically been able to overcome the core problem: predicting when and where incidents will occur.

A half-dozen basic obstacles, until very recently, have kept organizations from accurately determining the potential for arc flash exposure within their facilities and educating workers about threats within their work environments.

1. Now you see it, now you don’t: In a typical facility, day-to-day operating conditions are too dynamic to allow for the accurate prediction of arc flash threats. People joke about trying to service an aircraft’s engines while it’s still in flight, but eventually an aircraft lands. In a mission-critical facility, there’s never a risk-free time to conduct service, maintenance or technology upgrade procedures. Because these procedures have to be done on “live” equipment, errors become more likely.

2. While you were reading this, the threat escalated: The gradual aging and deterioration of power cabling, connectors and other components produce a corresponding increase in the potential for arc flash threats. Unfortunately, the rate at which this deterioration can cause arc flash problems is completely unrelated to the
timetable that arc flash studies are scheduled to be conducted, just as few people arrange to have their heart attacks during the same 30-minute window that they are in their physician’s office for an annual checkup.

3. Need to have vs. nice to have: NFPA 70E Article 130.3 requires that an arc flash study be conducted at least every five years or whenever a major modification occurs. These studies are typically complex and usually require that an outside expert be retained. These studies, which increase in cost with the size of the facility include data collection, revision of one-line drawings, short circuit and protective device coordination studies, warning label installation and arc flash training. For all of their good intentions, companies can be slower to spend money on things like inspections until the need for them is plainly evident.

4. It’s an arduous undertaking that never really ends: Greek mythology speaks of Sisyphus, who angered the gods and was given the punishment of spending eternity rolling a boulder to the top of a tall peak, only to have it roll down the other side of the peak each time. Though that’s a little more grueling than conducting an arc flash study, there are similarities: an arc flash study is a painstaking, labor-intensive undertaking and one that’s outdated almost as soon as it’s completed, because of equipment changes, components being handled during maintenance procedures or just plain aging.

5. A false sense of security: In a freshly inspected facility, workers assume that arc flash safety levels are at their highest, which can lull them into believing that it’s safe to lower their guard in terms of safety precautions. This is particularly true in facilities that are “self-inspected.” Self-conducted inspections seldom do the thorough job of experienced experts, setting the stage for potentially catastrophic problems down the road.

6. NIMBY becomes NIMMCF (not in my mission-critical facility): When many people hear a dangerous term such as “arc flash,” some have a difficult time envisioning that their air-conditioned data center or pristine mission-critical facility poses a safety threat. But the threat of arc flash is present anywhere there are high levels of electrical power: workers have been injured and killed using ladders and power-washing equipment, and a frightening story in the medical publication, Anesthesia & Analgesia, describes a nurse electrocuted in an operating room that was fully compliant with current National Fire Protection Association (NFPA) electrical codes.

Next-generation assessment
But within the past 18 months, a new software technology called “power analytics” has emerged that, though developed primarily to ensure power reliability and energy efficiency, has also been proven to provide real-time arc flash assessments.

The term “power analytics” refers to integrated software technologies that help organizations ensure their electrical power infrastructure is optimally designed at the CAD stage, performs precisely as intended in terms of reliability and energy efficiency once in the deployment/diagnostics stage, and operates flawlessly as organizations make real-time transitions between public and on-premise power sources in the grid management stages.

Once in the deployment/diagnostics stage, the diagnostics software maintains an uninterrupted watch over site operations, continually checking components, equipment, and systems and comparing their real-world status to the original CAD model. When deviations are detected, the system performs the calculations necessary to make intelligent recommendations about where arc flash hazards have the potential to emerge and gauges their severity.

Before entering an energized area and beginning work, site personnel simply query the system for a real-time arc flash status. It then responds with an up-to-date recommendation on the appropriate safety procedures and PPE necessary to work in the vicinity. Recommendations are based upon IEEE 1584 and the NFPA 70E standards titled, “IEEE Guide for Performing Arc-Flash Hazard Calculations” and “Standard for Electrical Safety Requirements for Employee Workplaces,” respectively.

For example, when performing repairs to equipment on which a worker could accidentally be exposed to an electrical hazard, power analytics systems can provide specific guidance on gloves, clothing, goggles and helmet the worker should wear to increase safety in the event of an accident. Forewarned about the nature of the threat, workers will be able to proceed with a greater knowledge about specific safety risks they might encounter.

There are no crystal balls that are 100% foolproof when it comes to detecting arc flash hazards. But the new generation of power analytics technologies are the most promising development yet for ensuring that workers are forewarned to the greatest extent possible about how to protect themselves from this all-too-common threat.

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When working on electrical circuits and equipment, your employees who are qualified to perform maintenance on electrical systems have two choices: work on circuits that are electrically safe (locked out and tagged), or work on circuits that remain energized.

OSHA standards and the National Fire Protection Association's (NFPA) 70E, Standard for Electrical Safety in the Workplace, have specific requirements for working on energized electrical systems. In §1910.333(a)(1), OSHA requires that “Live parts to which an employee may be exposed must be deenergized before the employee works on or near them, unless the employer can demonstrate that deenergizing introduces additional or increased hazards or is infeasible due to equipment design or operational limitations.”

According to the Bureau of Labor Statistics, in 2007 there were 305 electrocutions by contact with electrical wiring/equipment. There were another 2,420 injuries that required at least one day away from work.

Locking out and tagging of electrical equipment provides advantages beyond simply shock and arc flash protection. It’s much easier to work on electrical components without bulky personal protective equipment (PPE) such as rubber gloves, leather glove protectors and flame-resistant (FR) clothing. Also, handling tools and test equipment can be difficult when wearing gloves and protectors and can increase the chance of an electrical accident.

If you want your employees to work in the safest electrical work environment possible, they must understand your lockout/tagout program is used for all electrical work. But, if you must consider working on energized circuits, read on.

**Are you ready to cross the line?**

The electrical barrier

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**Establish the barrier**

Working on electrically energized systems isn’t the ideal, but on occasion, it might need to be done. With the right approach and appropriate equipment, the work can be done safely.

OSHA requires employers to post safety signs and tags and erect barricades to prevent or limit nonqualified employee access to exposed energized electrical systems. The NFPA 70E has similar wording for signs, tags, and barricades. The NFPA goes further than OSHA by providing specific shock and arc flash approach boundaries for qualified workers.

When your qualified employees cross over to the energized side of the barrier, are they fully qualified and prepared to be there? You should consider four points to ensure they’re ready to go: knowledge, personal protective equipment, hand tools, and test equipment.

**Know what you’re doing**

Perhaps the best employee protection is knowledge. Before anyone crosses the electrical barrier, they must be trained to do the electrical work. That’s the extent of OSHA’s requirements. However, if they understand your safety program and participated in preparing the electrical work permit, they’ll be best prepared to work on energized electrical equipment.

**Training**

OSHA’s training requirements for qualified employees are in the Safety-Related Work Practice
requirements at §1910.332. These requirements are generalized. Your employees need to know the generalities, but they also need to know specifics of the task.

**Electrical safety program:** Employees must understand and be able to implement your electrical safety program. The program should contain general program procedures that are required for both deenergized and energized electrical work. The best sources to use for your electrical safety program are OSHA’s Safety-Related Work Practices at §1910.331 through §1910.335, and the NFPA 70E.

**Energized electrical work permit:** Your employees also must know the specifics of the current job. OSHA is persistent in pointing out that knowledge of specific safety-related work practices is required. Section 1910.333(a), “Selection and use of work practices,” says:

“Safety-related work practices must be employed to prevent electric shock or other injuries resulting from either direct or indirect electrical contacts, when work is performed near or on equipment or circuits which are or may be energized. The specific safety-related work practices shall be consistent with the nature and extent of the associated electrical hazards.”

More specifically, §1910.333(a)(2) says:

“Energized parts. If the exposed live parts are not deenergized (i.e., for reasons of increased or additional hazards or infeasibility), other safety-related work practices shall be used to protect employees who may be exposed to the electrical hazards involved. Such work practices shall protect employees against contact with energized circuit parts directly with any part of their body or indirectly through some other conductive object. The work practices that are used shall be suitable for the conditions under which the work is to be performed and for the voltage level of the exposed electric conductors or circuit parts.”

Furthermore, §1910.333(c)(2) says that when work is to be performed on energized equipment:

“Only qualified persons may work on electric circuit parts or equipment that have not been deenergized under OSHA’s lockout and tagging procedures. Such persons shall be capable of working safely on energized circuits and shall be capable of working safely on energized circuits and shall be familiar with the proper use of special precautionary techniques, personal protective equipment, insulating and shielding materials, and insulated tools.”

OSHA requires that specific work practices be implemented to provide a safe work environment for the task being done. The practices must be consistent with the nature and extent of the hazards. However, OSHA doesn’t provide a method to consolidate and implement the specific requirements. One way to support safe work conditions is to use an energized electrical work permit. The permit to work on energized electrical systems puts workers, supervisors, and managers on the same page. With the work permit, everyone has knowledge of the task, the appropriate PPE, the specific procedure, and other important requirements. The NFPA 70E provides an example of a comprehensive work permit.

**Put on the PPE**

Once your employees are mentally prepared to cross the electrical barrier, they need to focus on physical protection. Employees must wear personal protective equipment (PPE) selected specifically for the electrical hazards they will encounter. In §1910.335(a), “Use of protective equipment,” OSHA requires that:

“Employees working in areas where there are potential electrical hazards shall be provided with, and shall use, electrical protective equipment that is appropriate for the specific parts of the body to be protected and for the work to be performed.”

Requirements for electrical protective equipment are published in Subpart I, “Personal Protective Equipment.”

**Shock protection:** Unfortunately, Subpart I only provides for rubber protective equipment for electric shock.

**Arc flash/blast protection:** OSHA does discuss arc flash/blast protection in §1910.335(a)(1)(v). The requirement is:

“Employees shall wear protective equipment for the eyes or face wherever there is danger of injury to the eyes or face from electric arcs or flashes or from flying objects resulting from electrical explosion.”

OSHA leaves it up to the employer to determine how to properly protect employees from arc flash/blast hazards. An excerpt from an OSHA Letter of Interpretation (LOI) dated 11/14/2006 says:

“OSHA’s present requirements in Subpart S, Safety-related work practices, are based on NFPA 70E-1983, which did not at that time include specific provisions for flame-resistant (FR) clothing [protective equipment]. Although more recent versions of NFPA 70E have included such body protection provisions, OSHA has not conducted rulemaking proceedings to update Subpart S by adopting comparable provisions specifi-
cally related to the use of FR clothing to protect against arc-flash hazards. OSHA’s existing Subpart S, therefore, does not include a specific requirement for the use of FR clothing.

Determining how to provide arc flash/blast protection can be a daunting task. If you follow the NFPA 70E, you have to determine the incident energy of the circuit. Incident energy is the amount of thermal energy, in calories per centimeter squared (cal/cm²), that will impinge on an employee if they experience an arc flash/blast. The number of variables, such as the distance the employee is from the arc event, short-circuits current, arc current, and clearing times for protective devices make the calculation a task reserved for electrical engineers. However, the 70E also provides tables that can eliminate the need to do an incident energy analysis.

Selecting the appropriate FR-rated clothing isn’t easy, but is necessary to protect employees fully. Face protection, gloves, footwear and head protection appropriate to the electric power involved also are required.

Use insulated tools
Using uninsulated hand tools is one potential cause of an arc flash. They also can provide a direct short to ground. The OSHA requirement at §1910.335(a)(2) for insulated hand tools states:

“When working near exposed energized conductors or circuit parts, each employee shall use insulated tools or handling equipment if the tools or handling equipment might make contact with such conductors or parts. If the insulating capability of insulated tools or handling equipment is subject to damage, the insulating material shall be protected.”

OSHA provides additional information for insulated hand tools in a Letter of Interpretation, dated 5/20/1996, which says, in part:

“Wearing rubber insulating gloves when using an insulated hand tool may be appropriate for a particular work application. For example, if an employee’s hand is exposed to contact with energized parts other than the one being manipulated with the tool, rubber insulating gloves would be required. Other PPE which provides for the electrical safety of the qualified person may also be used.”

The NFPA 70E provides a table to help determine when rubber insulating gloves and insulated and insulating hand tools should be used, depending on the task being performed and the voltages involved.

Know your test equipment
To be fully prepared to “cross the barrier,” your employees must be skilled at using appropriate test equipment. In §1910.334(c), “Test instruments and equipment,” OSHA points out that:

- Only qualified persons can test electrical circuits;
- Test instruments and associated leads, cables, and probes must be visually inspected before being used; and
- Test instruments must be rated for the circuits to be tested.

Using equipment that’s not rated for the circuits to be tested, or not having multimeters set at the appropriate settings, can pose an arc flash/blast hazard. In a 6/22/1998 Letter of Interpretation, OSHA says:

“Whether an employee needs to wear rubber insulating gloves while working with test equipment on energized circuits will depend on several factors including:

1. Whether the probes are designed so that the employee’s hand can slip off the end of the insulated handle, and
2. Whether there are other exposed energized parts that the employee’s hand might contact during testing.

If either of these conditions is present, the use of rubber insulating gloves or other electrical protective equipment would be warranted.”

Get it done
You know your employees are trained to do the job. They’re also familiar with your company’s electrical safety program. However, that’s not enough. Your employees also need to use the knowledge and apply it to the specific task at hand. Implementing an energized electrical work permit system and conducting a job briefing will address the specifics of the job. Going over each step of the work permit with your employees ensures that they’re wearing appropriate personal protective equipment and have the correct insulated hand tools and test instruments. Taking these steps ensures that your employees are ready to work across the electrical barrier.

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