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THE MAGAZINE OF ELECTRICAL DESIGN, CONSTRUCTION AND MAINTENANCE

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An Electrical Accident Waiting to Happen

*Why **recognizing human factors involved** with electrical work and **taking preemptive action** before disaster strikes are so important. Read more on **pg. 24***

IN THIS ISSUE

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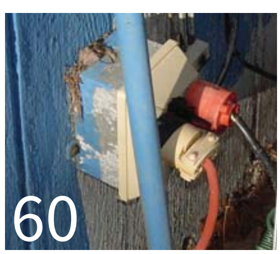

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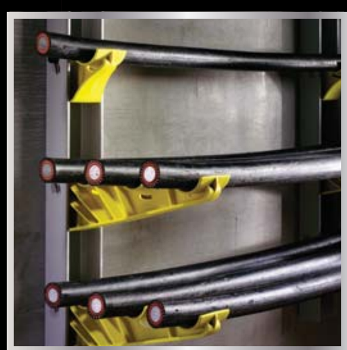

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THE ROLE OF GEN ZERS IN CONSTRUCTION AND THE WORKPLACE

Construction ▶ A new survey finds they can be a pain, but Tom Zind argues Gen Z's quirkiness may find productive outlets in the work world.

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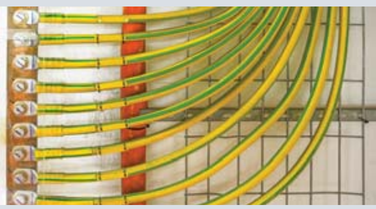

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MONTHLY QUIZ: GROUNDING AND BONDING CONNECTIONS

Quiz ▶ Test your knowledge of proper grounding and bonding connections with this five-question quiz.

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EC&M ASKS VIDEO — HOW TO AVOID A BUS DUCT FAILURE

Video ▶ In this episode of "*EC&M* Asks," Ron Widup, vice chairman, board of directors, and senior advisor of technical services for Shermco Industries, covers bus duct basics.

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May 2023, Vol. 122/No. 5

EC&M®

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Electrical Construction & Maintenance (USPS Permit 499-790 , ISSN 1082-295X print, ISSN 2771-6384 online) is published monthly by Endeavor Business Media, LLC. 1233 Janesville Ave., Fort Atkinson, WI 53538. Periodical postage paid at Fort Atkinson, WI, and additional mailing offices. POSTMASTER: Send address changes to Electrical Construction & Maintenance, PO Box 3257, Northbrook, IL 60065-3257. SUBSCRIPTIONS: Publisher reserves the right to reject non-qualified subscriptions. Subscription prices: U.S. ($68.75 year); Canada/Mexico ($ 112.50); All other countries ($162.50). All subscriptions are payable in U.S. funds. Send subscription inquiries to Electrical Construction & Maintenance, PO Box 3257, Northbrook, IL 60065-3257. Customer service can be reached toll-free at 877-382-9187 or at electricalconstmaint@omeda.com for magazine subscription assistance or questions.

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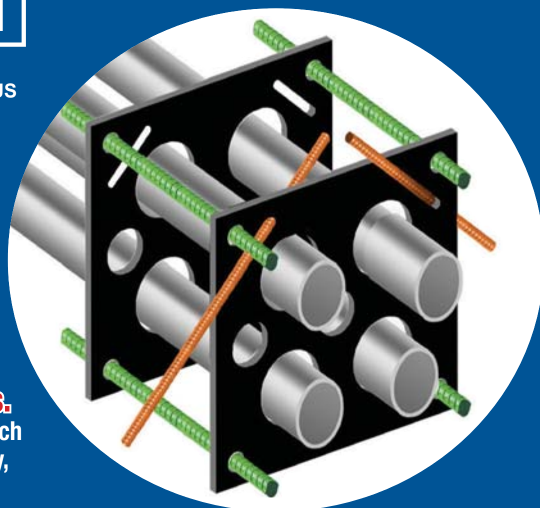

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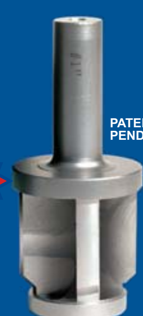

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INDUSTRY VIEWPOINT

Anatomy of an Electrical Accident

By Ellen Parson, Editor-in-Chief

Kicking off this month with Construction Safety Week, it seems only fitting that we dedicate this issue to the topic of electrical safety. Taking this week as an opportunity to recommit to safe work practices, it's a time for electrical professionals to break old habits and strive to improve safety cultures for themselves and their teams — with the ultimate goal of sending every worker home safely each and every day.

When selecting content for this issue, I always include the Top 10 OSHA violations from the previous year (see page 38). Revealed at the National Safety Council Safety Congress and Expo in September, if you review the historic data, it's not surprising this list remains relatively unchanged from year to year. But when you really think about it, the whole thing does have a Groundhog Day feel to it. How is it possible that the same category (fall protection) remains the top citation for the 12th year in a row? Sure, the numbers go up and down slightly from year to year, but there it is again. Obviously, there may be more to this than meets the eye. For one thing, the sheer number of people working at height in the skilled trades is obviously high, creating a more likely scenario that could end in a fall injury or fatality from a ladder, roof, scaffold, aerial work platform, etc. It's also a fairly easy and straightforward violation for an OSHA inspector to identify and cite. Although fall protection did see a decrease of 11 citations from 2021, approximately one-fourth of the *total* violations (5,260) originate from this category!

Lockout/tagout is another repeat offender (No. 6). Holding the same spot as last year, this category saw an increase in violations from 1,670 in 2021 to 1,977 in 2022. Longtime Electrical Consultant Mark Lamendola recently wrote an excellent piece (https://bit.ly/3AZppBO) on lockout/tagout (LOTO) principles that demonstrates why this task is not as simple as it may seem. In the article, he explains how, in its "simplest (and perhaps least effective) form," LOTO consists of the following three steps: 1) Identify the breaker (or fuse) that supplies power to your equipment; 2) Open the breaker; 3) Hang your lock, and tag on that breaker. However, a particular task could easily involve four or five times as many steps, according to Lamendola. Read through the entire article, in which he explains why there is no "one-sequence-fits-all methodology" when it comes to this type of work and walks readers through NFPA 70E's eight principles of LOTO.

Mark's article reminded me of a piece of advice from Randy Barnett, electrical codes program manager for NTT Training and subject matter expert for *EC&M*'s Tech Talk videos as well as *EC&M* Asks Q&As. In the cover story, starting on page 24, Barnett describes why he believes so many of the same types of electrical accidents continue to happen. Despite advancements in safety standards and compliance, fatalities/injuries continue to occur — as evidenced by the familiar Top 10 OSHA list — it's often the human factor (or human behavior) involved with electrical work that leads to disaster. Informative Annex Q from NFPA 70E, which designates human performance as a prerequisite for performing electrical work, outlines risk control methods electrical professionals can put into practice to identify and help reduce behavioral hazards to improve safety.

Flip or scroll through this entire issue for a fantastic lineup of safety-related content, including topics on reducing electric shock (page 8), what makes a qualified electrical worker (page 12), arc flash prevention vs. protection (page 30), arc flash risk management considerations (page 46), and safety product showcase (page 52). Considering the fact that the total number of OSHA citations did increase by more than 1,100 from 2021 to 2022, education will continue to be key in the crusade to improve safety and ensure better outcomes. There's always more we can do.

Ellen Parson

Shedding Shock Risk

Electric shock can have debilitating consequences other than electrocution. How can you reduce the risk?

By Mark Lamendola, Electrical Consultant

An electrocution is an event in which a person dies from receiving an electric shock or series of shocks. In 2020, 126 workers were electrocuted. Many people who receive a shock seem unharmed. That outcome is more common where the shock occurs with a 120V branch circuit than it is with, say, a 480V feeder. But the hazard of electric shock should not be disregarded if it's just a residential lighting circuit or an office receptacle circuit — people can also die from 120V shocks alone.

Electrocution is not the only consequence of electric shock. Many survivors find they are unable to work or their lives are irrevocably damaged in some other way. Some of the consequences include nerve damage, bone fractures, iritis, hypertension, brain damage, and secondary reactions that result in non-electrical injuries.


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SAFEGUARDING OTHERS

You must assess the risk to two parties: the electrician(s) involved in the actual work and everybody else. Let's start with everybody else. Improper wiring is one reason people receive a shock. Some examples:

- **Using the equipment grounding conductor (EGC) as a circuit return path.** This was done at a plant close to the Illinois/Tennessee border. Rather than run a neutral conductor for their lighting, they used the metallic raceway as the neutral. People got shocked all the time because the unbalanced current was flowing in the equipment grounding (bonding) conductor instead of the power wiring.
- **Another bad move is to wire around (instead of through) a GFCI.** This can be done by mixing the load/line conductors or by pigtailing the neutral. Don't wire a GFCI the way you might wire a normal receptacle; wire it the way a GFCI is wired.
- **Bonding neutral and ground on the load side.** This sends undesired current to flow through metallic objects.
- **Failing to bond metallic objects.** The NEC is full of specifics, and you can rewrite them all into one sentence. If a metallic object doesn't carry current, connect it to other metallic, non-current-carrying objects to eliminate dangerous differences of potential.

Unguarded wiring is another hazard. Where something is readily accessible, follow the relevant NEC requirements for safeguarding others against shock or make it no longer readily accessible.

An unsafe electrical condition is a third reason people receive a shock. Some electricians have a misplaced hero mentality, in which they save the company time by needlessly "working hot." This doesn't endanger just the electrician behaving so foolishly; it also puts others at risk. Sometimes adjacent equipment is inadvertently energized, shocking another person.

People have been badly shocked when trying to help a slumped-over coworker whose body, unbeknownst to them, is conducting electricity. Practice lockout/tagout [NFPA 70E, Art. 120] or go through the process of obtaining an Energized Electrical Work Permit [NFPA 70E, Art. 130].

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What actions or inactions can you think of that may endanger other people while you are working? Make a point of assessing the intended work to produce a list of these relevant to that particular job. Make sure to communicate to people in the area what you are doing and what the dangers are. Putting up a red tape barrier for the duration of the work is also not a bad idea.

PROTECTING YOURSELF

Much of the thought about protecting oneself from shock focuses on what steps to take when doing the work whether hot [Art. 130] or not [Art. 120]. But the protection starts before the work does. Consider:

- **Personal protective equipment (PPE)**. Insulating blankets have protected thousands of electrical workers from shock. But how do you know if your insulating blanket still insulates? The standard advice is to inspect it before you use it. The problem there is you arrive at the job without a spare, so then what do you do? Inspect it before putting it away, and you avoid this problem. Look for any kind of chemical or mechanical damage, such as abrasions or tears. Also, look for embedded wire scraps or similar. Other forms of PPE, such as insulating gloves, should also be inspected before being put away. Improperly stored PPE has a far greater chance of failing, so pay attention there.
- **Insulated tools**. The insulation can be damaged by any number of things. You might see mechanical damage in the form of a chunk missing. You might not see damage from electrical "punctures" that degrade the insulation. If you left your insulated screwdriver on a truck dash all day, is that insulation still good? If someone used your insulated pliers to hold a part they sprayed with solvent, those pliers might not be insulated anymore. If an insulated tool has been dropped from elevation, does the insulation still have its integrity? If your insulated tool is of the two-color design, there will be a visual indication the tool is no longer usable as insulated. Purchasing this design means you don't have to guess.
- **Uninsulated tools**. The common wisdom is to use only insulated tools on energized circuits. That means uninsulated tools can be used only on unenergized circuits. But what happens when the worn tip on your uninsulated screwdriver slips and the shaft subsequently makes contact with an energized terminal? Your first line of defense is to inspect your tools periodically and replace any that are not in "like new" condition. Your second line of defense is to assess the work area and consider the proximity of nearby energized circuits. When working inside a typical panel, space is tight and the likelihood of unintentional contact is high. Are you prepared for that?
- **Non-locking ratchets and sockets**. Whether due to cheap design or excessive wear, a ratchet/socket combo may be an accident waiting to happen. Dropping a socket across 2-phase terminals may result in your vaporization, but what if you drop it onto only one energized surface? How do you safely retrieve it? You can see the safety predicament here. Avoid this by using high-quality, industrial-grade ratchets, extensions, and sockets.
- **Fasteners.** Sometimes other people leave a hazard for the next person to deal with. You see evidence of this in screw heads that have a damaged slot (typically from using a worn screwdriver) or in a hex nut that is rounded (often from using pliers or using an adjustable wrench backward). When you see a fastener like this — and there is any energized equipment within arm's reach — treat the situation as a shock hazard. Maybe you can use a properly inspected electrical blanket between your damaged fastener and the energized terminals. Assess what other measures you can take. Then remove the fastener slowly and deliberately, so you don't end up having to use an extractor tool or other extreme measure to remove it. Replace the fastener with a new one, and use the proper tool with the recommended torque to apply the new fastener.

The fastener problem often is not isolated. What if the whole cabinet is full of screws with damaged heads? It is not safe in this condition. Write a work request to have it powered down and repaired. Note also, this poor workmanship is a sign that other problems likely exist.

ELECTRICAL WORK ENVIRONMENT

The fastener problem is part of the electrical work environment. Here are some other parts:

- **Tripping and slipping hazards**. Keep the area free of debris, and properly secure any portable cords. The last thing you want to do is "catch yourself" by grabbing something that's energized. Nor do you need others doing that around you.
- **Poor lighting**. The average age of an electrician has been past the "reading glasses age" for many years now. Older eyes need more light. Ensure the area is well-lit with no shadows, especially inside tight spaces like wiring cabinets. Use portable LED work lamps and/or an LED head strap lamp where permanent lighting cannot be made adequate.
- **Miniature labeling**. Presbyopia is a natural consequence of aging. The lens loses flexibility, and at around age 40, there's a noticeable loss in the ability to focus on small things like print. For most electricians, this issue is not just annoying. It's dangerous. Reading glasses can help only so much. If labels are consistently small, explain to management this is a violation of the 1990 Americans with Disabilities Act (ADA). Printing labels and instructions in Arial 11 or similar is an easy accommodation to make.

WHY NOT IN NFPA 70E?

You may be wondering why none of the preceding information is in NFPA 70E. If you read the standard from a "forest" perspective instead of a "trees" perspective, you see the information is baked in there. For example, practicing the concepts of awareness and self-discipline [Sec. 110.5] would lead you to see much of what this article discussed. In this age of distraction, awareness is an unusual skill to have. But it is key to being safe around electricity — even before you get there. **EC&M**

Mark Lamendola is an electrical consultant based in Merriam, Kan. He can be reached at mark@mindconnection.com.

What Makes a Qualified Electrical Worker

Who is qualified and who isn't when it comes to electrical safety — and what training is required?

By Thomas Sandri, Protec Equipment Resources

Electricity is a powerful force that can cause serious injury and death. When it comes to electrical job tasks, it only takes an instant to turn a momentary mistake into a life-altering event or even fatality. Therefore, qualified electrical workers must understand the hazards presented by exposed energized parts and know how to protect themselves using safe electrical work practices.

NFPA 70E, *Standard for Electrical Safety in the Workplace*, and OSHA 29 CFR 1910.332 define and state the requirements for determining whether an individual is a "qualified person" who has the training necessary to work on exposed energized electrical circuits or parts. So, how do you know whether your workers are qualified? Which workers are unqualified? Who requires training? This article reviews electrical safety training practices, worker assessments, and the requirements for training.

Photo courtesy of Shermco Industries

Qualified electrical workers must understand the hazards presented by exposed energized parts and know how to protect themselves using safe electrical work practices.

EMPLOYER RESPONSIBILITY

Employers must evaluate the workplace for known hazards or hazards that are inherent in the work performed. This discussion will focus on electrical hazards. This has long been an OSHA requirement.

Most companies are familiar with possible shock hazards and are also aware that OSHA requires their qualified workers to be properly trained to work on or near exposed energized electrical circuits or parts. Many companies, however, are unaware that it is also an OSHA requirement to train unqualified electrical personnel on how to recognize and avoid electrical hazards. Unqualified electrical workers — which may include maintenance personnel, painters, cleanup crews, laborers, mechanics, etc., who are not expected to work on exposed energized circuits or parts — must still receive sufficient training to ensure their safety and the safety of others in the workplace.

Qualified electrical workers must understand the hazards presented by exposed energized parts and know how to protect themselves using safe electrical work practices.

The same requirements also apply to the use of outside contractors to work on energized electrical systems. Although contractors may state that their personnel are qualified to work on electrical systems, they may not be qualified from OSHA's standpoint. Simply being an electrician is not enough. The person must receive the proper training in electrical theory, electrical safety, and training in the construction and operation of electrical equipment/installations along with the hazards involved.

When companies ignore these requirements, they do so at their own peril. Failure to comply with OSHA requirements puts workers at risk and can result in fines and exposure to multimillion-dollar lawsuits. Worse yet, they risk the health and safety of their employees by putting them in situations that are beyond their skill level or by exposing them to hazards they are not prepared to handle.

Qualified persons have training in avoiding the electrical hazards of working on or near exposed energized parts.

WHO IS QUALIFIED? WHO IS UNQUALIFIED?

OSHA defines a qualified person as "one who, by possession of a recognized degree, certificate, or professional standing, or who by extensive knowledge, training, and experience, has successfully demonstrated his/her ability to solve or resolve problems relating to the subject matter, the work, or the project."

A qualified worker is not simply someone who is trained and knowledgeable about the tasks he/she will be performing. A qualified worker must also be able to identify and protect oneself from all the hazards associated with the task and be able to demonstrate proficiency.

When the hazard relates to electricity, NFPA 70E expands this definition to "one who has demonstrated skills and knowledge related to the construction and operation of electrical equipment and installations and has received safety training to identify the hazards and reduce the associated risk."

The key points of this definition are how knowledgeable workers are about the equipment and whether they have received safety training. In addition to helping to prevent accidents, both items are critical to designate a person as qualified and to avoid difficulties if OSHA performs an inspection.

Qualified persons have training in avoiding the electrical hazards of working on or near exposed energized parts, whereas unqualified persons have little or no training. Training requirements for qualified persons and unqualified persons are contained in OSHA Section 1910.332 Training.

NFPA 70E defines an unqualified person as simply "a person who is not a qualified person."

There are two kinds of unqualified persons:

- An electrician who does not know the equipment or has not received safety training on the potential hazards involved.
- A non-electrician, such as a general maintenance worker or mechanic, who is not expected to work on live electrical equipment.

These definitions may be straightforward, but they provide only minimal guidance. Companies can get into trouble if they interpret the definitions to mean that they only need to train electricians who work on live circuits. Reviewing NFPA 70E, Art. 110 [General Requirements for Electrical Safety-Related Work Practices] helps clarify who needs to be trained and to what level. This Section covers the general requirements for electrical safety in a plant, and it applies to all workers (qualified as well as unqualified).

Qualified persons have training in avoiding the electrical hazards of working on or near exposed energized parts.

Article 110 outlines electrical safety-related work practices and procedures for people working on or near exposed, energized electrical equipment. The Article states that it is the employer's responsibility to issue safety-related work practices and train employees to implement them.

Work practices set the policy and direct employee activity in broad terms. They can be incorporated into an employer's overall occupational health and safety management system. Work practices should address planning all tasks and protecting employees from hazards. They should also incorporate the electrical safety program, which explains how to put practices to use. For example, work procedures might detail how an employee can maintain electrical equipment or use a specific test instrument.

Principles of work practices should include the following:

- Establishing an electrically safe work condition
- Identifying the hazards and minimizing the risks
- Protecting employees
- Planning all the tasks
- Anticipating unexpected events
- Ensuring employee qualifications and abilities
- Inspecting and maintaining electrical equipment
- Using the correct tools

Section 110.6 outlines training requirements for qualified persons [Sec. 110.6(A)(1)] and unqualified persons [Sec. 110.6(A)(2)]. Let's first look at the requirements for qualified persons.

TRAINING FOR QUALIFIED PERSONS

By default, a qualified person (defined earlier) must be competent. The general definition of "competent" is having sufficient skills, knowledge, or experience for a specific purpose. A worker could be competent to install a light fixture but not qualified under NFPA 70E to troubleshoot that fixture while it is energized.

NFPA 70E Art. 350 is the only place where the term competent is used. That definition, which uses a qualified person as its basis, includes responsibilities for all work activities or safety procedures related to custom or special equipment and is only applicable to Art. 350.

To be considered qualified for a particular task or work assignment, an employee must have internalized the requisite knowledge regarding the electrical system involved as well as the required procedures. The employee must also have received the safety training identified in Sec. 110.6. Exhibit 110.4 in NFPA 70E aids the employer and employees in understanding some of the traits necessary to be considered a minimally qualified person under NFPA 70E depending on the requirements of the specific tasks (for example responding to medical emergencies). For a flowchart of all of the steps, read the online version of this article at https://ecmweb.com/21264810.

A person might be qualified to perform a specific task on specific equipment while being unqualified to perform another task on the same piece of equipment. Qualification also does not necessarily carry over to a similar piece of equipment nor to an identical task on a different piece of equipment. Work practices, procedures, and hazards can vary by the task and the equipment. Qualification is not necessarily based on title, licensure, and so forth. For example, a licensed electrician might not be qualified to work on medium-voltage switchgear. To be qualified, the person must have knowledge and demonstrated skills concerning specific hazards, work practices, and procedural requirements.

Now let's look at NFPA 70E training requirements for unqualified persons.

TRAINING FOR UNQUALIFIED PERSONS

Employees not considered qualified persons must have the knowledge and skills necessary for their safety when interacting with electrical equipment, including during normal operation of the equipment. Following are some of the situations unqualified persons might encounter and must be aware of:

- **General potential hazards.** Understand and recognize potential hazards, including the relationship between exposure to potential electrical hazards and possible bodily injury.
- **Attachment plugs.** Understand how to properly remove an attachment plug from a receptacle.
- **Receptacle plug/caps**. Do not remove attachment plugs (caps) from receptacles when the combination is not load-break-rated.
- **Damaged equipment.** Do not use damaged electrical equipment (fixed or portable), receptacles, or damaged cables, cords, or connectors.
- **Impending failure of equipment.** Be aware of the signs of impending failure of electrical equipment, and do not remain around electrical equipment when there is evidence of impending failure.
- **Tripped circuit breakers.** Do not reset a circuit breaker after an automatic trip. Always notify a qualified person to determine the cause.
- **Flammable materials.** Do not use flammable materials near electrical equipment that can create a spark.
- **Overhead power lines.** Be aware of the proper approach distance from overhead power lines.
- **Alerting techniques.** Be aware of alerting techniques such as safety signs and tags, barricades, and warning attendants. Remain outside the shock protection or arc flash protection boundaries when energized work is being performed.
- **Limited approach shock boundary.** Do not cross the limited approach shock boundary unless advised and continuously escorted by a qualified person.
- **Restricted approach boundary.** Never cross the restricted approach boundary.

All employees should be provided with some basic, common-sense rules for avoiding electrical accidents and injuries. These rules might include the following:

- Do not overload circuits, such as by running multiple appliances from a single outlet.
- Never plug in equipment with a damaged electrical cord or use an extension cord that has damaged insulation.
- Never use electrical equipment, such as a power tool or appliance, if it is sparking, smoking, or otherwise seems to be malfunctioning.
- Keep metal objects (large and small) away from electrical equipment.

OSHA TRAINING REQUIREMENTS

What does OSHA say about training? OSHA Standard 29 CFR 1910.332 clarifies the training requirements for all workers, stating that they apply to workers who face a risk of electric shock that is not reduced to a safe level. OSHA requires the following workers to be trained in electrical safety because they face a higher-than-normal risk of electrical accidents:

- Blue-collar supervisors
- Electrical and electronic engineers

- Electrical and electronic equipment assemblers
- Electrical and electronic technicians
- Electricians
- Industrial machine operators
- Material handling equipment operators
- Mechanics and repairers
- Painters
- Riggers and roustabouts
- Stationary engineers
- Welders

Standard 29 CFR 1910 also calls for the following minimal training for qualified workers:

- Skills and techniques necessary to distinguish exposed live parts from other parts of electric equipment
- Skills and techniques necessary to determine the nominal voltage of exposed live parts
- Clearance distances and corresponding voltages to which they will be exposed

Training can be in the classroom or on the job, with the degree of training being determined by the risk to the employee.

The OSHA standard requires that unqualified persons be trained in and familiar with electrically related safety practices that are necessary for their safety. Finally, OSHA adds the following blanket statement: "Any other employees who may reasonably be expected to face comparable risk of injury due to electric shock or other electrical hazards must also be trained."

This makes it clear that virtually all employees who work anywhere near electrical equipment must be trained.

GETTING STARTED WITH TRAINING

In the past, OSHA has assessed employers more than $34 million in fines (34% were due to electrical hazards). With the stakes so high, it is essential that companies assess their electrical infrastructure and work practices. Quality training and a quality training program are a vital part of an assessment, and unless the instructor has the special expertise required, the company risks falling short of OSHA requirements.

Because of the complexities involved, many companies reach out to a consultant or training firm that can advise or provide employee safety training and continuing audits. At a minimum, training consultation or training firms should meet the following requirements:

- Use instructors trained in OSHA and NFPA, ensuring that course content is up-to-date, practical, and focused on the things OSHA cares about most.
- Use instructors who can draw upon real-world experiences to show trainees how to identify and assess electrical hazards.
- Offer a broad selection of courses (on-site and online) that go beyond theory to what experience proves are best practices.
- Offer courses on-site or at a nearby location or instructor-led virtual classrooms to minimize employee travel and time away from work.
- Provide employees with certification of training completion.

Training topics should include:

- Fundamentals of electricity.
- Standards that govern electrical work and their requirements, including NFPA 70E and others.
- Electrical safety work practices, including lockout/tagout procedures per 29 CFR 1910.
- The difference between qualified and unqualified workers and work limitations for unqualified workers.
- Comprehensive examples of acceptable and unacceptable work practices, including those in wet or damp locations.
- Use of key interlocking systems.
- Identifying type and level of hazards, including electrical shock and arc flash hazards.
- Identifying energized components and conductors.
- Determining nominal circuit and equipment voltages.
- The use of voltage sensors and meters.
- Interpreting hazard warning labels.
- Safe approach distances to exposed electrical conductors.
- Rules for justified energized electrical work and use of energized electrical work permits and job briefings.
- The consequences of poor electrical safety practices to people, equipment, and the environment.
- PPE requirements, including selection, proper use, and maintenance.
- Required and recommended maintenance and safety inspections.
- Grounds and grounding.
- Pertinence of OSHA or other local rules and penalties for non-compliance.

All training should include appropriate job aids and should be integrated with the employer's standard operating procedures and enforcement policies.

CONCLUSION

Qualified electrical workers must understand the hazards presented by exposed energized parts and know how to protect themselves using safe electrical work practices. However, the responsibility for providing the appropriate training to ensure the safety of qualified as well as unqualified workers falls on the employer. EC&M

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Using Data to Increase Job-Site Efficiency

How to minimize obstacles and chaos on the job site

By Dr. Perry Daneshgari, Dr. Heather Moore, MCA, Inc.


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Everyone likes order, predictability, and a stable environment. However, electrical professionals all know that is further from reality in any job site today than you can imagine. You like to have order, but you're not always willing to pay the price for it. MCA Inc.'s Dr. Perry Daneshgari mentions in his lectures to the industry, "Chaos is the norm, and order is the exception." Obstacles are plentiful on construction job sites. The chaos on the job sites is created due to a multitude of degrees of freedom that have to line up for the building to be built.

In addition to the job-site chaos, electricians face obstacles daily in their work environment. The obstacles not only slow down the job progress but also exacerbate the existing chaos due to multi-trade coordination by the general contractor (GC). The truth is that electrical professionals don't have to live with both of them at the same time. If you can manage one, you can help the other one. To manage the obstacle impacts on the project's progress, like anything else, they have to be made visible. In other words, you have to record, report, and take action about the job-site obstacles. To do that, you need to have a reference point that will allow you to know when something has become an obstacle to the job progress.

Since you have to live with chaos as part of the job site, do you have to live with obstacles as well? The answer is yes and no. When you try to bring together manpower, material, tools, information, and the money required to do all that, there will always be some losses; but how much loss you want to accept is a choice. The way to reduce obstacles comes neither through drastic change nor brute force. Rather, it is part of a continuous improvement by studying and responding to the signals sent from job sites using data.

Next time you walk the job site, see if you can find any examples of the following:

1. Absenteeism
2. Trade interference
3. Area not ready/available for work
4. GC/customer-caused shifts in work sequence
5. Material issues

These are a sample of the top five obstacles measured and reported annually by MCA, Inc.'s R&D department from its Short Interval Scheduling® (SIS) process and data across thousands of jobs and millions of hours over the past 20 years and found in "The Secret to Short Interval Scheduling," which appeared in *EC&M*'s May 2009 issue and be read at https://ecmweb.com/20889745. However, without this codification and process in place to measure, analyze, and improve on the obstacles, chaos tends to ensue. Thinking of the same five obstacles above, consider what process you have in place to know:

1. Where are they happening?
2. Why are they happening?
3. How big of an impact do they have?
4. What has been done to resolve them?

If your answer is, "We don't really have a process," you're not alone. Here is how the obstacles are typically reported, according to Dr. Heather Moore's "Exploring Information Generation and Propagation from the Point of Installation on Construction Jobsites: An SNA/ABM Hybrid Approach":

1. Not at all (50%+ of the time)
2. Verbally to a supervisor or project manager
3. Verbally in some type of meeting, with no notes or capture
4. If at all formal, typically via email, text, or a photo taken with a smartphone

Bringing order to the chaos can happen by taking small, simple steps to gather data about obstacles in a way that they can be resolved. These (and more) are part of the SIS process that provides job-site intelligence. If you don't have a process, start with one step at a time. In just a matter of weeks, you'll have more information than emails, texts, and phone calls can provide.

Step 1: Schedule what needs to be done for the day.
Step 2: Score the results (vs. schedule) daily.
Step 3: Categorize the obstacles.
Step 4: Review the results at various levels of the feedback loop.

Each step builds a habit that, on its own and despite the data it generates, will also bring order to the daily work environment and the challenges of trying to just "get the job done" in the midst of all the obstacles and chaos. Scheduling what needs to be done can be the biggest eye opener for your crew leads, sometimes recognizing that they may not know exactly what is needed, if they have what they need to accomplish that schedule, or how to quantify "what done means" (other than when the clock hits 2:30 p.m.). The easiest habit to return to is chaos, just like your laundry piling up, grass growing, or kid's closet after a good spring cleaning. It takes energy to bring order, and the steps above are small ones in the right direction to reduce the obstacles. EC&M

Bringing order to the chaos can happen by taking small, simple steps to gather data about obstacles in a way that they can be resolved.

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EV Installations on the Homefront — Part 1 of 4

Key capacity questions and answers for EV charging applications

By Dan Carnovale, Eaton

Electric vehicle (EV) adoption continues to grow rapidly — with the Edison Electric Institute projecting that nearly 22 million electric vehicles will be on U.S. roads by 2030. Electrical professionals are preparing for the increase in vehicle electrification and the infrastructure needed to support it. Yet not all EV charging applications are created equal. The evolving landscape of EV adoption makes it imperative for electrical professionals tasked with installing EV charging equipment in residential applications to consider important factors such as capacity, safety, configuration and grid interactive infrastructure.

We'll explore some of these factors in the coming months with an article series focused on EV charging installation considerations, beginning with the issue of energy capacity.

THE CAPACITY CONUNDRUM

One of the most critical elements of EV charging now and in the future is capacity — namely, the available energy capacity to meet vehicle charging requirements. EV purchasers will install a charger in their homes, plug in their vehicles, and expect energy to be available to maintain the level of charge needed for their daily travels. Available capacity will play a major role in meeting this expectation, and electrical professionals will have an opportunity to help vehicle owners understand why.

"Capacity is one of the least understood aspects of EV charging, and I believe it is one of the biggest opportunities for education moving forward," said Adam Schmitt, commercial service electrician at Ferry Electric Company in Pittsburgh. "Most of our customers wouldn't think to ask questions about capacity, but as an electrician, it's one of the first things I think about when installing equipment."

Before proceeding with residential installations, contractors should ask the following questions.

WHAT ARE THE VEHICLE'S CHARGING REQUIREMENTS?

The primary type of charger installed in single-family homes is a Level 2 AC charger, which provides 240V of power, ranging from 3.3kW to 19.2kW. With any Level 2 charger (however, charging speed will be limited by and dependent on the vehicle's onboard charger). Other variables that impact charging speed can include extreme weather (batteries won't charge quickly when they are too hot or too cold) as well as the current charge level of the battery (batteries will typically charge faster when they are at a low state of charge).

Energy capacity is one of the most significant consideration for EV charging installations moving forward.

The maximum rate of a charging session is determined by the lower of the capacity of the vehicle or the charging station. This is important to understand, as many vehicle owners may purchase a charger that can deliver 60A or even 100A, but only have the onboard vehicle capacity to charge at 32A. In this instance, electrical professionals should make it clear to homeowners what available capacity will deliver. For example, with

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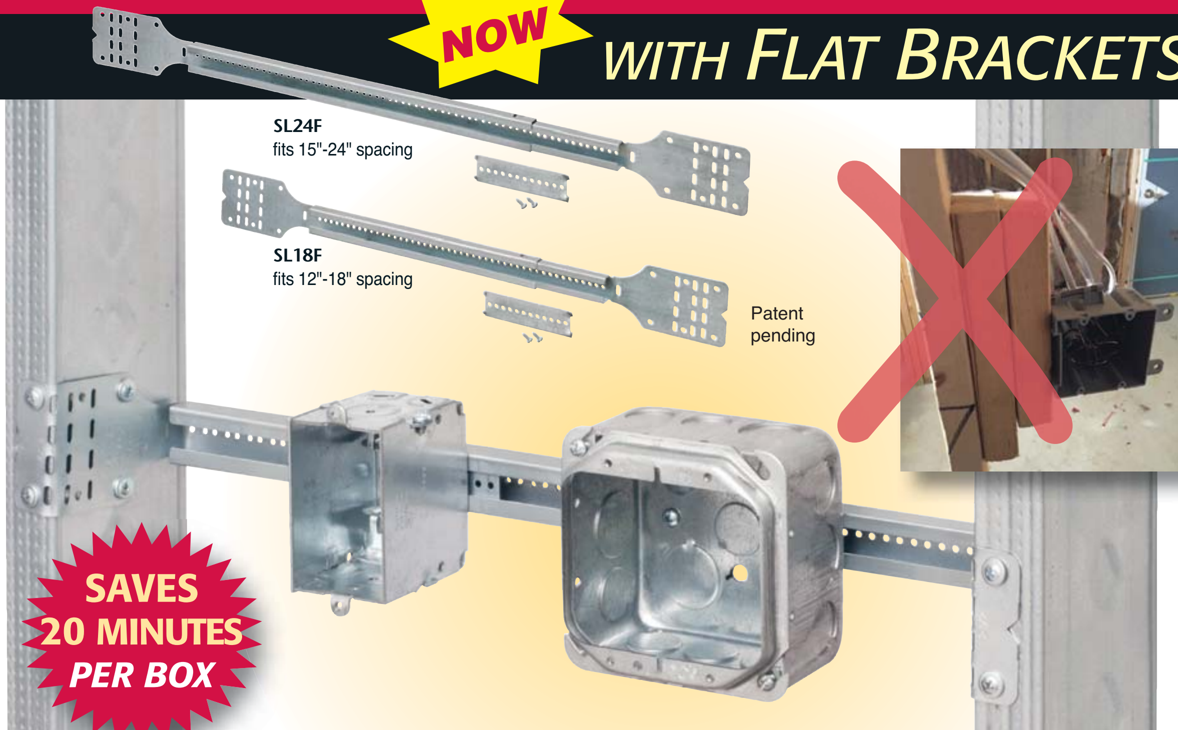

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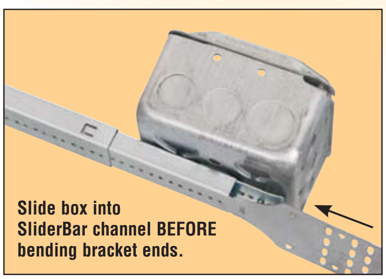

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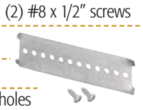

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Electrical professionals will pave the way for homeowners to make intelligent decisions about home energy management as it relates to EV charging.

a 32A charger, the vehicle may require 12 hours of charge time vs. six hours with a 60A charger for the same 80kWh charge.

DOES AVAILABLE ENERGY CAPACITY EXIST AT THE GRID LEVEL TO MEET THESE REQUIREMENTS?

This is a major factor when considering the installation of charging infrastructure because regardless of onboard charging capacity or the capabilities of the infrastructure itself, the ability to charge will only be as good as the availability of the energy supplying it.

Let's say an average American neighborhood has approximately nine 50kVA transformers and six 25kVA transformers supplying a total of 600kVA (9 × 50kVA + 6 × 25kVA) to 100 single-family homes or 6kVA per home. If the typical load for a home on average is 3kVA to 5kVA, then the transformers can easily support the capacity required for those loads. Add EV charging into the mix, however, and those loads will soon grow considerably, especially when multiple vehicles are charging simultaneously on a single transformer. In many neighborhoods, as many as six to eight homes share a single 50kVA transformer with 208A capacity. Add in 30A to 50A per electric vehicle charger in a home, and those homes can easily reach that capacity regardless of the electrical size of the load centers in the home.

This may not seem like a concern today as only 5.8% of U.S. vehicle sales in 2022 were electric. But that number is expected to rise quickly — S&P Global Mobility expects it to jump to 40% by 2030, and more optimistic projections see that number surpassing 50%. Those additional vehicles may quickly put a strain on grid capacity. Fortunately, electrical professionals can start preparing for the increase in demand now.

WHAT CAN BE DONE TO OFFSET CAPACITY CHALLENGES?

By understanding the multitude of capacity challenges that may exist, electrical professionals can take steps to help enable a smooth transition to EV infrastructure.

One step is to add battery energy storage along with solar energy to help supplement available grid capacity. Homeowners may be able to access available government and electric utility incentives to help offset the added cost of solar and storage adoption. Deploying battery storage can help provide an additional source of power when grid capacity is low, particularly for charging at times when usage is highest in the neighborhood.

Another step electrical professionals can take is to advise homeowners to proactively call their electric utilities and ask informed questions about the capacity that exists today and how that may change as more homes in their neighborhoods adopt EVs. More communication between homeowners and electric utilities is always beneficial and can only help electric utilities manage potential concerns while strengthening their customer relationships as EVs continue to transform the grid.

Finally, electrical professionals can lead the way in helping homeowners better manage home energy usage. Effective home energy management will be essential as more homes become electrified. With available tools like smart home apps, smart circuit breakers, and connected wiring devices, homeowners can incorporate vehicle charging equipment into their overall smart energy ecosystem to enable a better charging experience.

CONCLUDING THOUGHTS

The common thread in addressing capacity challenges with EV charging is education. As with any major purchase, an EV is a significant investment, and it's important to equip homeowners with the right information while taking steps to deliver a charging experience that helps them maximize the value of that investment.

The EV revolution is here. Electrical professionals should prepare now in advance to the inevitable wave of residential charging infrastructure installations that will be required to meet demand. Understanding where potential capacity issues exist and working with homeowners to address these challenges will go a long way toward streamlining adoption. EC&M

Dan Carnovale is the director of the Eaton Experience Centers in Pittsburgh and Houston. He is a registered professional engineer in the states of Pennsylvania, California, and Alaska, a certified energy manager (CEM) and a senior member of IEEE. He can be reached at danieljcarnovale@eaton.com.

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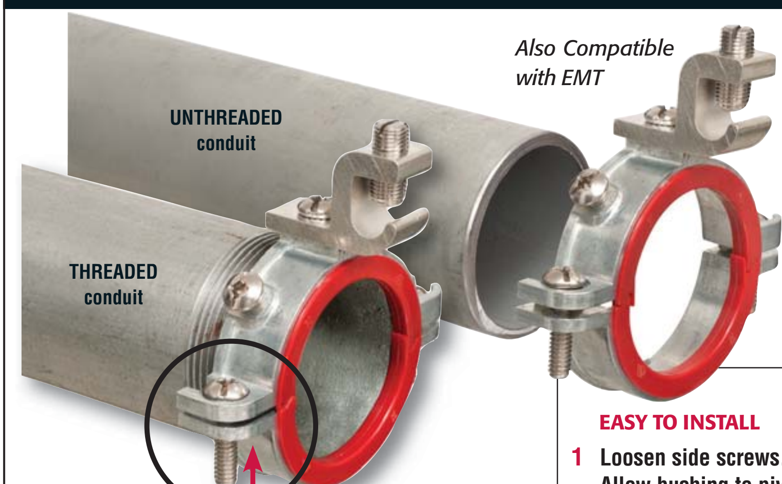

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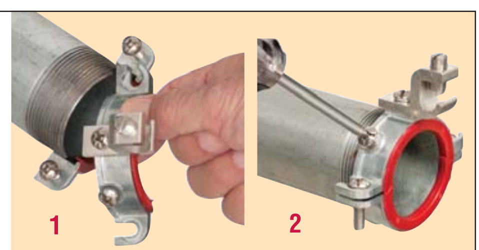

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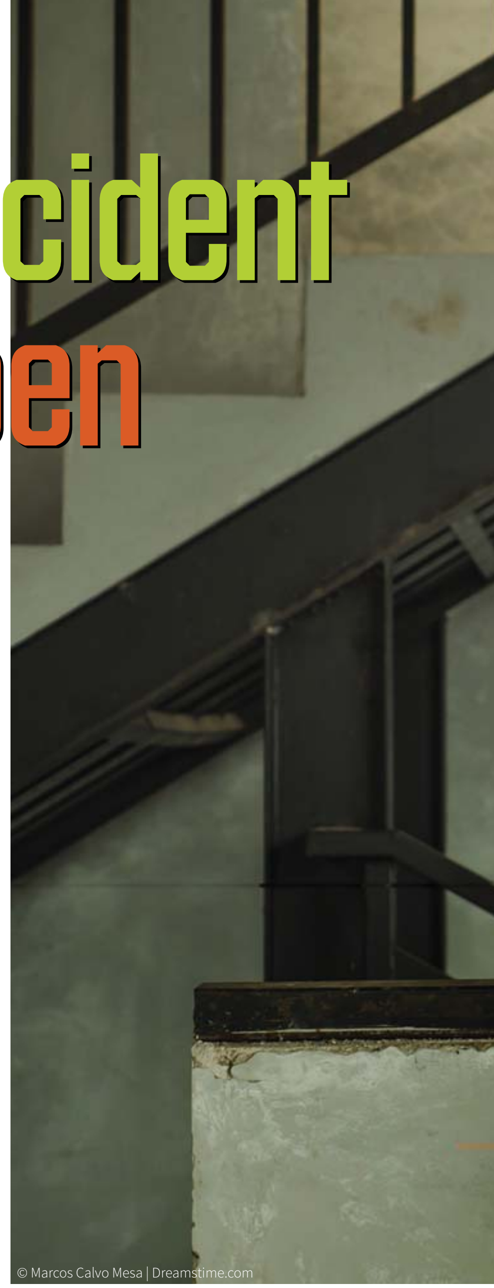
By Randy Barnett, NTT Training

An Electrical Accident Waiting to Happen

Despite advancements in safety standards and compliance, fatalities/injuries continue to occur. Recognize the human factor involved with electrical work, and take preemptive action before disaster strikes.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Electrical safety requirements, personal protective equipment (PPE), and safety by design have grown astronomically over the past 25 years. OSHA's rules for electrical safety date back almost 50 years. NFPA 70E, *Standard for Electrical Safety in the Workplace*, was first published in 1979 and continues to address improvements in technology and safe work practices. The current edition of NFPA 70E provides in-depth information on electrical safety program requirements and responsibilities, defines qualified persons, gives eight steps for creating an electrically safe work condition, details the process of electrical hazard analysis, and gives the rules for establishing protective boundaries and selection/use of electrical PPE. Yet, statistics over the past 10 years do not show significant declines in electrical fatalities and injuries. There were 126 electrical fatalities in 2020 (the most recent data available). There were an additional 2,220 non-fatal electrical injuries resulting in missed days from work and 620 electrical burn injuries (**Fig. 1** on page 25).

Despite increased compliance requirements, better technology, and the development of more practical and comfortable PPE, electrical incidents still happen (**Photo 1** on page 26). Following requirements for safe work practices in NFPA 70E and maintaining equipment in safe operating condition is still not enough. For many years, the American Society of Safety Professionals recognized, analyzed, and incorporated human behavior as part of its standards. The 2018 edition of NFPA 70E introduced Informative Annex Q — Human Performance and Workplace Electrical Safety. The 70E standard requires human performance be considered as a prerequisite to performing electrical work. After all, we are human, and we make mistakes!

ROLE OF HUMAN BEHAVIOR

We typically base decisions on past experiences. If we have not been injured performing a certain task, there is little or no reason to believe we will be injured the next time around. However, circumstances change. Incidents tend to occur because of variables coming together at once. The Domino effect does happen — an injury or even a fatality occurs as the result of a series of unsafe conditions or acts (**Photo 2** on page 26).

An example of such a series of conditions caused fourth-degree burns and potential amputation to a trained and qualified electrical worker's left hand while he was performing routine testing and troubleshooting of a 75VDC safety circuit.

- The worker had performed the task hundreds of times with no injuries or near misses.
- The test equipment to be used was faulty; the 75V power lead to the test set was not properly shrouded where it connected to the test set, and a frayed copper wire protruded from the shroud.
- While adjusting the test unit, the worker's ring finger (on his left hand) came in contact with the frayed copper strand. The initial shock caused an involuntary contraction of the muscles in the left hand, and the hand/arm was drawn tightly to the worker's chest. Smoke was pouring from the worker's hand. Attempts to push the hand away from the chest and pull the fingers open were impossible as the strength of the constricted muscles could not be overcome with the free right hand. Shortly, the worker was able to pull the power lead from his contracted hand with his free right hand.
- Pulling his fingers open on his left hand, the worker found exposed and burnt tissue and bone — a fourth-degree burn. The worker went into physical shock due to the trauma and immense pain.

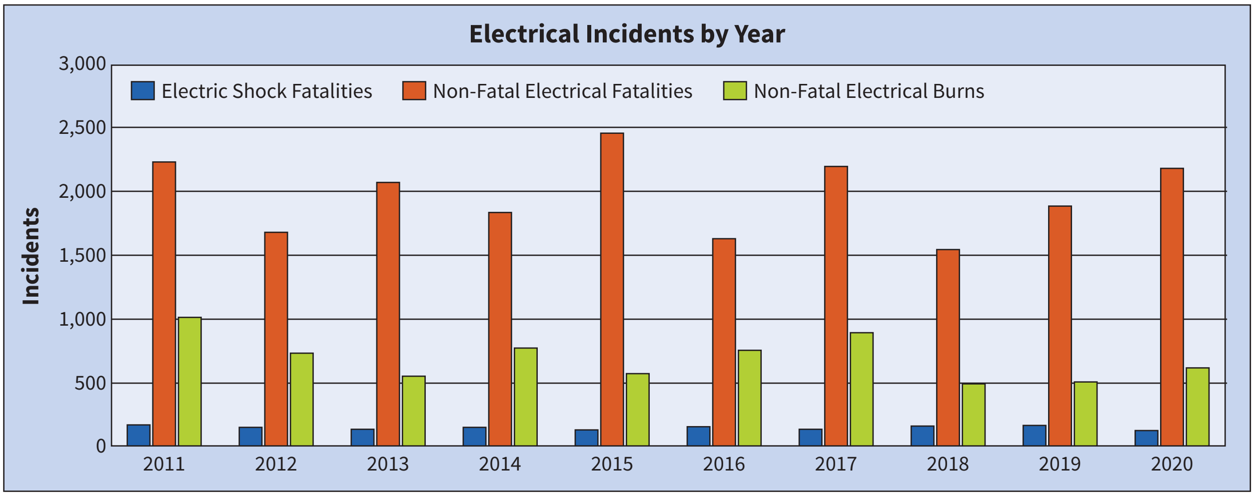

Fig. 1. The latest electrical safety statistics are assembled by the Electrical Safety Foundation International based on data from the Bureau of Labor Statistics. Notice that during this 10-year period, there has been no significant decrease in fatalities from exposure to live parts or non-fatal electrical incidents and a slight decline in electrical burn injuries.

Photo 1. Designing out safety issues plays a large factor in reducing incidents. Notice the heavy-duty design of this cubicle door on arc-resistant switchgear. With all doors closed, latched, and bolted, an arc flash will be safely vented out the top of the switchgear with no danger to a worker standing in front of the equipment.

- Disregarding the available radio on his belt, the worker hid his injury from fellow workers by holding a sweatshirt wrapped around his injured hand and drove himself to a nearby hospital. The worker walked into the emergency and collapsed.
- Preparations were made to amputate the hand the next day. Fortunately, blood flow returned to the hand, and the worker's hand was saved. A considerable lost time accident resulted.

Why would a worker risk using a faulty test set only to suffer a painful and debilitating injury, which was clearly a violation of NFPA 70E? An Informative Annex in 70E provides insight and can help recognize conditions to prevent such incidents. Here are contributing factors identified in the company's original incident report (could it be a domino effect?):

- Electricians were working seven days per week, 12 hours per day to meet production demands.
- The work was outdoors in hot, humid conditions.
- The test set had been identified as faulty, but the safety culture was "just be careful, as a newer model is on order."
- There was no written procedure for the task.
- The worker had just been told he may be "bumped" to another location in a different state. The worker had recently purchased a home for his young family and was anxious to get home and discuss the potential impact of this move with his family.

The answer to prevent the incident was not better technology, more PPE, or additional training. The incident occurred because of human behavior — the result of a culmination of unsafe conditions. Using human performance tools explained in NFPA 70E can identify such dangerous conditions (precursors) and help prevent near misses, injuries, and fatalities.

Photo 2. Installing a remote racking motor on a 480V low-voltage power circuit breaker is a common task that exposes workers to potentially a severe arc flash hazard. The domino effect could come into play: The work area is hot and uncomfortable; the hood makes it hard to breathe, and fog may accumulate on the face shield, making it hard to see. The breaker location on the bottom row is not an easy place to work. Frustration getting the motor to latch on the breaker could abruptly move the breaker enough to allow unmaintained equipment to fail and produce an arc flash. The worker does not have his arc-rated shirt tucked in which should have been addressed in the job briefing. What other pressures, concerns, or physical impairments may be affecting this worker?

Photo 3. Verifying an electrically safe work condition is considered working on live parts because components may still be energized. Most workers experience some uneasiness working on energized circuits as they should. PPE is generally not comfortable to wear. What else could the worker be thinking about during this task?

LOOK FOR THE SIGNS

Recognizing the need to address human performance as a contributing factor to electrical incidents, Informative Annex Q of 70E addresses how the concepts of human behavior can be applied to electrical safety. It recognizes that human error is unavoidable. However, through the observation of items such as attitudes, work environment, and safety culture, precursors to incidents can be identified. That is, by looking out for certain signs and indications, a potential incident can be recognized, actions can be taken, and the incident can be avoided (**Photo 3**).

In the example of the worker who severely injured their hand, several factors culminated to cause the incident. Fatigue, production stress, complacency, heat, and worries about job relocation all came together — along with an improperly

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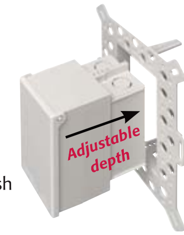

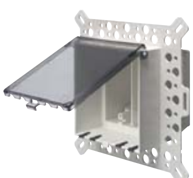

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maintained test set — to create unsafe human behavior. While eliminating all precursors may not be possible in every scenario, eliminating just one or two critical factors may be enough to help the worker stop, rethink their situation, and make a simple testing/troubleshooting task safe. Safety incidents are usually the result of several unsafe acts or conditions coming together at one inopportune time, operating much like a chain reaction (**Fig. 2**).

USING TOOLS TO PREVENT INCIDENTS

Utilizing the human performance tools identified in NFPA 70E could have prevented the injury in the previous example. Following are some of those tools:

- **Conduct a pre-job briefing**. The faulty test set would have been discussed, and corrective action could easily have been taken. The approach boundaries for DC voltages from 50V to 300V would have been identified as a result of the required hazard analysis review, and the worker's awareness would have been increased.
- **Perform a job-site review**. Achieve a realistic understanding of the job at hand. Increased awareness of working alone in a remote area while exposed to electrical hazards may have identified the need for more safety precautions.
- **Verify the use of appropriate procedures**. Human beings are fallible and make errors. Completing a checklist by initialing procedural steps and signing off to verify all steps were completed satisfactorily would have required the worker to "inspect test equipment including power and test leads." The faulty power leads would have been identified and repaired before the worker could sign his name to the procedure.
- **Self-check with verbalization** requires workers to verbalize their intent as they perform each procedural step rather than fumbling to make adjustments.
- **Stop when unsure**. The right to stop work under unsafe conditions is guaranteed by OSHA. Humility is one of the most important human actions when it comes to safety. Stop, rethink the task, and ask for help if uncomfortable. Recognizing the various amounts of stress the worker was under should surface while conducting the job briefing. Taking action on that recognition could have eliminated the incident.

LOOKING AHEAD

The electrical industry will inevitably continue to see advances in safety by design, PPE, test equipment, and other areas of technology. Of course, this is not enough to stop all injuries. Safety standards cannot do it all.

The *National Electrical Code* (NEC) has addressed methods of arc flash mitigation, labeling requirements, and line-side protection of terminals in service panels. NFPA 70B, *Standard for Electrical Equipment Maintenance*, lessens the chance of safety incidents from equipment failures. Safety by design efforts reduce exposure to hazards. Maintenance procedures and field safety audits minimize the chance of human error. Yet electrical workers encounter the stress of error precursors every day. Some can be controlled, but not all can be eliminated. Workers will continue to feel work pressure, be fatigued, take prescription medications, have personal conflicts, and have good and bad concerns outside the workplace. That's why one of the most important areas of advancement in electrical safety must be recognizing the human factors involved in electrical work and taking preventive actions before the fatality, injury, or burn can occur. **EC&M**

Randy Barnett is the Electrical Codes Program Manager for NTT Training. He can be reached at electricrb@yahoo.com.

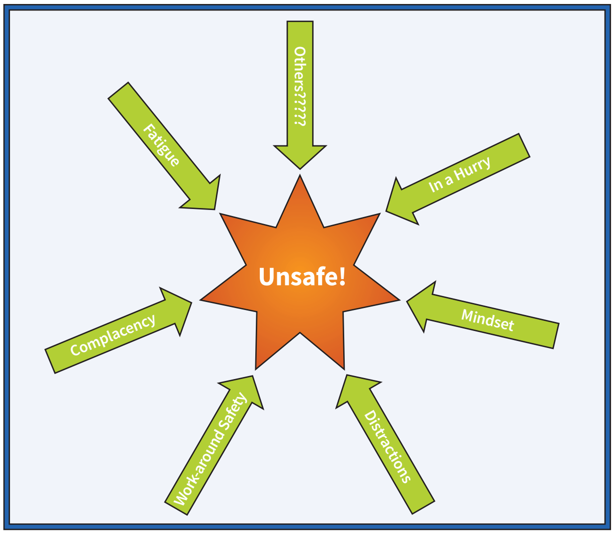

Fig. 2. Incidents are typically caused by a combination of issues. Removing any one of several potential issues may help prevent an incident. Proper job planning and job briefings should identify and eliminate hazards.

Five Tips to Improve Electrical Safety

- **Celebrate near misses**. Learn from mistakes. Investigate incidents, including near misses. Learning from past mistakes will always improve safety.
- **Incorporate safety by design**. Remove the human fallibility factor when possible.
- **Implement an "electrical safety committee" that reports to the overall safety committee**. Electrical workers have specific knowledge others do not possess. They will see electrical hazards others will not and know how to mitigate them.
- **Address human performance on the job**. Ensure your job safety plans and job briefing forms have lines to ensure human performance error precursors found in Informative Annex Q of NFPA 70E are addressed.
- **Safety meetings must address people**. Do workers feel comfortable discussing safety concerns? Are their concerns sincerely addressed? Are workers comfortable using and discussing the benefits of the employee assistance program?

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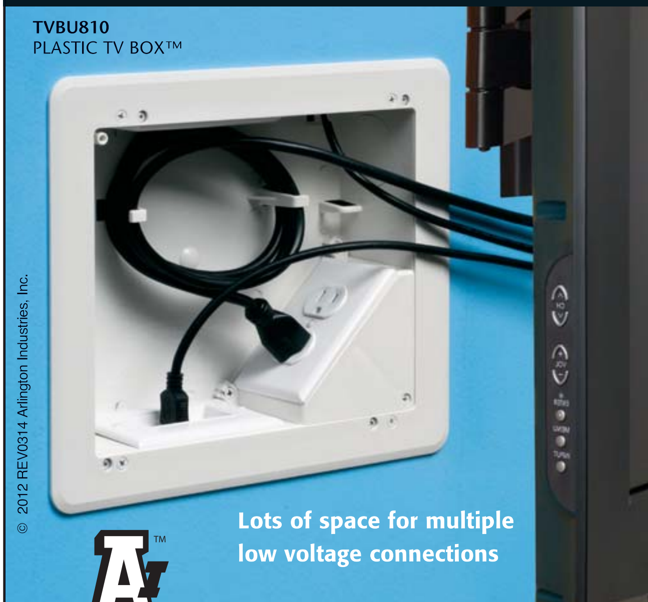

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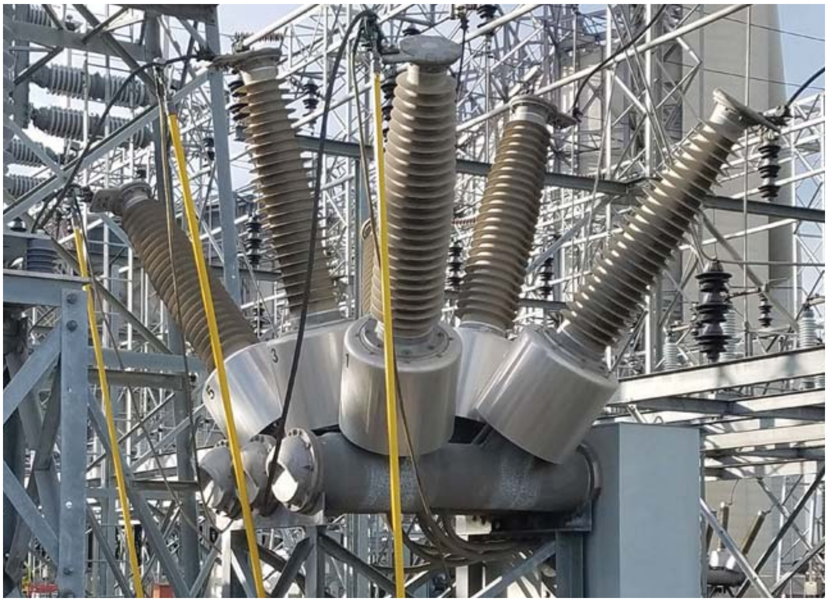
Arc Flash Hazards: Prevention vs. Protection

Why electrical professionals must consider potential hazards before the work starts to ensure safety



Grounding is an important part of putting medium- and high-voltage electrical equipment in an electrically safe work condition.

By Tommy Northcott, Jacobs Technology, Inc.

Have you ever found yourself faced with an electrical task that involves a potential arc flash hazard, and the first question you ask is: "What level of personal protective equipment (PPE) do I need to wear?" If your answer is yes, then I would argue you're likely in the majority.

I get asked far more questions about proper levels of PPE (both arc flash and shock) than any other electrical safety-related topic combined. And to be honest, at first, I was thankful — because the fact that so many people are inquiring about proper PPE shows a positive shift in safety in the electrical industry culture over the past few decades. However, over the years, it has become clear to me that we need to continue to drive this cultural shift even further. My goal is to get electrical workers to consider the PPE question as the last question in a series of other important considerations.

Anyone who has taught an NFPA 70E comprehensive electrical safety course knows that someone in the class almost always comments on how many requirements there are when performing a task that might involve an electrical hazard. Initially, people believe all the meetings, paperwork, discussions, and precautions seem to be excessive. I personally believe (and try to teach others) that once you switch your

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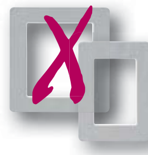

These cost-saving boxes don't include gaskets, but when caulked around the NM cable during installation, they **meet the requirements of NEMA 0S-4**. And help meet International Energy Conservation Codes (IECC), and other codes *where required.*

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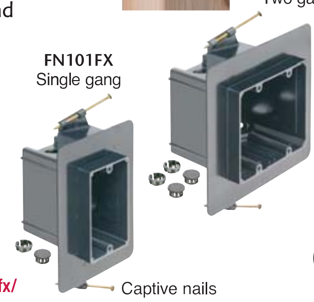

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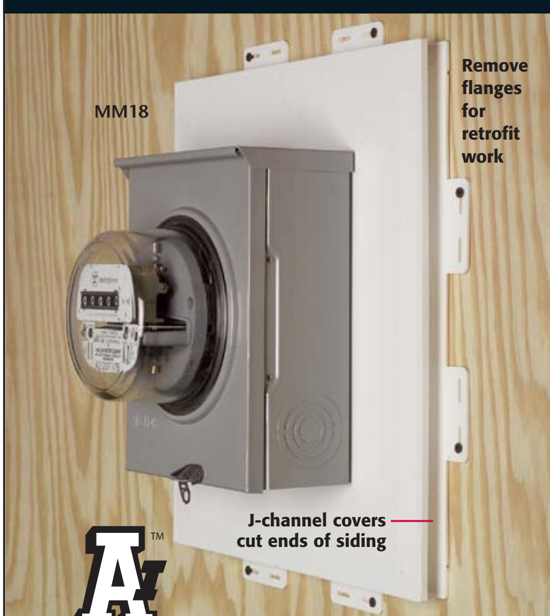

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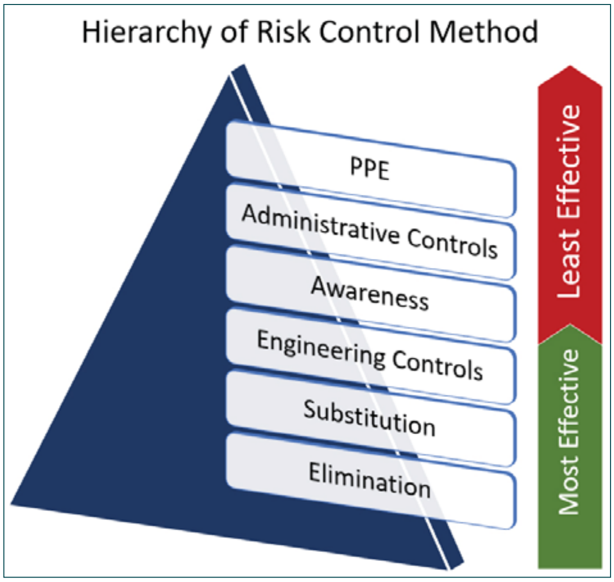
Arlington® 800/233-4717 • www.aifittings.com baseline from *protection* from the hazard to *prevention*, then all those steps start to make sense. Immediately jumping to protect yourself from the hazard with PPE is essentially assuming it will happen no matter what, prompting you to shield yourself from the hazard's effects. What NFPA 70E is really striving to achieve is preventing that electrical energy from ever manifesting itself into a hazardous situation in the first place.

For example, NPFA 70E made its bias toward prevention clear in the 2018 revision by explicitly stating that the priority must be elimination of the hazard (Sec. 110.1). This revision also emphasized the need to use the hierarchy of risk control method by moving this requirement from an informational note into the text of the standard. The hierarchy of risk control method provides an assessment process that requires first considering the most effective mitigation (elimination) before moving through the six-step process, which ends with the least effective method (PPE) as noted in Sec. 110.5(H)(3). Although arguably the most important step in any hazard risk assessment, it's definitely not the first one. To even get to the risk assessment step, you must first recognize there is potential hazard. All too often, this step gets overlooked when someone is involved in an electrical hazard incident. That reality is a driving force behind why some of the steps that seem excessive come into play.

An electrical hazard cannot be mitigated unless the worker first recognizes the potential for that hazard. Therefore, electrical workers cannot be assigned a job and then simply jump in and start executing the work. Every job must first be evaluated to determine if there is a potential for an electrical hazard. If there is, a qualified electrical worker (QEW) must work through several steps prior to starting the actual work. A QEW must perform an arc flash and shock risk assessment to determine both the likelihood of a hazardous event as well as the potential severity of the hazard (should it occur). The QEW must then complete a job safety plan and perform a job briefing with anyone who will be working on this job. On the surface, this may not seem excessive until these first few steps are unpacked to reveal the expectations within each one.

ARC FLASH RISK ASSESSMENT

Any work that includes the potential for exposure to an electrical hazard requires that an arc flash risk assessment be performed to identify any arc flash hazards, determine the likelihood of occurrence and the potential severity, and then determine if any protective measures are required to protect the workers. Part of the definition of a QEW is someone who has the skills and knowledge to recognize potential electrical hazards. This only comes from a combination of training and experience. For arc flash, any easy first step is to consider if the task involves exposed conductors or circuit parts that are not in an electrically safe work condition or if the task is starting or stopping current flow. If either of these two conditions will exist, then the QEW must determine if there is enough energy to create and sustain an arc. In lieu of having had an arc flash incident energy assessment performed on the equipment that provides arc flash energy levels, the NFPA 70E contains tables that can assist the QEW in this part of the assessment. If there is a likelihood of an arc flash, the QEW must then determine



The Hierarchy of Risk Control Method is used for every electrical task to determine the most effective means for mitigating electrical hazards.

and document what mitigating actions are required using the hierarchy of risk control method.

HIERARCHY OF RISK CONTROL METHOD

The hierarchy of risk control method is a system used to minimize or eliminate exposure to electrical hazards. Variations of this system are widely accepted and promoted by numerous safety organizations — it was officially adopted specifically for electrical hazards by the NFPA 70E in the 2018 revision. The six levels of the hierarchy of risk control methods, in order from most effective to least effective, are: elimination, substitution, engineering controls, awareness, administrative controls, and PPE. This method should be applied starting with the conceptual design of electrical systems all the way through the entire lifecycle of the system. For the purposes of this discussion, the focus is on the application of safe work practices on installed systems.

Elimination

Elimination is the physical removal of the hazard, which is the most effective hazard control. This is directly related to the NFPA 70E requirement to only work on equipment that is in an electrically safe work condition unless the task is infeasible in this condition. When a conductor is in an electrically safe work condition, there is no exposure to electrical energy. Therefore, the arc flash hazard has been eliminated. However, keep in mind that the action of opening a switch or circuit breaker as one of the steps in creating an electrically safe work condition could pose a potential arc flash hazard.

Substitution

The second most effective risk control method (substitution) involves replacing something that produces a hazard with something that does not produce a hazard or produces a lesser

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Labels that clearly warn workers of hazards inside equipment are an example of the Awareness Risk Control Method.

hazard. Here's a common example: A 480VAC main circuit breaker directly downstream of a transformer is a common location for high arc flash energy levels. The medium-voltage switch on the upstream side of that transformer often has a lower arc flash energy level. Opening the medium-voltage switch substitutes the high energy exposure at the breaker for a lower energy exposure at the switch.

Engineering controls
Engineering controls do not eliminate the hazard but rather isolate the QEW from the hazard. Installing covers over otherwise exposed conductors inside an electrical enclosure to reduce the likelihood of initiating an arcing fault while the enclosure doors are open is an example of engineering controls.

Awareness
Awareness is a method to alert workers of potential electrical hazards inside enclosures, vaults, or any other area. Warning and danger signs are a commonly used form of awareness.

Administrative controls
Administrative controls are methods of changing the way people work. Examples of administrative controls include procedure changes, policy changes, and employee training. Administrative controls do not remove the hazard but are intended to limit or prevent worker exposure to the hazards.

PPE
PPE is the last line of defense and does not eliminate or mitigate the hazard. Instead, it protects the worker from the result of the hazard. When an arc flash event occurs, if QEWs are wearing the appropriate level of arc flash PPE, they should not suffer any burns from the arc flash event.

The intent of the hierarchy of risk control method is to choose the highest-level method or combination of methods to mitigate or minimize the exposure and effects of the arc flash hazard. As shown in this explanation of the method, PPE is the last thing to be considered in this process. There are many other preferred options that can be implemented before jumping into arc flash PPE and working the job. Eliminating the hazard to begin with is always the priority. The shock risk assessment and application of the hierarchy of risk control method is identical to the arc flash process with a focus on the potential for shock hazard.

ELECTRICALLY SAFE WORK CONDITION

An electrically safe work condition is a condition where an electrical conductor or circuit part has been placed into a condition of no potential for electrical hazards for personnel safety. There are eight steps required before equipment can be considered to be in an electrically safe work condition. The QEW must first determine all the sources of electrical energy. The equipment must then be disconnected from all the sources. Whenever possible, the QEW must visually verify all disconnecting devices have been fully opened. Any electrical stored energy must be released, and any mechanical energy must be released or blocked. The disconnect devises must then be locked/tagged in accordance with a documented and established procedure. A QEW must then verify the absence of voltage using the live-dead-live method. Finally, when appropriately sized grounds can feasibly be applied to the conductor or circuit part, the grounds must be applied. Once these steps are complete, the electrical hazards have been effectively eliminated. Keep in mind that completing these steps poses potential for electrical hazards, and appropriate safety measures must be used to safeguard the QEW.

DOCUMENTATION

Prior to performing a job with potential exposure to an electrical hazard, there are several required documents to consider. The QEW must have a documented safety plan. This comes in many variations and can be called a Job Safety Analysis (JSA), Job Hazard Analysis (JHA), Safe Plan of Action (SPA), or any number of other similar titles. This formally documents the various risk assessments, mitigation methods, PPE, boundaries, and any other methods to ensure the safety of the workers. If the Restricted Approach Boundary (RAB) is to be crossed for anything other than non-intrusive diagnostic testing, this may also require an Energized Electrical Work Permit (EEWP). If a complex lockout/tagout (LOTO) is required, then there will be a documented LOTO procedure. Medium- and high-voltage switching requires a documented switching procedure. All of these documentation requirements before executing the work are designed to have the QEW think through the steps of the task, identify potential exposure to electrical hazards, and develop a plan for protection from those hazards.

EXAMPLE OF A REAL-WORLD APPLICATION

After providing electrical safety training for an organization comprised of electricians and electrical engineers, the

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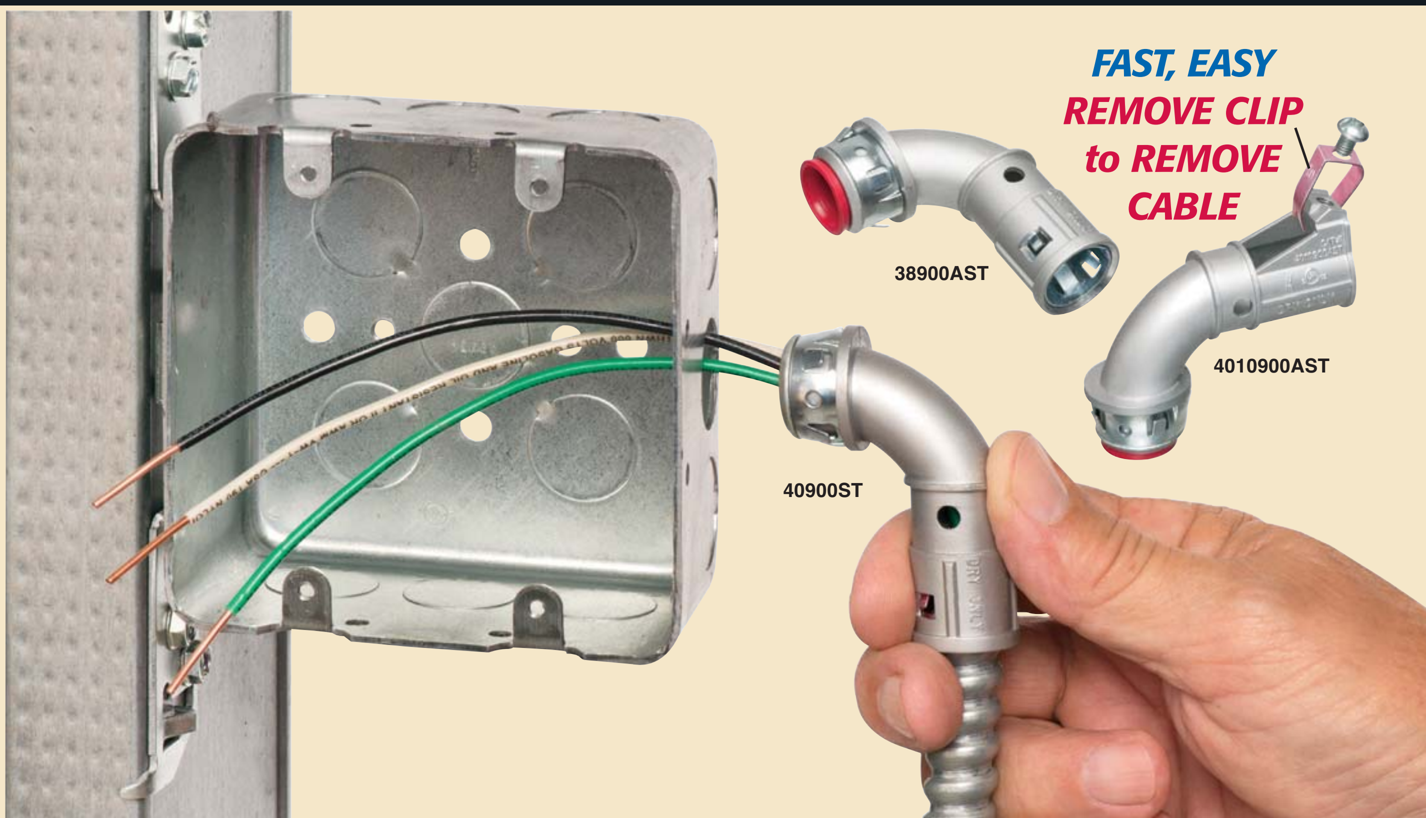

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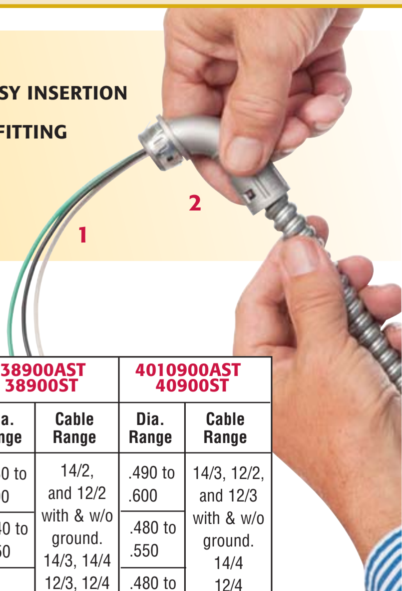

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SAVE 1 MINUTE *per connector over 2-screw styles*

90° SNAP2IT® CABLE RANGES

CABLE TYPE	38900AST 38900ST		4010900AST 40900ST	
	Dia. Range	Cable Range	Dia. Range	Cable Range
MC/HCF/AC Steel & Aluminum	.380 to .600	14/2, and 12/2 with & w/o ground. 14/3, 14/4 12/3, 12/4 10/2	.490 to .600	14/3, 12/2, and 12/3 with & w/o ground. 14/4 12/4 10/2
MCI-A Steel & Aluminum	.440 to .550		.480 to .550	
AC90, ACG90			.480 to .550	
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electricians stated that they all needed their own set of insulated tools. The shop supervisor, who also attended the training, asked me if I thought he should provide insulated tools for all his electricians. In my opinion, providing all the electrical workers with the insulated tools would inadvertently communicate to the workers that the supervisor expects them to work on energized conductors.

On the contrary, the best recommendation is to have one or more sets of insulated tools in locked toolboxes. If the insulated tools are needed, an Energized Electrical Work Permit (EEWP) is also required. Upon successful approval of the EEWP, the electrical worker can be provided with a key for the insulated tools to safely perform the task. However, many times, the process of working through an EEWP will result in finding a means to mitigate the hazard and performing the task in an electrically safe work condition. Leaders of QEWs should always look for ways to encourage and enable their QEWs to find innovative methods for executing their jobs in the safest conditions feasible.

WHY IS THIS ALL NECESSARY?

When it comes to electrical safety requirements in the workplace, it's easy to feel like there is an excessive number of steps to complete before a QEW ever begins the actual work. However, the requirements are on par with the nature of the hazard. The reality is that when an arc flash event or shock hazard initiates, there is no time to get out of the way at that moment to protect yourself. QEWs must consider the potential hazards before the work starts and already have the appropriate safeguards and mitigations in place to ensure their safety during the job. The intent of the NFPA 70E is to prevent exposure to electrical hazards as a priority over protecting workers from the hazards. The next time you find yourself asking what PPE you need to use, let that be a reminder to take a step back and use the requirements in the NFPA 70E to help plan the job to be safely executed. The requirements discussed here did not cover all of the requirements in NFPA 70E but were used as samples to explain the intent of having hazard prevention as a priority over hazard protection. **EC&M**

Tommy serves as a senior power engineer and branch manager for Jacobs Technology Inc. With more than 20 years in the electrical industry as an electrical engineer, project manager, arc flash program manager, electrical safety trainer, and utility manager, he brings a broad range of experience to his passion for electrical safety. He is also an NFPA 70E compliance subject matter expert, a principal member of the NFPA 70B Committee, electrical safety trainer, certified maintenance and reliability professional, and certified reliability leader. He can be reached at Thomas.Northcott@Jacobs.com.

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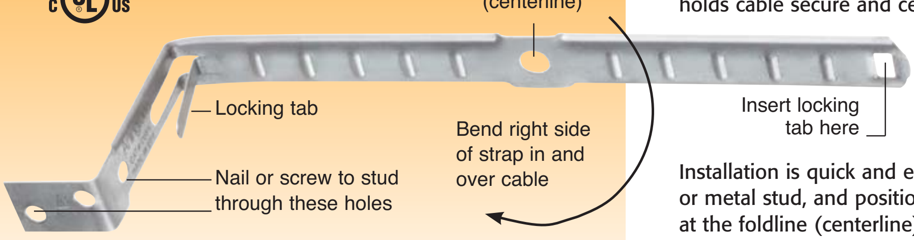

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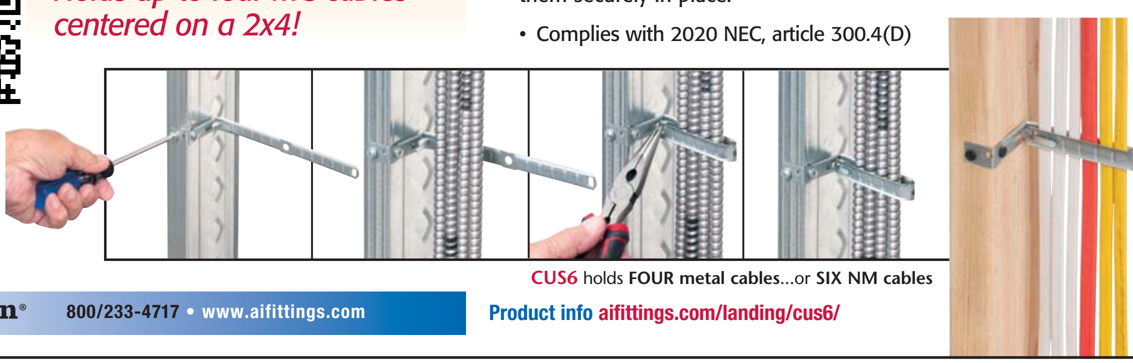
- Complies with 2020 NEC, article 300.4(D)



CUS6 holds **FOUR metal cables**...or **SIX NM cables**

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Top 10 **OSHA Violations** of 2022

See this year's updated rankings.

The U.S. Occupational Safety and Health Administration's (OSHA) Acting Director of OSHA's Directorate of Enforcement Programs Patrick Kapust presented OSHA's Top 10 most frequently cited safety standards for 2022. Announced on Sept. 20, 2022 during the 2022 National Safety Council (NSC) Safety Congress & Expo, the list remains relatively unchanged compared to past years.

For the 12th year in a row, Fall Protection — General Requirements secured the No. 1 position. Other notable changes to the 2022 listing include Hazard Communication jumping to No. 2, three spots higher than its 2021 ranking (No. 5). Powered Industrial Trucks also rose two spots to No. 7 from No. 9 in the previous year.

While reviewing the overall data from 2021, it's also important to note that the overall number of citations from the Top 10 did increase from 2021 to 2022 by more than 1,100.

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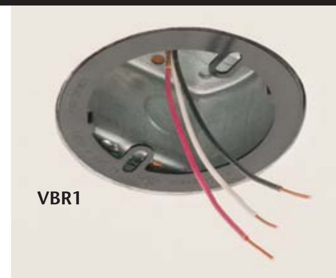

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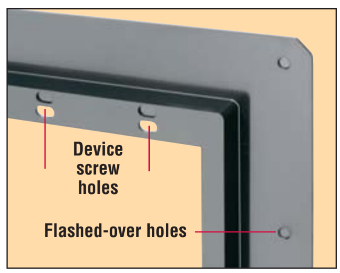

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No. 1: Fall Protection — General Requirements

For the 12th consecutive year, **Fall Protection — General Requirements** held its spot as the most frequently cited violation. It is associated with Standard 1926.501, setting requirements for employers to provide fall protection systems for their employees. This category saw a decrease of only 11 citations from 2021, with a total of **5,260** violations in 2022 — approximately ¼ of the total Top 10 violations in 2022. However, the 2022 total marks the lowest number of citations in a single year for this category since 2014, according to past data.

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No. 2: Hazard Communication

This category saw the most significant change from 2021 to 2022 compared to other violations on this year's Top 10 list. **Hazard Communication** (No. 2) had **2,424** violations in 2022, bringing it back to its 2020 ranking. In 2021, this category moved its way down to No. 5 on this list with 1,939 total citations — nearly 500 less than its most recent 2022 total. Its requirements, based on 1910.1200, have been updated to align with the UN Globally Harmonized System of Classification and Labeling of Chemicals (GHS), Revision 3. The standards dictate that the hazards of all chemicals produced or imported are classified, and the information concerning them is communicated to employers and their employees.

No. 3: Respiratory Protection

Respiratory Protection moved positions slightly from 2021 to 2022 — down one to No. 3 — and it also saw a significant drop in the number of total citations: **2,185** in 2022 compared to 2,521 in 2021. It is associated with 1910.134, which directs employers on establishing/maintaining a respiratory protection program. Its primary goal is to prevent workers from atmospheric contamination of harmful dusts, fogs, fumes, mists, gases, smokes, sprays, or vapors. It applies to the General Industry (part 1910), Shipyards (part 1915), Marine Terminals (part 1917), Longshoring (part 1918), and Construction (part 1926).

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STEEL BOX WITH BRASS COVER

LISTED SINGLE GANG FLOOR BOX KITS

CONVENIENT, FLUSH-TO-THE-FLOOR RECEPTACLE INSTALLATION

Arlington's **STEEL FLOOR BOX KITS** give installers a low cost, *convenient* way to install a receptacle *in a new or existing floor.*

Our Listed Single Gang Steel Floor Boxes deliver easy, flush-to-the-floor installation.

- Brass covers hide miscut flooring; gaskets prevent water intrusion; flip lids protect the box when it's not in use.
- Single gang brass and nickel-plated **Brass Covers** fit our boxes *and other manufacturers' single gang boxes.*

  Covers also sold separately.

FLB5331MB
Single gang
steel box kit w brass cover

for NEW or existing floors

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IN BOX® RECESSED COVER KITS

INSTALLS INSIDE 4.5" CONCRETE BOXES

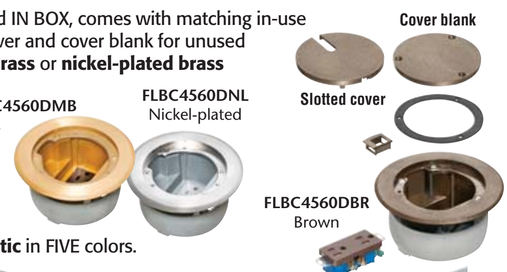
NEW!

c UL us

Arlington's **IN BOX® Recessed Cover Kits** are the neat way to install a receptacle in an installed 4.5" concrete floor box, *including our FLBC4500 or FLBC4502 boxes.*

IN BOX covers install fast, *inside the can* reducing trip hazards caused by plugs sticking out of the box. They look great. And, you can have power and low voltage in the *same* box.

Assembled IN BOX, comes with matching in-use slotted cover and cover blank for unused boxes in **brass** or **nickel-plated brass**



...and **plastic** in FIVE colors.

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Product info aifittings.com/landing/inbox-cover-kits/

No. 4: Ladders

This category dropped one position from 2021, coming in at No. 4 for 2022, with a total of **2,143** citations. However, **Ladders** still saw 125 more citations than the previous year when it held the No. 3 position, which had 2,018 total associated violations within this category. Most associated with 1926.1053, this standard covers all general requirements for ladders (including job-made ones) at various types of job sites and locations. It provides the designated loads required for each type of ladder to support.

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No. 5: Scaffolding

Scaffolding dropped one spot from No. 4 in 2021 to No. 5 in 2022. However, it did see a slight increase in the number of violations. In 2023, there were **2,058** citations, which is 200 more than the previous year. This category refers to standard 1926.451, which lays the groundwork for scaffolding-related safety measures. In most scenarios, each scaffold and scaffold component must be able to support (without fail) its own weight and up to four times the maximum intended load applied to it. This standard excludes aerial lifts.

No. 6: Lockout/Tagout

Lockout/Tagout maintained its No. 6 ranking for the third year in a row, but it did see an increase in violations from 1,670 in 2021 to **1,977** in 2022. This category follows the requirements of 1910.147, which coves the servicing and maintenance of machines and equipment in which the unexpected energization or start-up of the machines or equipment (or releases of stored energy) could harm employees. In addition, it establishes minimum performance requirements for the control of such hazardous energy.

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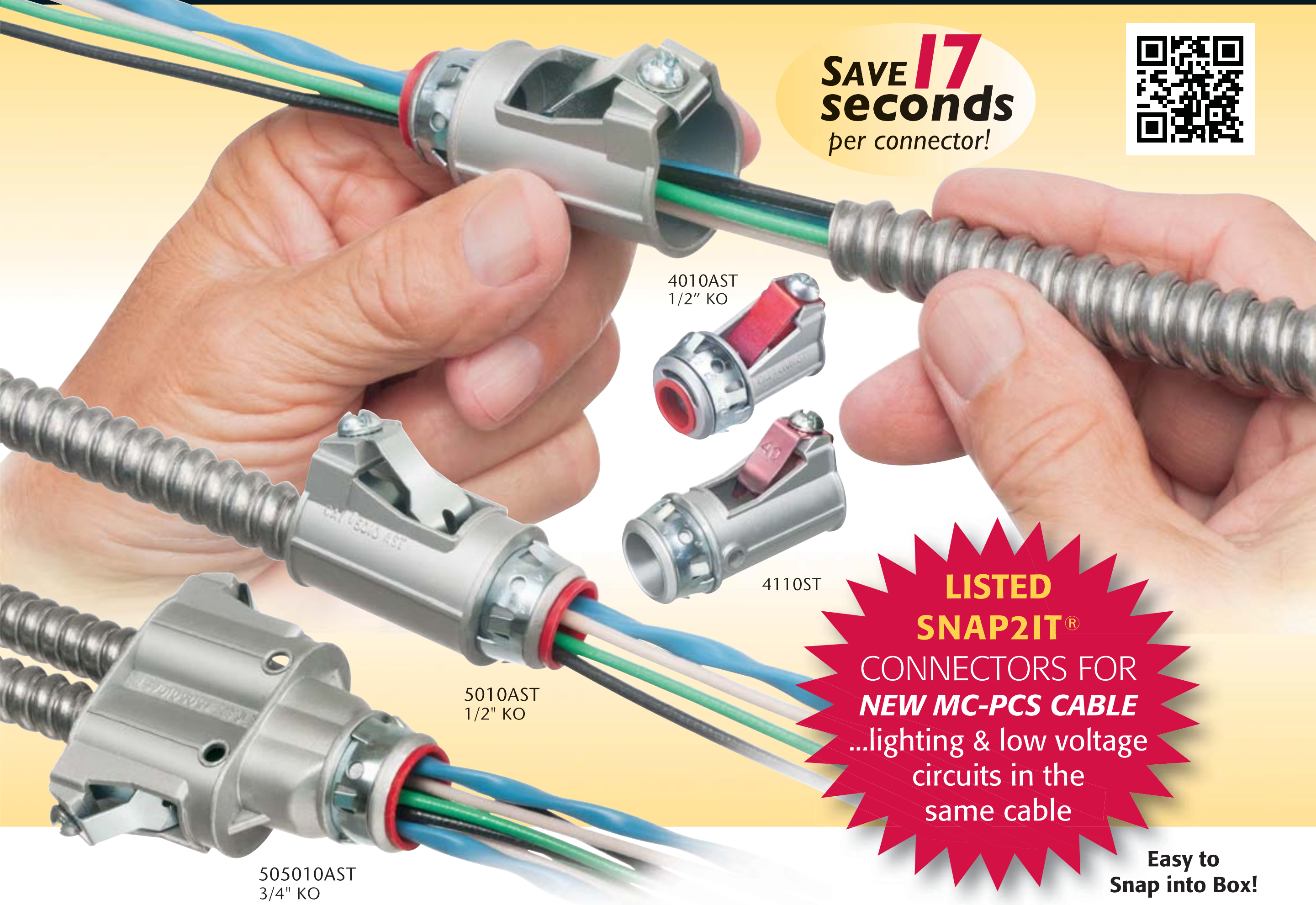
EASIEST CABLE INSERTION • NO TOOLS • SECURE HOLD



Fully assembled, **SNAP²IT®** fittings **handle the widest variety of MC cable *AND THE NEW MC-PCS cables.***

Compared to fittings with a locknut and screw, you can't beat these snap in connectors for time-savings!

- **Fits widest range and variety of MC cable** 14/2 to 3/3 AC, MC, HCF, MC continuous corrugated aluminum cable and MCI-A cables (steel and aluminum)...*including the new MC-PCS cable that combines power and low voltage in the same MC cable*

  ANY Snap2It Connectors LISTED for MC cable are also LISTED for MC-PCS cable! *These products offer the greatest time-savings.*
- **Fast, secure snap-on installation**
- **Easy to remove, reusable connector**

  From cable Loosen screw on top. Remove connector from cable.

  From box Slip screwdriver under notch in Snap-Tite® ring. Twist. Remove connector.

Easy to Snap into Box!

CATALOG NUMBER	**DESCRIPTION** Snap2It® connectors	**CABLE OUTSIDE DIA (OD)**
4010AST	Snap in, 1/2" KO w insulated throat	.405 to .610
5010AST	Snap in, 1/2" KO w insulated throat	.580 to .780
505010AST	Duplex Snap in, 3/4" KO w insulated throat	(2) .590 to .820
4110ST	Snap in, 1/2" KO	.525 to .705
414110ST	Duplex Snap in, 1/2" KO	(2) .525 to .640
NEW! **4141107ST**	Duplex Snap in, 3/4" KO	(2) .525 to .690

NEW!
4141107ST

Arlington®

Patented. Other patents pending.

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Product info aifittings.com/landing/snap2it-mc-cable-connectors

No. 7: Powered Industrial Trucks

Returning to its 2020 position, the **Powered Industrial Trucks** category ranks No. 7 in 2022 with a total of **1,749** violations, compared to only 1,404 total citations in 2021 when it was ranked No. 9. This category is associated with 1910.178, which describes the safety requirements related to fire protection, design, maintenance, and use of fork trucks, tractors, platform lift trucks, motorized hand trucks, and other specialized industrial trucks powered by electric motors or internal combustion engines.

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No. 8: Fall Protection — Training Requirements

The **Fall Protection — Training Requirements** category fell one position from 2021, when it held the No. 7 spot and had a total of 1,660 citations. Fortunately, 2022 saw a slight decrease in the number of violations in this category, with **1,556** total. The requirements of this category are described in 1926.503, which states that employers shall provide a training program for each employee who might be exposed to fall hazards to enable each employee to recognize the hazards of falling and the procedures to be followed to minimize those hazards.

No. 9: Personal Protective and Lifesaving Equipment — Eye and Face Protection

Dropping one position from 2020 to No. 9 in 2022, **Personal Protective and Lifesaving Equipment — Eye and Face Protection** saw a total of **1,401** violations, which is 50 less than occurred in 2021. According to 1926.102, the standard requires that employers ensure each affected employee uses appropriate eye or face protection when exposed to eye or face hazards from flying particles, molten metal, liquid chemicals, acids or caustic liquids, chemical gases or vapors, or potentially injurious light radiation.

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No. 10: Machine Guarding

Machine Guarding reclaimed its No. 10 spot for the third year in a row in 2022. Standard 1910.212 requires that one or more methods of machine guarding shall be provided to protect the operator and other employees in the machine area from hazards, such as those created by point of operation, ingoing nip points, rotating parts, flying chips, and sparks. Although it had the same ranking as the past couple of years, this category did see an increase in the number of violations – **1,370** in 2022, compared to 1,105 in 2021.

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FIXTURE BOXES for Siding

EASY INSTALLATION

Arlington's **8141F** and **8081F** boxes deliver the fastest, easiest way to install light fixtures and receptacles on siding. *Good looks. Smooth vertical mounting!*

- Easy to install one or two-piece styles for any siding type
- NM cable connector included
- UV rated for long outdoor use
- Textured, paintable finish

ONE piece 8141F Fixture Box	VS	TWO piece 8081F Electrical Box
No extra cover to lose or store		Separate cover and box
For light fixtures		For light fixtures, standard receptacles
Costs less than 8081F		

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SHIPS AS AN 'LB'... ANYBODY®

...BUT IT'S ANY BODY YOU WANT IT TO BE!

Arlington's aluminum *or plastic* **AnyBODY**™ ships as an LB, but converts *FAST* to a T, LL, LR or C by switching the cover plates and threaded flanges to create the style you need.

Easy and convenient, it saves you the hassle and cost of carrying five different conduit bodies.

- Competitively priced with LBs – ***NO EXTRA COST for the normally more expensive T*** – UL/CSA Listed
- **Plastic 1/2" to 4"** includes three flanges w/ glue-in pipe joint.
- **Aluminum 1/2" to 4"** includes threaded flanges for three openings. 1/2" to 2" are combination bodies: threaded for rigid, they also have a set-screw for use with EMT.

Aluminum T...C...LR...LL

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Product info aifittings.com/landing/anybody

By Fred Toepfer, Electrical Reliability Services

Arc Flash Risk Management Considerations

Key concepts every electrical professional must understand and put into practice to ensure a safe and reliable electrical operating environment

According to a recent National Fire Protection Association (NFPA) report, 126 workers died from exposure to electricity in 2020. Deaths from an arc flash are down from previous years, but most of these fatalities could have been prevented. Workers in highly charged areas can be exposed to electrical hazards that place them at risk of serious injury or death. Injuries occur when electrical safety is not given the proper attention, procedures are not followed, or employees are not trained appropriately. An arc flash blast can occur in a fraction of a second, resulting in skin burns, respiratory issues, hearing loss, eye damage, and death. Conducting an arc flash study helps organizations identify the likelihood of an arc flash hazard and is the first step in preventing it from occurring. This article will review the arc flash regulatory requirements, mitigation, and compliance strategies, consider the impact of an arc flash incident on employees and businesses, and provide a framework for developing an arc flash management program.

ARC FLASH AND THE RISKS INVOLVED

An arc flash is a sudden discharge of energy, connecting a component with the ground or another voltage phase in the same system through the air. This discharge can result from loose connections, exposed live parts, or other short circuits in faulty equipment. The resulting explosion produces dangerous

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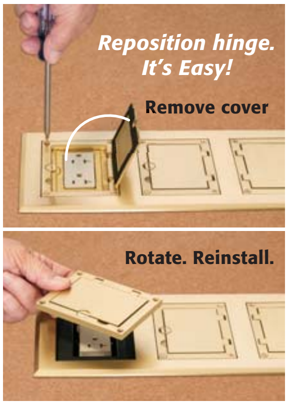
GANGABLE FLOOR BOX

FOR NEW CONCRETE FLOORS

Connections on sides lock single gang FLBC8500 boxes securely together

Lock two boxes together for a two-gang box. Add another for three-gang!



PLASTIC Listed Cover/frame kits NOW IN PLASTIC, FIVE Colors!

FLBC8510BR

Build a two- or three-gang concrete floor box by simply locking *single gang* boxes together!

Then buy the UL LISTED single, two- or three-gang cover/frame kit, *with devices included*, in **PLASTIC, FIVE COLORS** – ***or in economical diecast zinc with a brass or nickel finish***. *Fast, easy installation.*

Cover installs with hinge on either side.

UL LISTED

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Plastic Cover/frame Kit

Single gang
FLBC8510BR Brown
FLBC8510BL Black
FLBC8510GY Gray
FLBC8510CA Caramel
FLBC8510LA Lt Almond

Two-gang
FLBC8520BR Brown
FLBC8520BL Black
FLBC8520GY Gray
FLBC8520CA Caramel
FLBC8520LA Lt Almond

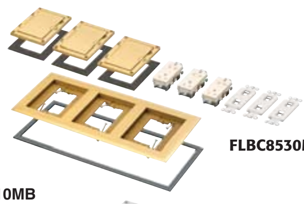
Three-gang
FLBC8530BR Brown
FLBC8530BL Black
FLBC8530GY Gray
FLBC8530CA Caramel
FLBC8530LA Lt Almond

Arlington®

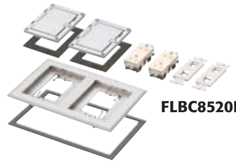
Metal Cover/frame Kit

Brass finish
Single gang **FLBC8510MB**
Two-gang **FLBC8520MB**
Three-gang **FLBC8530MB**

Nickel finish
Single gang **FLBC8510NL**
Two-gang **FLBC8520NL**
Three-gang **FLBC8530NL**



FLBC8530MB



FLBC8520NL

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Product Info aifittings.com/landing/gangable-box-kits/

intensities of force, heat, and light. In addition to damaging equipment, an arc flash can injure nearby workers. The impact can cause internal and external burns, resulting in severe injuries or death caused by intense UV light emissions, hot gases, or vaporized metals.

Across electrical systems, each equipment location will have a different arc flash incident risk level, depending on the available fault current and interrupting time to clear that fault. An arc flash analysis will detect the available fault current using a short-circuit study, and the interrupting time is calculated with a coordination study. These two protective device calculations are the basis for determining the arc flash incident energy in calories per centimeter squared, which provides the arc flash incident risk level. This information is included in the arc flash report, and the incident energy value will be included on device-specific arc flash equipment labels. When it is necessary to work on energized equipment, the arc flash label informs personnel of the magnitude of the potential hazard, so they can take appropriate steps to protect themselves with the proper PPE and other safety procedures.

An arc flash study and proper arc flash labeling are required by law to reduce the hazard for workers when working on or near energized equipment. The study also simultaneously provides selective coordination of electrical system protective devices that will minimize interruptions to the operation of the facility's electrical infrastructure.

MAXIMIZING EMPLOYEE SAFETY AND OPTIMIZING BUSINESS OPERATIONS

Establishing a risk management program for arc flash safety is the first step toward mitigating arc flash risk and ensuring worker safety while optimizing facility operation.

The NFPA 70E standard requires facility owners to perform an arc flash risk assessment before allowing a worker or contractor to perform a task on energized equipment. An arc flash risk assessment identifies the presence and location of potential hazards. It provides recommendations for PPE, boundaries for limited and restricted approaches, proposals for flash protection, and safe work practices. The Occupational Safety and Health Act (OSHA) requires all business owners have an NFPA 70E-compliant safety program — including an arc flash risk assessment and labeling. OSHA strictly enforces these requirements, and violations can result in hundreds of thousands of dollars in fines. There are even examples of repeated violations costing more than a million dollars when incidents have resulted in serious injury or death.

MITIGATING RISK WITH AN ARC FLASH MANAGEMENT PROGRAM

An arc flash risk management program is comprised of a typical sequence of tasks conducted by the system owner or in conjunction with a third-party service provider to implement a personnel safety and system reliability solution.

- The first task in the sequence starts with a commitment by the system owner to define, document, and implement safe operating practices. This activity should include electrical safety and policy procedures. Many of these procedures are described in the NFPA 70E standard related to workplace electrical safety.
- Specific hazards should be identified by location across the electrical infrastructure. Details of the electrical system layout are required as the basis to define a scope of work for a risk management solution.
- End-users or approved third-party service providers will confirm system data on-site. This data will be used to model an electrical representation of the system to perform a short circuit, coordination, and arc flash analysis. The analysis is performed according to industry standards using an available software application. The application software will aid a knowledgeable systems engineer in calculating the available fault current. From these calculations, the engineer will recommend protective device settings that optimize system operation while minimizing the magnitude of the arc flash hazard.
- Results are documented by device, including actions to replace underrated devices that can't safely interrupt the available fault current and relay settings to support the approved recommendations of the study.
- Once the user approves the study results, equipment labels are produced and affixed to each piece of equipment. The labels provide all the necessary information a worker will require to wear appropriate PPE and define safe working distances for qualified and unqualified workers. These labels are then available for installation on the electrical devices as defined in the study.
- Labeling equipment is only a part of the overall process of operating safely. There are many safety procedures outlined in OSHA and NFPA 70E. These include a requirement to train personnel who may be working on or near energized equipment. NFPA 70E requires personnel to be trained every three years and audited for retention of safety policies/procedures each year.

The arc flash analysis documents and analyzes a user's existing system for what it is. It could be a relatively new state-of-the-art electrical system with the latest gear, a decades-old system with equipment that is no longer manufactured, or something in between. As a result, there are situations where the ability to reduce the magnitude of arc flash hazards has its limits while also providing desired protection device coordination for optimal system operations.

An arc flash analysis is essentially a snapshot in time. It documents the user's electrical system as currently configured. Any changes to the system could invalidate all or a portion of the results provided in the study report. Accordingly, NFPA 70E requires the study to be rerun every five years or when significant changes have been made to the system. Periodic updates not only keep the study current to retain the benefits of safety and system reliability but also to make the ongoing implementation of an arc flash safety program less costly and complex.

In addition, NFPA 70E requires a current single-line diagram to be included in each arc flash update. The single-line diagram references each device in the model and is a critical component of the final arc flash report.

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CONCRETE PIPE SLEEVE

THE EASY, ECONOMICAL WAY TO SLEEVE THROUGH CONCRETE POURS!

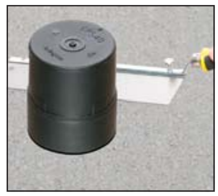
Arlington's **Concrete Pipe Sleeves** are the economical way to sleeve through concrete pours in tilt-up construction WALLS – and FLOORS *allowing cable and conduit to run easily from one floor to the next.*

No costly core drilling – No cutting holes in the form. Plus, you can position the hole prior to pouring the concrete.

- Attaches to form with nails or screws
- Stackable up to 23" h for extra deep pours
- Vents keep wet pipe sleeves from sticking together
- Multiple hole sizes: 1-1/2" • 2" • 3" • 4" • 5" • 6"

CPS40

Nail sleeve to form.



After concrete sets, cut sleeve flush with surface.

Insert conduit into sleeve.

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Product info aifittings.com/landing/concrete-pipe-sleeve

THE INDUSTRY STANDARD FROM ARLINGTON

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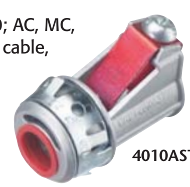
SNAP2IT® CONNECTORS

NO TOOLS, SNAP IN • EASIEST CABLE INSERTION • SECURE HOLD

- **Widest *total* cable ranges** *for our ENTIRE line:* 14/2 to 3/3 *Larger Snap2It connectors also available.*
- **Widest variety of cables** AC90 and ACG90; AC, MC, HCF, MC continuous corrugated aluminum cable, MCI-A cables (steel/aluminum)
- **Easiest cable installation**
- **Fast, secure installation** No pullout
- **Removable, reusable** from cable or box



4010AST

WIDEST CABLE RANGES FASTEST INSTALLATION!

CATALOG NUMBER	SNAP2IT® CONNECTORS w insulated throat	CABLE OUTSIDE DIA (OD)
38AST	Snap in, 1/2" KO	.405 to .605
3838AST	DUPLEX Snap in, 1/2" KO	.405 to .605, 3/8" Flex*
40AST	RED TINT Snap in, 1/2" KO	.485 to .610
4040AST	RED TINT, DUPLEX Snap in, 1/2" KO	.485 to .610, 3/8" Flex*
4010AST	ANGLED CLIP Snap in, 1/2" KO	.405 to .610

* Flex CSA Listed with anti-short bushing

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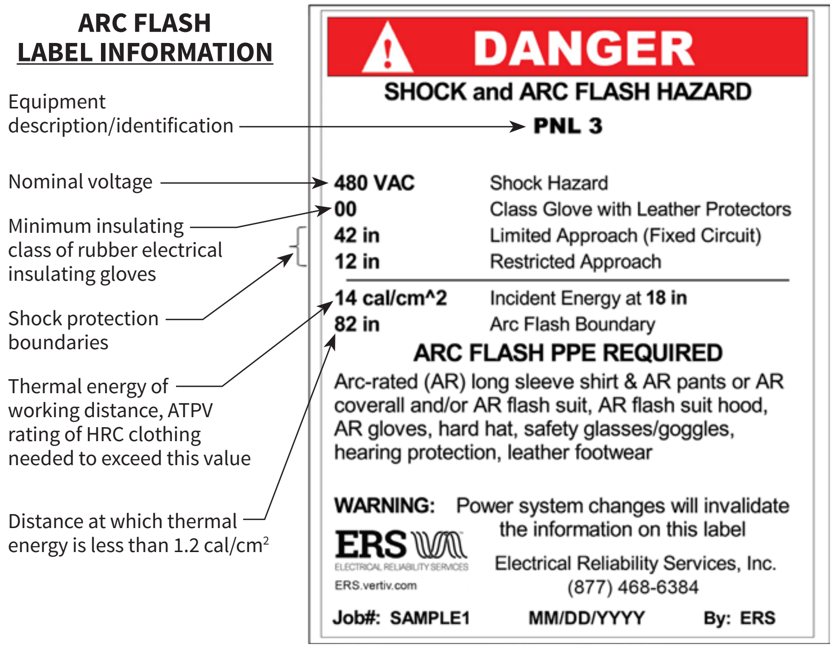
Arlington®

Product info aifittings.com/landing/snap2it-complete-series

ARC FLASH LABELING

Arc flash labels follow a specific layout according to NFPA 70E guidelines. See the **Figure** at right for a detailed diagram of the arc flash-related information included on every label. Note that there may be some variations based on customer preference and historical safety procedures already in place. Changes to the standard in recent years include the elimination of the prohibited approach boundary for shock hazard and PPE category 0. PPE category designations of 1-4 are no longer required when the analysis method review in this article is used.



Example of pertinent information that must be included on every arc flash label.

ARC FLASH TRAINING

Arc flash safety training, as mentioned above, is required every three years by OSHA 1910 and NFPA 70E. A typical arc flash safety course will include demonstrations on how to determine incident energy values and arc flash boundaries and instruct on how to interpret arc flash labeling. The information will guide participants in the selection of methods designed to minimize arc flash hazards and in choosing the proper personal protective equipment (PPE). A training course can be conducted in one day and should in general cover the following topics:

- Safety basics
- Electric flashover
- Arc flash and blast
- Codes and standards
- Standard maintenance requirements
- Work-safe practices
- Arc flash label interpretation

ARC FLASH SAFETY COMPLIANCE

OSHA1910, NFPA 70E, and IEEE1584 are the primary standards that drive arc flash compliance activities. These standards provide policies and procedures that facilitate electrical safety. They have been developed and refined over time from real-world experience. OSHA requires employers to provide their employees with working conditions that are free of known dangers. It refers to NFPA 70E to fulfill the performance-based requirements in the OSHA standards. The purpose of NFPA 70E is to ensure workers are provided with a working area that is safe from the unacceptable risk associated with the use of electricity in the workplace. The IEEE1584 standard referenced in NFPA 70E provides the mathematical model used as the basis to calculate arc flash incident energy values. A review of these standards and how they are to be applied should be part of every discussion related to an arc flash management program.

Third-party service providers can help system owners comply with arc flash standards and assist with creating a custom arc flash management program. When hiring a third-party service provider, consider their ability to offer the following expertise and assurances:

- Trained and qualified field technicians experienced in performing on-site tasks including, data collection, labeling, relay settings, breaker testing, device replacement, and installation of an engineered solution.
- Expertise in single- and multi-site implementation.
- Qualified arc flash training programs to educate employees and measure understanding of safety procedures.
- System engineers to perform system analysis, review results and provide supporting documentation.
- Application engineering capabilities to advance and apply additional mitigation solutions.
- An approved process for managing system changes that support ongoing personnel safety and system reliability.
- A review and update of safety policy to ensure compliance with applicable codes and standards.

IN SUMMARY

Arc flash incidents represent a significant risk to personnel, system performance, and company reputation. System owners by law are required to be actively involved in risk management, and accountability is not excused due to ignorance of the standards. NFPA 70E specifies safety training every three years and arc flash study updates every five years (or after changes have been made to the electrical system). Following these standards is essential to a safe and dependable operating environment. In the end, it's all about safety and reliability. **EC&M**

Fred Toepfer, engineering services business development manager for Electrical Reliability Services, received his BSEE degree from Louisiana State University and MBA from Vanderbilt University. He has more than 30 years of sales and marketing experience in the electrical industry related to service and new product/business development. He can be reached at Fred.Toepfer@Vertiv.com.

ADJUSTABLE BRACKET • FOR NEW CONSTRUCTION

FAN/FIXTURE BOX

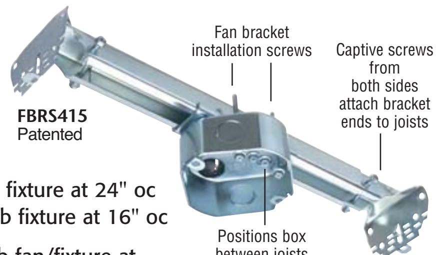
FLUSH CEILING INSTALLATIONS

Arlington's heavy-duty, plated steel fan/fixture box has an adjustable bracket that mounts securely between joists spaced 16" to 24" o.c.

Flush ceiling installations

FBRS415 is designed for ceilings up to 1-1/4" thick. For 1/2" ceilings, use the pre-bent positioning tab. For other ceiling thicknesses, bend along the appropriate score line.

- 15.6 cu. inch box ships with captive screws, mud cover, installed NM cable connector



FBRS415
Patented

UL ratings
70 lb fan/90 lb fixture at 24" oc
70 lb fan/150 lb fixture at 16" oc

CSA rated 50 lb fan/fixture at 16" and 24"

Product info aifittings.com/landing/fbrs415

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UL LISTED

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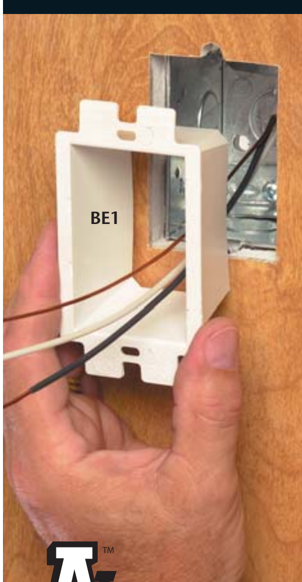
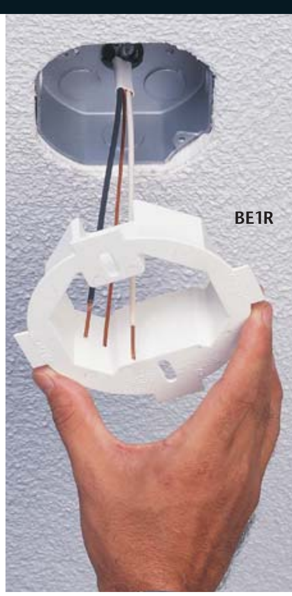
BOX EXTENDERS

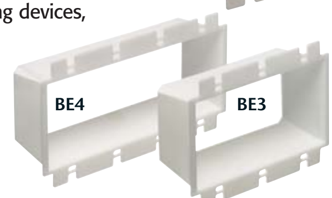
EXTENDS SET BACK BOXES UP TO 1-1/2 INCHES





Arlington's **UL/CSA Listed** Box Extenders extend set back electrical boxes up to 1-1/2".

Made of heavy-duty, non-conductive plastic, they level and support wiring devices, protecting wires against damage and stripping.



BE1R for round or octagonal boxes, the single-gang (BE1), two-gang (BE2) for all standard devices, switches and GFCIs and **three- and four-gang box extenders for multiple gang boxes!**

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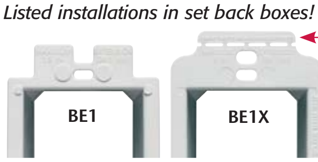

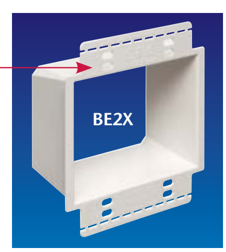

Product info http://www.aifittings.com/landing/box-extenders/

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The industrial-grade VIZZ series headlamps are designed to provide powerful, lasting, reliable, hands-free illumination to increase operator safety and productivity in a variety of conditions. The product features an IPX7 waterproof rating, lightweight design, and two separate modes (flood and spot) that can be easily switched between with the push of a button. In addition, the series has dimming capability and comes with an industrial headlamp kit with a nylon head strap, a rubber hard hat strap, and double-sided velcro to affix the light to a helmet. It is offered in two distinctive headlamp models: the VIZZ II and VIZZ IND.

Princeton Tec

Ventilation System

The company's ventilation system in this arc flash PPE suit features a Kydex shell and runs on AA batteries for 6 hr, reaching 35 CFM. The ventilation system improves comfort by increasing the amount of airflow in the suit. Additionally, the the lift-front face shield is integrated into the hood. The hood completely covers a users head and is worn over a hard hat with a headlight available on the top.

Cementex

Work Shoes

The company introduces its line of steel toe and safety sneakers and boots as well as casual leather high-top sneakers. The steel toe, puncture-resistant boots are available in black or brown and are available for men and women. The line also includes the Sports steel toe, a high-top safety sneaker that is anti-slip, anti-static as well as puncture resistant; the Future, a sporty steel-toe sneaker that is made from breathable cotton and has a sturdy sole; and the Signature, a classic leather high-top sneaker.

Ed Hennings Co.

Work Boots

The Wedge collection includes the AMP LT Wedge, a classic 10-in. wedge boot. The upper is crafted from SPR leather, making it abrasion resistant and durable against chemicals and acids. The counter lock system on the heel of this pull-on boot acts as both a heel-stabilizer to prevent heel slippage and a protectant for kicking your boot off using your other foot. The Wedge line also includes AMP LT Power Wedge, a heat-resistant 8-in. work boot with performance features such as a chemical-resisting leather upper with a Tec-Tuff leather vamp and reflective accents.

Georgia Boot

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THAT FIT SEVERAL CABLE SIZES

Save time and money! Arlington's low cost MC cable fittings, *for dry locations only,* are super-convenient and cost-effective. End stop bushings vary the size of the opening so *ONE trade size fits several cable sizes!*

Changing end stop bushings is fast and easy. *No need to remove the strap.* Insert the bushing that works the best with the cables you're installing.

Reduce inventory – Costs much less than steel and **malleable iron fittings**

Built-in end stop

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8418 for **1000** Mcm wire and TECK90

Catalog Number	Trade Size	Cable O.D. Min	Cable O.D. Max	Wire Bundle O.D. Min	Wire Bundle O.D. Max	Conductor size # of Conductors* (AWG/KCMIL)
8412	1"	.780	1.120	.660	1.000	6/3, 6/4, 4-3, 4-4, 2-3, 2-4, 1-3
8413	1-1/4"	1.000	1.460	.870	1.370	2-3, 2-4, 1-3, 1-4, 1/0-3, 1/0-4, 2/0-3, 2/0-4, 3/0-3
8414	1-1/2"	1.360	1.770	1.250	1.590	2/0-4, 3/0-3, 3/0-4, 4/0-3, 4/0-4, 250-3, 250-4
8415	2"	1.700	2.200	1.550	2.050	250-4, 300-4, 350-3, 350-4, 500-3
8416	2-1/2"	2.100	2.700	1.950	2.400	500-3, 500-4, 600-3, 600-4, 750-3
8417	3"	2.500	3.300	2.350	3.000	600-4, 750-3, 750-4
8418	**3-1/2"**	**3.300**	**3.600**	**3.031**	**3.500**	**750-3, 750-4, 1000-4**

NEW

* Examples of 3- and 4-conductor cables accommodated.

800/233-4717

www.aifittings.com

Arlington®

Product info aifittings.com/landing/8412

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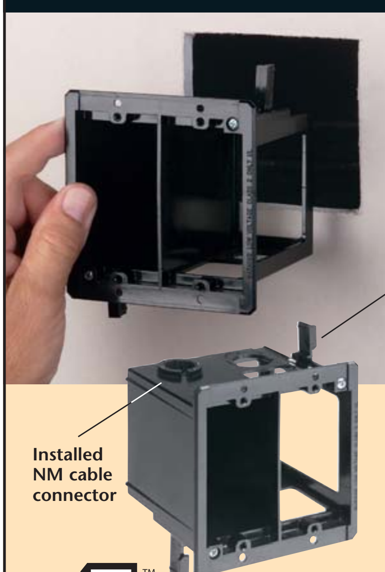
FOR RETROFIT PROJECTS



This convenient combo box has power and low voltage openings in the *same box* for a neat, time-saving installation.

The box adjusts to fit wall thicknesses from 1/4" to 1-1/2". Mounting wing screws hold it securely in place.

- 2-Hour Fire Rating
- Low voltage side has a combo 1/2" and 3/4" KO for raceway
- Includes NM cable connector (power side)

LVDR2

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Product info aifittings.com/landing/combo-boxes

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NEC Requirements for Switches

Don't let switch-related Code violations darken your reputation.

By Mike Holt, NEC Consultant

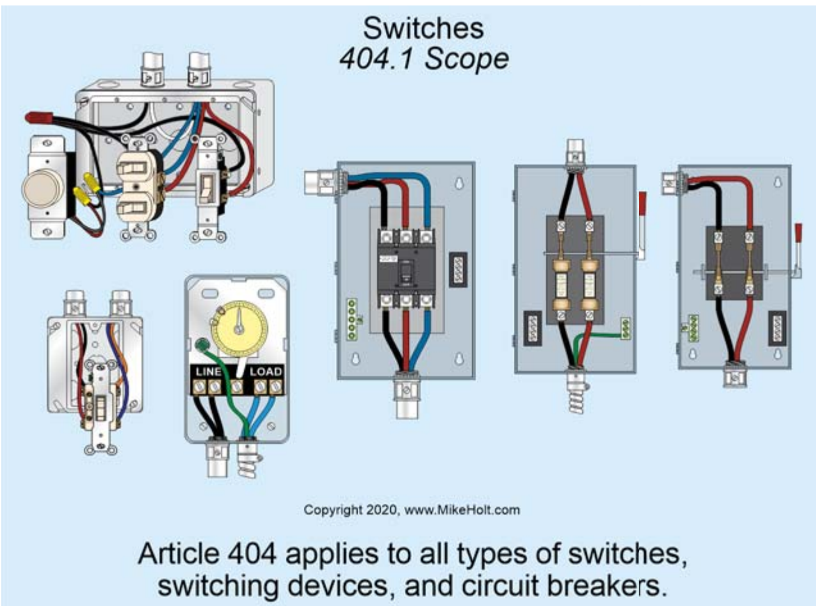

Fig. 1. The scope of Art. 404 can be found in Sec. 404.1.

The requirements of Art. 404 apply to all types of switches including snap (toggle) switches, dimmer switches, fan switches, knife switches, circuit breakers, occupancy sensors, and automatic switches, such as time clocks and timers [Sec. 401.1] (**Fig. 1**).

SWITCH CONNECTIONS

When wiring 3-way or 4-way switches, only the phase conductors can be switched [Sec. 404.2(A) and (B)]. As a conductor for switching purposes (switch leg), you can use a permanently reidentified white conductor within a cable [Sec. 200.7(C)(1)].

Switches controlling line-to-neutral lighting loads must have a neutral conductor installed at all switches serving bathroom areas, hallways, stairways, and habitable rooms or occupiable spaces as defined in the building code [Sec. 404.2(C)]. Where 3-way and 4-way switches are visible in a room, only one of the switches requires a neutral conductor.

You don't have to install a neutral conductor at lighting switch locations under any of the following conditions:

(1) Where conductors enter the box enclosing the switch through a raceway with enough cross-sectional area to accommodate a neutral conductor.

(2) Where the box enclosing a switch can be accessed to add or replace a cable without damaging the building finish.

(3) Where snap switches with integral enclosures comply with Sec. 300.15(E).

(4) Where the lighting is controlled by automatic means.

(5) Where switches control receptacles.

A neutral conductor must be installed for any replacement switch that requires line-to-neutral voltage [Sec. 404.22] to operate the electronics of the switch in the standby mode.

Exception: A neutral conductor is not required for replacement switches installed in locations wired prior to the adoption of Sec. 404.2(C) where the neutral conductor cannot be extended without removing finish materials. The number of electronic lighting control switches without a neutral conductor on a branch circuit cannot exceed five, and the number of switches connected to any feeder cannot exceed 25.

SWITCH ENCLOSURES

Switches and circuit breakers must be mounted in an enclosure listed for the intended use [Sec. 404.3(A)].

Switch or circuit-breaker enclosures can contain splices and taps if the conductors, splices, and/or taps do not fill the wiring space at any cross-section to more than 75%. Switch or circuit-breaker enclosures can have conductors feed through them if the wiring does not fill the wiring space at any cross section to more than 40 % per Sec. 312.8 [Sec. 404.3(B)].

Any surface-mounted switch or circuit breaker in a damp or wet location must be installed in a weatherproof enclosure [Sec. 404.4(A)]. A flush-mounted switch or circuit breaker in a damp or wet location must have a weatherproof cover [Sec. 404.4(B)].

Switches must not be installed within tub or shower spaces unless installed as part of a listed tub or shower assembly [Sec. 404.4(C)].

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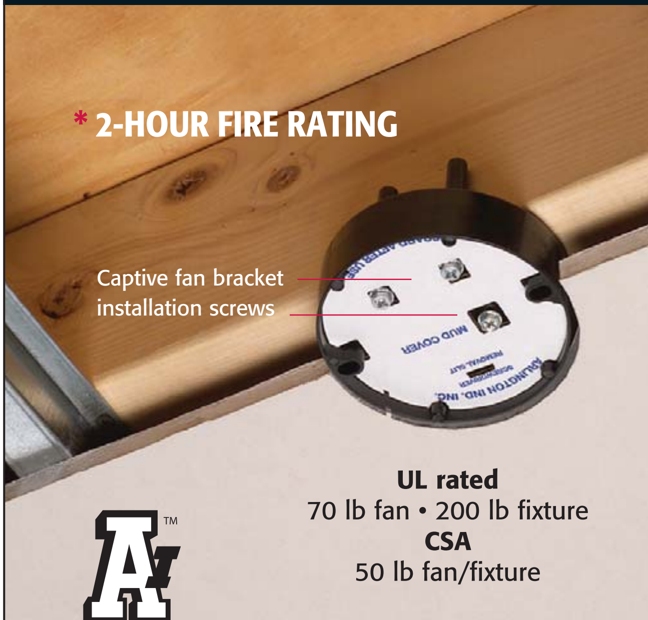

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CSA
50 lb fan/fixture

Arlington's convenient fan/fixture pan box works with 1/2", and single *or double* 5/8" drywall – *on furring strips or hat channel.*

FB412

- Easy mounting in new work
- Fan bracket installation screws ship captive until ready for use
- Secure joist-mount installation
- 14.4 cu. in. **UL/CSA Listed**

FB412 with 5/8" double drywall

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FBA426
Adjustable Fan/Fixture Box
21.0 cu in

Bracket installation screws ship captive

Underside

Depth adjustment screw

Arlington's **IN/OUT**™ ***fan/fixture boxes*** adjust up to 1-1/2" to accommodate varying ceiling thicknesses, like single or double drywall. **FBA426** is Listed for fans up to 70 lbs; fixtures up to 100 lbs.

- Pre-set for 1/2" ceiling – depth adjustment screw positions the box flush with the ceiling *after it's in place*
- Complies with 2020 NEC, 314.20 for set back boxes
- (4) screws attach box securely to joist in new work
- **2-Hour Fire Rating**

Patented

20.0 cu in
FA426
for Fixtures *only* up to 50 lbs

1

2

1 Cutaway: Box set back in double drywall

2 Install ceiling. If necessary use depth adjustment screw to position box flush with ceiling.

Product info aifittings.com/landing/fba426

INDICATING

Switches and circuit breakers must be marked to indicate whether they are in the "on" or "off" position [Sec. 404.7].

This is typically accomplished by marking on the toggle of the switch itself or by indicative labeling. If you find a switch not so marked, chances are it is a 3-way or 4-way switch, which can be on or off in either the up or down position.

When the switch is operated vertically, install it so the "up" position is the "on" position [Sec. 240.81].

Exception No. 1: Double-throw switches, such as 3-way and 4-way switches, are not required to be marked "on" or "off."

Circuit breakers used to switch fluorescent lighting must be listed and marked "SWD" or "HID." Circuit breakers used to switch high-intensity discharge lighting must be listed and must be marked "HID" [Sec. 240.83(D)].

ACCESSIBILITY AND GROUPING

Switches and circuit breakers must be operable from a readily accessible location with the center of the grip of the operating handle, when in its highest position, not more than 6 ft 7 in. above the floor or working platform [Sec. 404.8(A)]. There's no minimum height for switches.

Exception No. 1: On busways, fusible switches and circuit breakers can be located at the same level as the busway where suitable means is provided to operate the handle of the device from the floor.

Exception No. 2: Switches and circuit breakers can be mounted above 6 ft 7 in. if they are next to the equipment they supply and accessible by portable means.

Snap switches are not permitted to be in enclosures with other switches or receptacles if the voltage between adjacent devices exceeds 300V, unless the devices are installed in enclosures equipped with barriers identified for the purpose that are securely installed between adjacent devices [Sec. 404.8(B)].

GENERAL-USE SNAP SWITCHES, DIMMERS, AND CONTROL SWITCHES

Faceplates for switches, dimmers, and control switches must completely cover the outlet box opening, and where flush mounted, the faceplate must seat against the wall surface [Sec. 409(A)].

The metal mounting yokes for switches, dimmers, and control switches/metal faceplates must be connected to the circuit equipment grounding conductor [Sec. 409(B)]. Use one of these methods:

(1) Metal boxes. The switch yoke is secured with metal screws to a metal box or a metal cover that is connected to an equipment grounding conductor [Sec. 250.109]. The metal faceplate is secured with metal screws to a switch that is connected to an equipment grounding conductor [Sec. 250.109].

(2) Nonmetallic boxes. The switch yoke must be connected to the circuit equipment grounding conductor. The metal faceplate is secured with metal screws to a switch that is connected to an equipment grounding conductor [Sec. 250.109].

Exception No. 1: Where no means exists within the box for bonding to an equipment grounding conductor — or if the wiring method at the existing switch does not contain an equipment grounding conductor — a switch without such a connection to the equipment grounding conductor is permitted for replacement purposes only. A switch installed under this exception must have a faceplate that is nonmetallic and noncombustible with nonmetallic screws, or the replacement switch must be GFCI protected.

Exception No. 2: Listed assemblies are not required to be bonded to an equipment grounding conductor if all the following conditions are met:

(1) The device has a nonmetallic faceplate and the device is designed such that no metallic faceplate replaces the one provided,

(2) The device does not have a mounting means to accept other configurations of faceplates,

(3) The device is equipped with a nonmetallic yoke, and

(4) All parts of the device that are accessible after the faceplate is installed are manufactured of nonmetallic material.

Exception No. 3: An equipment grounding conductor is not required for a snap switch with an integral nonmetallic enclosure complying with Sec. 300.15(E).

General-use snap switches, dimmers, and control switches mounted in boxes that are set back from the finished surface must be installed so the extension plaster ears are seated against the surface [Sec. 404.10(B)].

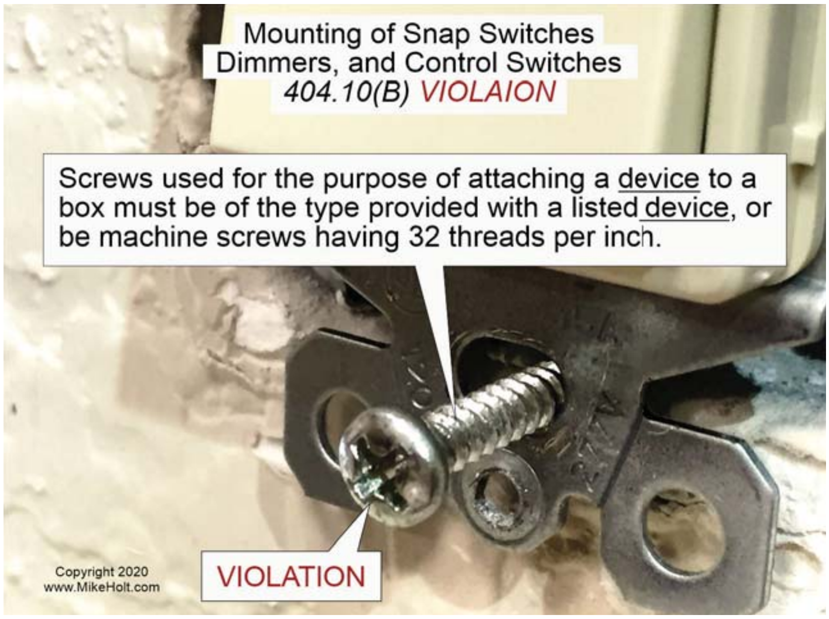

Fig. 2. The NEC requirements for mounting snap switches, dimmers, and control switches are outlined in Sec. 404.10(B).

Screws used for the purpose of attaching a device to a box must be of the type provided with a listed device or be machine screws having 32 threads per inch or part of listed assemblies or systems, per the manufacturer's instructions **(Fig. 2)**.

In walls or ceilings of noncombustible material (such as drywall) boxes are not permitted to be set back more than ¼ in. from the finished surface. In combustible walls or ceilings, boxes must be flush with, or project slightly from, the finished surface [Sec. 314.20]. There must not be any gaps more than ⅛ in. at the edge of the box [Sec. 314.21].

Metal enclosures for switches and circuit breakers must be connected to an equipment grounding conductor of a type recognized in Sec. 250.118 [Sec. 250.4(A)(3)]. Where nonmetallic enclosures are used with metal raceways or metal-armored cables, they must comply with Sec. 314.3 Exception No. 1 or Exception No. 2 [Sec. 404.12].

SNAP SWITCH RATING AND USE

General-use snap switches must be listed and used within their ratings as indicated [Sec. 404.14]. The alternating current types can control the types of loads listed in Sec. 404.14(A)(1) through (5). For example, a snap switch can control motor loads not exceeding 80% of the ampere rating of the switch at its rated voltage [Sec. 404.14(A)(4)].

General-use dimmer switches can control only permanently installed incandescent luminaires unless listed for control of other loads [Sec. 404.14(E)].

Other electronic control switches, such as timing switches and occupancy sensors, can control only permanently connected loads. Use these only for loads that do not exceed their ampere rating at the voltage applied.

KEY TAKEAWAYS

While Art. 404 provides detailed requirements, the gist of all those can be stated in these three points:

1. Use the correct switch for the application.
2. Install per the NEC requirements for that switch in that application.
3. Install with good workmanship.

This last point includes such things as not having big gaps around a panel or wall mounted switch, mounting it straight, and mounting it right side up. Always ask, "Did I do a professional-looking job?" If not, it probably doesn't meet Code. **EC&M**

These materials are provided by Mike Holt Enterprises in Leesburg, Fla. To view Code training materials offered by this company, visit www.mikeholt.com/code.

Stumped by the Code?

By Mike Holt, NEC Consultant

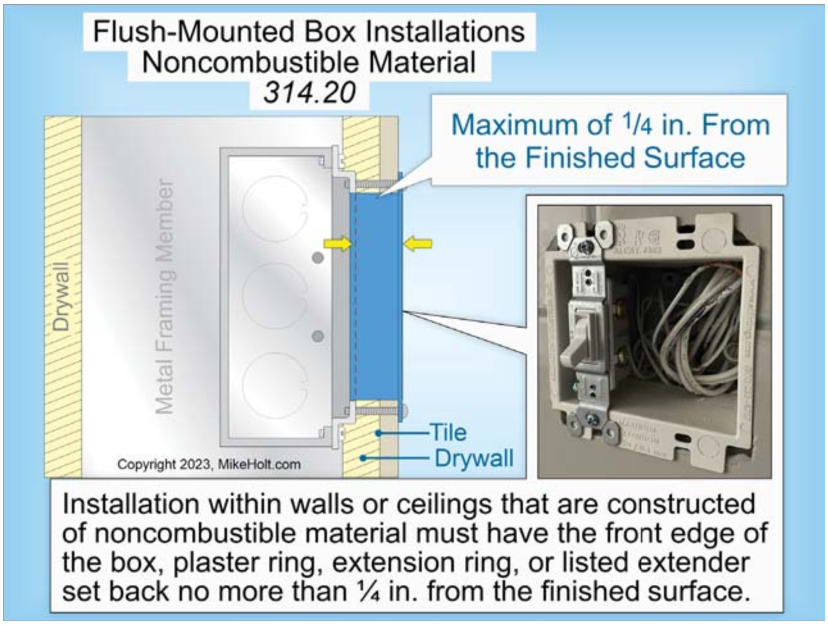

Fig. 1. The NEC requirements for flush-mounted box installations can be found in Sec. 314.20.

All questions and answers are based on the 2023 NEC.

Q. What are the NEC requirements related to flush-mounted boxes?

A. The NEC requirements related to flush-mounted boxes can be found in Sec. 314.20.

Noncombustible Walls and Ceilings. Installation within walls or ceilings finished with a noncombustible material must have the front edge of the box, plaster ring, extension ring, or listed extender set back no more than ⅛ in. from the finished surface (**Fig. 1**).

Combustible Walls and Ceilings. Installation within walls or ceilings constructed of wood or other combustible material must have the front edge of the box, plaster ring, extension ring, or listed extender extend to, or project out from, the finished surface.

Author's Comment:

- Plaster rings and extension rings are available in a variety of depths to meet the above requirements.
- Final finished surfaces (such as backsplashes and tile) may need the use of listed extenders to meet the requirements of this section.

Q. What are the NEC requirements when boxes are installed in noncombustible surfaces?

A. The NEC requirements for this installation are found in Sec. 314.21.

Gaps around boxes that are recessed in noncombustible surfaces (such as plaster, drywall, or plasterboard) must be repaired so there will be no gap greater than ⅛ in. at the edge of the box (**Fig. 2**).

Author's Comment: Other examples of noncombustible surfaces include ceramic wall tile, ceramic or marble floor tile, brick, cinder block, and other types of masonry or stone. All these examples are subject to the requirements of Sec. 314.20 and Sec. 314.21. **EC&M**

These materials are provided by Mike Holt Enterprises in Leesburg, Fla. To view Code training materials offered by this company, visit www.mikeholt.com/code.

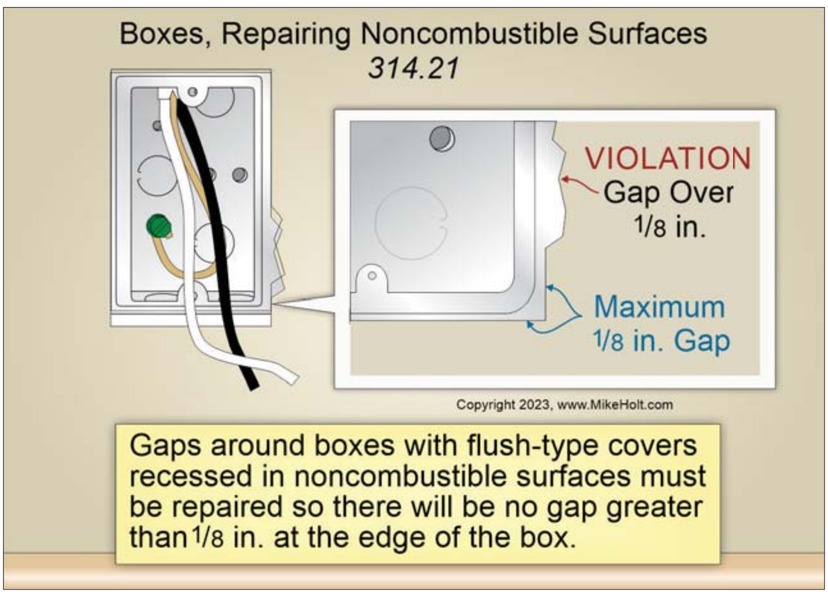

Fig. 2. The rules for boxes installed in noncombustible surfaces are found in Sec. 314.21 of the NEC.

Illustrated Catastrophes

By Russ LeBlanc, NEC Consultant

All references are based on the 2023 edition of the NEC.

CORROSION OF CONFORMITY

This photo shows us an excellent example of why Sec. 300.6 exists in the Code. That Section requires, among other items, raceways, cable armor, boxes, fittings, supports, support hardware, cabinets, boxes, and other enclosures to be made of materials suitable for the environment where they are installed. For ferrous metal equipment, Sec. 300.6(A) requires these items to be protected against corrosion on the inside and outside by an approved corrosion-resistant coating. Whatever coating was used on this equipment did not seem to fare very well. Rust has eaten away the bottom of the disconnecting means to the point where the raceway has completely separated from the enclosure, leaving the conductors exposed to being damaged from the jagged edges of the rusty metal enclosure. Rain and moisture can now easily enter the meter socket enclosure, increasing the risk of shock and fire. The rays of the sun can also wreak havoc with the exposed conductor insulation too. The lack of electrical continuity and mechanical connection between the raceway and enclosure now violates Sec. 300.10 requirements along with many bonding and grounding requirements in Art. 250. I don't think either of these enclosures comply with the requirements in Sec. 312.2 anymore.

VENDING MACHINE VIOLATIONS

I spotted this contraption behind a vending machine on the outside of a local store. The vending machine power supply cord is the black cord with the orange cord cap. I'm not sure where the orange cord with the yellow cord cap is going, but I do know there are a few concerns here. First is the receptacle power tap installed in this outdoor wet location. I'm fairly certain that type of equipment is not rated for use in this wet location. Section 406.9(B) requires 15A and 20A, 125V and 250V receptacles installed in wet locations to be installed in an enclosure that is weatherproof with an attachment plug cap inserted or removed. This enclosure does not comply with that requirement. The cord caps on the power supply cords do not appear to be types that are rated for use in this wet location either. Installing and using listed or identified products without following instructions is a violation of Sec. 110.3(B). Installing power supply cords, cord sets (extension cords), flexible cords, or flexible cables in raceways is generally prohibited by Sec. 400.12(6), unless specifically permitted elsewhere in the Code. One example of this is wet niche lights for swimming pools where the cord is run from the forming shell, through a raceway, and to a swimming pool junction box as specified in Sec. 680.23(B).

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CODE VIOLATIONS

What's Wrong Here?

By Russ LeBlanc, NEC Consultant

How well do you know the Code? Think you can spot violations the original installer either ignored or couldn't identify? Here's your chance to moonlight as an electrical inspector and second-guess someone else's work from the safety of your living room or office. Can you identify the specific Code violation(s) in this photo? Note: Submitted comments must include specific references from the 2023 NEC.

Hint: Janitor's closet crisis

'TELL THEM WHAT THEY'VE WON...'

Using the 2023 NEC, correctly identify the Code violation(s) in this month's photo — in 200 words or less — and you could win an Arlington Industries 18-in. Slider Bar and plastic box for mounting between studs with non-standard spacing. E-mail your response, including your name and mailing address, to russ@russleblanc.net, and Russ will select three winners (excluding manufacturers and prior winners) at random from the correct submissions. Note that submissions without an address will not be eligible to win.

MARCH WINNER

Our winner this month was Michael Anders, an *EC&M* reader from Charlottesville, Va. He was able to correctly cite some Code concerns with this installation.

Securing NM cables to an electrical metallic tubing (EMT) raceway is generally going to be a violation of Sec. 300.11(C). Raceways can be used as a means of support for cables, where the raceway contains power supply conductors for electrically controlled equipment and is used to support Class 2 or Class 3 circuit cables that are solely for the purpose of connecting to the equipment control circuits.

Another concern I have is whether NM cables should be installed here at all. This is the entrance to a boiler room for an apartment building, and it seems to me that the NM cable is installed in a high-traffic area where the cable may be exposed to physical damage. This exposed installation violates requirements found in Sec. 334.15. One more concern is the use of NM cables in a building with walls and ceilings constructed of metal mesh and plaster. While not specifically a violation, the metal mesh often has jagged and sharp edges that could easily damage unprotected NM cables where cables penetrate those surfaces. I've seen this happen several times.

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