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THE MAGAZINE OF ELECTRICAL DESIGN, CONSTRUCTION AND MAINTENANCE

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*How electrical operations and maintenance professionals can effectively work with safety personnel.* *Read more on pg. 36*

IN THIS ISSUE

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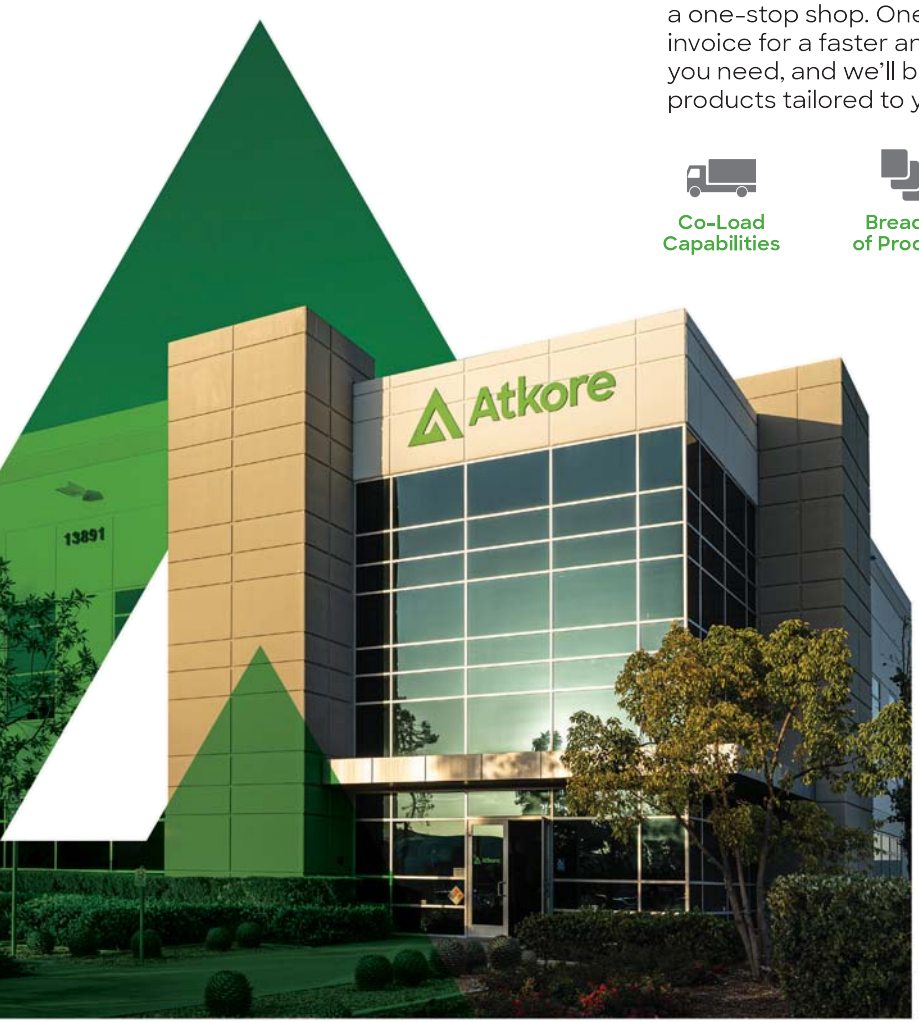


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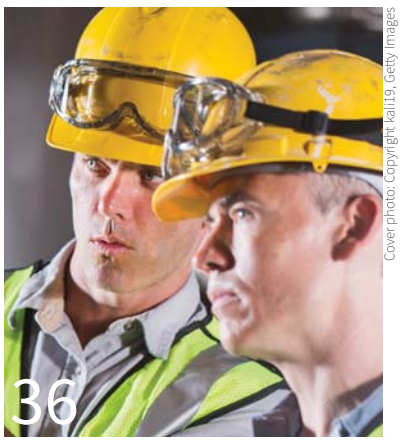

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## OTHER FEATURES







## NATIONAL ELECTRICAL CODE






Image courtesy of Moxa


ISSN 0013-4260
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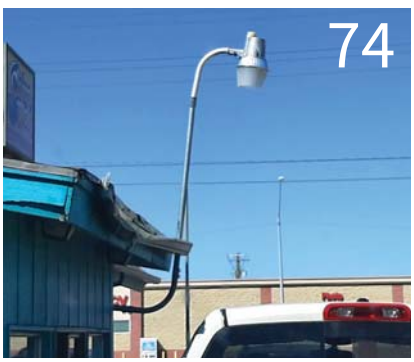


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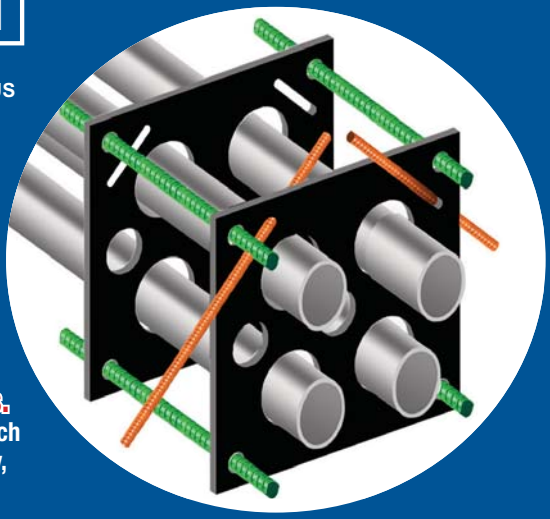

**Bore Spacers** **IP2**

Sizes 1/2" thru 6"

*Roll assembled conduit into caissons and under obstructions*

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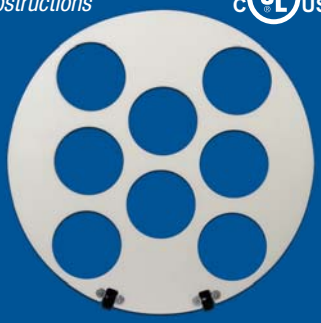

Assemble Conduit Above Trench-

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### THE TOP 15 STATES FOR CLEAN POWER ADDITIONS

Photo Gallery ▶ These states' additions totaled 21,010MW in 2020 and include wind, utility solar, battery storage, and more.
**https://bit.ly/3k5d5YP**


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### CODE CONVERSATIONS PODCAST, EPISODE 1

NEC ▶ Code Consultant Russ LeBlanc explains why the practical applications of Sec. 230.85 can cause some confusion.
**https://bit.ly/3EPGv5a**

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### HEAT INJURY STANDARD ON THE FRONT BURNER

Safety ▶ OSHA is moving aggressively on monitoring work sites for worker heat exposure, prompting concerns from construction interests.
**https://bit.ly/3ESy4pN**



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Editorial Office: Endeavor Business Media, LLC, 1233 Janesville Ave, Fort Atkinson, WI, 53538.

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Subscription Services Department: For subscriber services or to order single copies, call customer service at (847) 559-7598 or send an email to electricalconstmaint@omeda.com.

Postmaster: Send address changes to EC&M, P.O. Box 3257, Northbrook, IL 60065-3257 U.S.A.

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# Candid Code Conversations Showcased in New *EC&M* Podcast Series

By Ellen Parson, Editor-in-Chief

Whether they're related to sports, entertainment, true crime, traveling, cooking, DIY, or a host of other personal or professional topics, we all have our favorite podcasts we listen to on a regular basis. I'm excited to tell you about a new one we recently launched on *EC&M* that I believe could definitely become your new favorite: Code Conversations with Russ LeBlanc. Most of you probably already know Russ. He's a master electrician, electrical instructor/trainer, certified electrical inspector, and longtime contributor/Code Consultant to *EC&M*, bringing you some of our most popular pieces of content, such as our infamous What's Wrong Here photos and commentary, Moving Violations videos (where he uncovers some of the craziest NEC violations you can imagine in the most unsuspecting places), and Illustrated Catastrophes (where he breaks down Code violations in the field in real time and offers insight on how to make the installations Code compliant).

In every episode of Code Conversations, Russ and I will sit down to discuss difficult-to-decipher concepts surrounding the 2020 National Electrical Code or areas that seem to cause the most confusion. The great part is that this podcast will always be 10 minutes or less — guaranteed. We want to make sure it's super accessible, so keeping your time commitment to a minimum enables you to quickly get the practical information you need on how to apply the NEC in real-world settings.

Launched in October, the first Code Conversations podcast is available at https://bit.ly/3nAhvYy. In it, we discuss why discrepancies seem to come up so often with emergency disconnects and then examine the practical applications of Sec. 230.85. Although the idea of providing a disconnect on the exterior of one- and two-family dwelling units for emergency personnel to have the ability to turn off the power quickly (and without the need to enter a burning or flooded building with all of the circuits still energized) sounds like a great idea in theory, when it comes to interpreting the Code, Sec. 230.85 can cause confusion. Tune in to that episode and future episodes on our website at https://www.ecmweb.com/members/podcasts/code-conversations or download on podbean at https://ecmwebcodeconversations.podbean.com/.

Expect to see a new episode of this podcast every month on topics such as:

- Stuck in the Middle on Support Requirements for EMT Raceways
- What's Actually Mandatory When It Comes to Microwave Installations?
- An Inside Look at the Trio of GFCI Requirements in Sec. 210.8(D)
- Analyzing the Intent and Application of Sec. 210.52(2)
- Identification Methods for Grounded Conductors
- Breaking Down "Breaker Lock"
- Disconnecting Means for Electric Ranges
- Metal Roof Jack Misconceptions
- Non-Grounding Receptacle Replacements
- Rules for Multi-Wire Branch Circuits

Please let me know if you have any pressing NEC podcast topics you'd like to listen to in the future, and don't forget to check out the free members-only portal (https://www.ecmweb.com/members ) on our website for more podcasts and other content resources for electrical construction professionals. Finally, I'd like to thank Associate Editor Ellie Coggins for her multimedia editing expertise, putting these podcasts together, and making this valuable information easily accessible to all of our readers and listeners.

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# Smoking Out the Main Causes of Electrical Fires

## Why approximately 20% of structure fires reported to fire departments are classified as "electrical" in nature

By Vyto Babrauskas, Ph.D., Fire Science and Technology Inc.

Fire statistics in the United States are collected by means of a reporting system called the National Fire Incident Reporting System (NFIRS). This system is operated by the federal government, specifically the Federal Emergency Management Agency (FEMA). FEMA publishes some statistics from this database, but a more comprehensive analysis is provided by the National Fire Protection Association (NFPA). From this data, we can determine that approximately 20% of structure fires reported to fire departments (these are the only fires that are counted) are classified as electrical fires.



### DEFINING AN ELECTRICAL FIRE

What exactly is an electrical fire? Some countries have such antiquated reporting systems that if a person overheats a pan of cooking oil on an electrical stove (and the burning oil ignites their kitchen), it's reported as an "electrical fire." Most readers realize that such a definition is inaccurate. But what is the best definition? Although our industry has not hashed this out, in my view we can use the following definition: "Electrical fire — a fire occurring due to a static electricity discharge or an electrical fault or failure."

This definition recognizes that wiring or equipment must malfunction in some way for a fire to occur. It also recognizes that static electricity (which includes lightning) must be encompassed, but that "fault" or "failure" are not terms that are usefully applied to static electricity. This is because (apart from certain specialized equipment) static electricity discharges are not a normal feature of our environment.

Electrical fires are the No. 2 cause of structure fires, while the No. 1 cause is cooking, as noted in NFPA's "Home Structure Fires," written by Marty Ahrens and Radhika Maheshwari. NFPA claims that arson is the No. 4 cause but is only 8% of total structure fires. However, research has shown, including a report presented by Dr. David Icove on "Project Arson: Uncovering the True Arson Rate in the United States" at the International Symposium on Fire Investigation in 2014, that with regard to arson, NFIRS statistics are suspect, and the true value is probably much higher. But the 20% or so fraction of electrical fires may actually also be higher. The problem is that while EEs or electrical inspectors are trained and qualified to understand electrical fires, fire department personnel generally are not. Thus, fires reported as "undetermined" are

likely either electrical or arson, with the fire department unable to make a definitive finding.

Another problem with NFIRS is that the system does not have a single "bin" for electrical fires. There is a bin for electrical distribution and lighting equipment, but it only covers the electric power distribution system. Much of the remaining electrical fire cases fall under various categories of "equipment." From such categorization, it's difficult to determine what is an electrical cause and what isn't.

Let's take water heaters as a simple example of equipment. These plumbing fixtures are rarely abused or misused, but they do fail and cause fires. However, the statistics don't consider that some water heaters are electric while others are gas-fueled. The latter may be associated with fire incidents, but they will not be electrical fires. Thus, the 20% value will not be directly found in the NFPA reports and requires some effort to make the best estimates and tally all contributing factors.

## TOP CAUSES OF ELECTRICAL FIRES

Although it's useful to know what fraction of all fires is electrical, it is even more relevant to examine the causes of these electrical fires. Here, the national statistics are also not absolute. **Table 1** shows the breakdown of fires as established by NFIRS. The lack of knowledge is evident in the dominance of "unclassified" and "unspecified."

Given this unsatisfactory situation, the best recourse is to reflect on forensic experience. I have had a long career in fire safety science, with the last 25 years predominantly focused on forensic work. **Table 2** shows rankings I produced based on my experience.

The top three mechanisms should be of major concern to all persons involved in electrical safety. The No. 1 mechanism is poor connections. Yet, NFIRS statistics do not recognize this category at all. It also does not recognize No. 2, which is arc tracking. Another important thing to note about this list is that there is no entry for "short circuits." Clearly, short circuits occur and can be dangerous. Nevertheless, they do not comprise a single mechanism by which a fire can start. The mechanisms that might be involved in short-circuiting are many, but certainly arcing in air, ejection of hot particles, and dielectric breakdown of solid insulation will be important ones.

For a breakdown of mechanisms that is based on statistical study rather than forensic experience, let's turn to a Canadian governmental agency that readers may not be acquainted with: the Electrical Safety Authority (ESA) of Ontario. This agency has a mission to study electrical accidents and injuries, including

| Factor Contributing to Ignition | Percent |
|---|---|
| Unclassified electrical failure or malfunction | 51% |
| Unspecified short-circuit arc | 24% |
| Short circuit arc from defective or worn insulation | 10% |
| Arc or spark from operating equipment | 6% |
| Arc from faulty contact or broken conductor | 5% |
| Short circuit arc from mechanical damage | 4% |

**Table 1.** Three-quarters of electrical fires are unclassified or unspecified.

| Mechanism | Importance |
|---|---|
| Poor connections | Most ↓ Least |
| Arcing across a carbonized path (arc tracking) | |
| Arcing in air | |
| Excessive thermal insulation | |
| Overload | |
| Ejection of hot particles | |
| Dielectric breakdown in solid or liquid insulators | |
| Miscellaneous phenomena | |

**Table 2.** Physical mechanisms causing electrical fires, ranked according to importance by expert judgment.

| Ignition mechanism | Category | Total Incidents | Percent |
|---|---|---|---|
| Poor connection, high-resistance fault | Resistive | 48 | 21.8% |
| Series arc | Arcing | 46 | 20.9% |
| Overloaded equipment | Resistive | 38 | 17.3% |
| Short circuit | Resistive | 24 | 10.9% |
| Parallel arc: arc tracking | Arcing | 14 | 6.4% |
| Overloaded circuit | Resistive | 13 | 5.9% |
| Sparks | Arcing | 13 | 5.9% |
| Parallel arc: arcing through char | Arcing | 11 | 5.0% |
| Static electricity ignition of gases or dust clouds | Arcing | 6 | 2.7% |
| Overvoltage, undervoltage, open neutral | Resistive | 4 | 1.8% |
| High-voltage arc | Arcing | 3 | 1.4% |
| Direct contact of combustibles to heat source | — | 39 | — |
| Unknown | — | 59 | — |

**Table 3.** Data for ignition mechanisms in Ontario fires (2002 to 2007).

fires and electric shock incidents.

In 2008, this agency set out to find the mechanisms that led to electrical fires in Ontario. Their results, collected from the Electrical Safety Authority's "Electrical Ignition Causes of Fires in Ontario from 2002 to 2007," are shown in **Table 3** on page 10.

The percent values presented exclude the unknowns and direct contact of combustibles to a heat source (which are not electrical fires according to the prior definition). The outcome is not perfect, but it is more useful than the NFIRS output.

Poor connections are the No. 1 cause, which aligns with my experience in the United States. Since arc tracking and arcing through char are considered synonyms, both by myself and by NFPA, they should not be placed into separate categories. Short circuits, as stated, are not a unique physical mechanism. Also, overvoltage is not a failure mechanism; if it results in overload, then overload is the mechanism, while dielectric breakdown is another possibility. Thus, although the ESA scheme is not flawless, it is a major advance over what NFIRS has to offer in the United States.

Although it's useful to know what fraction of all fires is electrical, it is even more relevant to examine the causes of these electrical fires.

## THE UNITED STATES VS. CANADA

In fairness to the U.S. situation, it is important to emphasize that the ESA statistics were compiled by EEs working at ESA and analyzing in detail electrical fire incidents. Such resources are not available to the fire departments that input their data into NFIRS. Overall, though, electrical fires in Ontario, Canada, are likely to be much more similar than dissimilar to those in the United States. Thus, the ESA findings should be helpful to safety specialists not only in Canada but also in the United States. Note that this study was a one-off effort so data for later years is unavailable. EC&M

*Dr. Vyto Babrauskas is a forensic science specialist working in the areas of fire and explosion safety. He recently published the handbook, "Electrical Fires and Explosions," in April 2021. He can be reached at vytob@doctorfire.com.*

# Connectivity Tips for Switchgear and UPS PQ Monitoring

To ensure a stable power supply, monitor power quality so that electrical devices are protected from unwanted interruptions and damaging fluctuations.

By Moxa

As more electrical devices are deployed in industrial applications, the need to protect these critical systems increases. Unexpected power outages lead not only to higher maintenance costs of electrical equipment, but also to lower operational efficiency, productivity, and overall business revenue. To ensure a stable power supply, facility managers need to monitor power quality so that electrical devices are protected from unwanted interruptions and damaging fluctuations.

Switchgear and uninterrupted power supplies (UPSs) are two essential pieces of equipment to consider when developing a comprehensive power quality monitoring plan. Switchgear components control, protect, and isolate electrical equipment from abnormal fluctuations in electricity. As a result, the facility manager needs to constantly monitor the status of circuit breakers, surge protectors, current transformers, and power quality meters used inside the switchgear. In addition, UPSs are valuable for providing nonstop power supply when the main power source fails and the backup power supply, such as a generator, is not immediately available.

To monitor the real-time status of a system, the switchgear and UPS need to connect with an energy management system (EMS) so that operators can make instant decisions to minimize system downtime. Establishing a reliable communication system allows the operator to monitor power quality and respond to emergencies quickly.

Image courtesy of Moxa

Consider the following three tips when developing communication systems for power quality monitoring applications:

**Tip 1.** The communication system needs to withstand high electromagnetic interference (EMI). As for electrical equipment, communication systems for power quality monitoring also need to be protected to ensure operators can receive the real-time status of power quality. Communication devices are typically located near power equipment that generates high EMI, which can easily interrupt network communications.

To minimize EMI interruptions, use fiber cables that provide strong EMI immunity over long distances and

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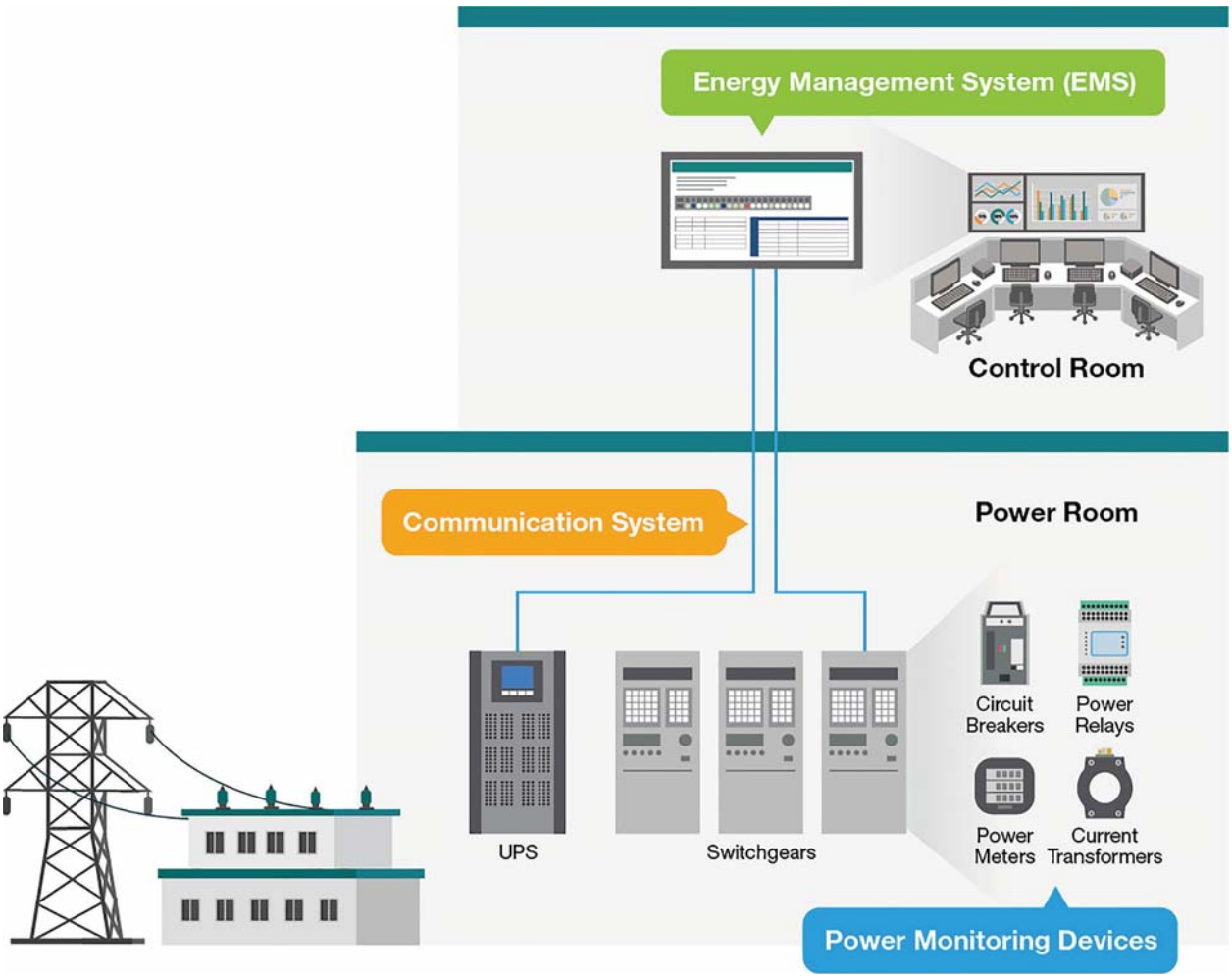


Switchgear and the UPS need to connect with an energy management system (EMS) to monitor the real-time status of an application's power quality.

are a suitable option for transmitting data from the power equipment to the control center. Connectivity devices should also feature additional protection mechanisms, such as dual-power and dual-port inputs, ensuring nonstop operation if one of the power sources or ports fails.

**Tip 2.** The communication system requires rapid recovery to reduce downtime. Connected devices for power quality monitoring are typically serial-based and use industrial protocols, such as Modbus RTU. On the other hand, EMSs typically use Ethernet-based OT/IT protocols, such as Modbus TCP, SNMPv3, and BACnet/IP. It usually takes a protocol gateway to enable communication between these devices and systems. When communication errors occur, operators cannot receive the status of power quality in time, making it difficult to spot abnormalities for incident responses. Furthermore, it is challenging for engineers to perform root cause analysis when they lack sufficient information and need to overcome the increased complexity of troubleshooting across different protocols. When choosing a protocol gateway for a communication system, check if it comes with troubleshooting tools that can help quickly identify the root cause of an incident and get the system back online quickly.

**Tip 3.** Plan wisely for the communication network, and get power data online easily and securely. When developing a power quality monitoring application, there is a need to collect not only power-related data, but also environmental data to ensure a stable power supply without environmental interruptions. Both power and environmental sensors come in a variety of interfaces, so choose connectivity solutions that are easy to install and maintain in a space-limited cabinet.

The network plan should also include connectivity security. When switchgear and UPS equipment are connected over public networks, they may expose systems to potential threats. Thus, networking devices must be protected so that vulnerabilities cannot be exploited by hackers. EC&M

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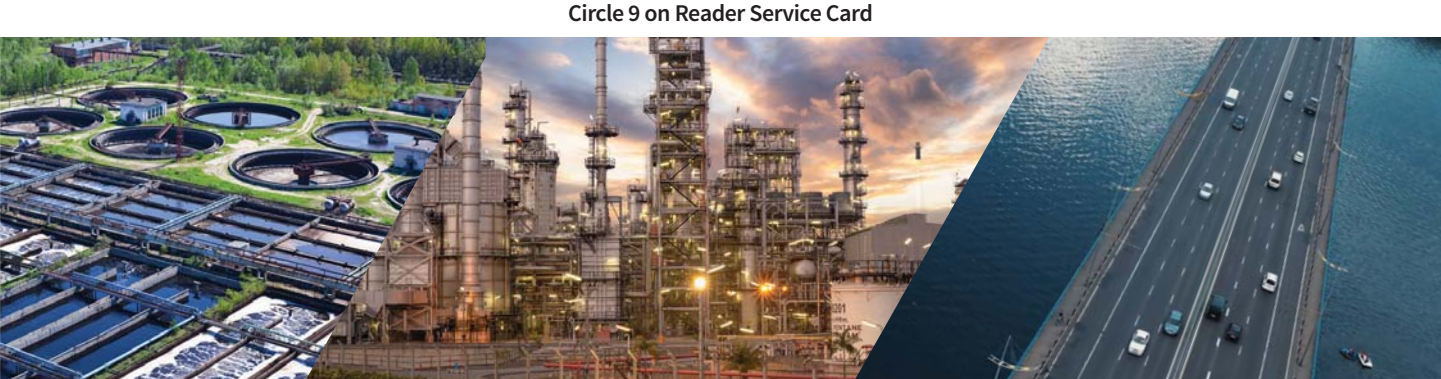

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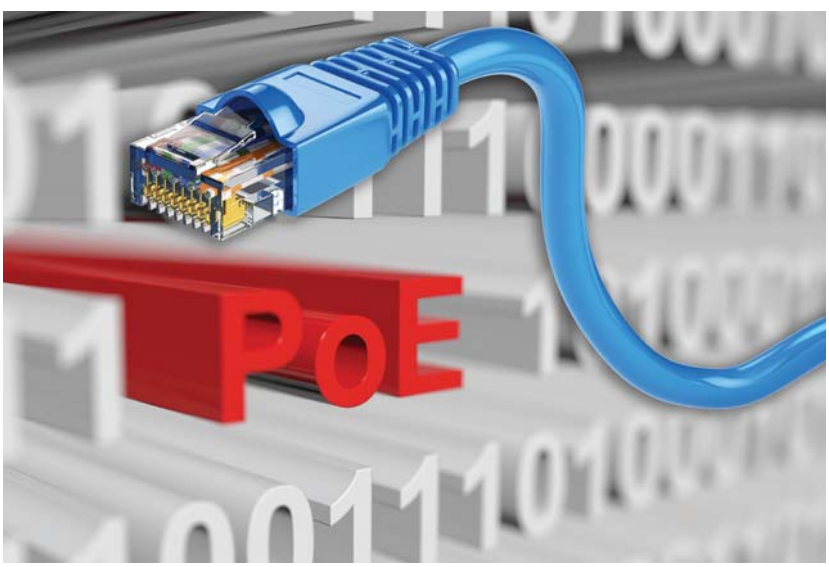
# Raise Your Power over Ethernet Comfort Level

## Knowing the ins and outs of this technology can help you seize new opportunities.

By Mark Mullins, Fluke Networks

As an electrician, there's no doubt you're hearing a lot about Power over Ethernet (PoE) as a means of delivering low-voltage DC power over network cabling to LED lights. With 90% growth expected in the next 10 years from PoE lighting alone — and many jurisdictions allowing installation of these systems by low-voltage contractors rather than licensed electricians — you need to get out in front of this technology. To take full advantage of the opportunity and ensure that your PoE lighting installations go smoothly, however, you need to understand how PoE works, the various standards and classifications, performance parameters, and how best to test and troubleshoot these systems.




### HOW DOES PoE WORK?

You probably already know how DC power works. You're also probably familiar with implementing AC-to-DC conversion technology to distribute DC power to LED lights and other DC-powered devices. PoE is a bit different in that it eliminates the need for any AC power or conversion, delivering DC power directly over the same cable used to connect devices in an IT network, such as Category 5E, 6, or 6A balanced twisted-pair cables. Unlike unintelligent non-networked DC-powered devices, PoE devices also transmit data, such as control information for lighting systems (i.e., luminosity, color temperature, etc.) or a video signal for a surveillance camera.

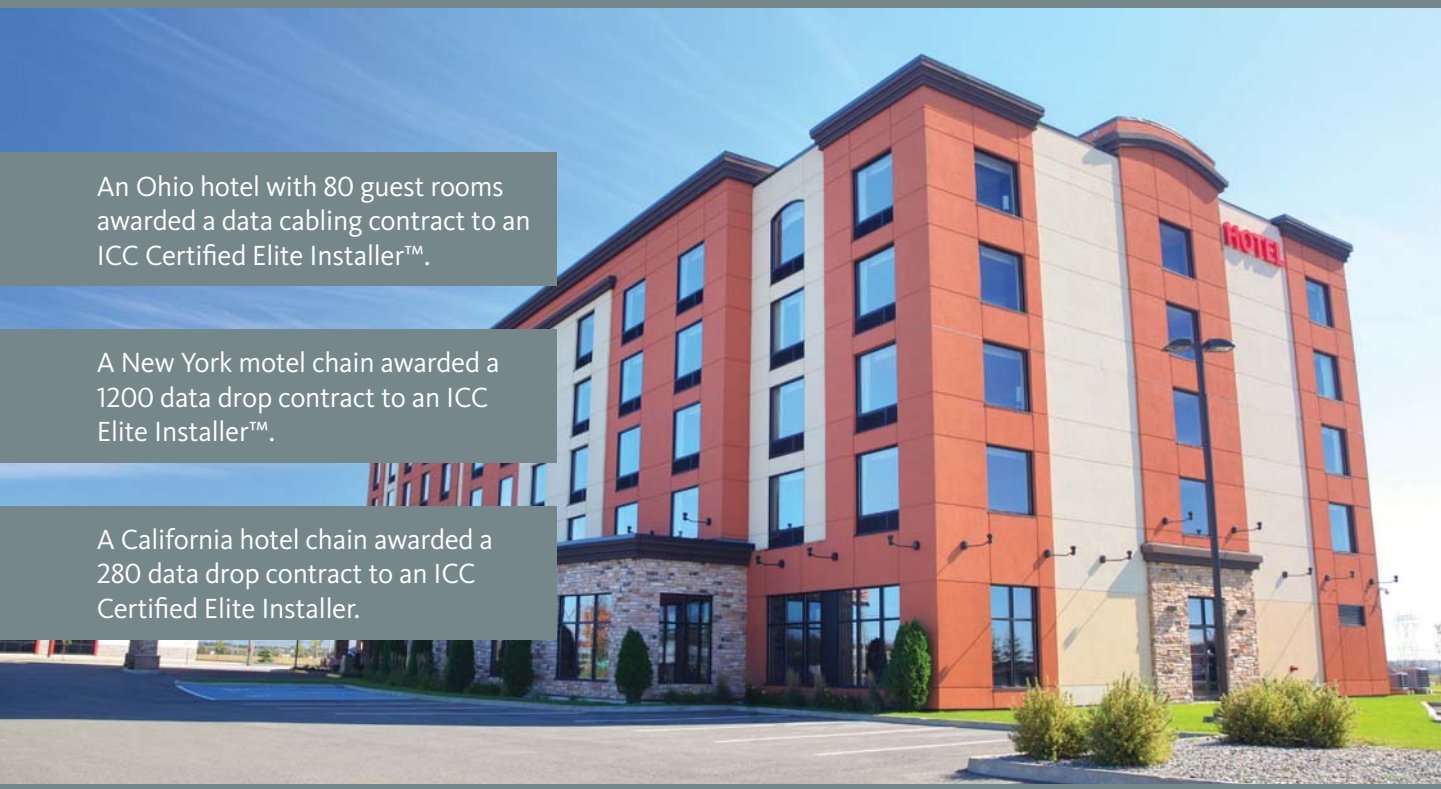
In a PoE circuit, DC power is delivered to a powered device (PD) such as an LED luminaire from power sourcing equipment (PSE). This is typically a PoE-enabled Ethernet network switch located in an IT telecom room. For customers that have non-PoE switches, power can be delivered using a PoE injector that sits between the switch and the device.

Regardless of the type of PSE, power is delivered by the PSE only after it is requested by the PD. If the PD is disconnected, then the PSE will remove power. This is referred to as a PoE handshake. It works by the PSE sending out detection signals to determine if a PD is connected and then supplying the amount of power requested by the PD. This handshake ensures non-PoE devices on the network do not receive DC power that could damage sensitive electronics. In addition, it improves safety over other power delivery methods that always have power flowing, regardless of whether a device is connected. It's important to note that with PoE, the voltages are only in the range of 43VDC to 57VDC and are therefore considered to be safety extra-low voltage (SELV).

PoE power can be delivered differently depending on the power level and type of PoE being used, which is defined by its IEEE standard. The first PoE standard introduced in 2003 was the IEEE 802.3af standard, referred to as Type 1, which delivers a maximum of 15.4W (13W available at the device). This was followed by IEEE 802.3at Type 2 (sometimes referred to as PoE+) in 2009, which delivers maximum power to 30W (25.5W available at the device).

Both Type 1 and Type 2 PoE deliver power over just two pairs of a four-pair cable using one of two methods — Alternative A and Alternative B. As shown in **Fig. 1a** and **Fig. 1b** on page 18, Alternative A power is delivered simultaneously with data over pairs 1-2 and 3-6, while Alternative B is delivered over spare pairs 4-5 and 7-8. Alternative B is only

# Are You Profitable Installing Hotel Cabling Projects?

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compatible with lower-speed systems that only require two pairs for sending data, while Alternative A is compatible with both two-pair and four-pair data systems.

In 2018, IEEE introduced the 802.3bt standard that delivers power across all four pairs simultaneously with data to provide more power. Referred to as four-pair PoE (4PPoE) and sometimes denoted as PoE++, this standard includes Type 3 that delivers a maximum of 60W (51W available at the device) and Type 4 that delivers a maximum of 90W (71.3W available at the device), as shown in **Fig 2** on page 20.

Before the IEEE 802.3bt standard, switch manufacturer Cisco introduced a proprietary four-pair PoE technology referred to as Universal PoE (UPoE) that was able to deliver a maximum of 60W. Cisco UPoE is now capable of delivering 90W of PoE and is in complete compliance with 802.3bt standards. Thus, the term UPoE is often used interchangeably with 4PPoE or PoE++.

Regardless of which type of PoE is being used, DC power is transmitted over the pairs by applying common-mode voltage, meaning that the current is split evenly between each pair and between the two conductors of a pair.

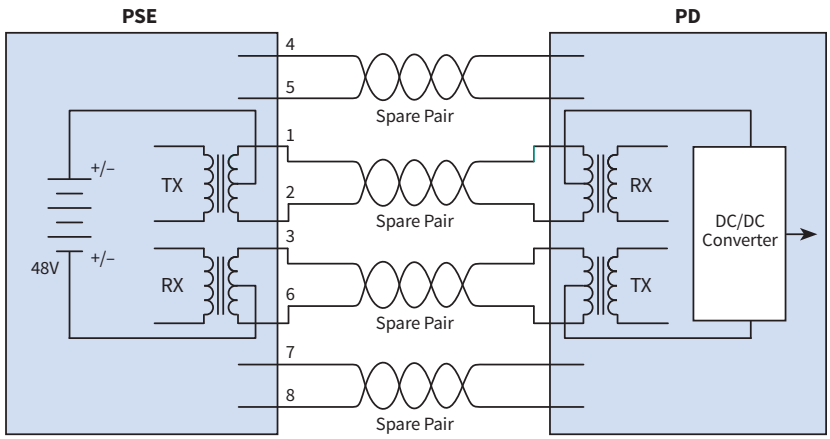



**Fig. 1a.** Alternative A – Power is delivered over pairs 1-2 and 3-6 simultaneously with data.

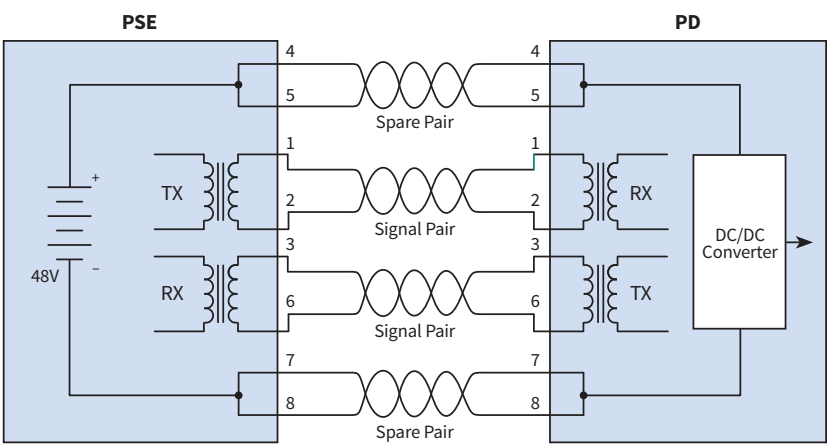



**Fig. 1b.** Alternative B – Power is delivered over spare pairs 4-5 and 7-8.

## DEFINING PoE CLASSES

IEEE PoE standards and types encompass a wide range of power. For example, while Type 1 delivers a maximum power of 15.4W with 13W available at the device, some devices may only need 7W of power or less. To further define the power levels, PoE is divided into eight classes ranging from Class 1 with just 4W delivered, to Class 8 with the maximum 90W delivered as shown in the **Table** on page 20, which demonstrates the IEEE standards and the various classes within those standards.

To facilitate implementation, the Ethernet Alliance developed a PoE certification program for easily identifying PSEs and PDs by class to determine compatibility. This program tests and certifies products with a simple marking system that shows the class for PSE and PD (**Fig. 3** on page 20). If the label on the PSE indicates a class that is equal to or higher than the PD, they are compatible.

Another reason for classification is to allow power requirements to be negotiated for better management of the PSE's total power budget. For example, if the PSE is Class 6, but the PD is only Class 5, the PSE can match the requirements of the device rather than putting out more power than is required.

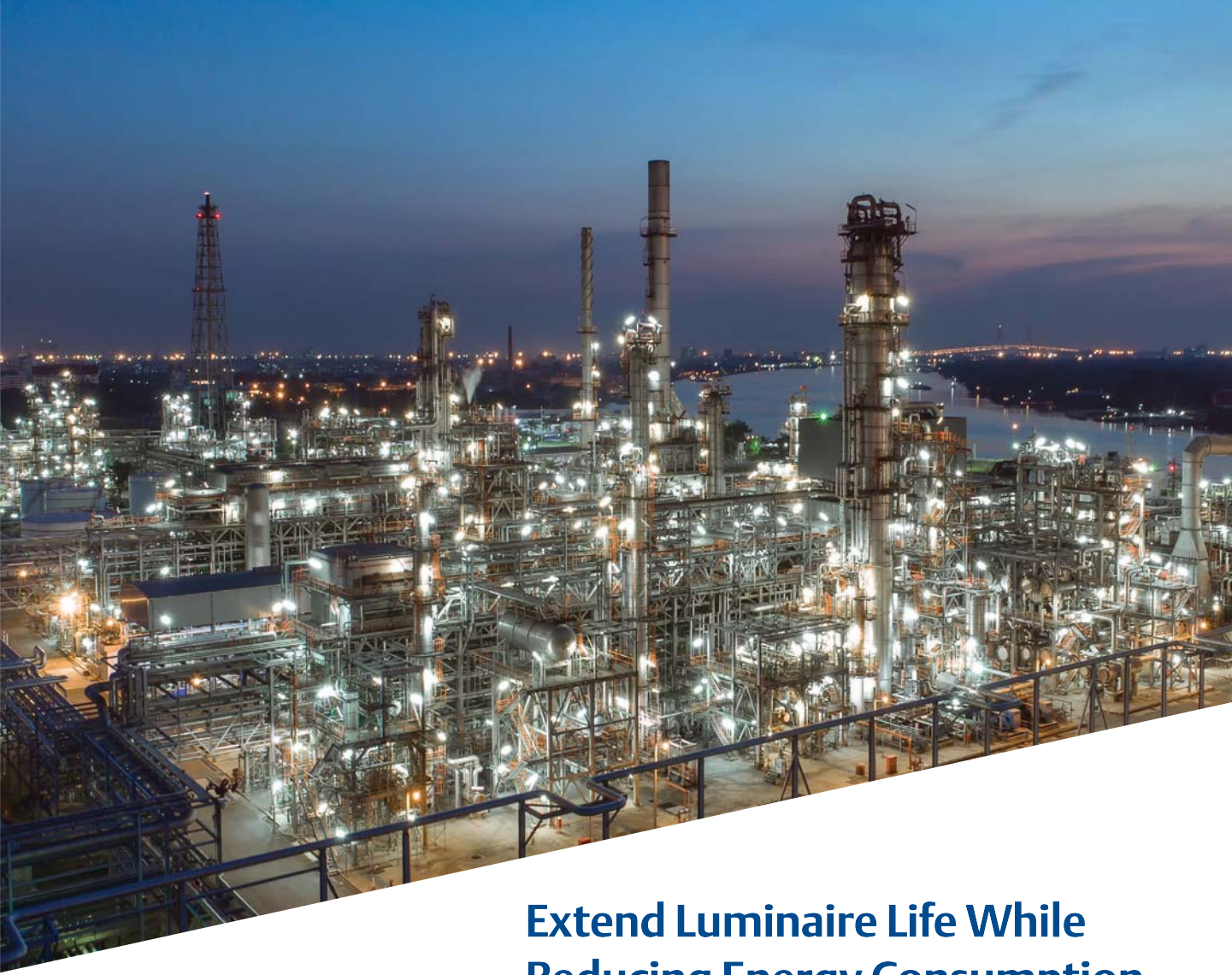
## POTENTIAL PoE PITFALLS

In low-voltage twisted-pair cabling for networks, there are a variety of performance parameters defined by industry standards that need to be considered because they can impact data transmission, such as length, attenuation, crosstalk, and return loss. Network cable plants are tested for compliance to industry standards for certification, which typically is required to achieve a vendor warranty from the cabling system manufacturer. When it comes to PoE, there are additional performance parameters to consider.

As previously mentioned, PoE is delivered via a common-mode split between pairs and between conductors of a pair. For this power split to happen, the DC resistance between two conductors in a pair and the DC resistance between pairs must be balanced. If DC resistance is not balanced, it can cause PoE to malfunction and distort the data signals transmitting on the same pairs. Industry standards specify the maximum DC resistance unbalance within a pair and from pair-to-pair.

It's important not to confuse DC loop resistance and DC resistance unbalance. Measured in ohms (Ω), DC loop resistance is the sum of the DC resistance of two conductors in a pair looped at one end of the link, rather than the difference (**Fig. 4** on page 22).

In addition to DC resistance unbalance, bundles of network cables



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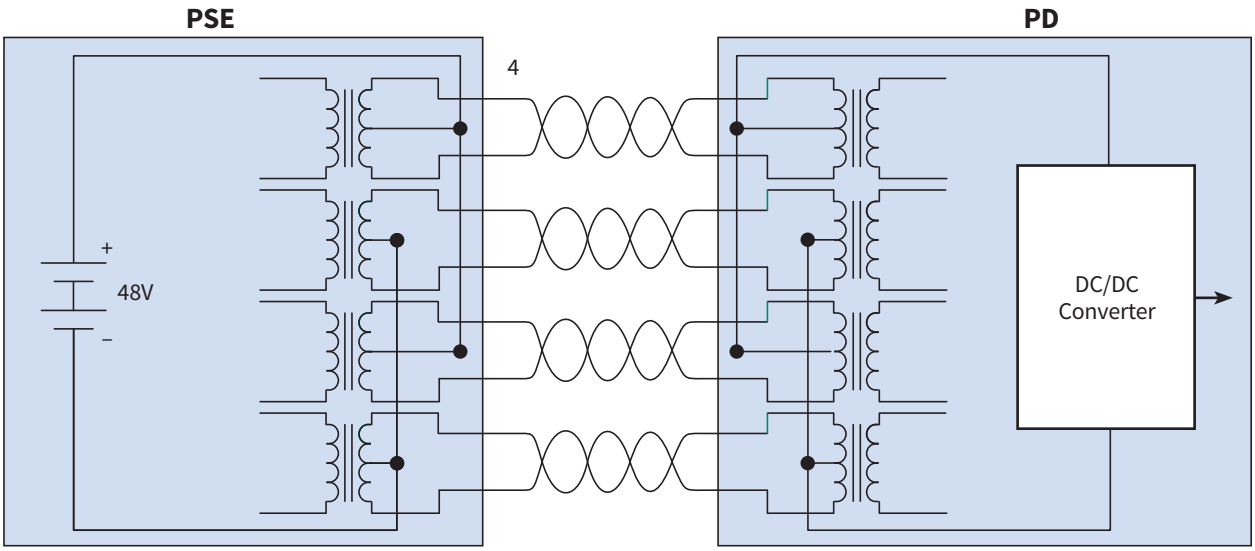


**Fig. 2.** Four-pair PoE — Power is delivered over all four pairs simultaneously with data.

| | Type 3 PoE (802.3bt) | | | | | | | Type 4 PoE (802.3bt) |
|---|---|---|---|---|---|---|---|---|
| | Type 1 PoE (802.3af) | | | Type 2 PoE (802.3at) | | | | |
| No. of Pairs | 2-pair only (Type 1 and 2) | | | | Always 4-pairs | | | |
| | 2-pair or 4-pair (Types 3 and 4) | | | | | | | |
| Class | Class 1 | Class 2 | Class 3 | Class 4 | Class 5 | Class 6 | Class 7 | Class 8 |
| PSE | 4W | 7W | 15.4W | 30W | 45W | 60W | 75W | 90W |
| PD | 3.84W | 6.49W | 13W | 25.5W | 40W | 51W | 62W | 73.3W |

These are the PoE types, standards, and classes.

delivering PoE can experience heat rise with the cables, especially those in or near the middle of a bundle, with no way to dissipate the heat. When the temperature within network cables increases, signal loss (i.e. attenuation) also increases. In network cabling, this signal loss is referred to as insertion loss. Just like in AC electrical systems, the higher the power level and smaller the cable gauge, the more the cables heat up.

Heat rise within bundles of cables carrying PoE can especially be of concern in higher temperature environments such as above the ceiling in hot climates. Because heat rise can cause signal loss, it can prevent proper data transmission and prevent PoE devices from functioning. To address the issue, the National Electric Code (NEC) requires that Class 2 and Class 3 circuits carrying more than 60W of power comply with bundling requirements. Section 725.144 of the NEC includes ampacity tables for four-pair cables that provide recommended bundle sizes based on the temperature rating and gauge of the cable, as well as the ampacity (current expressed in amperes) carried by each conductor in the cable.


**Fig. 3.** Shown here are Ethernet Alliance marks for PDs (left) and PSEs (right).

Using the ampacity tables can be avoided by not bundling cables during installation or through the use of Class 2 or Class 3 LP-rated cables that are listed by UL as suitable for carrying power and data circuits up to their marked ampere limit for each conductor without exceeding the temperature rating of the cable. If LP-rated cables and avoiding bundles are not an option, it is recommended to keep bundle sizes to 24 cables. In bundles

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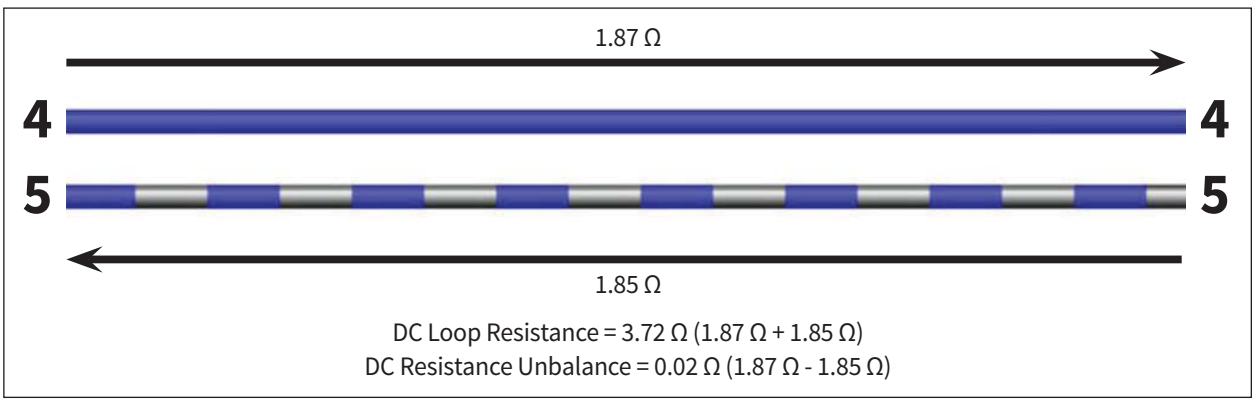


**Fig. 4.** DC loop resistance is the sum of the DC resistance of two conductors in a pair, while DC resistance unbalance is the difference in resistance between the two conductors.

of 24, cables that are 24 AWG or larger with a minimum operating temperature of 60°C (i.e., typical for most category twisted-pair network cables) will not cause an issue in most installations.

## HOW TO TEST AND TROUBLESHOOT PoE

In AC power systems, you're familiar with voltage drop calculations and measuring voltage with a digital multimeter. The first recommendation for testing PoE systems is to field test the cabling for DC resistance unbalance. While vendors may specify a DC resistance unbalance value on their cable, field testing is recommended. This is because it is often caused by poor workmanship, such as exceeding maximum bend radius, not maintaining pair twists as close to the point of termination as possible, or not terminating each conductor consistently.

Fortunately, there are cable testers on the market that enable testing for DC resistance unbalance along with other important data performance parameters. The tester screens in **Fig. 5** show testing results for DC resistance unbalance on individual pairs (PAIR UBL) and between pairs (P2P UBL). Note that these tests are not part of the standard Category cable field tests and should be specified and enabled in addition to those tests. This further testing adds a negligible amount of time to a standard Category test.

If you need to troubleshoot the system once the actual PSE is up and running, you will want to check the class to make sure that the class of the PSE is equal to or higher than that of the PD. An easy way to accomplish this is with a network tester that, when connected to the PSE, can display the class (1-8) of power available on the link. That information can then be compared to the specifications of the PD.

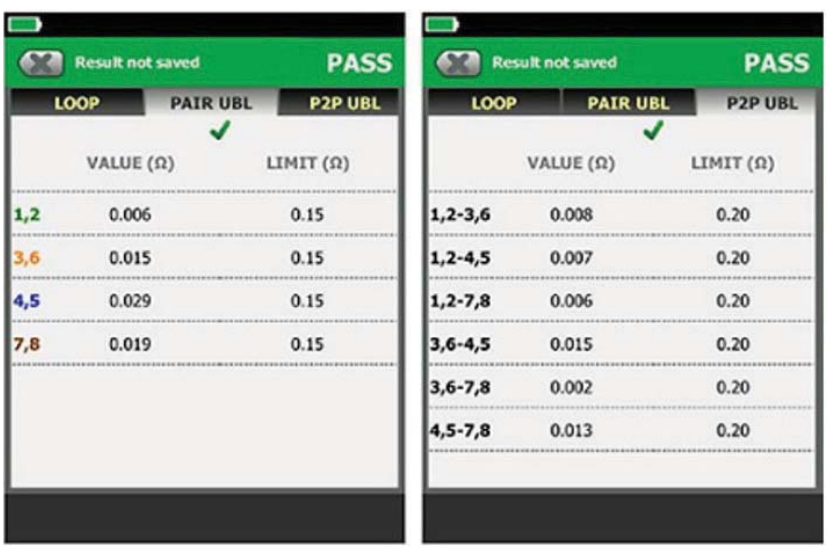


**Fig. 5.** Testers are available that test DC resistance unbalance on individual pairs and from pair to pair.

The final option for troubleshooting is PoE load testing, which involves acquiring real-time information about the actual amount of power at the PD. If there is a problem with the PSE (such as incorrect configuration or too many devices requesting too much power), or excessive loss along the length of the cable, then the amount of power may not match the class of power required by the PD.

To conduct PoE load testing, you need a tester that can communicate with the PSE. These testers then place a load on the connection and measure exactly how much power is being delivered.

While you may be new to PoE, it doesn't have to be complicated. With the right tools, equipment, and training, you can add this type of work to your service offering and compete with low-voltage specialty contractors. EC&M

*Mark Mullins currently oversees Fluke Network's Global Communications efforts. As a member of the Ethernet Alliance Marketing Committee, he is responsible for promoting the Gen 2 Power over Ethernet Certification program. He can be reached at mark.mullins@flukenetworks.com.*

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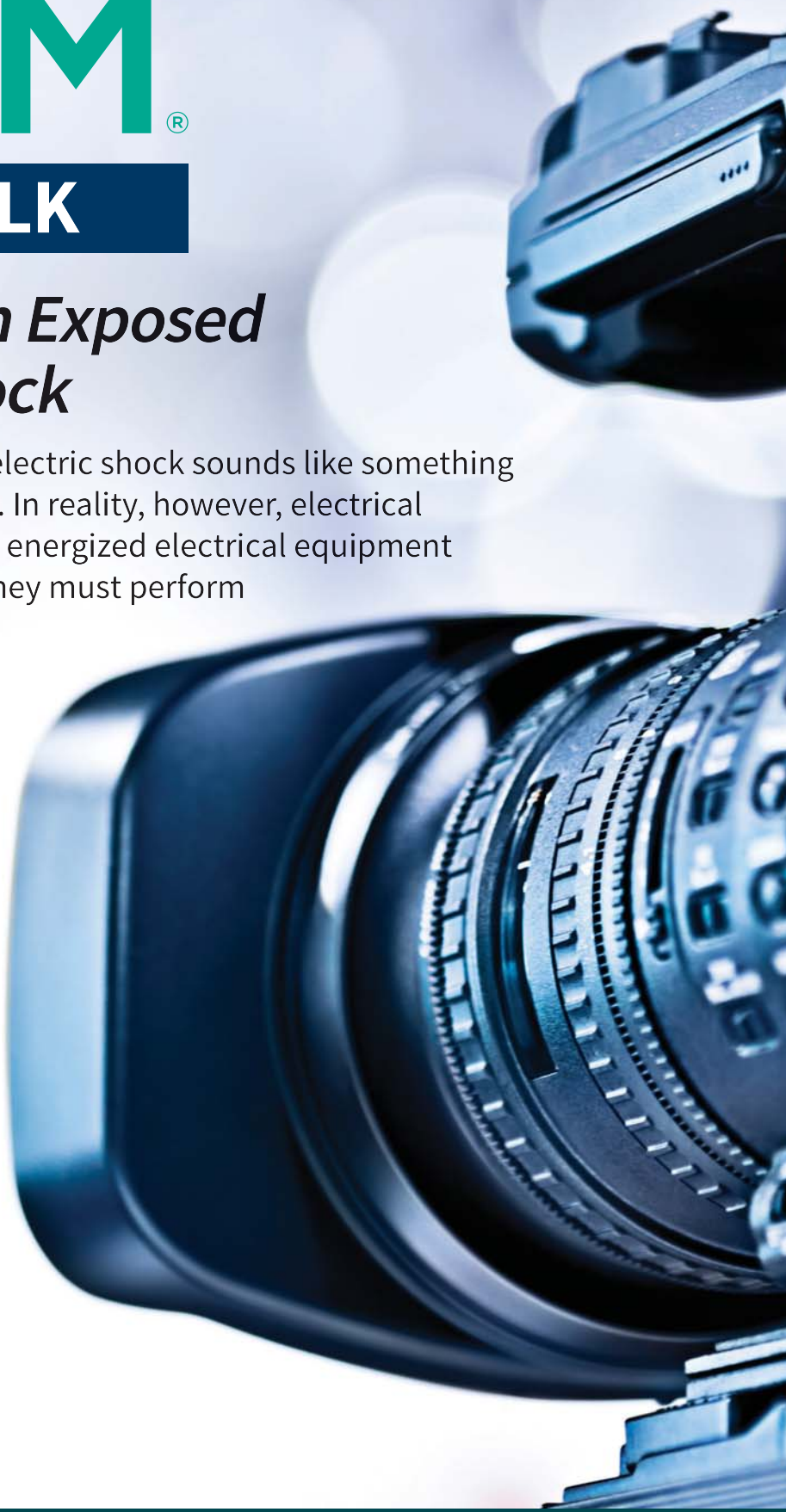
TECH TALK

# *Working When Exposed to Electric Shock*

Working when exposed to electric shock sounds like something we would never want to do. In reality, however, electrical workers must troubleshoot energized electrical equipment every day. In some cases, they must perform repair or installation work while exposed to energized conductors and circuit parts. In the December Tech Talk video, we will review the requirements for working under such conditions.

In particular, we will look at the insulated tools available on the market to keep us safe, their requirements, and practical applications.



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# The Importance of Contract Documents in an Estimate

## Become familiar with the documents that control every aspect of a project.

By Don Kiper, Estimating 101

Most estimates are prepared from plans and specifications, collectively known as "the contract documents." These documents should provide the contractor with the necessary information to bid on the project.

Every aspect of a project will be controlled by the contract documents, and the contractor's work will be judged by them. The contract documents are how the architect and engineer communicate the design to the contractor. The consequences of failing to understand the requirements of the contract are significant.

The "drawings" outline the quantity of work, and the "specifications" clarify the quality of work. The drawings and the specifications should identify and specify every material item and the means of installation.

Early in his or her career, the estimator should have a full understanding of the contract documents. They are binding between an owner and contractor. Every estimator must become familiar with these documents and how to interpret them because the estimate can only be as accurate as the estimator's interpretation. Risks increase when the estimator fails to properly understand these documents.

When someone refers to the plans and specs, he or she is referring to the drawings and the project manual.


### PART 1: UNDERSTANDING THE DRAWINGS

The most basic skill in becoming a quality estimator is the ability to read construction drawings. Drawings are filled with symbols, abbreviations, and notes that an estimator must translate into material quantities and/or labor hours. Drawings communicate the desired wishes of the owner and the requirements of the architect.

The architect is the lead designer of the project but does not do all the design work. He is usually assisted by consulting engineers, such as civil, structural, mechanical, plumbing, and electrical. The architect oversees coordination of the consulting engineers and compiles the final set of design drawings.

Most drawings start with a cover sheet that provides general information about the project. There are 11 basic disciplines of drawings.

**1. Life Safety** — These provide for quick reviews of critical life safety items, including construction type per allowable area, occupant loads, means of egress, fire protection systems, fire department vehicle access, hydrant locations, and more.

**2. Phasing** — Some projects require portions to be completed in succession. The phasing drawings usually indicate specific areas and their completion date.

**3. Landscape** — Landscape drawings may include landscape luminaires and site luminaires.

**4. Civil** — These drawings typically include grading, site utilities, drainage, streets, roadways, and curbs.

**5. Structural** — Structural drawings provide the estimator with the main structure design. Slab thicknesses, foundation types, and expansion joints are found on these drawings.

**6. Demolition** — Renovations to existing facilities usually have demolition drawings. They provide areas set for complete demolition and selected removals.

**7. Architectural** — These plans are prepared by an architect. They typically

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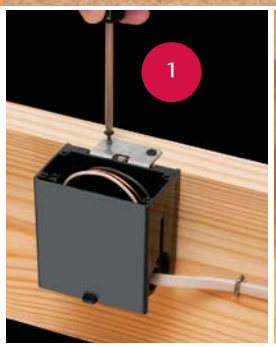


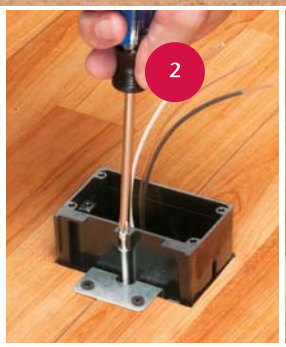


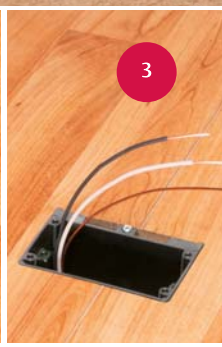


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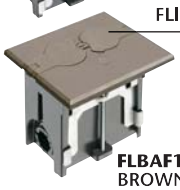


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include floor plans, elevations, and sectional plans. This set will also include finish schedules, door schedules, and architectural details.

**8. Mechanical** — The architect will employ a consulting engineer to prepare the mechanical drawings. The mechanical drawings sometimes include HVAC and plumbing requirements. They should also include ductwork, air handlers, condensing units, and other equipment associated with climate control of the building.

**9. Plumbing** — These detail the water lines, plumbing fixtures, sewer lines, and gas lines.

**10. Electrical** — These typically include the following drawings: site power, site lighting, branch power, lighting, fire alarm, communications, and schedules. They also include a one-line diagram of the power feeders.

**11. Telecommunications** — Sometimes the electrical engineer will provide a separate set of drawings that include all telecommunications. These drawings include, but are not limited to, data outlets, horizontal cabling, cable trays, and data racks.

## PART 2: DRAWING TYPES

A project's drawings will not only have a combination of different disciplines, but also different types of drawings. Each drawing type provides important information that will help estimators understand the project. There are four basic types of drawings.

**1. Plans** — A plan view is a horizontal view looking down from the top of the building. Most projects have more than one plan (e.g., foundation plans, floor plans, and framing plans).

**2. Elevations** — Elevation drawings show how the building or structure looks from the outside. Typically, all four sides of a building are shown.

**3. Sections** — Section drawings are used to show key components of the building. These drawings are a close-up view of how the structure is going to be constructed.

**4. Details** — Details on drawings are a blown-up view of a selected portion of the work. For example, a detail on a drawing may show how the cable tray will be supported. Projects may also have details for the following: luminaire hanging details, utility pole connections, mechanical equipment, and poke-thru assemblies.

| Specification Groups | |
|---|---|
| **Subgroups** | **Divisions** |
| 1. General Requirements | 01 |
| 2. Facility Construction | 02-19 |
| 3. Facility Services | 20-29 |
| 4. Site and Infrastructure | 30-39 |
| 5. Process Equipment | 40-49 |

Estimators should familiarize themselves with the CSI MasterFormat Organizational Structure.

## PART 3: THE PROJECT MANUAL

The project manual is the second part of the contract documents. The project manual is sometimes referred to as the "specs." The estimator must understand the conditions of the contract and the effect they have on the bid price.

The estimator will need to do a thorough review of the spec sections that are applicable to the project he or she is bidding.

**1. Bidding documents** — The bidding documents typically include the following: Advertisement for Bids, Instructions to Bidders, Bid Forms, and the Agreement Form or Contract.

**2. General conditions** — The general conditions set forth the rules by which the project is constructed and administrated.

**3. Supplemental conditions** — The supplemental conditions deal with the project's specific matters related to the contract. Supplemental conditions also modify items in the general conditions.

**4. Technical specifications** — The technical spec sections will comprise the majority portion of the project manual. The primary purpose of this portion of the specifications is to set forth the following: quality of materials, the standard of workmanship, and methods of installation.

Most construction specifications are arranged by the CSI MasterFormat, as shown in the **Table** above. The estimator must be familiar with the format and arrangement of the specifications.

Within each division, there are product sections. These are broken into three parts: general, products, and execution. Understanding the products and execution portions is vital. The contractor must install the specified products in the right manner.

Section format descriptions are as follows:

**1. General** — The "General" heading indicates any related documents, a summary of the items, submittals, and quality assurance. Sometimes it includes the following: abbreviations, definitions, delivery, storage, handling, and warranty requirements.

**2. Products** — The "Products" heading provides manufacturers and a list of product types, catalog numbers, and specifications for each item.

**3. Execution** — The "Execution" heading offers installation means and methods. Under this heading, the following are listed: conduit types, minimum sizes and uses, conductor materials and insulations, connection types, mounting heights, and protection.

The drawings and the project manual should specify all materials and installation methods and standards for a project.

The estimator must have the ability to identify portions of the contract documents that are incomplete. When these documents are incomplete, the contractor's risk will increase. The wise estimator will seek clarification on omissions in the documents prior to bidding on the project.

Remember, the estimator must produce an estimate based on the drawing quantities and products specified in the project manual. EC&M

*Don Kiper is an independent electrical estimating trainer and consultant based in Niagara Falls, N.Y. He can be reached at don@electricalestimating101.com.*

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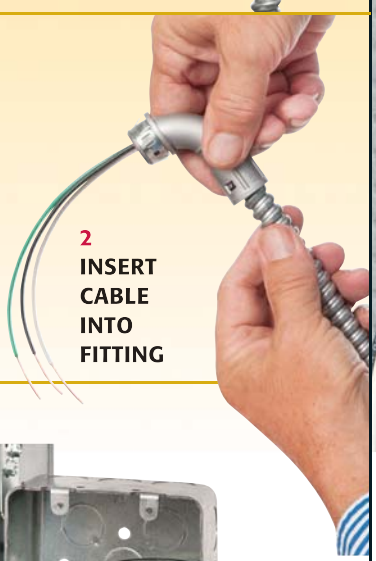

**2**
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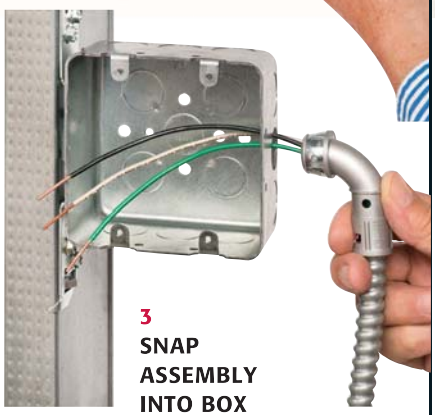

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|---|---|---|---|---|
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| **MCI-A** Steel & Aluminum | .440 to .550 | | .480 to .550 | |
| **AC90, ACG90** | .450 to .550 | | .480 to .550 | |
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# Sobering Stats for Electrical Contractor Workers' Comp Claims

## A leading insurer's long-time study of group claims places electrical contractors second highest on its list.

By Tom Zind, Freelance Writer

Curious whether your workers' compensation claims experience is in line with that of the rest of the specialty contracting world? A leading insurer may have some answers.

AmTrust Financial Services, Inc.'s, recent report that examined a decade's worth of claims (some 26,000 in total) from electrical, plumbing, HVAC, carpentry, and similar contractors shows that claims among that group skew to younger companies and newer workers; injuries from falls, strains, and burns are common and often consequential; and claims-inducing injuries peak in the summer months.

If you're an electrical contractor with claims experience, you are not alone. That specialty accounted for 19% of the AmTrust claims filed, second only to plumbers, who filed 28%, possibly reflecting outsized representation among the contractors covered, but perhaps indicative, too, of the presence of more workplace- or task-related dangers than other contractors.

Owing to routine work around electricity, electrical contractors might seem the most at risk among specialty contractors for worker injuries and claims. When it comes to chronic workers' compensation issues, however, the big risk probably doesn't come from contact with high voltage, but instead routine, day-to-day activities. AmTrust says 31% of claims from electricians were due to falls, while 27% were tied to sprains, in line with numbers for plumbers.

Falls have been getting more attention in construction workplace safety circles, and the report helps confirm the need. The median amount of lost work time due to falls or slips was 21 days, with 34 days the median for falls from ladders or scaffolding, which along with lifting strains produced the most claim-producing injuries (**Fig. 1** on page 30).

By comparison, the median lost time for all injuries was 13 days. Others exceeding that included burns at 19 days and cuts at 14 days. At 11 days, strains came in under the all-injury average, but those related to repetitive motion and reaching were 23 and 17, respectively. Injuries that resulted in the most lost workdays were falls, burns, and abrasions.

Recuperation times for workers employed by artisan contractors may be poised to move higher because the workforce is aging. While employees with less than a year of experience accounted for one-third of the claims AmTrust examined, those with six-plus years accounted for almost another third (see **Fig. 2** on page 30).

That might suggest younger workers are getting injured because they're less experienced, but older workers are

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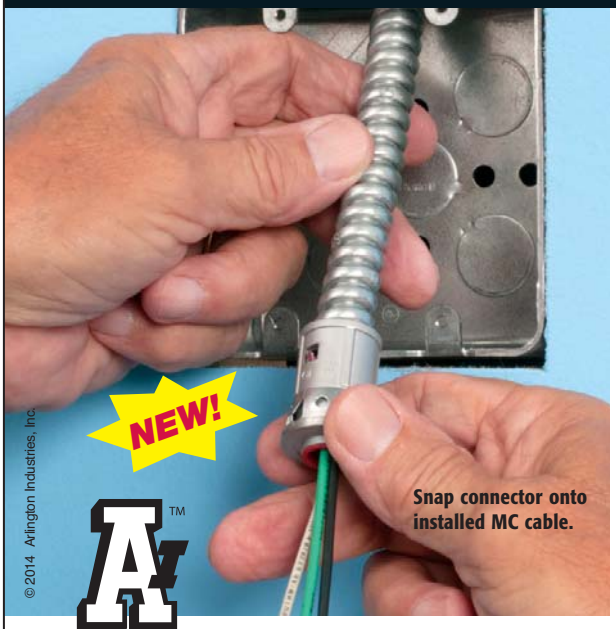
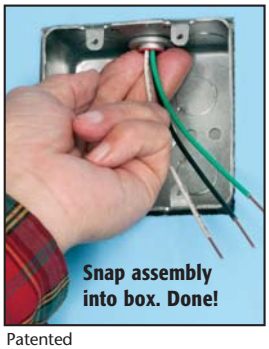
## FOR RETROFIT INSTALLATIONS




Arlington's new one-piece **RETROFIT SNAP2IT®** fittings are *easy to use in an OLD WORK installation*, and handle the widest variety of cables! They're ideal for adding additional circuits to a load center. And you get the same labor-savings in a retrofit installation!

Easy snap-in installation - NO TOOLS. Install connector into the knockout in an ***existing* box**, pulling cable/conduit through the knockout. Slip the fitting onto the cable, then snap the assembly into the box. That's it... a secure installation with *no pullout*.




Patented

**Widest total cable ranges** 14/2 to 10/3
**Widest variety of cables** AC, MC, HCF, MC continuous corrugated aluminum cable, MCI-A cables (steel and aluminum), AC90, ACG90 and FLEX


Arlington® 800/233-4717 • www.aifittings.com

Product info aifittings.com/landing/38rast-40rast/

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2021 NECA Show Stopper

NOW IN THREE COVER SIZES • NON-METALLIC

Made in

# HOLE COVER KITS

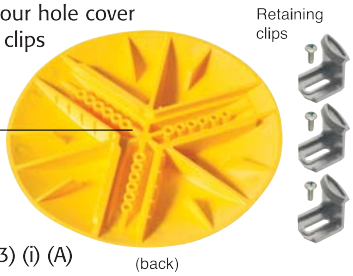
## RATED FOR 250 LBS

## ENSURES COMPLIANCE WITH OSHA


Arlington® 800/233-4717 • www.aifittings.com

Arlington's non-metallic hole cover kits offer the *fastest way* to cover a hole – and ensure compliance with OSHA safety standards on a multi-story building site.

Available in ***three*** sizes, our hole cover kits come with retaining clips that adjust to fit a range of hole sizes.




- Reference scale for precise sizing to hole diameter
- Complies with OSHA Standard 1910.28 (b) (3) (i) (A)
- Rated for 250 lb load

***HC1742** fits 1-3/4" to 4-1/4" opening,*
***HC1762** a 1-3/4" to 6-1/4" hole*
***HC3792** 3-3/4" to 9-1/4" hole*

HC1742 w/ clips set for 1-3/4" hole

HC1762 set for a 6" hole

Patent pending

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

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getting injured because their bodies are more at risk and may be less supple.

"The median age for a worker claim was 44, older than we find in most other industries we cover," says Matt Zender, senior vice president for workers' compensation strategy. "As the industry — and maybe electrical contractors in particular — find it harder to find good workers to replace those leaving the industry the result is less properly trained and less skilled individuals. One thing we find is that as you move from journeyman to master electrician, there's a likelihood of claims going down because you've been doing it longer and know how to work safely. But when you're a master and you're injured, you're more likely to have a more severe claim because you can't bounce back as easily. So as the frequency of claims drops, their severity may increase."

The riskiest workers' compensation scenario might be less skilled workers employed by companies just getting started in business. AmTrust found that specialty contractors in business less than four years accounted for 75% of all claims. Whether it's because they have so many balls in the air trying to get established or they lack the resources to devote to safety, younger companies are the source of more claims. But young or established, Zender says contractors are constantly challenged to keep safety top of mind — and that can be consequential.

"In the contractor space, we know that owner-operators are wearing many hats, and many are working from the dashboards of their trucks," he says. "While we don't expect to see them always prioritizing safety above making a profit or customer service, companies that do so can have an advantage. Most are cognizant of their insurance spend and understand that paying attention to safety and getting credits (for fewer claims) can allow them to bid more competitively than the guy down the street who isn't getting them."

The key to keeping the most common claims down, Zender says, is understanding risk and ensuring that employees are trained and take the time needed to perform routine tasks safely, information AmTrust provides for fall protection, for example. Inattention due to productivity

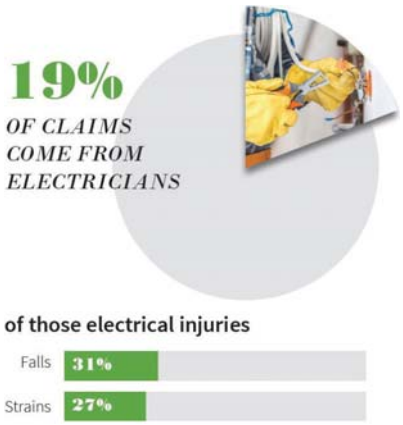



**Fig. 1.** Thirty-one percent of electrician injury claims result from falls.

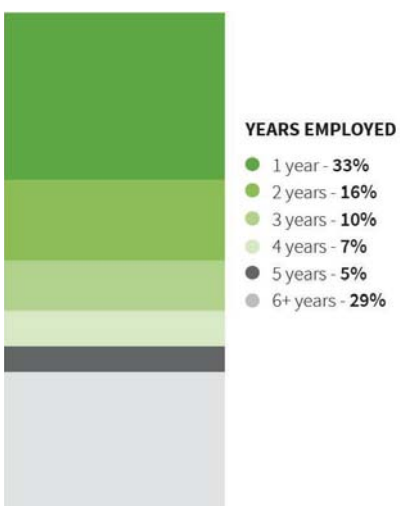



**Fig. 2.** Employees with less than a year of experience accounted for one-third of the claims AmTrust examined, while those with six-plus years accounted for almost another third.

demands and heavy work schedules probably leads to many such injuries, and there's some evidence that contractors under the gun in that regard might sustain more worker mishaps. In addition, AmTrust's report found claims peaked in the summer months when companies might be loaded with work and stretched more thinly. Contractors in regions that allow more year-round work also had more claims. Thus, Arizona claims were 42% higher than the national average, and Florida's were 34% higher. EC&M

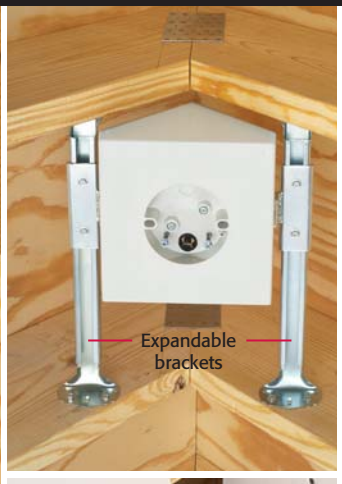
*Tom Zind is a freelance writer based in Lees Summit, Mo. He can be reached at tomzind@att.net.*

FOR CATHEDRAL CEILINGS IN NEW CONSTRUCTION

# CENTERED. SIMPLE.

## WITH ARLINGTON'S FAN/FIXTURE BOX

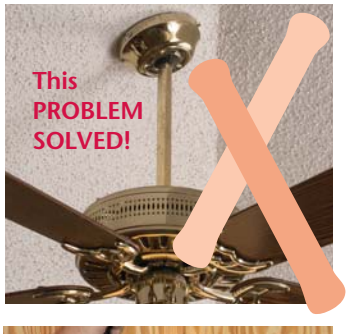

*Position box between framing members by sliding it along the expandable brackets*




Get a centered, safe installation with Arlington's one-piece FBX900 Fan and Fixture Box. *Save time and money too.*

FBX900 has expandable brackets that mount securely between joists, eliminating the need to cut and nail 2X4s to center a fan or fixture in the room.

- Self-contained – No loose parts
- Supplied template levels, positions bracket between rafters
- Fits cathedral ceilings with angles greater than 80°
- Large, 8" square mounting surface handles fans with large canopies




Arlington™

**UL Ratings**
*FBX900 Fan/Fixture: 70 lbs*
*FB900 Fan: 70 lbs, Fixture: 200 lbs*


Use FB900 to install a fan/fixture box *next to a rafter*

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**Product info** aifittings.com/catalog/fan-fixture-boxes/fan-and-fixture-mounting-box-with-adjustable-brackets-for-new-construction/FBX900

# Using Aggregated Data to Analyze Specialty Contractor Performance

## Metrics provide an overall snapshot of the health of the industry, including how it pertains to specialty contractors.

By Anne Hunt, Trimble Viewpoint

Many contractors today use some type of construction management software to oversee the myriad of details inherent to projects both large and small — from billing and invoicing to inventory and timelines. These details help contractors improve workflows and grow profits by creating a unified set of data that can help optimize business performance.

While this information has always helped contractors manage their companies individually, it's now being aggregated and analyzed by Trimble Viewpoint, a construction ERP company that began pulling this data from roughly 1,000 customers and publicizing it into a Quarterly Construction Metrics Index starting in Q4 2020. The index, which is designed to help industry leaders understand the current construction landscape and assess how their own companies are performing against industry averages, tracks metrics that provide an overall snapshot of the health of the industry, including as it pertains to specialty contractors — project starts, contract values, hiring trends, and cash flow statistics.

While various industry groups and governing bodies regularly publish industry benchmarks, using data pulled from a customer base provides a deeper, more insightful look at data that is used for day-to-day business management. The following is a snapshot of this data for the last three quarters as it relates to specialty contractors, along with an examination of what it means for the vertical in retrospect and looking ahead to the rest of the year.

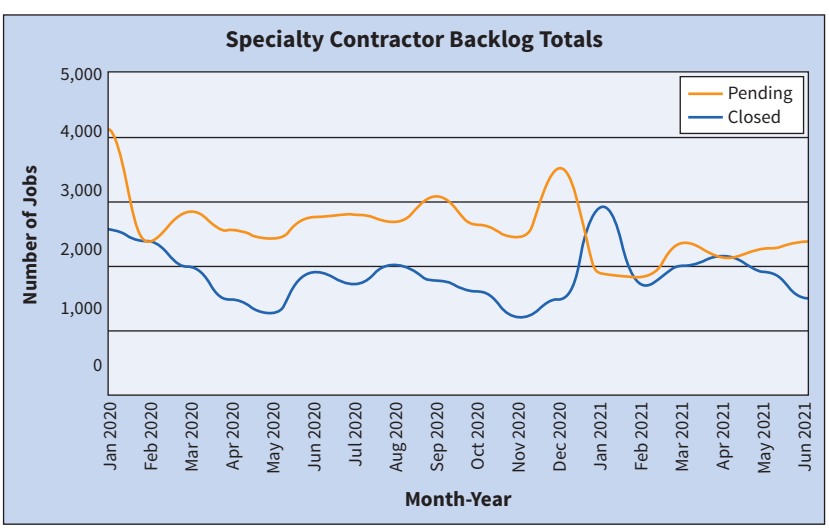



**Fig. 1.** When it comes to specialty contractors, January and February of this year saw pending jobs decline 25% to 30% compared to the same period in 2020, while March was in line with 2020. April through June of 2021 experienced a slowdown in new projects.

### THE CHALLENGE OF 2020

2020 was a challenging year for the construction industry with project starts and hiring both down 30% and contract values down 25%. However, according to the Quarterly Construction Metrics Index for Q4 2020, specialty contractors had a smoother ride compared to general contractors and heavy highway/civil contractors that saw significantly lowered project starts, hiring rates, and contract values.

While the reasons vary by business, much of this was attributed to specialty contractors being able to pick up work left behind by general contractors and because of their service businesses, which largely continued unabated despite the pandemic.

### A ROUGH START TO 2021

Surprisingly, the Q1 2021 Index indicated that specialty contractors hit a few bumps at the beginning of 2021, seeing declines when it came to pending jobs, contract values, and hiring. Specifically, pending jobs declined 25% to 30% in January and February compared to the same period in 2020 (**Fig. 1**).

CONVENIENT • LOW COST

# FLOOR BOX KITS

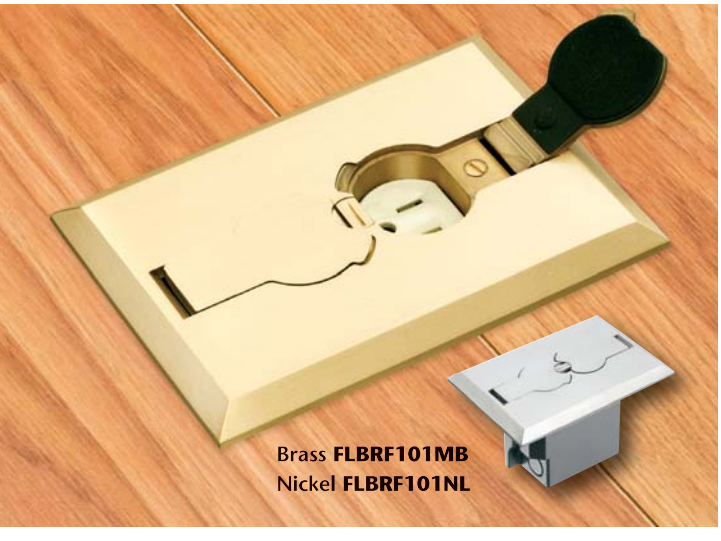
## FOR EXISTING FLOORS

FLUSH TO FLOOR INSTALLATION

Nickel **FLBR101NL**
Brass **FLBR101MB**

Brown **FLBR101BR**

**Non-Metallic covers in FOUR COLORS**



Brass **FLBRF101MB**
Nickel **FLBRF101NL**

***EASY TO INSTALL!***

1

2

3

4

***Arlington's UL LISTED FLOOR BOXES are the low cost way to install a receptacle flush in an EXISTING FLOOR***

WHITE
**FLBRF101W**
ASSEMBLED

BLACK
**FLBRF101BL**

LIGHT ALMOND
**FLBRF101LA**

BROWN **FLBRF101BR**
KIT COMPONENTS

- Oversized rectangular covers hide miscut flooring; gaskets prevent water intrusion; **threaded plugs or flip lids** protect box when it's not in use
- **Rectangular Covers**
  **Non-Metallic**
  White, light almond, brown, black
  **Metal** Nickel-plated brass and Brass

UL LISTED

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**Fig. 2.** In Q2 2021, specialty contractors' net hiring increased 9.7%, with June 2021 experiencing the highest growth.

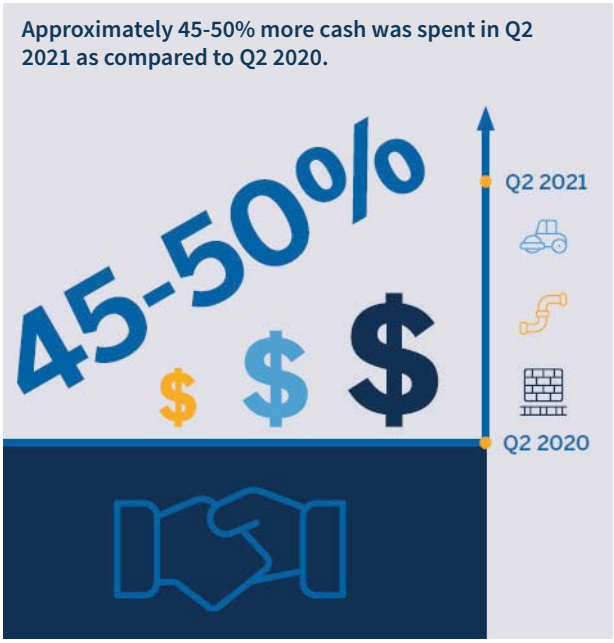


**Fig. 3.** Specialty contractors spent 43% more cash in Q2 2021 than in Q2 2020, signaling signs of a recovery.

Contract values were down 50% in the quarter. Hiring was also down 50% in January/February and down 30% in March.

The continuation of social distancing requirements and distribution issues likely played into delayed project starts, preventing many businesses from functioning properly. The lowered project starts for specialty contractors may have also been due to the abundance of previous work finally catching up with them. One positive stat revealed that specialty contractors spent roughly 150% more in Q1 2021 compared to Q1 2020, which may have indicated they were confident new projects were on the horizon as cash spending is typically an indicator of business confidence.

Andy Gordon, chief operating officer for Colorado-based Encore Electric, says that his company was fortunate to have had a lot of work in January and February. This was largely due to the health care and data center vertical markets, both of which saw active growth during the pandemic. At the same time, "there was a lot of uncertainty with our sales funnel and many projects were delayed, redesigned, or altogether canceled. Additionally, this was when commodities, particularly steel, plastics, copper, and aluminum, became very unstable in both cost and availability," he says.

## THE BEGINNING OF A RECOVERY?

In contrast, the Q2 2021 Index demonstrated that specialty contractors experienced a sizable bounce back. Backlogs increased 20%, mostly due to big project increases in April (45%) and May (50%). Net hiring increased 9.7% (**Fig. 2**), with June being the highest month of growth.

Contract values remained stable, and 43% more cash was spent in Q2 2021 as compared to Q2 2020 (**Fig.3**).

During the second quarter of 2021, the industry as a whole benefited from the rebound in projects that were put on hold during 2020. Investment in existing structures and infrastructure remained high throughout the quarter, boosted by favorable finance rates, and contributing to the project increases seen in the specialty trades.

Continued high growth in residential construction subcontracts and increases in service work (as opposed to new construction work) by specialty trade contractors likely fueled hiring; however, recruiting skilled labor has and will continue to be a challenge for the industry.

Finally, the significant increase in cash spending is a partial bellwether for increasing confidence and backlogs in the market. Nonetheless, continued uncertainties in the supply chain and volatile material prices may dampen this impact looking ahead.

"Q2 2021 felt like the most normal quarter of any of the past 18 months," Gordon says. "Projects that were slow to start, started. New project contracts were awarded, and there were fewer COVID-19 impacts on our workforce. Our recruiters were constantly looking to bring in new people, and I don't anticipate that changing anytime soon."

## A LOOK AHEAD

The remainder of 2021 continues to offer a ray of hope for specialty contractors, many of whom successfully weathered the initial storm of 2020 and have seen their businesses rebound throughout this year — particularly during the last quarter. That being said, variables outside of anyone's control continue to exist (from material prices and supply chain issues to the Delta variant and the Infrastructure Bill), which may elevate or hinder the industry's ability to recover, depending on how the chips fall. EC&M

*Anne Hunt is the director of data and analytics for Trimble Viewpoint. For more information, visit www.viewpoint.com.*

THE SPACER™

Made in USA

# CABLE SPACER

## FOR POWER and LOW VOLTAGE CABLE


***The SPACER***™, Arlington's versatile cable spacer holds up to eight individual cables *centered* on a 2x4.


Quick, easy installation. *Just nail or screw The SPACER to a wood or metal stud!*


- Holds single or double row of power or low voltage cables:
  -One to eight 14/2
  -One to four 14/3, 12/2, 10/2
  -One or two 12/3
- Positions, fastens, routes power or datacom cable
- Complies with article 300.4(d) of NEC

***Also available...***
***Screw-on CS14SC***

**Product info**
**aifittings.com/landing/spacer**

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* 2-HOUR FIRE RATING

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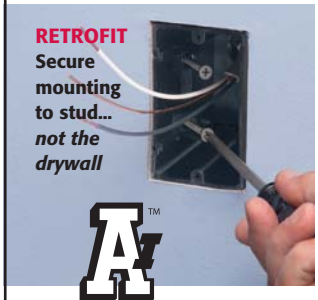
# PLASTIC ONE BOX™

## FOR NEW OR OLD WORK

**NEW**
**Box set too far forward or back? Back the screws out and reposition.**

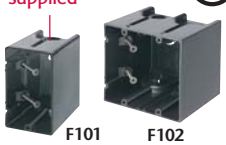


**RETROFIT**
**Secure mounting to stud... *not the drywall***

ONE-BOX mounts directly to a wood or steel stud for an extra-secure installation.

- Angled screws INSIDE attach ONE-BOX to stud
- No wings – no wobble
- Fast, easy to install
- Extra-large 22 cubic inch capacity (single gang)

NM cable connector supplied



**F101** *Single gang*
**F102** *2-gang*

**F101H** *Single Horizontal*

***Also** in 3-Gang, 4-Gang and HORIZONTAL STYLES!*

**Product info**
**aifittings.com/landing/one-box**

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GALVANIZED STEEL

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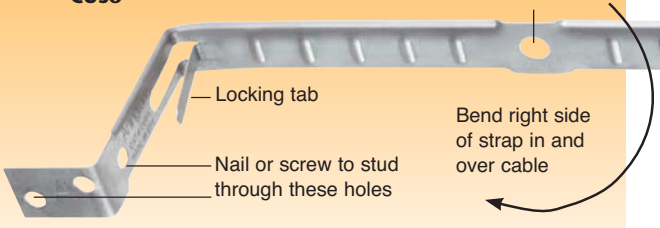
NEW

# CABLE SUPPORT

## ECONOMICAL...HOLDS UP TO FOUR MC CABLES • EASY TO INSTALL




*Holds up to four MC cables centered on a 2x4!*

Arlington's economical CUS6 galvanized steel Cable Support holds cable secure and centered on a metal or wood stud.

It's perfect for fastening and positioning *up to four* individual metal clad cables – or six NM cables on a 2x4.

Installation is quick and easy. Nail or screw ***CUS6*** to a wood or metal stud, and position the cables. Next bend the strap at the foldline (centerline). Fold the strap over the cables and insert the locking tab in the opening as shown to hold them securely in place.

- Complies with 2020 NEC, article 300.4(D)

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

**Arlington®** 800/233-4717 • www.aifittings.com

**Product info aifittings.com/landing/cus6/**



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By Travis Livermore and Jeremy Presnal

# SPEAKING THE SAME LANGUAGE

## How electrical operations and maintenance professionals can effectively work with safety personnel

For non-specializing safety professionals, electrical work is often highly mysterious. Electrical operations and maintenance leaders, along with field personnel, often find even knowledgeable safety professionals to be somewhat unrelatable and vice versa. Unfortunately, this reality, or perceived reality, frequently leads to ineffective use of the safety professional that falls far short of the potential benefit to companies in the electrical field. This article strives to foster understanding between safety professionals and electrical operations and maintenance leaders, along with field personnel, to maximize the potential of the relationship for reducing risk. In short, how can safety professionals and field personnel learn to be on the same page and make every day on the job safer?

### QUESTIONS, QUESTIONS, AND MORE QUESTIONS

Effective safety professionals ask a plethora of questions when conducting a work-site visit. This approach is especially true in the electrical arena. Often, a particular question serves dual purposes. The safety professional wants to know if activities comply with company procedures and regulations. He also wants to ascertain whether employees understand safe work practices and what is required, along with whether safe work practices are generally followed (i.e., beyond that particular job). Finally, safety professionals ask questions so they can learn and better understand the work conducted by those whom they support as well as verify that program procedures and safe work practices are functioning effectively.

Another reason safety professionals ask questions is to brainstorm solutions. A safety professional may observe a situation that he thinks could be handled more safely; however, he has no definitive solution. In these situations, he may ask whether the task has been performed differently in the past or if the employee has any ideas on how it can be done more safely. It is not uncommon for an employee to recall a safer approach to the task during such a conversation. These questions aren't meant to put employees in the "hot seat" or throw field personnel under the bus. Quite the opposite: This approach is about finding a safe solution that works in the environment and could be replicated by others.

Safety professionals also ask questions for which they already know the answer. This is generally done to gauge the effectiveness of the applicable company procedures, safe work practices, and worker training. For example, they may ask an employee how he will perform test-before-touch. Because the gear is low voltage, he may already know the employee will need to use a contact meter rather than only using a proximity meter to ensure the absence of voltage. Nonetheless, such a question is an opportunity to both prompt the employee to do the correct thing and allow the employee to talk about how he does his job and share knowledge.


Universally, craftspeople and electrical technicians take pride in their work and the specialized knowledge required to perform it. This approach typically results in both individuals feeling good about the interaction.

## INEXPERIENCED SAFETY PROFESSIONALS IN THE ELECTRICAL CONTEXT

Unfortunately, some safety professionals supporting electrical workers are not as effective as they would be supporting other disciplines and craftspeople. This challenge may be the result of ignorance due to lack of experience, education, formal training, a misunderstanding of the role, a company's approach to safety that envisions a team of safety cops enforcing rules, or (less commonly) a character flaw.

On large construction projects, for example, where safety people may be responsible for the safety of cranes and rigging, fall protection, excavations, hot work, confined space operations, and mobile equipment, electricians or technicians often feel isolated from frequent interactions with safety professionals because they know that safety folks either do not understand their work or are too busy to focus on it. They may have casual conversations with safety personnel but in general do not regularly share job specifics and/or worker challenges. This result is unfortunate, because a cognizant and knowledgeable safety professional can be of great use in preventing injuries. Safety professionals have the responsibility to learn and arm themselves with the capacity to be effective. However, electrical operations, construction, and maintenance leaders, along with field personnel, can benefit from explaining certain concepts and

Understanding safe working procedures empower electrical contractors to tell a customer "no" when safe conditions cannot be met.

jargon to less experienced safety professionals. They should view interactions with a safety professional as opportunities to develop the safety professional for future interactions with others in the company, resulting in an increased ability to identify opportunities for improvement and ultimately reduce risk.

Safety professionals who seek to expand their electrical knowledge, enjoy visiting job sites, and are receptive to technicians, craftspeople, and company leaders should be retained and cultivated.

## SPEAKING THE LANGUAGE

Successful safety professionals specializing in the electrical field will spend at least some of their own time reading to gain knowledge. Nonetheless, while they may initially feel ready and able after reading an article on diodes, rectifiers, and super doping, they may become overwhelmed or completely lost when they make a site visit, unable to identify the equipment at which they are looking. While Khan Academy or Paul's Online Math Notes may show them how to apply the mesh current method or how differential equations are applied to solve a simple resistor-capacitor-inductor circuit, they may not be able to read a one-line diagram well. While they should learn how to review diagrams, they may still be useful even before adding this ability to the knowledge arsenal. They will still be able to recognize whether one-line diagrams are available and being reviewed before switching and lockout/tagout (e.g., energy control) begin — an issue that persists in the industry. They will be able to talk to individual employees about whether anyone explained the switching procedure to them, if they walked down the job and reviewed all isolation points, if personal grounds are being applied, and the method used to verify that energy control occurred.

Safety folks need not fully understand all technical aspects of electrical work to understand and track whether procedures are followed and whether individual employees are informed and understand how to work safely. Tracking these factors on a large scale — and presenting the data to operations and maintenance leaders — is an invaluable service. To best utilize data presenting opportunities for improvement and reduction of risk, operations and maintenance leaders must present it to their employees in a way that conveys how important it is to them as leaders rather than how important it is to the safety professional. Then, they must follow up to ensure that improvement has occurred. For a safety program to be successful, leaders and frontline workers must understand the personal risk that everyone takes on the job and be committed to safe work that gets them and their teammates home safely each night. Safety performance is about real people and lives, not just checking boxes for a field report.

The most valuable safety professionals constantly advance their knowledge. Field personnel are an invaluable asset in this regard. A few areas that often cause confusion between electrical maintenance technicians and safety professionals — and also between clients and electrical contractors — include terminologies such as "primary" and "secondary," "load" and "line" sides, and even the term "breaker."

While the terms "primary" and "secondary" are associated with transformers, in practice, they are also sometimes used to refer to the load and

PRESS-ON INSTALLATION

# EMT BUSHINGS

## ECONOMICAL CABLE PROTECTION

- Fast & easy press-on installation
- Holds tight as cables are pulled
- Protects cable from abrasion
- Less expensive alternative to costly fittings when used just for wire
- Meets NEC requirements (2020) for 300.15 protection

*Per NEC 300.22(c)*

Listed for Air Handling Spaces

In a variety of sizes for 1/2" to 4"
- EMT
- Rigid
- PVC

Made in USA

Product info
www.aifittings.com/catalog/emt/insulating-bushings/EMT400

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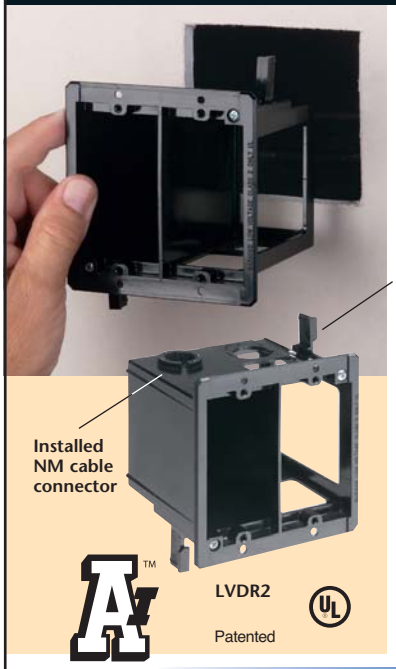
POWER & LOW VOLTAGE

# COMBO BOX

## 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

Patented

Product info
www.aifittings.com/catalog/specialty-boxes/power-and-low-voltage-box-for-existing-construction/LVDR2

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RAIN-TIGHT • CONCRETE-TIGHT FITTINGS FOR

Made in USA

# JACKETED MC CABLE

## ONE FITTING FITS MULTIPLE JACKETED MC CABLE SIZES


Save time and money with Arlington's *rain-tight, concrete-tight* fittings for jacketed MC cable.

***ONE fitting FITS MULTIPLE cable sizes!***

***LTMC50*** *ships ready to use on #10, #12 or #14 jacketed MC cable. Try the NEW SIZES too...LTMC507 and LTMC75.*

Because they fit more than one cable size, these fittings reduce inventory, saving you the cost of stocking several *different* fittings.

***Ideal for Parking Decks, High-rise Residential***

1/2" LTMC50 (components)

| Catalog Number | Cable Ranges (Armor Diameter) | |
|---|---|---|
| LTMC50 | .415" - .565" | |
| LTMC507 | .550" - .730" | goes into 1/2" KO |
| LTMC75 | .725" - .890" | goes into 3/4" KO |

Product info aifittings.com/landing/ltmc507-ltmc75/

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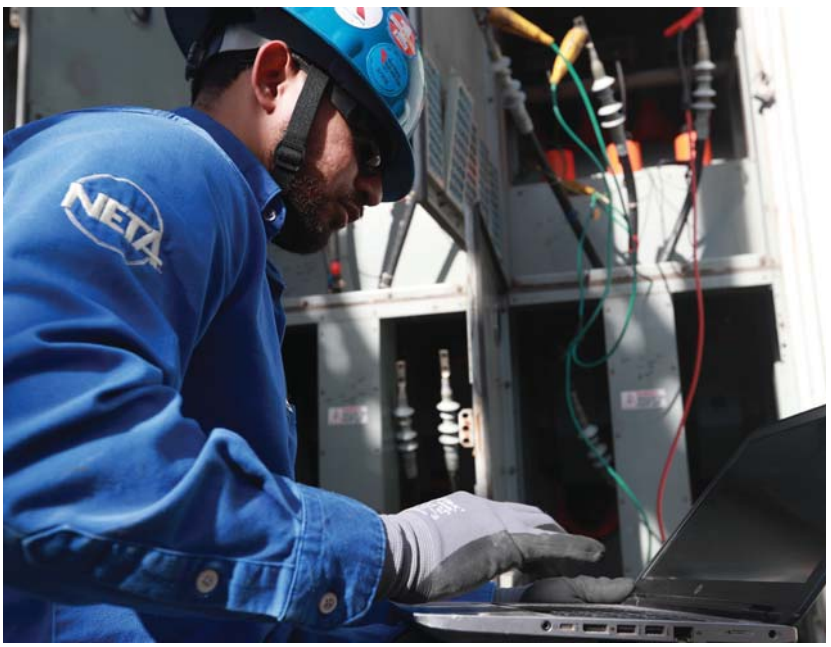


Safety professionals often ask questions to gauge effectiveness of company procedures, such as, "How will you perform test-before touch (TBT)?"

line sides of equipment. Some safety professionals and even electricians may immediately begin thinking about transformers when they hear the words "primary" or "secondary," even though the speaker may simply be talking about the load and line sides — or upstream and downstream of a particular piece of equipment. On a somewhat related note, safety people who are new to companies specializing in electrical work may only think of isolation and lockout from a mechanical perspective. In other words, they are more accustomed to isolation and lockout of only the load side to isolate a downstream motor or other equipment from its source of electricity rather than isolation of a breaker to test the breaker, which would require isolation on both the load and line sides.

Some safety professionals will use the word "breaker" to describe a motor control center (MCC) bucket that contains not only a breaker, but also other important components, such as relay circuits, contactors, and coils. Additionally, they may refer to an MCC room as an "MCC," when, in reality, an MCC room contains multiple MCCs.

Operations and maintenance leaders can make their safety professionals more value-adding by coaching them on the terminology and encouraging field personnel to coach and interact with them as well.

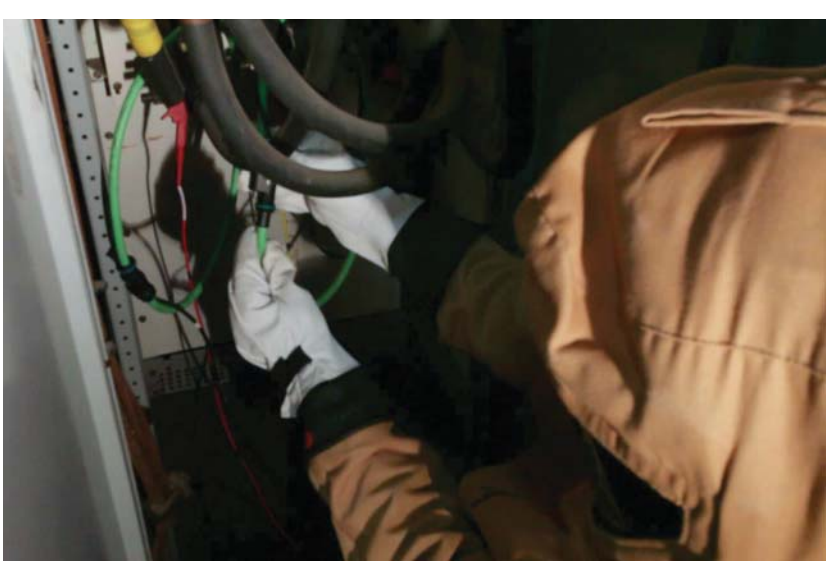
## WELCOMING FEEDBACK AND CHALLENGE

Safety people are accustomed to employees and leaders challenging what they advocate. The mere fact that challenge occurs is an indicator that leaders and employees are at least cognizant of what is required. Leaders and employees should not become laconic due to the arrival of a safety person. Rather, they should freely express how the company's safety policies are impractical or create greater hazards. Because effective safety people recognize that the best knowledge comes from those performing the work and utilizing the associated safety programs, procedures, and work practices, they welcome feedback and explanations of how current policies or procedures may not work well, along with how they can be improved.

Experienced safety people know that impractical policies or procedures will not keep employees safe because, in many instances, they will simply be disregarded. They strive to develop safe work practices that are workable and as simple as possible, because that is the best way to gain worker buy-in and thereby reduce risk and strengthen the health of their programs.

## PLANNING, BOOTS ON THE GROUND, AND PROGRAM DEVELOPMENT/EVALUATION

Having safety professionals is just the beginning. Knowing how and where to best use them is a separate challenge. For electrical contractors with employees


OSHA standards require that personal protective equipment (PPE) for the eyes and face be worn whenever there is danger of injury to the eyes or face from electric arcs, flashes, or flying objects resulting from an electrical explosion.

LOW COST • ZINC

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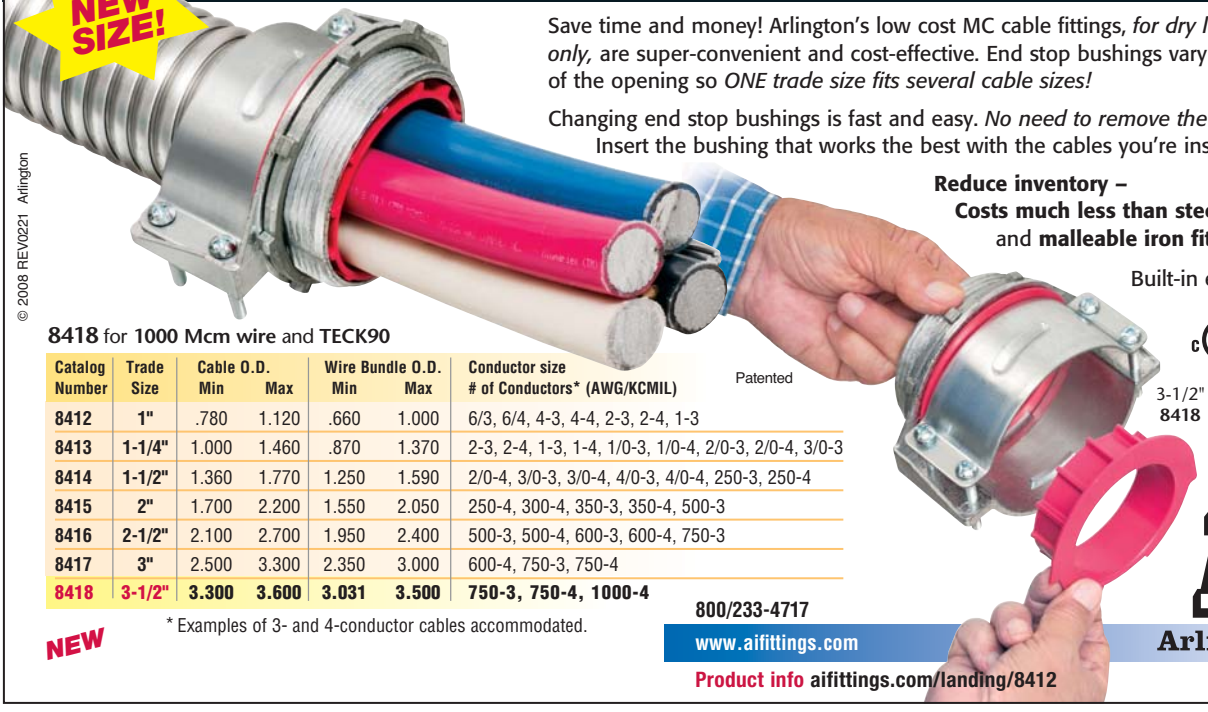
# MC CABLE FITTINGS

NEW SIZE! 3-1/2"

## 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

Patented

3-1/2"
**8418**

**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.

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Product info aifittings.com/landing/8412



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FLUSH-WITH-THE-CEILING INSTALLATIONS

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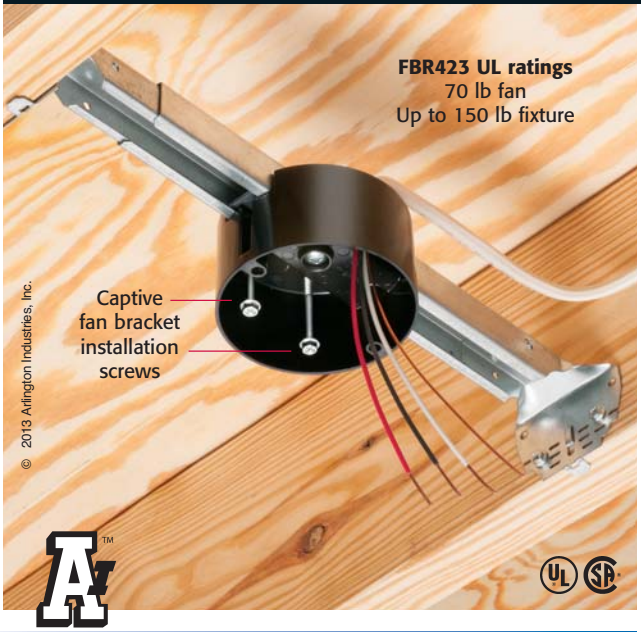
# NEW FAN/FIXTURE BOX

## THE LOW COST BOX...WITH ADJUSTABLE STEEL BRACKET AND *PLASTIC* BOX




Arlington's low cost, economical *steel* fan/fixture bracket with *plastic* box delivers super-secure, versatile on-center mounting between joists spaced 16" to 24".


- Easy mounting in new construction... fan bracket installation screws ship captive
- Bracket ends adjust for flush installation on ceilings up to 1-1/4" thick. They're pre-set for a 1/2" ceiling. Bend along score line for other ceiling depths.

- 23.0 cu. in. plastic box is positionable anywhere along bracket
- UL/CSA Listed

*** 2-HOUR FIRE RATING**



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Product info aifittings.com/catalog/fan-fixture-boxes/steeladjustable-bracket-with-plastic-box/FBR423



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Field personnel can work with EHS professionals to establish safe working procedures for any task or environment.

spread out over what may be a large geographical area, it may be especially challenging. Contracts often require an on-site safety professional, depending on the number of workers. While this requirement is triggered by a minimum number of workers and increases as the number of workers grows, it may be true that actual risk is greater on smaller projects. Logically, on larger projects with more workers, the likelihood of an injury generally is probably greater. However, the likelihood of a life-altering injury or fatality from shock, arc flash, and/or arc blast may be lower due to the involvement and attention of more supervisory personnel.

On the other hand, small jobs tend to take a less formal approach, which may result in the skipping of important steps in establishing and/or verifying an electrically safe working condition, such as donning shock and arc flash PPE while testing for absence of voltage. Therefore, it may be advantageous for safety professionals to visit smaller jobs to ensure required processes are followed.

The significance of planning for safety cannot be overstated. Salespersons or estimators may not fully understand all the critical risks that exist on a job and fail to include the cost of the tools or time to prepare and perform work safely. For example, an aerial lift that allows employees to reach access points for applying personal grounds may be necessary to avoid employees standing awkwardly on a ladder with a hot stick holding a heavy set of grounds overhead in a substation. If this cost is not considered initially, this may result in less profit and the client may be impacted


For safely testing motors, caution tape establishes a safe perimeter around moving parts.

PHOTOVOLTAIC

# NEW CABLE CONNECTORS

## CONNECTS, PROTECTS MULTIPLE PV1000 CABLES

Arlington's non-metallic NMPV series photovoltaic cable connectors are ideal for solar, and other jobs, requiring the connection of multiple cables into raceways, fittings, and combiner or junction boxes. This connector series is perfect for PV1000 cable.

**NO Sealant Required.** *No need to seal off raceway where wires exit fitting.* Grommet (included) seals and separates wires and prevents moisture, debris and insects from entering the raceway.


- **For PV1000 and other cables** from .245 to .280
- 3/4" **NMPV753** holds up to 3 cables...
  1" **NMPV1005** holds up to 5...
  1-1/4" **NMPV1257** holds up to 7

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Product info aimedia.co/media/catalog-pages/D-4.pdf

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ECONOMICAL SINGLE and TWO-GANG NON-METALLIC

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# VAPOR BOX for Devices

## NAILS TO STUD IN NEW CONSTRUCTION

SAVE! WITH THESE COST-SAVING BOXES

NEW

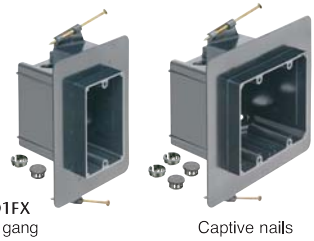

Designed for devices, Arlington's *economical* single and two-gang **Vapor Boxes** offer easy nail-on installation in new construction.

*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.*


- Nails ship captive. Plugs and NM cable connectors supplied.

**2-hour Fire Rating**

Patent pending

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Product info aifittings.com/landing/fn101fx-fn102fx/

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With thorough understanding of safety procedures, electrical contractors arrive on the job with all of the necessary personal protective equipment (PPE) they may need to complete the work, minimizing delays and downtime.

by delays. This type of frustration can be avoided by involving safety professionals early in the planning process.

Electrical contractors are often asked to do work because the customer does not have the expertise or staff resources. Sometimes, this fact leads to customers requesting that electrical contractors open a breaker with an incident energy level greater than the rating of available personal protective equipment (PPE) or requesting that contractors enter confined spaces that cannot be fully de-energized without a full outage. Telling a customer "no," even for safety reasons, can be uncomfortable and requires courage. It can sometimes create tension in the relationship. Safety professionals can be used in these situations to help facilitate communications and educate the customer regarding why the task is outside the contractor's risk tolerance. Such a scenario presents a great opportunity to deliver ideas regarding alternative options for completing the work or articulate what equipment changes could be made in the future to better mitigate the hazards.

Program development, implementation, maintenance, auditing, training, and improvement are the bread-and-butter of safety people. This article has emphasized that safety people need not be the most technically adept to add value. Compliance program stewardship and improvement is a perfect example. Safety people develop programs and improve processes in many areas by promoting conversation, talking to experts, and talking to boots-on-the-ground personnel. Their specialty is the integration of ideas and work practices into something that works on real job sites and can be replicated for future projects. Leaders in the electrical field can and should use them in this manner.

In conclusion, effective safety professionals in the electrical field can greatly assist in the reduction of risk for their companies, and their support can be maximized by operations and maintenance leaders and personnel who are willing to answer questions, ask tough questions, and freely share knowledge. EC&M

*Travis D. Livermore is the corporate safety manager at Shermco Industries in Dallas. Travis has worked in environmental, health, and safety (EHS) management for more than seven years and has several years of experience in the legal field. He can be reached at travis.livermore@shermco.com.*

*Jeremy Presnal is vice president EHS & workforce development at Shermco Industries. Jeremy has been working as an EHS professional for more than 18 years with experience in power generation, petrochemical, construction, and manufacturing companies. He can be reached at jpresnal@shermco.com.*


Equipment lockout tags are used to indicate equipment should not be operated and is not in a safe condition for use.

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NEW

# CABLE CONNECTORS

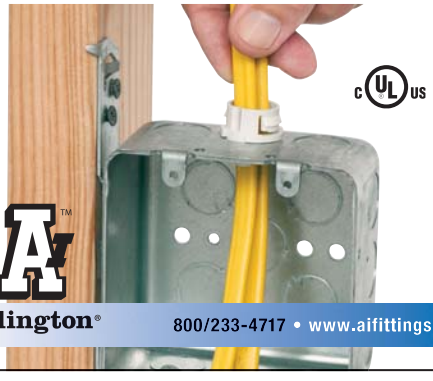
## EASY PUSH-IN INSTALLATION OF ONE OR TWO CABLES

*from* ***OUTSIDE*** *a* ***New Work Box...***

Save money with Arlington's non-metallic NM cable connectors – the *lowest cost* NM cable connectors on the market – and the fastest to install! Easy push-in installation...

Listed for single or multiple cables, Arlington's new **White Button**® 1/2" NM94X and the ***NEW 3/4" NM95X*** offers smooth, easy cable insertion of one *or two* cables into a single opening from inside or outside the box.

***NM94X... BETTER than our popular NM94 AT THE SAME PRICE!***

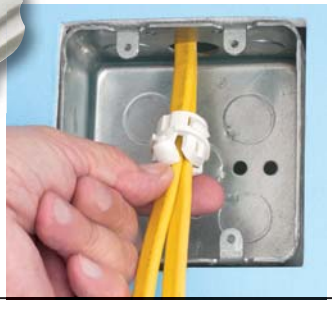


- 1/2" trade size NM94X holds:
  (1) 14/2 to 6/2, (1) 14/2/2, (1) 12/4,
  (1) 12/2/2, (1) 14/3 to 10/3,
  (2) 14/2 to 10/2, (2) 14/3,
  (2) 12/3,
  (1) 14/2 and (1) 12/2,
  (1) 14/2 and (1) 10/2,
  (1) 12/2 and (1) 10/2

NM94X

- **Easy** removal with pliers or screwdriver
- **Listed.** Exceeds UL/CSA pullout requirements

*or* ***INSIDE*** *an* ***Existing Box.***





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Product info aifittings.com/landing/NM94X

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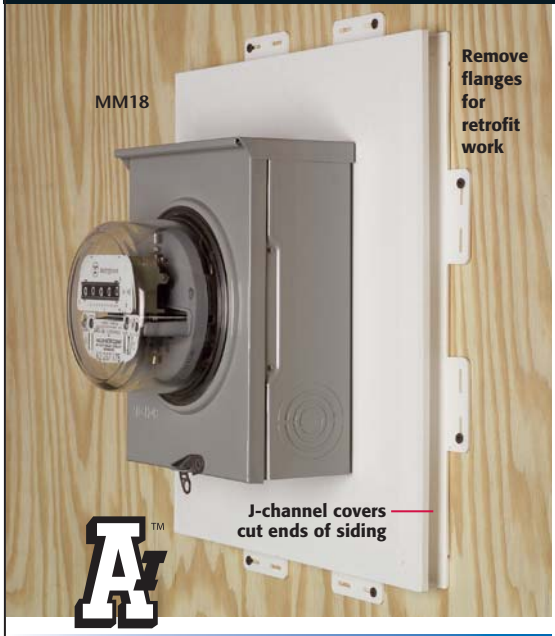
# METER MOUNTING BASE

## INSTALLS ON SIDING – AND OTHER SURFACES

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Arlington's one-piece, non-metallic Mounting Bases provide a smooth, flat mounting surface for most electric meters, *including the largest sizes* – as well as a variety of other products such as timers, disconnects, inlet boxes and more.

UV rated, paintable plastic for long outdoor life.

Available with squared-off corners, they're *gangable* so you can create the mounting base you need for the product you're installing.

NEW 5x7





Product info aifittings.com/landing/mm7

NEW

| | |
|---|---|
| **MM7** 5" X 7" | MM18 15-7/8" X 17-5/8" |
| MM10 7" X 10" | MM23 17-5/8" X 23" |

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# Changes to the 2021 NFPA 70E That Help Ensure Electrical Safety

## Elevating electrical safety to new heights

By Corey Hannahs, NFPA

Every three years, the world has an opportunity to evaluate how we can be safer when working around electricity. NFPA 70E, *Standard for Electrical Safety in the Workplace,* is revisited on a triennial basis, at which time public input that has been submitted is assessed and suggested changes to the standard are considered. As the name not only implies but also clearly states, NFPA 70E is the standard on how to be safe when working on and around electricity.

Although created at the request of the United States Department of Labor –Occupational Safety and Health Administration (OSHA) as a performance-based means to fulfill OSHA's prescriptive-based requirements, NFPA 70E has become the world's go-to document for protecting personnel

**LOOKS GREAT • SAVES TIME**

# ADJUSTABLE SLIDERBAR™

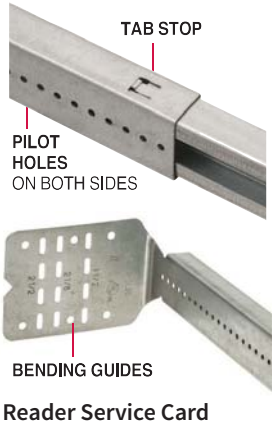
NEW!


## *The NEAT Way to Mount Plastic and Metal Boxes*

Arlington's steel **SLIDERBAR**™ offers the easy, NEAT way to mount a single gang box (vertical or horizontal) *or a two-gang* box between wood *or metal studs* with non-standard cavities.

**No more cutting, nailing and fitting extra 2x4s!** ***SLIDERBAR saves about 20 minutes*** *per box.* Available in two sizes for studs spaced 12 to 18 or 15 to 24 inches apart, they allow positioning of one *or more* boxes anywhere in the stud cavity.

Bending guides on the bracket assure proper positioning on studs. The interlocking tab stop prevents accidental disassembly. And pilot holes on BOTH sides of **SLIDERBAR** allow for easy attachment of one or two boxes on both sides of the bar.




| | |
|---|---|
| **SL18 SLIDERBAR** | Adjustable, fits between studs, 12" to 18" o.c. |
| **SL24 SLIDERBAR** | Adjustable, fits between studs, 15" to 24" o.c. |
| **SLB101 BOX ONLY** | Plastic • SINGLE GANG • pre-formed screw holes |
| **SLB102 BOX ONLY** | Plastic • TWO GANG • pre-formed screw holes |
| **SL1B18 KIT** | **SL18** SLIDERBAR, SINGLE GANG Plastic Box |
| **SL2B18 KIT** | **SL18** SLIDERBAR, TWO GANG Plastic Box |
| **SL1B24 KIT** | **SL24** SLIDERBAR, SINGLE GANG Plastic Box |
| **SL2B24 KIT** | **SL24** SLIDERBAR, TWO GANG Plastic Box |

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**Product info aifittings.com/landing/sliderbar**

Some requirements in Art. 110 have been reorganized for a more logical progression, including moving general principles of lockout/tagout from Sec. 120.2(A) to revised Sec. 110.2 and general principles of an electrically safe work condition and energized work requirements from Sec. 130.2 to revised Sec. 110.3.

by reducing exposure to electrical hazards in the workplace. The 2021 cycle of NFPA 70E considered many valuable suggestions that were submitted by people from all over the world. During the NFPA standards development process, the "Electrical Safety in the Workplace" technical committee that oversees NFPA 70E evaluated 332 Public Inputs (PIs), resulting in 86 First Revisions during the First Draft and 115 Public Comments, resulting in 45 Second Revisions.

Revision cycle changes can often be separated into two buckets:

1) Those that impact the standard itself; and

2) Those that impact the person using the standard.

In certain cases, the change dips into both buckets to some extent. Changes that fall more into impacting the standard itself are those that bring more clarity to a section or better alignment with other codes and standards, such as the National Electrical Code (NEC). These changes often help the end-user to better understand the book but don't necessarily change anything regarding processes or procedures — like those that primarily impact the end-user of a standard. Although the 2021 NFPA 70E cycle saw a variety of changes, those incorporated were somewhat weighted toward the ones that impacted the standard itself. Some changes of note for this cycle include:

## STANDARD IMPACT CHANGES

- **Article 100 — General Definitions:** Within Art. 100, several terms were deleted because they were not used within the context of NFPA 70E. These included definitions for *Accessible (as applied to wiring methods)*, *Accessible, Readily (Readily Accessible)*, and *Branch Circuit*. The word *exposed* was added to the existing definition of *shock hazard* to further indicate that parts must be exposed to be a hazard.
- **Article 100 — Electrically Safe Work Condition:** An Informational Note was added to the definition for *Electrically Safe Work Condition (ESWC)*, which clarifies that an ESWC is not a procedure but rather a state wherein all hazardous electrical conductors or circuit parts to which a worker might be exposed are maintained in a de-energized state for the purpose of temporarily eliminating electrical hazards for the period of time for which the state is maintained. Section 110.1 also saw informational Note No. 2 added that again clarifies how an ESWC is defined and expounds on how it ties into Art. 120, which gives the requirements for establishing an ESWC.
- **Article 110:** Some requirements in Art. 110 have been reorganized for a more logical progression, including moving general principles of lockout/tagout (LOTO) from Sec. 120.2(A) to revised Sec. 110.2 and general principles of an electrically safe work condition and energized work requirements from Sec. 130.2 to revised Sec. 110.3. There were several PIs received, stating that Sec. 130.2 should be moved to Art. 110. After review of the PIs, the committee created First Revision No.93-NFPA 70E-2018, which justified their decision with a committee statement that read, "Locating the requirement to de-energize in Art. 110 prioritizes and emphasizes the requirement: the requirement to de-energize is a requirement of an Electrical Safety Program; the requirement to de-energize should be located before lockout requirements; and Art. 130 can be focused on requirements related to work involving an electrical hazard. The voltage threshold of 50V is used to be consistent with previous actions taken during the last revision cycle."
- **Section 110.5(K):** A new section was added that requires electrical safety programs to include a policy on establishing an electrically safe work condition.
- **Section 110.5(L):** A new section was added that clarifies the LOTO program must be either part of the electrical safety program (ESP) or the ESP must reference the LOTO program.
- **Article 130:** Sections 130.1 and 130.2 have been rewritten to accommodate the relocation of information from former Sec. 130.2(A) to Sec. 110.3 and to keep the focus of Art. 130 on requirements related to work involving electrical hazards.

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# THE SCOOP™

## ENTRANCE PLATES, HOODS, DEVICES


**The SCOOP**™ series of reversible, non-metallic ENTRANCE HOODS, PLATES AND DEVICES protect cable while delivering good looks and installation versatility. They also reduce labor and eliminate extra connections.

Our newest **CABLE ENTRY DEVICES** come with *or without* a wall plate for efficient cable management. **HOODS** for decorator-style wall plates, single and two-gang **PLATES** install facing in or out...and save time!

- Low voltage cable protection
- Best way to run cable

**CED130**
entry device
w slotted cover

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STEEL AND PLASTIC

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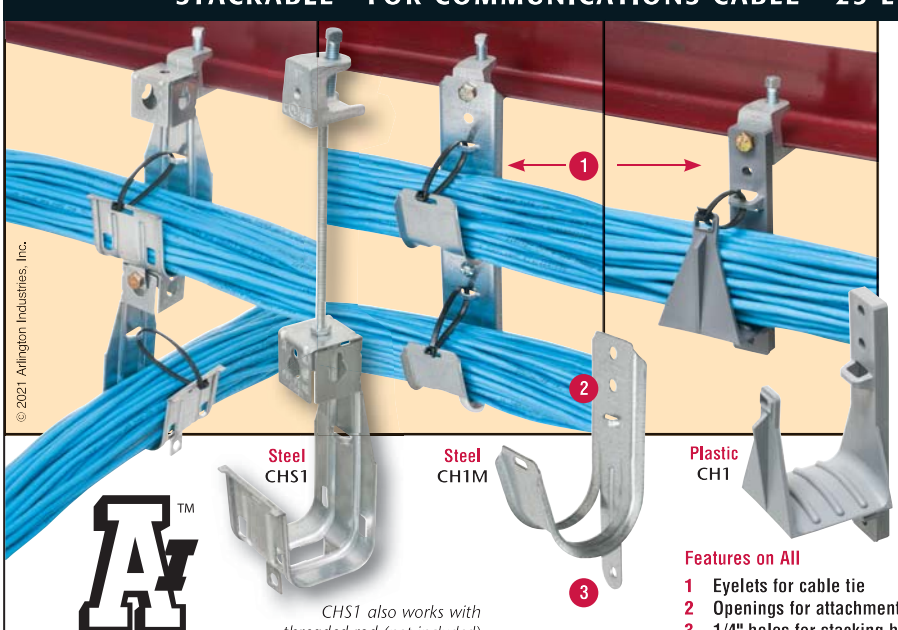
NEW

# LISTED CABLE HOOKS

## STACKABLE • FOR COMMUNICATIONS CABLE • 25 LB SUPPORT RATING




Available in heavy duty **Plastic** and ***two styles*** in **Steel,** Arlington's Cable Hooks can handle any jobsite condition. They're super convenient for communications cable!

- 25 lb Support Rating – maintains integrity of high performance data cable
- Supports *up to 90* Cat 5e cables with the center radius of bundle spread over 2" opening
- Listed for air handling spaces
- **Parallel or perpendicular stackability** for vertical support of multiple cable tiers
- Easy attachment to various supports, beam clamps and strut

**Features on All**

1 Eyelets for cable tie
2 Openings for attachment to beam clamp
3 1/4" holes for stacking hooks

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Product info aifittings.com/landing/Cable-Hooks

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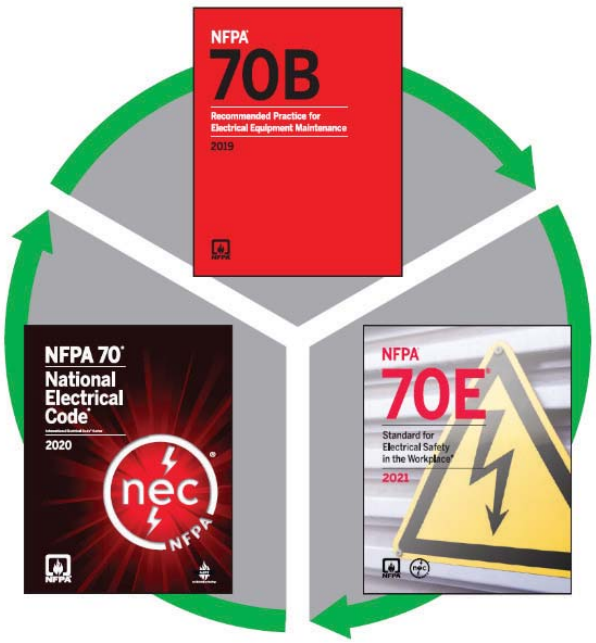


NFPA 70E is a crucial component in achieving the electrical cycle of safety.



## USER IMPACT CHANGES

- **Table 130.5(C)**: Revisions have been made to Table 130.5(C), which can be used to help estimate the likelihood of occurrence of an arc flash incident, including a new entry for the initial circuit breaker or switch operation and again after maintenance, as each has a higher likelihood of an arc-flash event.
- **Section 350.9:** Energy thresholds for electrical equipment and systems in laboratories have been revised to accurately reflect the data in the Informational Note's resource document, and the capacitive circuit threshold has been deleted to prevent duplication and potential confusion with new Art. 360.
- **Article 360 and Annex R:** New Art. 360 was added to provide safety-related requirements for working with capacitors. Annex R was also added, providing further information for technicians that are working with capacitors. Prior editions of NFPA 70E did not contain requirements for working with capacitors, which can be unique in their dangers due to stored energy.

There is also some crossover as to how NFPA 70E changes can impact both the standard and the user. Every change to the standard technically impacts the user — even if only from a clarity aspect when reading the document. Some changes are easier to look at and understand; they really just impact the document, such as removing definitions that are not utilized within the standard. Others impact the processes and procedures employees and employers must follow to ensure safety when working with electricity.

The Informational Note that was added to the definition for an "Electrically Safe Work Condition" is a good example of having an impact on both aspects. It brings clarity within the context of the standard that an ESWC is not considered to be a procedure but goes on to state exactly what an ESWC is, which directly impacts the end-user by knowing what an ESWC entails. Depending on perspective and knowledge of NFPA 70E, an argument could likely be made that many changes impact both the standard and the end-user, whether that is an employer or employee.

Revisions to the 2021 NFPA 70E standard have made a lasting impact on electrical safety. Those changes were brought about by some valuable public contribution that was provided during the standards development process. However, our work isn't done. The 2023 NFPA 70E standards development process is already in motion with the public input stage having closed on June 1, 2021. The first draft of the 2023 NFPA 70E will be posted on March 22, 2022, at which time the public comment stage will remain open until May 31, 2022. Make your voice heard. Electrical safety is a continuing journey, not a destination. For your well-being and of those around you, you must come along for the ride. The wheels are in motion. EC&M

*Corey Hannahs is senior electrical specialist at the National Fire Protection Association (NFPA), Quincy, Mass. In his current role, Hannahs serves as an electrical subject matter expert in the development of products and services that support NFPA documents and stakeholders. He can be reached at channahs@nfpa.org.*

STEEL BOX WITH BRASS COVER

# LISTED SINGLE GANG FLOOR BOX KITS

## CONVENIENT, FLUSH-TO-THE-FLOOR RECEPTACLE INSTALLATION

**FLB5331NL**
Single gang
steel box kit
w nickel-plated brass cover

**FLB5331MB**
Single gang Kit
w brass cover



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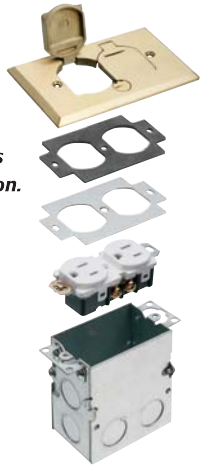
Arlington's **STEEL FLOOR BOX KITS** give installers a low cost, *convenient* way to install a receptacle *in a new or existing floor.*

***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.*

for NEW or EXISTING FLOORS



**FLB5331MB**
Single gang steel box
kit w brass cover

Product info aifittings.com/landing/floor-box-kits/

c UL us

Circle 35 on Reader Service Card

# IN BOX® RECESSED COVER KITS

## *INSTALLS INSIDE* 4.5" CONCRETE BOXES

NEW!






Arlington® 800/233-4717 • www.aifittings.com

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**


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

Circle 36 on Reader Service Card

# What the 2020 NEC Surge Protection Mandates Mean

## ... and what still needs to be done.

Lightning strikes and related electrical surges not only pose the direct risk of fire, but also raise the potential for significant damage to electronic equipment, such as home entertainment systems, home office equipment, security alarm monitoring, and modern appliances. The cost of replacement and repair can be substantial.

By Rick Syverson, nVent ERICO

Every three years, the National Electric Code (NEC) undergoes revisions that move us forward toward protecting life and property more effectively. While adoption of these updated versions of the Code is not always universal, they provide significant guidelines on how to make the electrical systems we all depend on safer for everyone who uses them.

Although some of the most recent changes to the 2020 NEC may seem to have come out of nowhere, that is not an accurate impression. Certain changes that made it into this edition have been nearly a decade in the making.

ADJUSTABLE • NON-METALLIC • 2-HOUR FIRE RATING

Made in USA

# IN/OUT™ BOX for Ceiling Fixtures

## EASY TO INSTALL... IN NEW CONSTRUCTION




Arlington's IN/OUT BOX ***for ceiling fixtures*** adjusts up to 1-1/2" to accommodate varying ceiling thicknesses, like single or double drywall. And mounts securely to a joist in new construction.

- Pre-set for 1/2" ceiling... Always accessible depth adjustment screw allows installer to adjust box before *or after* the ceiling is in place, up to 1-1/2"
- Complies with 2020 NEC, 314.20 for set back boxes
- Fixture rated


When wall board is complete...


adjust box position (if necessary)

Arlington®

Product info aifittings.com/catalog/specialty-boxes/in-out-box-for-ceiling-fixtures/FA426

800/233-4717 • www.aifittings.com

Circle 37 on Reader Service Card

ADJUSTABLE BRACKET • EASY INSTALLATION IN EXISTING CEILING

# FAN/FIXTURE BOX

## HIGHER WEIGHT RATINGS






Arlington®

800/233-4717 • www.aifittings.com

Arlington's extra heavy-duty, plated steel fan/fixture box with adjustable bracket has ***higher UL Weight Ratings***:
at 24" on-center: **70 lb Fan, 90 lb fixture**
at 16" on-center: **70 lb Fan, 150 lb fixture**

The 20.0 cu. inch FBRS4200R installs *between* rafters with 16" to 24" on-center spacing, holding a fan or fixture securely in place. It's easy...

**REMOVE BOX from bar.**
**INSERT BAR in opening.** Embed bracket ends in joist. Tighten hex, first by hand then with a wrench. Pull wire.
**REATTACH BOX to bar.**

No parts to lose. Installation screws ship captive, along with a mud cover and installed NM cable connector.


FBRS4200R
Patented

CSA Rated: at 16" or 24" oc 50 lb fan or fixture

aifittings.com/catalog/fan-fixture-boxes/steel-fan-and-fixture-box-with-adjustable-mounting-bracket-for-existing-construction/FBRS4200R

Circle 38 on Reader Service Card

# NEW CONCRETE

NEW FEATURES!

# FLOOR BOX

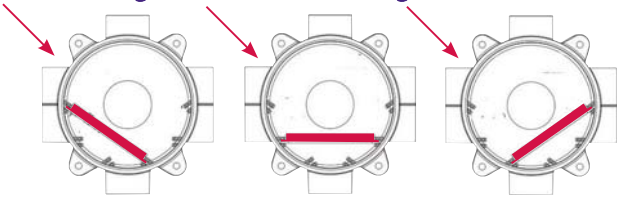
***REVERSIBLE LEVELING RING • SIX CONDUIT HUBS • OPTIONS FOR DIVIDER POSITION***


Arlington's FLOOR BOXES, COVER KITS, and accessories **FOR NEW CONCRETE** are the low cost, *convenient* way to install a receptacle *flush with a new floor*.

Made of heavy-duty plastic, our FLBC4502 4.5" non-metallic **concrete floor box** has more: SIX conduit hubs and FOUR plugs and THREE options for positioning the low voltage divider in the box.

The NEW FLBC4502LR **leveling ring** makes installing a cover *easy* on *ANY 4.5" concrete box* including our FLBC4500 and the new FLBC4502. *It's REVERSIBLE!* ***Side A*** fits *any* 6" round cover with a 3-1/2" screw hole pattern. ***Side B*** has *a second set* of holes that fits 6" covers with a 3-3/8" screw hole pattern.


***THREE Options for Low Voltage Divider Positioning***



***Openings for optional screws*** to raise box so concrete flows beneath

**ARLINGTON Cover KITS** for FLBC4502, FLBC4500 boxes

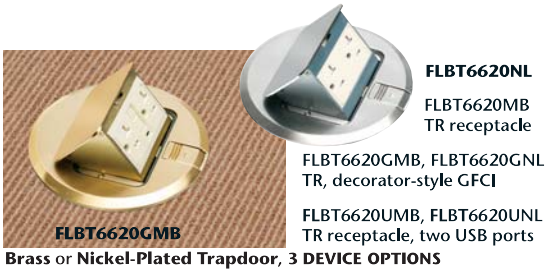

**Brass** or **Nickel-Plated Cover, FLIP LIDS** — **Brass** or **Nickel-Plated Cover, threaded plugs**

Arlington offers a variety of **cover kits** for our concrete boxes: round with flip lids or threaded plugs in brass or nickel-plated brass. Metal trapdoor covers with three device options. *And in plastic, in six colors.*

Get a great-looking, time-saving receptacle installation *in new concrete* with floor box kits, covers and more – *from Arlington!*


FLBC4520BR Brown
FLBC4520W White
FLBC4520BL Black
FLBC4520CA Caramel
FLBC4520GY Gray

**PLASTIC SINGLE FLIP COVERS in 6 COLORS**




**FLBT6620NL**

FLBT6620MB
TR receptacle

FLBT6620GMB, FLBT6620GNL
TR, decorator-style GFCI

FLBT6620UMB, FLBT6620UNL
TR receptacle, two USB ports

**Brass** or **Nickel-Plated Trapdoor, 3 DEVICE OPTIONS**

PRODUCT INFO aifittings.com/landing/flbc4502/

Patented. Other patents pending.

**Circle 39 on Reader Service Card**

ULTRA THIN FLANGES, METAL COVERS

# RECESSED IN BOX® COVER KITS

## FOR 4.5" CONCRETE BOXES


**FLBC4580MB**
**brass-plated** covers
stamped steel flange

**FLBC4580NL**
**nickel-plated** covers
stamped steel flange

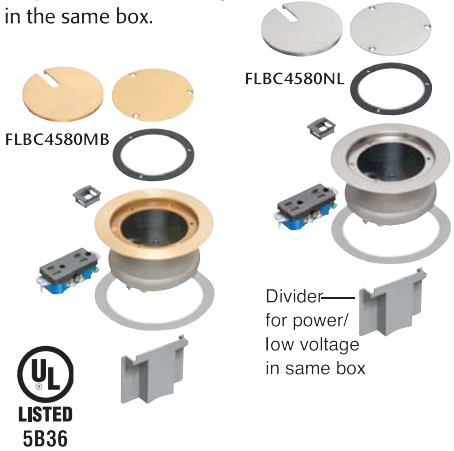
**IN BOX® with Ultra-Thin Stamped Steel Flange**

Arlington's NEW recessed FLBC4580 **IN BOX® Cover Kits** are *the solution* to installing a receptacle in a 4.5"concrete floor box, like our FLBC4500 or FLBC4502 boxes. They install *into* the box so they look great and reduce the trip hazard caused by protruding plugs.


Our UL Listed **FLBC4580** IN BOX Cover Kits ***COST 20% LESS than SOLID brass and nickel-plated brass covers.*** This new series has brass-plated or nickel-plated diecast zinc covers with plated-to-match ***ULTRA-THIN, STAMPED STEEL FLANGES*** *for cost-saving, flush-to-the-floor installation.*

Use the *blank* cover when not in use; substitute the *slotted* cover when cords are plugged in.

Easy to install, IN BOX Cover Kits have a divider for power *and low voltage* in the same box.




Arlington™

www.aifittings.com • Scranton, PA 18517 • 800/233-4717

PRODUCT INFO aifittings.com/landing/flbc4580

Patent pending



Circle 40 on Reader Service Card

The focus of this article is the changes to the NEC that deal specifically with surge protection devices (SPDs) — and how those protections have now been mandated to apply to residential dwellings for the first time.

## WHY THE FOCUS HAS SHIFTED

Before any standards for surge protection could be set, it was important to evaluate the extent of the damage caused to facilities by lightning events. For years, the National Electrical Manufacturers Association (NEMA) Surge Institute tried to access that information from nationally recognized insurance companies. The goal in getting the information was to assess how much of a threat surge damage was so the organization could provide proper guidance to front-line installers to prevent the damage from happening in the first place.

Before any standards for surge protection could be set, it was important to evaluate the extent of the damage caused to facilities by lightning events.

The problem was that the insurance companies were reluctant to provide the information on damage claims because they did not want to let their competitors know what their payouts were. To work around that reluctance, NEMA finally decided to send surveys directly to commercial and industrial customers to collect the data independently. The response to the survey was so overwhelming that NEMA followed up with a more detailed survey to dig more deeply into the data.

The result was a well-publicized NEMA report in 2014, detailing the effects of surge damage at structures like long-term nursing facilities, hospitals, and other industrial buildings. As a result of NEMA's findings, significant changes were made to the 2017 NEC, including the addition of several specific Articles to address overall facility safety.

Once those guidelines were in place, NEMA turned its attention to solidifying changes for residential dwellings, a segment that had previously been low on the priority list.

## PRACTICALLY SPEAKING

With multiple dwelling units, there are inductive loads such as HVAC, chillers, and other motors that could create transient voltages. An SPD at the service would not be an effective way to mitigate the transient voltages because the issue mishap could take place in just one of the multiple units. This mishap could cause transient voltages that would migrate into the other units. With each dwelling unit having an SPD installed, transient voltages are better addressed no matter what the source.

As electricians become more educated on SPDs, UL 1449, and IEEE guides for installation, residential protection will become more of a standard product. With home automation becoming more common, SPDs with network interfaces will become more common as well.

The requirements in Sec. 230.67 of the 2020 NEC are designed to protect residential dwellings from surges due to lightning strikes and electric utility faults. Much like the initial changes for commercial facilities, the new guidelines for residential dwellings are a good first step — but more will need to be specified in future updates. There is more processor-driven equipment in today's residences than ever before. Between connected televisions, home security systems, laptops, and refrigerators, there is hardly a room in the house now that does not have electronic equipment in it. That increased electrification of the home has been reflected in the financial cost to insurance companies for surge protection damages.

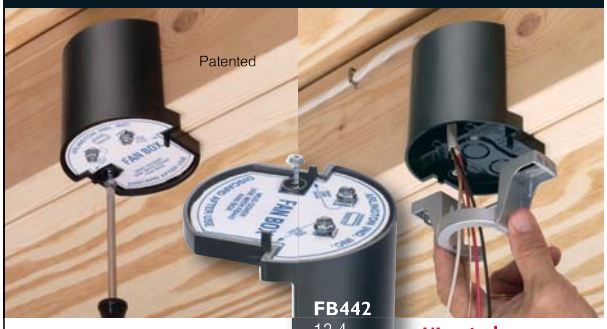
In the mid-1990s, the number of claims made with insurance companies

LOWEST COST • L-SHAPED

Made in USA

# FAN/FIXTURE BOX

## SECURE MOUNTING TO SINGLE, DOUBLE JOISTS




Super-secure installation! Our lowest cost, L-shaped fan/fixture box mounts to single or double joists with a captive center screw.

*No loose parts!* Installation screws ship captive, ready to install box and bracket.

**UL rated** fans up to 70 lbs; fixtures to 200 lbs.

- For 1/2" or 5/8" drywall
- Fast, easy installation
- Locator posts assure proper positioning of fan/fixture bracket
- 2-hour Fire Rating

Arlington®

Product info aifittings.com/catalog/fan-fixture-boxes/l-shaped-fan-and-fixture-mounting-boxes/FB442

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LOW PROFILE • 4" DIAMETER

Made in USA

# SCONCE BOX

## FOR SHALLOW WALL CAVITIES OR OBSTRUCTIONS


Arlington's **Low Profile Sconce Box** is perfect for retrofit installations with shallow wall cavities - or obstructions running behind the wall.

This non-metallic box installs FAST in an existing 1/2" *or* 5/8" wall with a 4" hole saw.

- Mounting wing screws hold it firmly in place
- Accommodates most sconce light canopies

**FSC405R** Sconce Box

Patented

Arlington®

Product info aifittings.com/catalog/fan-fixture-boxes/low-profile-sconce-box/FSC405R

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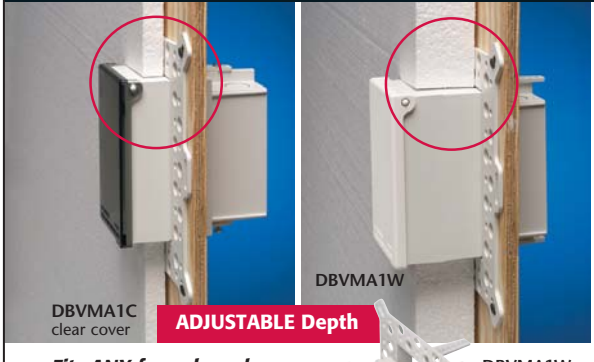
ONE-PIECE. SAVES TIME – LOOKS GREAT!

Made in USA

# RECESSED IN BOX®

## LOW PROFILE, EXTRA DUTY COVER • *TWO STYLES* for *1-1/2"* and *Foam Wall Systems*




One-piece **IN BOX®**, the recessed electrical box for exterior use, eliminates installing an electrical box and bubble cover assembly, so *you save big* on labor and materials.

IN BOX installs in the wall – so less shows outside. Fewer parts to handle. Time savings. *A great-looking job with Arlington's IN BOX!*

- Non-metallic, 22.0 cu. in. box with EXTRA-DUTY weatherproof-in-use clear or white cover
- Accepts single-gang devices; no gaskets required




***Fits ANY foam board*** *on 2-3/4" to 5" wall or* ***custom stucco finishes*** *1/4" to 2-1/2" thick.*


DBVMA1W white cover

for Help in Maintaining CONTINUOUS INSULATION in foam sheathing applications

***IN BOX MEETS 2020 NEC Section 406.9*** *for protection of exterior outlets which require the use of extra-duty weatherproof-in-use cover for all outdoor 15 or 20 AMP receptacles.*

*For* ***1-1/2" wall systems,*** *including foam. Eliminates separate flashing.*

DBVME1W

aifittings.com/catalog/inbox/low-profile-in-box-for-foam-wall-systems/DBVMA1C

aifittings.com/catalog/inbox/low-profile-in-box-for-one-and-half-inchwall-systems/DBVME1C

Patented/Additional patents pending

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that resulted in compensation for surge damage was more frequent, but the amount of the average damage claim remained around $4,000. By the 2000s, the number of surge protection claims was declining, but the amount of damage reported had skyrocketed to an average of $15,000 per claim.

## WHAT THE NEW REQUIREMENTS MEAN FOR YOU

The 2020 NEC specifically requires SPDs to be installed on all services supplying dwelling units. Whether it is a single-family home, two- to three-family dwelling unit, or apartment structure, SPDs are now required. Where exactly you install this SPD has led to industry discussions.

One item that some electrical professionals view as a shortcoming is a suggestion that an SPD can be installed in a meter panel or disconnect that is many feet away from the service panel containing the circuit breaker. After all, the electric utility meter socket is not part of the service, and the components between the meter socket and service panel are all defined as part of the service. However, others believe that for full protection, the SPD should be installed at the service panel, not the meter panel.

Some industry professionals note there is no guidance on the maximum surge protection for residential dwellings. For some industries that are using the same utility voltage as residential homes, the engineering community requires the minimums associated with the UL 1449 rating, whose specifications include the Short Circuit Current Rating and Nominal Discharge Current Rating. In most cases, there is also a maximum surge rating specified. In lightning protection systems, there are minimum UL 1449 ratings required, but there are SPDs in the residential dwelling segment that would not meet those specifications for these engineering-specified projects or lightning protection systems.

As with all regulations, the NEC will continue to evolve, addressing protection for these other vulnerable areas. It is also expected that better installation practices will be adopted, and the UL 1449 ratings will be looked at more carefully for service entrance requirements.

## WHEN WILL STATES ADOPT NEC 2020?

At the writing of this article in August 2021, 12 states had adopted the 2020 NEC for their jurisdictions, including the regulations for SPDs. Twelve additional states are currently in transition. The remaining states are operating on earlier versions of the NEC or other electrical codes.

Fortunately for consumers, it doesn't necessarily take a statewide mandate for the provisions of the 2020 NEC to be adopted. Municipalities, counties, and other authorities having jurisdiction

> The 2020 NEC specifically requires SPDs to be installed on all services supplying dwelling units.

(AHJs) can adopt the most up-to-date NEC regulations on their own — and frequently do. Though a patchwork approach is not ideal, the more AHJs that adopt the 2020 NEC, the more likely it is that the state in which they operate will eventually adopt it as well.

As the electrification of the U.S. economy continues and new forms of generation are developed (renewable energy sources), it will be more necessary than ever to protect this valuable infrastructure from unwanted surges. And as damage claims continue to climb in value, insurance companies will begin to require SPDs on residential dwellings that are particularly vulnerable.

The 2020 NEC updates are an excellent first step in streamlining the regulations concerning SPDs, and it will be fascinating to see where they go in the future. EC&M

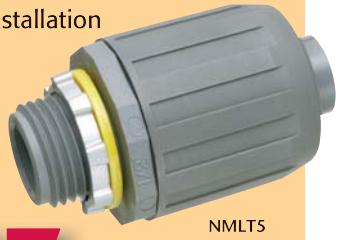
*Rick Syverson is the North American surge market manager for nVent ERICO.*

SAVE TIME...FAST, EASY *PUSH ON* INSTALLATION

# PUSH-ON CONNECTORS

## FOR NON-METALLIC LIQUID-TIGHT CONDUIT


**PUSH ON**
installation



NMLT5

**17** seconds
per connector

VS

**Conventional**
installation

NMLT50

**57** seconds
per connector


## SAVE 40 seconds or *33¢ per push-on connector!

Arlington's push-on connectors offer the fastest, easiest way to install non-metallic liquid-tight conduit, type B.

Our one-piece connectors reduce labor steps and eliminate lost pieces. They ship fully assembled with no disassembly needed – and are removable and reusable.

Save time and money with our user-friendly, straight and 90° push-on connectors.

*at $30.00/hour labor rate

NMLT905

**NON-METALLIC**

| Catalog Number | Trade Size | Straight | 90° |
|---|---|---|---|
| NMLT5 | 1/2" | ✔ | |
| NMLT905 | 1/2" | | ✔ |
| NMLT7 | 3/4" | ✔ | |
| NMLT907 | 3/4" | | ✔ |
| NMLT10 | 1" | ✔ | |
| NMLT9010 | 1" | | ✔ |
| NMLT12 | 1-1/4" | ✔ | |
| NMLT9012 | 1-1/4" | | ✔ |
| NMLT15 | 1-1/2" | ✔ | |
| NMLT9015 | 1-1/2" | | ✔ |
| NMLT20 | 2" | ✔ | |
| NMLT9020 | 2" | | ✔ |

Arlington™

UL LISTED CSA

Made in USA

www.aifittings.com Scranton, PA 18517 800/233-4717 Patented.

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Product info aifittings.com/landing/nmlt20

# Motors, Drives, Motor Controls, and Power Distribution Equipment

## Decentralized drive package

This decentralized drive package for indoor and outdoor applications features WG20-series gear units, EUSAS motors, and the MW500 variable-speed drive (VSD). Products from the MW500 VSD family are designed for applications from 0.12kW to 9.2kW for line voltages from 380V to 480V and come in three frame sizes (A, B, and C), as well as from 0.12kW to 1.5kW for 200V to 240V with the WG20 geared motor series, available in models with helical, parallel shaft, and helical bevel gear units. When the gear unit in this setup is connected to the EUSAS integral motor, the motor can be operated in frequency inverter mode (100-Hz/120-Hz characteristics), offering double the power at a constant torque.

**WEG**

## Motor control centers

The ReliaGear LV MCC is a low-voltage motor control center (MCC) that is UL/cUL 845-listed and designed for use in a variety of applications with a focus on smart MCC solutions. Safety features include a retractable stab mechanism that allows for closed-door racking, an integrated surge protection device, and reinforced door latches. The ACS580 VFDs are compatible with a wide range of fieldbus protocols, allowing for easy integration with other systems. Numerous motor management relays, including the company's UMC100.3, allow for communication, protection, and control, while the Tmax molded-case circuit breakers offer the option for Ekip trip units with added ability for digital protection, management, measurement, and remote monitoring.

**ABB**

## Motor testing meters


The motor testing dynamometers offer high accuracy testing for designers and manufacturers of electric motors of any size to meet a range of national and international standards, including IEC 60034-2-1, IEEE 112B, and Canadian standard C390-93. The products can be used to test from two-pole to eight-pole motors, ranging from 10W to more than 3MW. The testers have been engineered so that individual machines can test a wide range of motor sizes — from large industrial equipment to consumer products — and still maintain necessary accuracy tolerances.

**SAKOR Technologies**


## Motor disconnect switches

The CDS Series of non-metallic, curved-top motor disconnects features a curved profile to eliminate standing water and minimize contaminant buildup in food processing and other cleanroom operating environments. The NSF-certified series offers a chemically resistant thermoplastic enclosure with UL Type 4X and IP69K ratings; a lockout/tagout-compliant handle; and a 30A, 25-hp rating to satisfy most line disconnect requirements. The product also offers laser marking for permanent identification, captive stainless-steel cover screws, poured-in-place seamless gasket, standard early-break auxiliary contacts (1 N/O, 1 N/C), and a 65,000A SCCR rating with Class J fuse.

**MENNEKES**

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## Approved Across the Country

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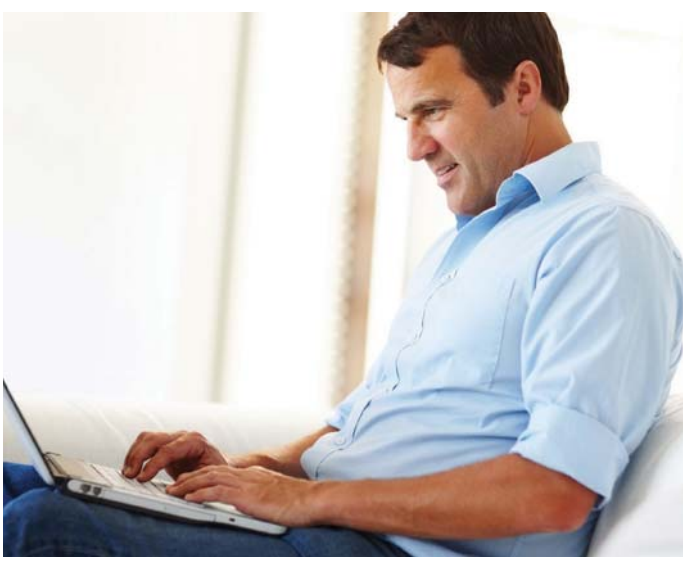

For over 30 years we have specialized in creating easy to use Electrical CEU programs built on Mike Holt's Best-Selling products & state of the art graphics. Choose a Mike Holt Course today & let us help you take your skills to the next level.

## SAVE 15%*

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* Special expires in 30 days and can't be combined with any other offer, or applied to previous orders

**Mike Holt Enterprises**

"…as for me and my house, we will serve the Lord." [Joshua 24:15]

# NEW PRODUCT SHOWCASE

## Pump motor system

The ID300 Fusion integrated motor drive includes U.S. MOTORS brand 1-hp to 10-hp UL-certified induction motors and customizable variable-speed drives. It incorporates the functions of a VFD into the motor and allows OEMs to embed the pump curve information into the drive so that the pump runs at its optimal efficiency point without an external sensor. An onboard programmable logic controller (PLC) can regulate the pressure (constant pressure/variable flow), and, when programmed with the pump curve, the PLC can perform sensorless constant pressure control. In addition, it offers a small modular design built to withstand harsh environments.

**Nidec Motor**

## Medium-voltage drive

Measuring 7.58 ft to 9.88 ft wide, the A-frame PowerFlex 6000T medium-voltage drive accepts up to 13.8kV primary voltage. Designed for new and retrofit industrial environments with variable and constant torque applications, the product allows the direct connection of high-voltage feeds from the main distribution line without any extra step-down transformer or substation. In addition, the drive offers faster commissioning with adaptive control, energy savings with an economizer mode, reduced downtime with predictive maintenance, and a common control platform from 0A to 680A. The company's TotalFORCE technology enables high-performance motor controls combined with advanced self-monitoring capabilities and a digital platform.

**Rockwell Automation**

## Severe-duty motor

The SIMOTICS SD200 severe-duty motor in frame size 440 offers 75-hp to 800-hp output and features a 444-5013 cast-iron frame for operation in 460V and 575V ranges. Designed to power equipment in harsh environments, the motors meet or exceed NEMA Premium MG1 Table 12-12 efficiencies and come in a variety of options, including IP56 ingress protection, encoders, brakes, blowers, and more. The frame, end-shields, fan guard, and diagonally split, oversized terminal box are cast-iron constructed and complemented by zinc-plated hardware, epoxy paint, and stainless-steel nameplates. An offset rotor bar provides improved efficiency, while larger bars and end rings reduce resistance. Each die-cast aluminum rotor assembly is balanced for extended bearing life and includes a high-strength C1045 carbon steel shaft for maximum performance.

**Siemens**

## Filter

The SineWave Nexus filter is designed to not only clean the PWM waveform generated by VFDs, but also virtually eliminate common-mode voltage. By filtering out the damaging common-mode voltage, motor bearings are not subject to harmful voltages that lead to motor failure. The filter also eliminates the need for isolation transformers or shaft grounding rings, reducing maintenance time and cost. According to the company, the small-package filter solution helps increase motor life, eliminate motor failures due to bearing currents, and reduce motor noise and heating.

**MTE**

## Tool chest

The Packout rolling tool chest enables users to store larger tools and equipment while providing the ability to transport two Packout stacks onto the site with the new dual-stack top. Features include an industrial-grade handle, 9-in. all-terrain wheels, an impact-resistant body, and metal reinforced locking points. In addition, the 35-gal tool chest has a 250-lb weight capacity and an interior organization tray. The locking lid support feature keeps the top securely open, which prevents sudden lid closure while working with tools and accessories.

**Milwaukee Tool**

## Recessed box covers

FLBC4560D recessed covers are designed to install into a 4.5-in. concrete floor box to reduce tripping. Available with metal flanges in brass or nickel-plated brass, the covers also come in plastic in light almond, gray, caramel, black, and dark brown colors. Easy to install, the UL-listed products feature a divider to accommodate power and low voltage in the same box.

**Arlington Industries**

## Slip joint pliers

TwinGrip pliers are the industry's only slip joint pliers with a five-adjustment pushbutton, according to the company. Featuring both front and side gripping areas, the front gripping area is suitable for gripping stripped screws and bolts. The jaws of the side gripping area include opposing teeth that allow the tool to grip round, square, and hex materials with maximum force. With five adjustment positions, the product offers a gripping capacity for diameters and widths across the flats from $^{5}/_{32}$ in. to $^{7}/_{8}$ in. In addition, they easily grab flat objects with the 3-point contact system. Other features include a slim head design, durable box joint design for great stability, a pinch guard, special hardened teeth (approximately 61 HRC), and high-grade chrome vanadium steel construction.

**KNIPEX**

# The Differences Between Grounding and Bonding — Part 11 of 12

## If you install "special equipment," some Chapter 6 requirements add to the grounding and bonding requirements of Art. 250.

By Mike Holt, NEC Consultant

*This article is the eleventh in a 12-part series on the differences between grounding and bonding.*

Three Chapter 6 Articles have significant implications for grounding and bonding special equipment:

- Article 600 — Electric Signs and Outline Lighting.
- Article 680 — Swimming Pools, Fountains, and Similar Installations.
- Article 690 — Solar Photovoltaic (PV) Systems.

### ELECTRIC SIGNS AND OUTLINE LIGHTING

Metal equipment of signs, outline lighting systems, and skeleton tubing must connect to the circuit equipment grounding conductor (EGC) of a type recognized in Sec. 250.118 [Sec. 600.7(A)(1)].

If the EGC is of the wire type, size it per Sec. 250.122 [Sec. 600.7(A)(2)]. Make EGC connections per Sec. 250.130 in a method specified in Sec. 250.8 [Sec. 600.7(A)(3)].

Metal parts of signs and outline lighting systems must be bonded together and connected to the transformer or power-supply EGC [Sec. 600.7(B)(1)]. Bonding is not required if the power supply is Class 2-rated [Sec. 600.7(B)(1) Exception].

Make bonding connections per Sec. 250.8 [Sec. 600.7(B)(2)]. To bond secondary circuit conductors for neon tubing, you can use listed flexible metal conduit or listed liquidtight flexible metal conduit if the total length of the flexible metal conduit does not exceed 100 ft [Sec. 600.7(B)(4)].

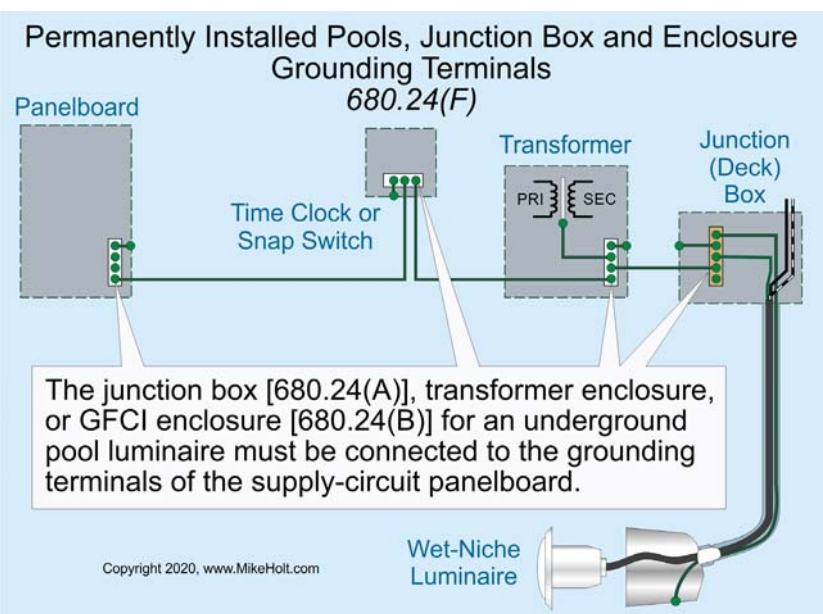



**Fig. 1.** Bonding and grounding requirements for permanently installed pool equipment.

Bonding conductors must be copper and at least 14 AWG [Sec. 600.7(B)(7)]. Bonding conductors installed outside a sign or raceway must be protected from physical damage.

### SWIMMING POOLS, FOUNTAINS, AND SIMILAR INSTALLATIONS

Many of these requirements intend to equalize potential between metal parts, thus you will see "equipotential bonding" used in Art. 680.

Terminals for grounding and bonding equipment must be identified as suitable for use in wet and corrosive environments and be listed for direct burial use [Sec. 680.7].

The wiring methods to a pool-associated motor must contain an insulated copper EGC sized per Sec. 250.122. The EGC must be at least 12 AWG [Sec. 680.21(A)(1)].

If raceway running to an underwater luminaire is metal, then it must be listed

and identified as red brass or stainless steel [Sec. 680.23(B)(2)(a)].

A nonmetallic raceway run to the forming shell of a wet-niche luminaire must contain an 8 AWG insulated (solid or stranded) copper conductor that terminates to the forming shell unless a listed low-voltage lighting system that does not require grounding is used [Sec. 680.23(B)(2)(b)].

Branch-circuit [Sec. 680.23] or feeder [Sec. 680.25] wiring installed in corrosive locations must contain an insulated copper EGC sized per Sec. 250.122, but at least 12 AWG. It must also be a rigid metal conduit, intermediate metal conduit, rigid polyvinyl chloride conduit, or reinforced thermosetting resin conduit [Sec. 680.14] or liquidtight flexible nonmetallic conduit [Sec. 680.23(F)(1)].

Branch-circuit conductors for all through-wall underwater pool luminaires must have insulated copper EGCs without joint or splice except as permitted in Sec. 680.23(F)(2)(a) and (b). Size branch-circuit and feeder EGCs per Sec. 250.122, but they must be no smaller than 12 AWG.

The circuit EGC for the underwater pool luminaire cannot be spliced, except for the two applications described in Sec. 680.23(F)(2)(a) and (b).

The branch-circuit conductors for the underwater pool luminaire on the load side of a GFCI or transformer [to comply with Sec. 680.23(A)(8)] cannot occupy raceways or enclosures with other conductors unless the other conductors are [Sec. 680.23(F)(3)]:

(1) GFCI-protected or,

(2) EGCs/bonding jumpers as required by Sec. 680.23(B)(2)(b) or,

(3) Supply conductors to a feed-through-type GFCI.

The junction box [Sec. 680.24(A)], transformer enclosure, or GFCI enclosure [Sec. 680.24(B)] for an underground pool luminaire must connect to the grounding terminals of the supply-circuit panelboard [Sec. 680.24(F)] (**Fig. 1** on page 64).

The function of equipotential bonding is to eliminate voltage gradients in the pool area and not to provide a path for ground-fault current. Equipotential bonding in the vicinity of swimming pools reduces the potential differences (shock hazards) created by stray currents or piping connected to the swimming pool.

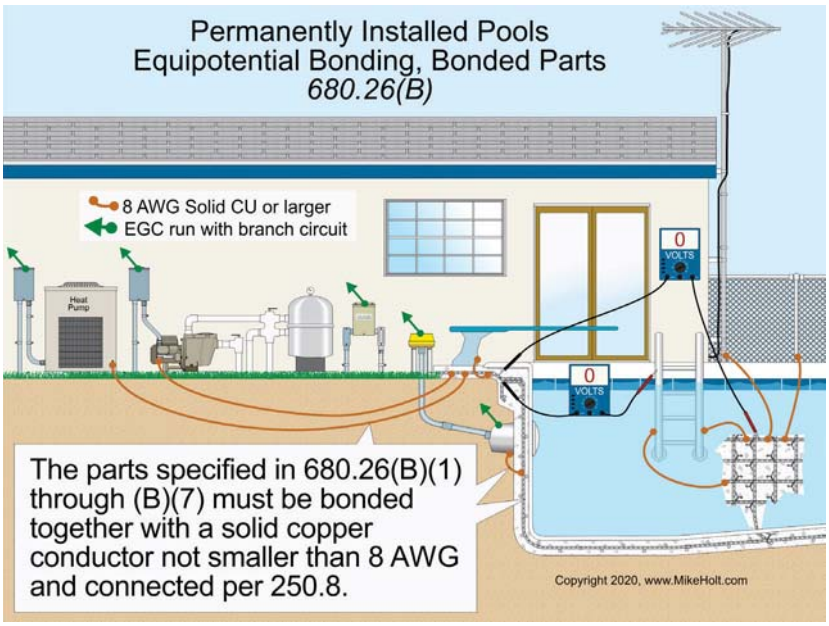



**Fig. 2.** This equipotential bonding is not required to extend to any panelboard, service disconnect, or grounding electrode.

To accomplish equipotential bonding, the parts of a permanently installed pool listed in Sec. 680.26(B)(1) through (B)(7) must be bonded with a solid copper conductor at least 8 AWG with a listed pressure connector, terminal bar, or other listed means per Sec. 250.8(A) [Sec. 680.26(B)] (**Fig. 2**). This equipotential bonding is not required to extend to any panelboard, service disconnect, or grounding electrode.

Conductive pool shells must conform to Sec. 680.26(B)(1). For example, unencapsulated structural reinforcing steel bonded by steel tie wires or the equivalent [Sec. 680.26(B)(1)(a)].

Perimeter surfaces must be attached to the concrete pool reinforcing steel at a minimum of four points uniformly spaced around the perimeter of the pool [Sec. 680.26(B)(2)]. In addition, they must conform to other requirements of Sec. 680.26(B)(2)(a), (b), or (c). Many of these requirements are new with the 2020 cycle.

Metal fittings sized over 4 in. in any dimension and within (or attached to) the pool structure (e.g., ladders and handrails) must be connected to the swimming pool equipotential bonding means [Sec. 680.26(B)(5)]. As of the 2020 NEC, metallic pool cover anchors 1 in. or less in any dimension and 2 in. or less in length do not have to be bonded to the equipotential bonding means.

Metal parts of electrical equipment associated with the pool water circulating system must be connected to the swimming pool equipotential bonding means [Sec. 680.26(B)(6)].

Fixed metal parts within 5 ft horizontally [Sec. 680.26(B)(7) Exception No. 2] and 12 ft vertically [Sec. 680.26(B)(7) Exception No. 3] from the inside wall of the pool must be connected to the swimming pool equipotential bonding means [Sec. 680.62(B)(7)].

*Exception No. 1: Those separated from the pool by a permanent barrier that prevents contact by a person don't have to be bonded.*

If the pool water in a nonconductive pool structure does not have a direct electrical connection to one of the bonded parts described in Sec. 680.26(B), an approved corrosion-resistant conductive surface that is at least 9 in.$^2$ in contact with the water must be bonded per Sec. 680.26(B) [Sec. 680.26(C)].

Where bonded items such as ladders, rails, or underwater luminaires are in direct contact with the pool

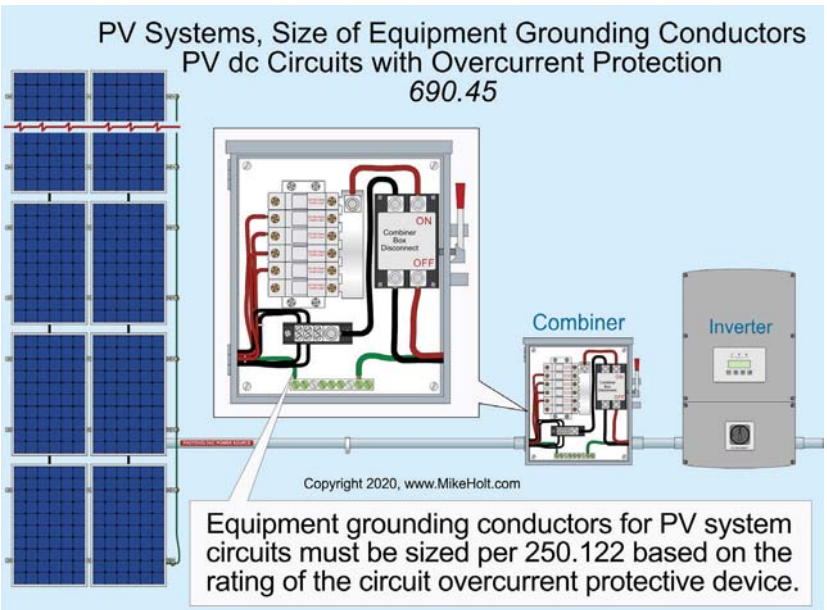



**Fig. 3.** Size equipment grounding conductors based on the rating of the circuit overcurrent protecting device.

water and provide the required surface area, it is considered to comply with this requirement.

Equipotential bonding of perimeter surfaces for outdoor spas and hot tubs is not required if the four conditions enumerated in Sec. 680.42(B) are met.

For fountains, the following equipment must connect to the circuit EGC [Sec. 680.54(A)]:

(1) Other than listed low-voltage luminaires not requiring grounding, all electrical equipment within the fountain or within 5 ft of a fountain inside wall.

(2) All electrical equipment associated with the recirculating system.

(3) Panelboards that are not part of the service equipment and supply any electrical equipment associated with the fountain.

Six types of parts, as listed in Sec. 680.54(B)(1) through (6), must be bonded and connected to an EGC on a fountain branch circuit.

The grounding requirements of Sec. 680.21(A), Sec. 680.23(B)(3), Sec. 680.23(F)(1) and (2), Sec. 680.24(F), and Sec. 680.25 apply to fountains [Sec. 680.55(A)]. Fountain equipment supplied by a flexible cord must have all exposed metal parts connected to an insulated copper EGC that is an integral part of the cord [Sec. 680.55(B)].

For hydromassage tubs, the five types of parts listed in Sec. 680.74(A)(1) through (5) must be bonded (for example, pump and blower motors).

Metal parts required to be bonded by Sec. 680.74(A) must be bonded using a solid copper conductor at least 8 AWG. Bonding jumpers are not required to extend to any remote panelboard, service disconnect, or any electrode [Sec. 680.74(B)].

When installing a double-insulated circulating pump or blower motor, allow for the fact that the replacement might not be double insulated. To do this, terminate a bonding jumper to the EGC of the motor branch circuit and make it long enough to terminate the other end on the replacement motor.

## SOLAR PHOTOVOLTAIC (PV) SYSTEMS

Exposed metal parts of PV module frames, electrical equipment, and any enclosure containing PV system conductors must connect to the PV system circuit EGC per Sec. 250.134 or Sec. 250.136 [Sec. 690.43].

Metallic support structures listed, labeled, and identified for bonding and grounding metal parts of PV systems can be used to bond PV equipment to the metal support structure that has been connected to the PV circuit EGC [Sec. 690.43(B)].

Metallic support structures used as an EGC must have identified bonding jumpers between separate metallic sections, or the support structure must be identified for equipment bonding purposes and connect to the PV circuit EGC as required by Sec. 690.43.

The bonding requirements contained in Sec. 250.97 apply only to solidly grounded PV system circuits operating over 250V to ground [Sec. 690.43(D)].

EGCs for PV system circuits must be sized per Sec. 250.122, based on the circuit overcurrent protection ampere rating [Sec. 690.45] (**Fig. 3**).

Where no overcurrent protective device is used in the PV system direct-current circuit, size the EGC for the system's direct-current circuit per Table 250.122, based on an assumed overcurrent device for the circuit sized per Sec. 690.9(B).

Increases in EGC size due to voltage drop are not required.

A building or structure supporting a PV system must use a grounding electrode system installed per Part III of Art. 250 [Sec. 690.47(A)].

The PV array EGCs must connect to a grounding electrode system per Part VII of Art. 250. This connection is required in addition to the EGC requirements in Sec. 690.43(C). Size the PV array EGCs per Sec. 690.45.

For specific PV system grounding configurations as permitted in Sec. 690.41(A), apply Sec. 690.47(A)(2) if it's solidly grounded or Sec. 690.47(A)(1) if it's not.

## SPECIAL EQUIPMENT, SAME GOAL

From these three Articles (600, 680, and 690), you can see there's more to bonding some equipment than what you find in Art. 250. Equipment in Chapter 6 is there because something about it means Chapters 1 through 4 are not enough. But always, the goal of bonding is to reduce or eliminate differences of potential. EC&M

*These materials are provided to us 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

*All questions and answers are based on the 2020 NEC.*

**Q.** What is the Code rule that addresses side and rear access requirements to switchgear and panelboards?

**A.** Each section of equipment that requires rear or side access to make field connections must be so marked by the manufacturer on the front of the equipment. Section openings requiring rear or side access must comply with the workspace and access to workspace requirements of Sec. 110.26 [Sec. 408.18(C)].

**Author's comment:** The 2020 addition of this NEC Section goes a long way to providing much safer access to the sides and the back of switchboards and switchgear where such access may be necessary to make wiring connections. This addition exemplifies the NFPA's intent and continued efforts to reduce exposure and risk to unnecessary hazards to keep electrical workers safe.

**Q.** A luminaire installed in a bathtub or shower area must meet what NEC requirements?

**A.** A luminaire installed in a bathtub or shower area must meet all of the following requirements [Sec. 410.10(D)]:

(1) No part of chain-, cable-, or cord-suspended luminaires, track luminaires, or ceiling paddle fans can be located within 3 ft horizontally and 8 ft vertically from the top of the bathtub rim or shower stall threshold (**Fig. 1**).

(2) Luminaires located within the actual outside dimensions of a bathtub or shower to a height of 8 ft from the top of the bathtub rim or shower threshold must be marked for damp locations or marked suitable for wet locations. Where subject to shower spray, the luminaires must be marked suitable for wet locations (**Fig. 2**).

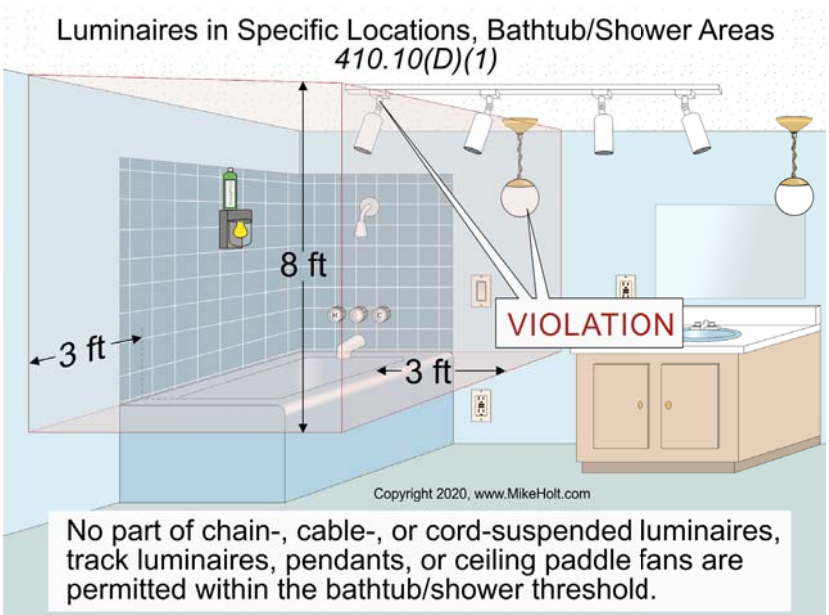



**Fig. 1.** NEC rules for luminaires installed in a bathtub/shower areas per Sec. 410.19(D)(1).

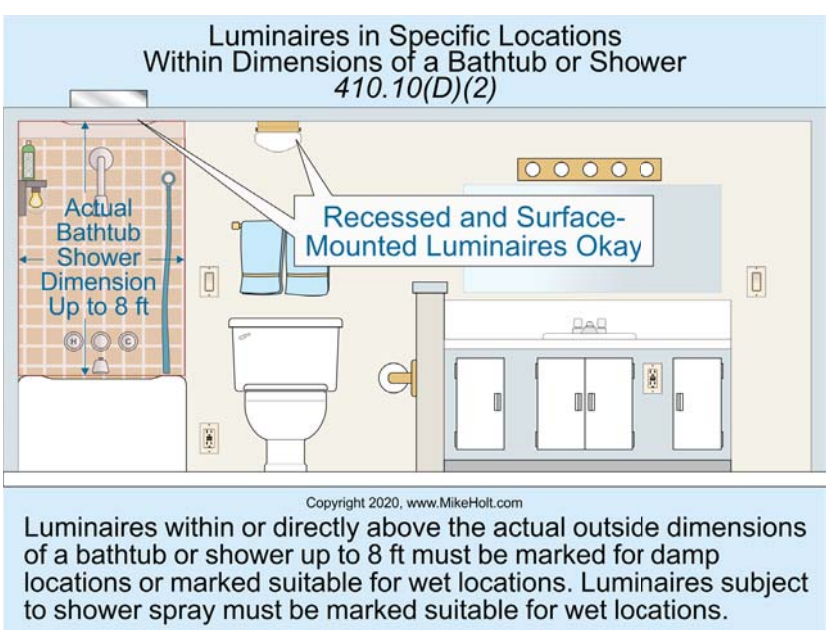



**Fig. 2.** Rules for luminaires directly above the outside dimensions of a bathtub or shower.

**Author's comment:** The previous Code language required the luminaire to be marked "wet locations where subject to shower spray." There is no such marking on any luminaire. EC&M

# Illustrated Catastrophes

By Russ LeBlanc, NEC Consultant

*All references are based on the 2020 edition of the NEC.*

## A ROADSIDE NIGHTMARE

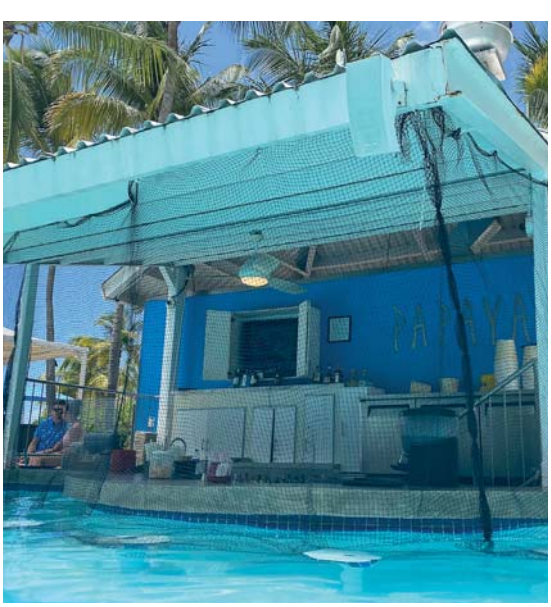
An *EC&M* reader who wishes to remain anonymous sent in this photo. "I found this weathered meter installation that I believe is feeding some DOT lighting and still energized," he said. "It was next to a sidewalk but behind a fence just out of public reach."

I think the term "weathered" is a bit generous. The service disconnect switch is completely rusted out, leaving the energized parts dangerously exposed. Although this enclosure may have complied with the rules in Sec. 110.27 for guarding live parts against accidental contact when first installed, it certainly does not comply now. Severe corrosion has taken hold of this equipment and is not letting go. Section 300.6 requires equipment to be constructed of materials "suitable for the environment in which they are to be installed." Using stainless steel or nonmetallic equipment would have been the better choice here. The severe corrosion has compromised many of the bonding and grounding requirements in Art. 250 for this equipment as well. Regardless, this installation is overdue for a complete replacement.

## POOL BAR PROBLEMS

Look at the top right side of this photo, and you will see a speaker mounted to the front of the roof overhanging this pool. I noticed this while on a recent trip to Puerto Rico. Although COVID-19 restrictions prohibited guests from sitting at the pool bar, that did not prevent me from taking photos of the Code violations I found. Regarding the speaker, Sec. 680.22(D) requires outlets other than those covered in Sec. 680.22(A) through (C) to be located no less than 10 ft from the inside walls of the pool. For audio system equipment powered by a listed Class 2 power supply, Sec. 640.10(B) restricts placement only by the manufacturer's instructions. Although I wasn't able to get an exact measurement, the paddle fan installed above the bar area appears too low and too close to the edge of the pool. Section 680.22(B) requires fans installed within 5 ft horizontally of the inside walls of the pool to be no less than 12 ft above water level. Also, the tips of those fan blades look like they are encroaching that 5 ft horizontal space, but that fan is definitely not 12 ft high.

*Note: I'd like to thank my wife Amy for supporting my work. She knows I'm constantly hunting for Code violations to photograph, even when we are on vacation.*



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# 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 2020 NEC.

**Hint:** Spectacular EMT failure

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

*Using the 2020 NEC, correctly identify the Code violation(s) in this month's photo in 200 words or less, and you could win an Arlington Industries SL1B18 single-gang slider bar kit, which includes an 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.*

## SEPTEMBER WINNERS

Our three winners this month were: Garret Konz, an *EC&M* reader from Lincoln, Neb.; John Marcotte, an electrical supervisor for Mohegan Sun, Uncasville, Conn.; and Rick McLain, a master electrician with Falcon Electric LLC, Springfield, Mo. They knew that using PVC conduit to support boxes, luminaires, and other equipment is not permitted.

Section 352.12(B) is straightforward in prohibiting PVC conduit for support of luminaires or equipment other than conduit bodies. The weight of the box, receptacle, cover,

and luminaires are causing the PVC conduit to bend and bow. A simple touch of the receptacle cover causes the entire installation to bounce back and forth and side to side, as if on a trampoline. How long do you think it will be before the PVC conduit snaps?

The outlet box is not considered properly supported either. Outlet boxes must be supported in accordance with one or more of the requirements in Sec. 314.23(A) through (H). Using PVC conduit to support outlet boxes is not mentioned in any of those provisions.

Lastly, I know it may not be clearly visible in the photo, but the receptacle was not a weather-resistant (WR) type as required by Sec. 406.9(B)(1).

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