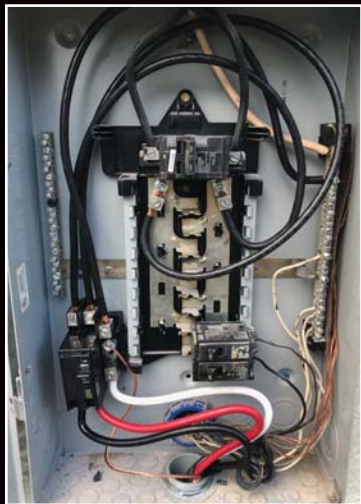


CODE CATASTROPHES

*The 10 craziest
Code violations of
2020. Read more
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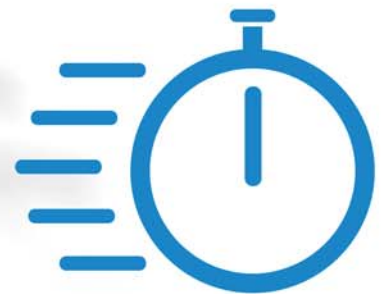


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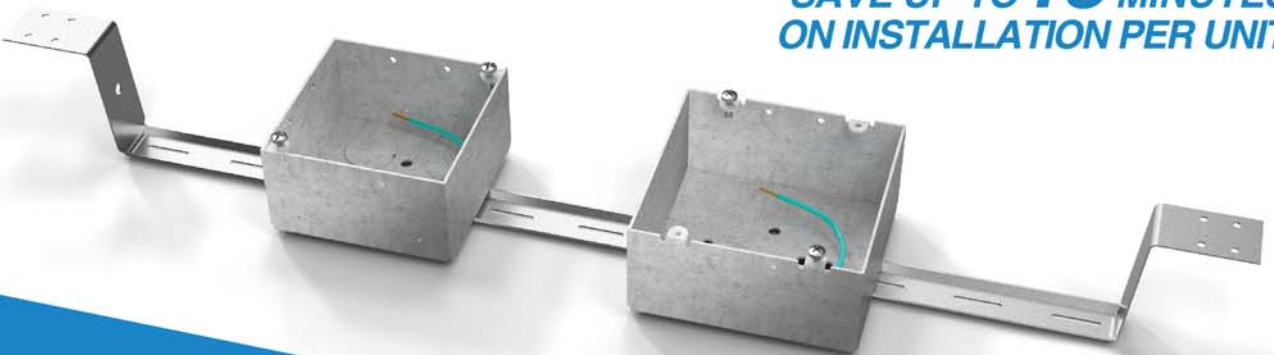
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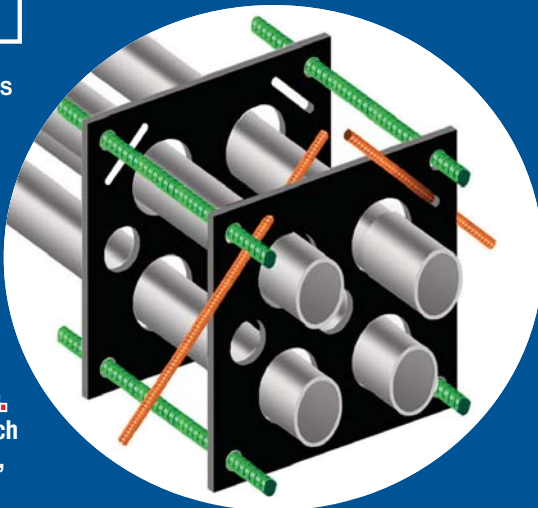
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Make Time to Honor the Next Generation of Electrical Professionals

By Ellen Parson, Editor-in-Chief



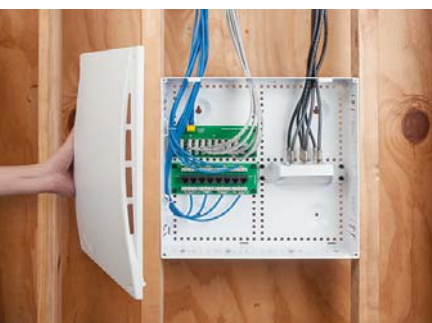
It's no secret that the electrical industry has been suffering through a skilled labor shortage for the last several years. Although the solution to this problem is certainly more complicated than it may seem at first glance, the basic dilemma is undeniably simple. Substantially more people are leaving the profession in pursuit of different career paths or through retirements than are joining the ranks to replace them. During the course of writing this column, I came upon an interesting piece. Although it's a few years old, the research still holds merit. Read the full article at <https://bit.ly/3oFrefo> to see why human resources recruiting firm Adecco maintains the ratio of those who work "skilled trades" vs. "other jobs" is reversing among younger workers.

For the last five-plus years, respondents to our annual Top 50 Electrical Contractors survey have consistently revealed that their biggest business challenge was recruiting quality employees. Last year, however, that number dropped considerably — with 51% of participating electrical contractors indicating that they experienced worker shortages in 2019 as compared to 85% who answered affirmatively in 2018 (survey results are based on the previous full year of data). This particular data point suggests the tides may be turning when it comes to the labor shortage; however, another factor — employee retention — may be in play. In 2020, 50% of respondents to the same survey said they planned to layoff workers compared to 0% the previous year. Similarly, 77% of firms planned to add employees in 2019 compared to only 29% this year. Despite this discovery, the future for electrical professionals looks overwhelmingly bright. According to the latest numbers from the U.S. Bureau of Labor Statistics, employment of electricians is projected to grow 8% from 2019 to 2029, much faster than the average for all occupations. If you're looking to join the electrical trade, this translates into increased salary potential, job opportunities, and incentives.

Millions of Baby Boomers (those born between 1946 and 1964) retire every year. However, according to a blog posted in November by Richard Fry, a senior researcher at Pew Research Center, the pace at which this group is retiring has begun to accelerate. In the third quarter of 2020, for example, he reveals that approximately 28.6 million Baby Boomers left the workforce to retire. "This is 3.2 million more Boomers than the 25.4 million who were retired in the same quarter of 2019," he writes. Read the full post at <https://pewrsr.ch/3buSoly> for more perspective.

Given the finality of these inevitable retirements coupled with the challenge of attracting young professionals to the electrical trade, it seems only natural to encourage you to take a few moments to sit back and reflect on the next generation. Do any of you know young colleagues who consistently go above and beyond the call of duty, especially demonstrating innovation, efficiency, and creativity while incorporating technology into their jobs? If so, we want to hear from you! Four years ago, *EC&M* made a commitment to recognize the industry's top young talent by developing the "Under 30 *EC&M* All Stars." Since then, nominations for this annual honor have increased by more than 400%. Industry veterans: Please take the time to nominate a worthy young electrical professional (under 30 years of age) for this recognition. It only takes a few minutes (nominations should be 200 words or less), and it's a win-win for everyone. Our "30 Under 30" will be featured as a special report in the May print issue, online, and in a photo gallery. Fill out the form at <https://bit.ly/3qhFcV4> to nominate yourself or a coworker by February 19, or email the information to eparson@endeavorb2b.com.

Ellen Parson



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Why Motor Systems Fail and What You Can Do About It

Maintenance teams should consider different categories of components when troubleshooting motor problems.

By Sean Silvey, Fluke Corp.

Motor and drive system technology continues to advance throughout the industry. Oftentimes, this increased complexity presents a challenge to the teams who are making sure the equipment runs at peak performance. Even then, some motor failures result from mechanical failures or even problems introduced at installation. Thus, maintenance teams need to take different categories of components into consideration when troubleshooting motor problems.

Understanding the common reasons for motor failure and knowing how to troubleshoot and repair these systems can prevent costly downtime and improve operational efficiency. The following are common reasons motors fail.

POWER ISSUES

Transient voltage spikes. Transient voltages, like the name suggests, can come from several sources, either inside or outside a plant. They can strike distribution systems from loads for adjacent equipment turning on or off, power factor correction capacitor banks, and even weather events. These transients, which vary widely in amplitude and frequency, can erode or break down the insulation in motor windings. Determining the source of these transients is often difficult because of their seemingly randomness or infrequency of occurrences. Symptoms can show up in different ways. For instance, transient voltage may appear on control cables that don't cause direct equipment damage but still can trip components and disrupt operations.

Impact: Insulation breakdown on motor windings leads to early motor failure



Photo courtesy of Fluke Corp.

Breakdown in windings and bearing wear are the most common causes of motors failure, but those conditions arise for many different reasons.

and unplanned downtime

Tool to measure and diagnose: Power quality and motor analyzer, monitoring devices

Degree of criticality: High

Voltage imbalance. The 3-phase distribution systems that are common in industrial plants often serve single-phase loads. An imbalance in impedance or load distribution can, in turn, contribute to imbalance across all three of the phases. Potential faults may be found in the cabling to the motor, the terminals at the motor, and potentially in the motor windings themselves. This imbalance can lead to stresses in each of the phase

circuits in a 3-phase power system. All three phases of voltage should always have the same magnitude.

Impact: Imbalance creates excessive current in one or more phases that then increases operating temperatures, leading to insulation breakdown.

Tool to measure and diagnose: Power quality and motor analyzer, monitoring devices

Degree of criticality: Medium

Harmonic distortion. Harmonics are essentially any unwanted additional source of high-frequency AC voltages or currents supplying energy to the motor windings. This additional energy



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is not used to turn the motor shaft but instead circulates in the windings and ultimately contributes to internal energy losses. These losses dissipate as heat that, over time, will deteriorate the insulation properties of the windings. Some harmonic distortion of the current is normal on any part of the system serving electronic loads. To investigate harmonic distortion, use a power quality analyzer to monitor electrical current levels and temperatures at transformers to ensure that they are not overstressed. Each harmonic has a different acceptable level of distortion, which is defined by standards such as IEEE 519-1992.

Impact: Motor efficiency decreases, increasing costs and operating temperatures

Tool to measure and diagnose: Power quality and motor analyzer, monitoring devices

Degree of criticality: Medium

Excess shaft voltage. If motor shaft voltages exceed the insulating capacity of the bearing grease, flashover currents will occur and impact the outer bearing, causing pitting and grooving on the bearing races. The first signs of this are noise and overheating. As the bearings begin to lose their shape and metal fragments mix with the grease, bearing friction increases. This often destroys the bearing within a few months. Bearing failure is an expensive problem to repair and leads to costly downtime. Measuring shaft voltage and bearing current is an important diagnostic step to prevent excessive shaft voltage. Since shaft voltage is only present while the motor is energized and rotating, you will use a carbon brush probe attachment for the measurement on a portable oscilloscope.

Impact: Arcing across bearing surfaces create pitting and fluting resulting in excessive vibration and eventual bearing failure.

Tools to measure and diagnose: Portable oscilloscope, motor drive analyzer, carbon brush probe attachment

Degree of criticality: High

VARIABLE-FREQUENCY DRIVE (VFD) ISSUES

Reflections on drive output PWM signals. Variable-frequency drives use a



Photo courtesy of Fluke Corp.

Having the right tools to troubleshoot and repair can prevent costly downtime and improve operational efficiency.

pulse-width modulation (PWM) technique to control the output voltage and frequency to a motor. Reflections can be generated when there is an impedance mismatch between the source and load. Impedance mismatches can come from improper installation, improper component selection, or when equipment degrades over time. In a motor drive circuit, the peak of the reflection can be as high as the DC bus voltage level. Generally, reflections or transients >50% of nominal voltage are problematic.

Impact: Motor-winding insulation breakdown leads to unplanned downtime.

Tools to measure and diagnose: Portable oscilloscope, insulation multimeter

Degree of criticality: High

Sigma current. Sigma currents are stray currents that circulate in a system. Sigma currents are created because of signal frequency, voltage level, capacitance, and inductance in conductors. These stray currents can circulate through protective earth systems and cause nuisance tripping or lead to excess heat in windings. Sigma current can be found in motor

cabling. It is the sum of the current of the three phases at any one point in time. In a perfect situation, the sum of the three currents would equal zero. Thus, the return current from the drive would be equal to the current to the drive. Sigma current can also be understood as asymmetrical signals in multiple conductors that can capacitively couple currents into the ground conductor.

Impact: Mysterious circuit trip due to protective earth current flow

Tool to measure and diagnose: Portable oscilloscope

Degree of criticality: Low

Motor overloading. As the name suggests, motor overload happens when a motor is under excessive load. Typical symptoms for motor overload are excessive current draw, insufficient torque, and overheating. Excessive motor heat is a major cause of motor failure. An overloaded motor's individual components, such as bearings, motor windings, and other components, may appear to operate normally, but the motor will run hot. Because of this, checking for overload is a good place to start when troubleshooting

motors. Some 30% of motor failures are caused by overloading, so it is important to know how to identify and measure motor overloading.

Impact: Premature wear on motor electrical and mechanical components leading to permanent failure

Tools to measure and diagnose: Infrared camera, industrial logging multimeter

Degree of criticality: High

MECHANICAL

Shaft misalignment. Shaft misalignment occurs when the motor drive shaft is not in correct alignment with the load, or the component that couples the motor to the load is misaligned. Professionals often erroneously think a flexible coupling eliminates and compensates for misalignment, but a flexible coupling only protects the coupling from misalignment. Even with a flexible coupling, a misaligned shaft will transmit damaging cyclical forces along the shaft and into the motor. These forces cause excess wear on the motor and increase the apparent mechanical load. Misalignment also might feed vibration into both the load and the motor drive shaft. Types of misalignment include:

- Angular misalignment: Shaft centerlines intersect but are not parallel.
- Parallel misalignment: Shaft centerlines are parallel but not concentric.
- Compound misalignment: A combination of parallel and angular misalignment. *Note:* Almost all misalignment is compound misalignment. However, technicians often talk about misalignment as two separate types because it is a best practice to correct misalignment by addressing angular and parallel components separately.

Impact: Premature wear in mechanical drive components that leads to premature failures

Tools to measure and diagnose: Vibration tester, vibration analyzer, vibration sensors, shaft alignment tool

Degree of criticality: High

Shaft imbalance. Imbalance occurs in a rotating part where the center of mass does not lie on the axis of rotation. A heavy spot exists somewhere on the rotor. Although motor imbalance cannot be eliminated, it is possible to identify a normal range and rectify the problem. Imbalance can be caused by numerous factors, including:

- Accumulation of dirt.
- Missing balance weights.
- Manufacturing variations.
- Uneven mass in motor windings or other wear-related factors.

Impact: Wear in drive components leads to premature failures

Tools to measure and diagnose: Vibration tester, vibration analyzer, vibration sensors

Degree of criticality: High

Looseness. Rotating looseness occurs when too much clearance exists between rotating and stationary parts of a machine, such as a bearing. Non-rotating looseness occurs between two

normally stationary parts, such as a foot and a foundation or a bearing housing and a machine.

Impact: Wear in mechanical drive components leads to failures.

Tools to measure and diagnose: Vibration tester, vibration analyzer, vibration sensors, laser shaft alignment tool

Degree of criticality: High

Bearing wear. A failed bearing has increased drag, emits more heat, and has lower efficiency because of a mechanical, lubrication, or wear problem. Bearing failure can be caused by:

- A heavier load than designed for.
- Inadequate or incorrect lubrication.
- Ineffective bearing sealing.
- Shaft misalignment.
- Incorrect fit.
- Normal wear.
- Induced shaft voltages.

Bearing failure creates additional problems that accelerate motor failure. In fact, 13% of motor failures are caused by bearing failure, and more than 60% of the mechanical failures in a facility are caused by bearing wear. Thus, knowing how to troubleshoot bearing wear is an important skill.

Impact: Wear on rotating components results in bearing failure

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Tool to measure and diagnose: Vibration tester

Degree of criticality: High

IMPROPER INSTALLATION FACTORS

Soft foot. Soft foot is a condition where the mounting feet of a motor or driven component are uneven, or the surface on which the mounting feet sit is not even. Soft foot can frustrate professionals who try tightening the mounting bolts on the feet only to introduce new strains and further misalignment. Soft foot often happens between two diagonally positioned mounting bolts—such as how an uneven chair or table tends to rock in a diagonal direction. There are two kinds of soft foot:

1. Parallel soft foot: When one of the mounting feet sits higher than the other three.

2. Angular soft foot: When one of the mounting feet is not parallel or “normal” to the mounting surface.

In both cases, soft foot can result from an irregularity in the machine mounting feet or in the mounting foundation on which the feet rest. Any soft foot condition should be identified and remedied before a shaft is properly aligned. A quality laser alignment tool typically can identify a soft foot problem.

Impact: Misalignment of mechanical drive components

Tool to measure and diagnose: Laser shaft alignment tool

Degree of criticality: Medium

Pipe strain. Pipe strain occurs when stresses, strains, and forces from connected infrastructure transfer backward onto the motor and drive to introduce misalignment. The most common example of pipe strain is in motor/pump combinations, where something creates force to the pipe works such as:

- A shift in the foundation.
- A new valve or another component installation.
- An object striking, bending, or pressing on a pipe.
- Broken or absent pipe hangers or mounting hardware.

Forces such as these can put an angular or offset force on the pump, which, in turn, causes the motor/pump shaft to become misaligned. Thus, it is



Photo courtesy of Fluke Corp.

Monitor your asset's vibration to catch many mechanical issues before they create costly downtime.

recommended that you check machine alignment routinely. Precision alignment is temporary and can change over time.

Impact: Shaft misalignment and subsequent stresses on rotating components, leading the premature failures

Tool to measure and diagnose: Laser shaft alignment tool

Degree of criticality: Low

STRATEGIES TO PREVENT MOTOR FAILURES

Motors and their control systems are ubiquitous in critical processes throughout manufacturing and industrial facilities. If they fail, the cost of downtime as well as repairing or replacing motor can be substantial. That's why your maintenance teams need the appropriate skills, training, and tools to properly prioritize equipment criticality, monitor equipment health, and develop a preventive maintenance program that keeps motors in good working order to help forestall failures. In addition, maintenance teams need the training and procedural knowledge to troubleshoot intermittent problems to avoid failures because of normal operating stresses.

Implement the following four strategies to prevent premature failures in

motors, drives, and rotating components:

1. Document normal operating conditions, machine specifications, and performance tolerance ranges.

2. At installation, be sure to capture and document critical operating measurements. Also, track these measurements before and after maintenance and at other intervals, depending on their criticality.

3. Develop an archive of reference measurements to facilitate trend analysis and identify changes in status and conditions. Modern computerized maintenance management systems (CMMSs) can help manage data and help with this type of trend analysis.

4. Plot individual measurements to establish a baseline, and then capture measurements over time to determine trends. It is recommended that any change in the trend line of more than $\pm 10\%$ to 20% (or any other percentage determined, based on your system performance or criticality) should be investigated to the root cause to understand why the issue is occurring. **EC&M**

Silvey is an application specialist with Fluke Corp., Everett, Wash. He can be reached at sean.silvey@fluke.com.

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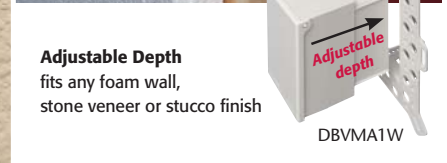


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IN BOX meets 2020 NEC, Section 406.9 for the protection of exterior outlets which require the use of an extra-duty weatherproof while-in-use cover for all outdoor 15 or 20 AMP receptacles.

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Keeping Up with Changes in NEC Article 547

Per the 2020 NEC, GFCI protection is now required for other agricultural related structures. See how this Article has evolved over the years to keep up with technology.

By Dean Hunter, Minnesota Department of Labor and Industry

Growing up in Northern Minnesota, I worked on my grandfather's 30-cow dairy farm. In the early 1970s, Grandpa decided to upgrade his milking operation and build a new barn. It was a huge undertaking, as the new barn included an automated milking system and a bulk tank that allowed for the milk to be picked up by the local milk truck.

In comparison, today's milking operations are nothing short of amazing. There are dairy operations that accommodate 10,000 cows. These barns have 24/7 robotic milking systems, automated feeding systems, sophisticated ventilation systems, and on-site veterinary facilities for herd management (**Photo 1**) — something my grandfather would never have thought possible.

Since its introduction in the 1978 edition of the NEC, Art. 547 has morphed and changed to keep pace with ever-changing technology (**Photo 2** on page 16). Because agricultural buildings are considered a Chapter 5 "special occupancy," it is important to note that the "general wiring methods" found in Chapters 1-4 of the NEC apply unless modified or supplemented in Art. 547 (Sec. 90.3).

Let's review some of the notable changes that took place over the years in reference to this Code Article.

For the 1987 NEC, the Correlating Committee created an Ad Hoc Subcommittee to address "Electrical Grounding of Agricultural Buildings." The committee introduced many grounding requirements that still exist today. The



Photo 1. Agricultural buildings don't look like my grandpa's dairy barn anymore.

changes included the requirement for copper equipment grounding conductors (EGCs) on all circuits as well as the introduction of the term "equipotential plane" (EP) to define the area used to reduce the potential effects of stray voltage and mandate that the conductive elements be connected to the grounding system. In addition, underground installations now required EGCs to be insulated or covered copper. A new 4-wire system requirement was added to address when an overcurrent device was not provided at the distribution point.

In the 1996 NEC, new language mandated conductive elements (wire mesh)

be embedded in a concrete floor to form the EP. There was also a new requirement for a voltage gradient at entrances and exits for all new installations.

A distribution point disconnect requirement was added during the 1999 NEC revision cycle. Other changes adopted in the 1999 NEC included requirement of 3- or 4-wire distribution systems, depending on where the overcurrent protection device was located, and voltage gradient(s) at entrances and exits were revised to more permissive language. In addition, an exception for the EP was added for the slatted floor installations supported by a structure



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- Mounting wing screws hold it firmly in place

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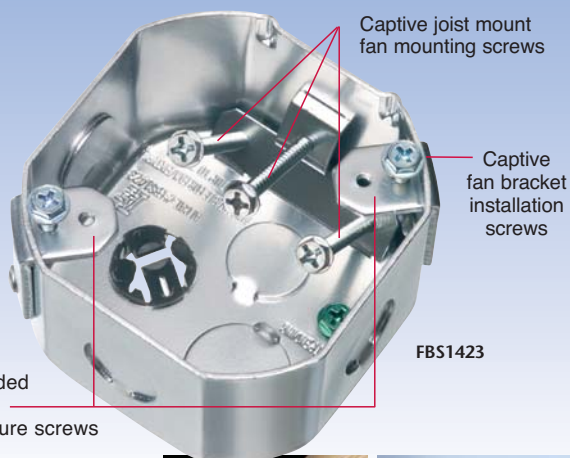
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Designed for installations of a fan or fixture, Arlington's **steel One Box™** mounts to a joist for an extra-secure, fan-rated installation.

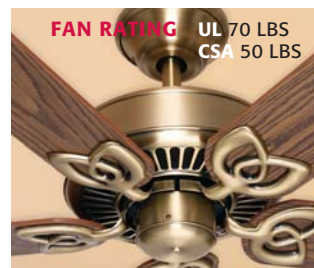
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Fan installation screws ship captive. No wobble with One Box!
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that is part of the EP grounding system.

The 2002 NEC introduced GFCI protection requirements for the 125V, 15A or 20A general use receptacles in outdoor areas, wet and damp locations, and where an EP was installed. Language deleted the requirements for voltage gradients at entrances and exits. The Code text clarified the language around the requirement for the premises site isolation disconnect. In addition, rules were added to recognize that the utility provided disconnect could be used as the site isolation device. Also, the EP bonding requirements were adjusted to include only areas where conductive elements were “likely to become energized.”

With release of the 2005 NEC, we now had a definition for the term “site isolation device.” The new verbiage limited the site isolation device to a pole-top disconnect, as stated in Sec. 547.9. Underground installations (i.e., ground-mounted disconnects) were simply referred to as the distribution point. The clarification mandated that the feeders and branch circuits, when extended from the distribution point, required an overcurrent protection device. Remember, during this Code cycle, the site isolation switch was not required to have overcurrent protection, which is still the case today.

New language was included in the 2008 NEC to require an additional GFCI



Photo 2. Modern technology has made its way to agricultural buildings in recent years.

protected 125V, 15A, or 20A receptacle within 3 ft of where an accessible non-protected GFCI receptacle was located. Furthermore, luminaires were required to have a suitable guard where exposed to physical damage.

With release of the 2011 NEC, CMP-19 (now CMP-7) deleted the language for GFCI-protected receptacle within 3 ft of the accessible, non-protected GFCI receptacle. However, this Code cycle introduced a labeling requirement for all agricultural site distribution points and mandated that the 8 AWG EP bonding conductor be solid.

The 2014 NEC revised the definition of “equipotential plane” and new provisions allowed for the separate covered or insulated underground EGC to be either copper or aluminum.

The 2017 NEC deleted the term “covered” in Sec. 547.5(F), which meant the separate underground EGCs were now only required to be “insulated.”

With the recent release of the 2020 NEC, GFCI protection is now required for other agricultural-related structures [Sec. 210.8(B)]. However, in outdoor wet and damp locations, dirt confinement areas, and where an EP is installed, only the 125V, 15A and 20A receptacle(s) require GFCI protection.

The distribution point required by Sec. 547.9 clarifies that the disconnect is only required for buildings or structures that confine livestock. In addition, the revised text allows non-agricultural buildings or structures to be fed with existing 3-wire feeders if they meet the requirements of Sec. 250.32(B)(1), Exception No. 1.

As we look to the future, we need to remember that the general conditions surrounding agricultural environments are still very much the same today as they were when I was a kid working on my grandfather’s dairy farm. These areas are harsh, damp, wet, and corrosive. The requirements set forth in Art. 547 are meant to ensure equipment longevity — especially when it comes to grounding and bonding components — and protection of livestock and the individuals working in these facilities.

EC&M

Dean Hunter is the chief electrical inspector for the Minnesota Department of Labor and Industry. He currently serves as an IAEI representative on the NEC CMP-7 (formerly CMP-19) and is a member of the UL Electrical Council. He also participates as a technical committee member on NFPA 225, 501 and 501A.

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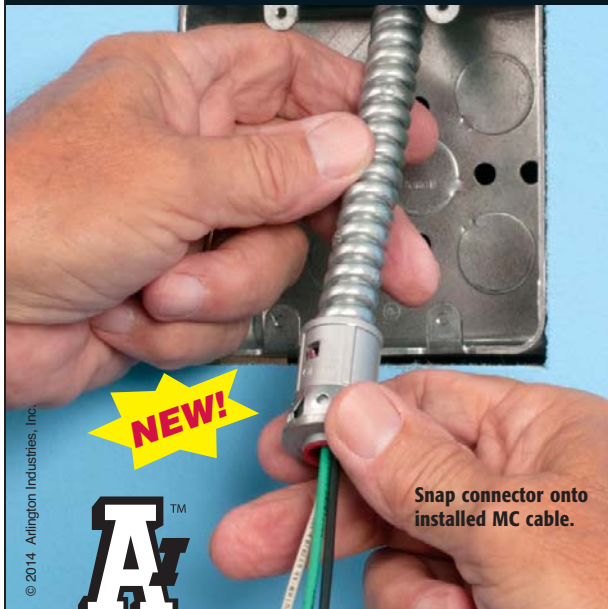


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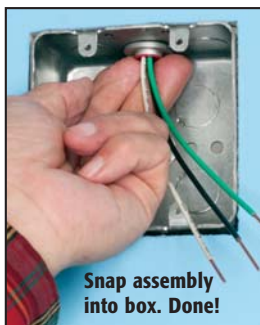
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8412	1"	.780	1.120	.660	1.000	6/3, 6/4, 4-3, 4-4, 2-3, 2-4, 1-3
8413	1-1/4"	1.000	1.460	.870	1.370	2-3, 2-4, 1-3, 1-4, 1/0-3, 1/0-4, 2/0-3, 2/0-4, 3/0-3
8414	1-1/2"	1.360	1.770	1.250	1.590	2/0-4, 3/0-3, 3/0-4, 4/0-3, 4/0-4, 250-3, 250-4
8415	2"	1.700	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

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



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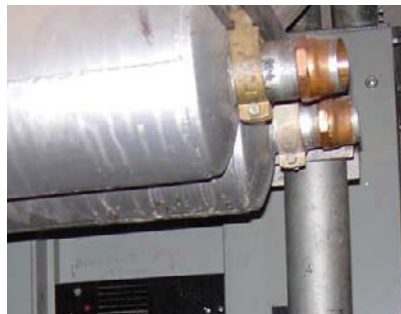
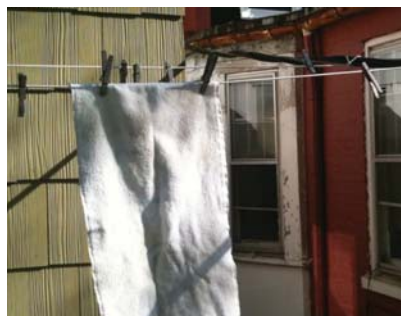
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THE 10 CRAZIEST CODE VIOLATIONS

of 2020

Presenting the most bizarre electrical installation mishaps of last year that violated the NEC.

By Russ LeBlanc, NEC Consultant

Since *EC&M* readers continue to rank the National Electrical Code (NEC) as the No. 1 most-important topic we cover, it's not surprising that the "Top 10 Craziest Code Violations of 2019" was one of our most well-read photo galleries of last year — up there right after "The Top 25 Changes in the 2020 National Electrical Code." Back by popular demand, here are the most extraordinary Code

violations uncovered by our NEC Consultant Russ LeBlanc in 2020. Following are our picks for the absolute craziest Code catastrophes photos of last year that violated the NEC. Shoddy electrical installers beware: If you're behind an electrical installation gone wrong like those featured here, there's a good chance your handiwork may turn up in the pages of *EC&M* or on our website someday soon. *Note:* All references are based on the 2020 edition of the NEC.



SUSPENDED CEILING SURPRISE

Russ typically likes surprises, but not when they smack him in the head when he's removing suspended ceiling tiles. This junction box was just resting on top of the ceiling tile, and it fell right out when he slid the tile over. Surprise! Boxes must be supported in accordance with one or more of the methods specified in Sec. 314.23(A) through (H). These methods include: securely fastening the box to a surface; rigid support in the form of a brace; using nails or screws to fasten the box; using clamps, anchors, or other identified fittings; or even using support wires. There are no Code rules that permit simply resting the box on top of a removable ceiling tile. Installing a box in this manner could cause physical harm to the unsuspecting worker who moves that ceiling tile. It can also startle someone to the point where it knocks them off the ladder and results in serious injuries. Thankfully, this event did not result in any injuries. Another problem is the lack of cover for this box. Section 314.25 requires a cover, faceplate, lampholder, or luminaire canopy to be installed for a completed installation.

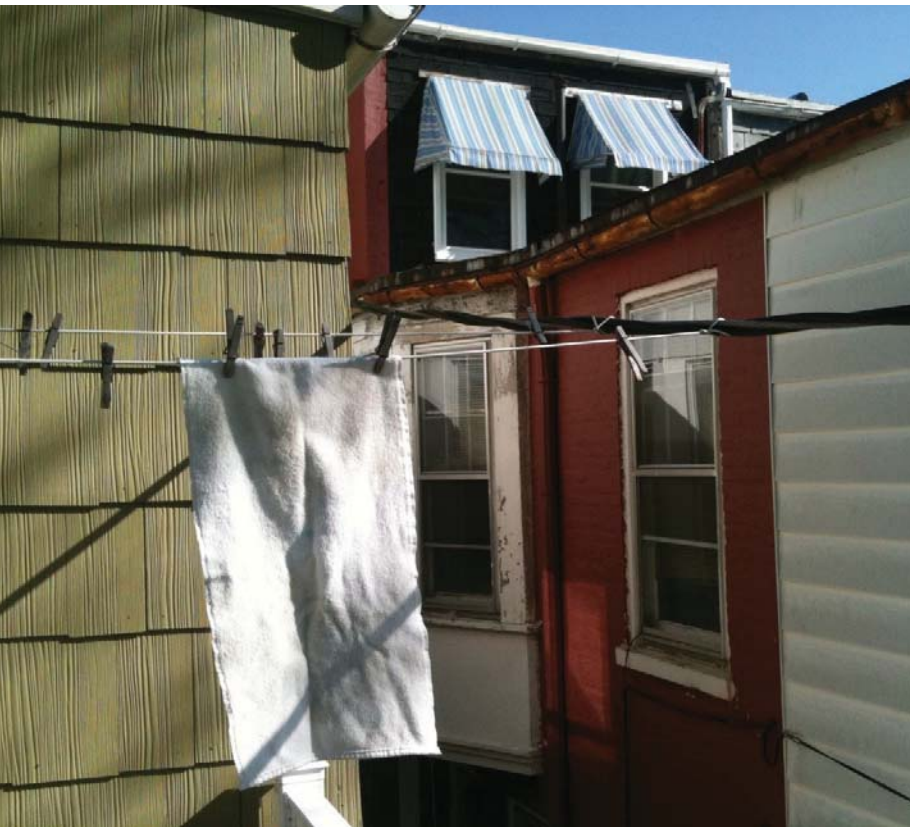
HOLIDAY HAZARD

This Christmas lighting display was quite a surprise. Russ discovered it on his way home from teaching class on a Tuesday night. While the gas station manager probably had good intentions, he clearly had no idea of the dangerous conditions he created by draping Christmas lights all over the gas pump island! Some of the light strings were swinging in the breeze and actually contacting the middle dispenser. Extension cords were strewn on the ground from the building to the island, and more cords ran from the island to the perimeter of the lot to illuminate rows of trees. In the photo, one of these orange extension cords is visible on the ground right in front of the pumps. Table 514.3(B)(1) describes the areas within 18 in. horizontally of these dispensers as Class 1, Division II. This Class 1, Division II location also includes the area 18 in. above grade level, extending 20 ft horizontally in all directions from the dispenser enclosures. Wiring and equipment installed in Class 1 locations must comply with Art. 501. These holiday lights and extension cords



are not designed for use in hazardous locations. With no intention of being a "Grinch," Russ felt compelled to notify

the Fire Prevention office about this unsafe display. The lights were removed the following day.



AIRING YOUR DIRTY LAUNDRY

“This was taken from the second floor back deck of an apartment,” says Stephen M. Daniels, president of Stephen M. Daniels Electrical Contractors in Lancaster, Pa. “The clothesline was tied to the triplex feeding the main electrical service.” Although we cannot be 100% sure if these wires are covered by the scope of the Code, it certainly makes for a great conversation if they are. Section 230.9(A) requires service conductors installed as open conductors or multiconductor cable without an overall outer jacket to maintain a clearance of at least 3 ft from windows that are designed to be opened, doors, porches, balconies, ladders, stairs, fire escapes, or similar locations. Section 230.24(A) requires overhead service conductors to have a vertical clearance of not less than 8 ft above the surface of roofs. This vertical clearance above the roof is required to be maintained for no less than 3 ft in all directions from the edge of the roof. Lastly, Sec. 300.11(D) prohibits cable wiring methods from being used as a means of support for other cables, raceways, or nonelectrical equipment.

HOW LOW CAN YOU GO?

Russ wasn't 100% sure where the service point was for the service conductors installed overhead from the pole on the right-hand side of this building. It could be at the pole, line terminals of the meter, or at the splices on the wires entering the weatherhead. For this discussion, let's say the service point is at the pole. That being the case, the lowest point of the drip loop is way too low and is not NEC compliant. Section 230.24(B)(1) requires a minimum clearance of 10 ft from the lowest point of the drip loop to this sidewalk, which is accessible to pedestrians. These drip loop conductors are only 7½ to 8 ft above the sidewalk. Russ says he's average height and he could almost touch them while standing underneath and reaching up. A person just a little taller than Russ could easily reach them. Regarding another concern, there also appears to be some communications cables “hitching a ride” along the service raceway. This is a violation of Sec. 300.11(C) and Sec. 805.133(B). To be Code compliant, these cables must be independently secured and supported.



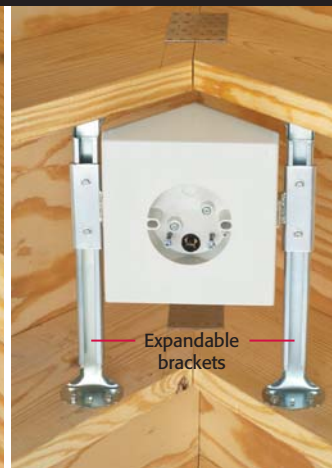
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FBX900 has expandable brackets that mount securely between joists, eliminating the need to cut and nail 2X4s to center a fan or fixture in the room.

- Self-contained – No loose parts
- Supplied template levels, positions bracket between rafters
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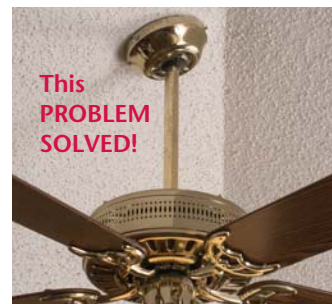
UL Ratings

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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THIS DRIVES ME PLUMB CRAZY

As you can see by this photo, plumbers and electricians are still waging a never-ending battle for space. Russ didn't know who was here first, but the result is an installation with no clear working space as required by Sec. 110.26(A). For equipment such as switchboards, panelboards, and other equipment likely to be examined, adjusted, serviced, or maintained while energized, Sec. 110.26(A)(1) requires a minimum working space depth ranging from 3 ft to 5 ft, depending on conditions and voltage. The minimum width of the working space required by Sec. 110.26(A)(2) is 30 in., or the width of the equipment, whichever is greater. The minimum height required by Sec. 110.26(A)(3) for the working space extends from the floor, grade, or platform to a height of 6½ ft or the height of the equipment, whichever is greater. Working in crowded and cramped conditions such as this greatly increases the danger of the already hazardous job of working on energized electrical equipment. Building owners and managers need



to recognize this threat and coordinate with all the building trades in an effort

to prevent situations such as this from arising on their property.



ROGUE RECEPTACLE INSTALLATION

Brandon Spivey, owner of Event Horizon & Services in Nashville, Tenn., was kind enough to share this photo with us. He said, "The plugs were covered with a fabric panel with no other housing." Brandon also said he is "new to this all, and learning, but this seems like a Code violation." Brandon, you are correct. There are definitely Code violations here. Section 406.5 requires receptacles to be mounted in identified boxes or assemblies. Attaching receptacles to a couple of wooden blocks does not meet Code minimum requirements. It appears these boards were being used as some type of "box extender." A listed extension ring or listed box extender should have been secured to the flush-mounted box instead. The exposed energized terminals create a shock hazard and violate the rules of Sec. 406.5(I), which requires receptacles to be enclosed so that no live terminals are exposed to contact. The lack of a box cover for the outlet box is a violation of Sec. 314.25. According to Brandon, an equipment grounding conductor (EGC) run separately from the circuit conductors was connected to these isolated ground receptacles. This violates Sec. 250.146(D) and Sec. 300.3(B) if the EGC was not run with the circuit conductors.



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NEW DESIGN!

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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.

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Catalog Number	Cable Ranges (Armor Diameter)
LTMC50	.415" - .565"
LTMC507	.550" - .730" goes into 1/2" KO
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System components get the job done quickly and easily.

Support Brackets attach directly to framing members, without structural damage. They hold cables securely in place, and open for easy cable insertion!

The **Slide-On Trough** holds and protects cable. To add length, install more sections that join together with **Coupling**.

Angles and Tees make turning corners a breeze.

Push-on **End Caps** complete the job!

FLAT SURFACE
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WALL MOUNT
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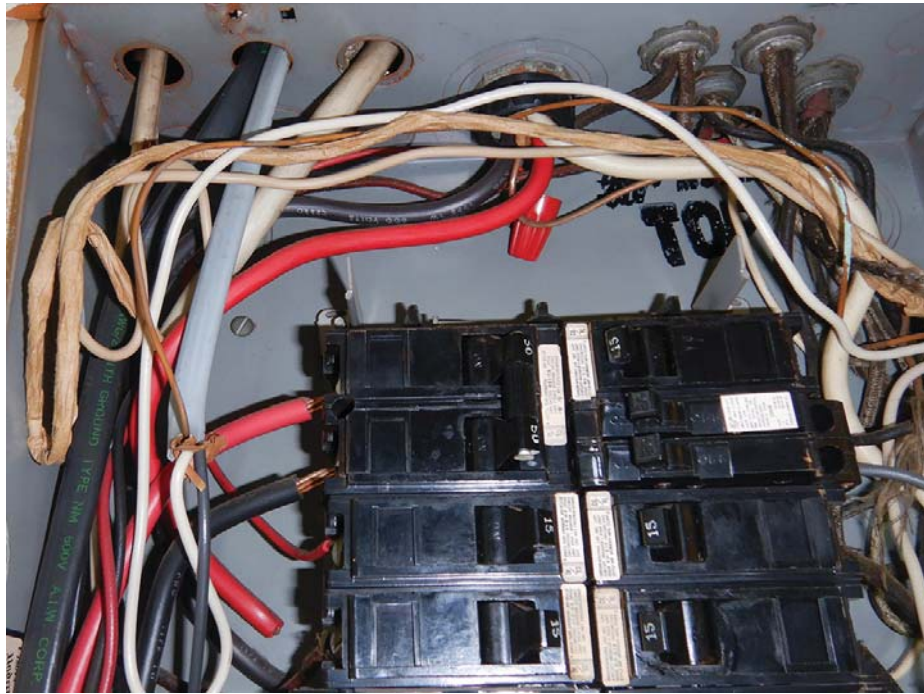
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UNCLAMPED CABLE COLLECTION

Who needs cable connectors when the cables can simply be shoved into the panelboard cabinet? This is obviously not the correct way to terminate NM cables in a panelboard cabinet. Section 312.5(C) is very clear when stating “each cable shall be secured to the cabinet, cutout box, or meter socket enclosure.” There is an exception relieving this requirement for NM cables installed through sleeves entering the top of surface-mounted enclosures. However, the exception is not applicable to this installation. Similarly, Sec. 300.11(A) requires cables to be securely fastened in place. With no connectors used to secure these cables to this cabinet, we can say these cables are not securely fastened in place. Another violation here is the use of “tandem” or “twin” circuit breakers in this panelboard. This is a circuit-limiting, class CTL-type panelboard designed for only 12 circuits. Using circuit breakers and panelboards in a manner not consistent with their listing or labeling instructions is a



violation of Sec. 110.3(B). For panelboards, Sec. 408.54 requires a design to prevent the installation of more overcurrent devices than that for which

the panelboard is designed, rated, and listed. This could include notches on certain bus bars to accommodate only certain types of breakers.



TRESPASSERS BEWARE!

Stephen M. Daniels, owner of Stephen M. Daniels Electrical Contractors of Lancaster, Pa., was kind enough to share this photo with us. “I was doing a service call for a dead circuit (forgive the pun), and took the panel cover off,” said Daniels. “There were missing knockouts, which is how the furry panel guest got in. This is another reason why the Code calls for no open KO in panels or boxes.” Russ could not agree more. Installing knockout seals is important for many reasons, including keeping trespassers out of the enclosure. Section 110.12(A) makes it clear that unused openings (except mounting holes and other openings such as drainage holes and air vents that are intended for the operation of the equipment) must be closed in a manner that provides protection substantially equivalent to the wall of the enclosure. Sealing up the unused openings also helps keep arcs and sparks from escaping (and possibly igniting) nearby combustible materials. Debris and liquids can also fall into unsealed and unused openings, causing damage to internal parts of the equipment. While the Code rules will not always prevent every critter from finding a way into enclosures, they will help minimize the possibility.



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CABLE SUPPORT

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

Nail or screw on
CUS6

Foldline
(centerline)

Locking tab

Nail or screw to stud
through these holes

Bend right side
of strap in and
over cable

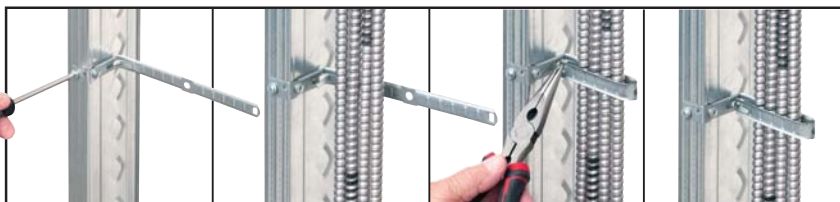
Arlington's economical CUS6 galvanized steel Cable Support holds cable secure and centered on a metal or wood stud.

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)

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



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

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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.

**Larger
Holes!**



3/4" NMPV753



1-1/4" NMPV1257



1" NMPV1005

- For PV1000 and other cables from .250 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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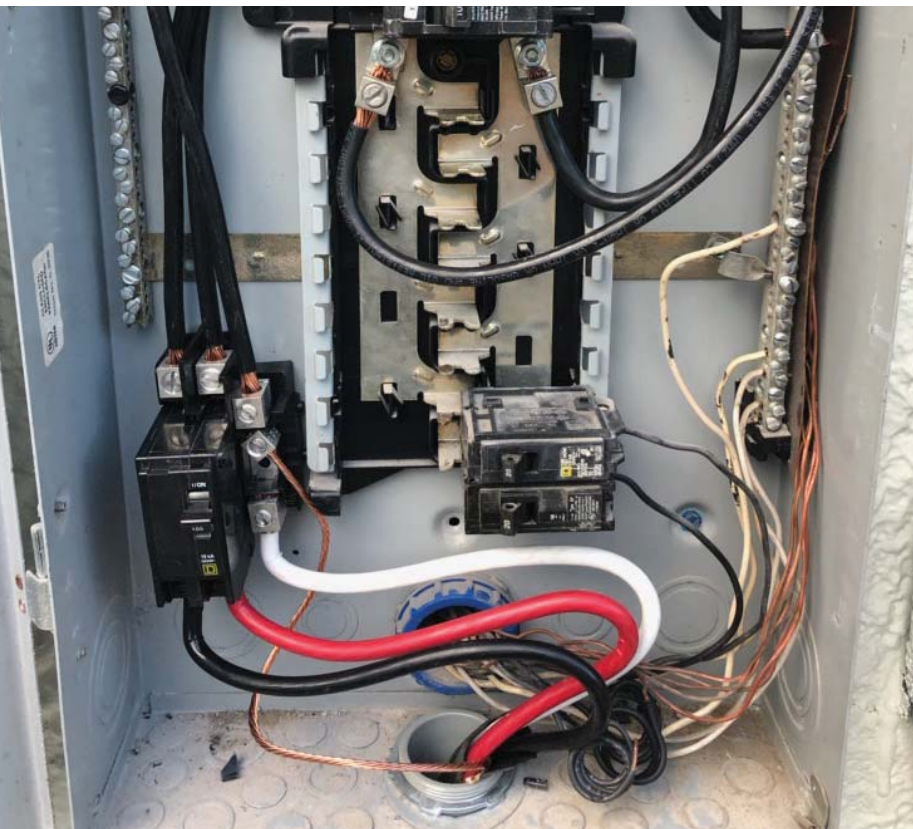
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WHICH WAY IS UP?

At first glance, Russ thought this circuit breaker was turned off. Upon closer examination, he realized it was in the ON position, despite the handle pointing in the down position. There are even two sets of ON/OFF labels facing in opposite ways that add to the confusion. For circuit breaker handles that operate in the vertical position instead of operating rotationally or horizontally, Sec. 240.81 requires the “up” position of the handle to be the ON position. This breaker is off when the handle is up and on when the handle is down. It appears this circuit breaker enclosure may have been designed to be installed upside down as well as right-side up. Installing a circuit breaker in this position may have been permitted at one point, but it has not been allowed for a very long time. It can lead to a terrible mistake if the user is not paying very close attention to the ON/OFF markings on the enclosure. Can you imagine what could happen in an emergency if this switch was accidentally thrown into the ON position when the operator thought he was shutting it off?



SUBPAR SUBPANEL FEED

This photo was sent in by Eugene Lawrence with E-1 Electric LLC, in New Orleans. “We noticed this load center at a house in New Orleans,” says Lawrence. “We were called out to check on a job done by others. These photos show what we found. They were trying to feed a subpanel. As you can see, the feeder cable coming out of the conduit is connected to an added ‘wrong main.’” This was a great catch, Eugene. The original panelboard is not being used in a manner consistent for which it was designed and listed. Installing extra foot lugs on the bus bars and using circuit breakers from the wrong manufacturer violates the requirements of Sec. 110.3(B). The installers also failed to properly identify the grounded neutral conductor with white or gray as required in Sec. 200.6(B). Installing NM cables in PVC conduit located in an outdoor wet location such as this is a violation of Sec. 334.12(B)(4). Section 300.9 reminds us that “where raceways are installed in wet locations above grade, the interior of these raceways shall be considered to be a wet location.”

SNAP²IT[®] CONNECTORS

EASIEST CABLE INSERTION • NO TOOLS • SECURE HOLD

SAVE **17**
seconds
per connector!



4110ST

5010AST
1/2" KO

505010AST
3/4" KO

LISTED
SNAP2IT[®]
CONNECTORS FOR
NEW MC-PCS CABLE
...lighting & low voltage
circuits in the
same cable

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

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

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

ANY Snap2It Connectors LISTED for MC cable are also LISTED for MC-PCS cable! These products offer the greatest time-savings.

- Fast, secure snap-on installation
- Easy to remove, reusable connector
From cable Loosen screw on top. Remove connector from cable.
From box Slip screwdriver under notch in Snap-Tite[®] ring. Twist. Remove connector.



Easy
to Snap
into Box!



Arlington[®]

NEW!

CATALOG NUMBER	DESCRIPTION Snap2It [®] connectors	CABLE OUTSIDE DIA (OD)
4010AST	Snap in, 1/2" KO w insulated throat	.405 to .610
5010AST	Snap in, 1/2" KO w insulated throat	.590 to .920
505010AST	Duplex Snap in, 3/4" KO w insulated throat	(2) .590 to .920
4110ST	Snap in, 1/2" KO	.525 to .705
414110ST	Duplex Snap in, 1/2" KO	(2) .525 to .625
4141107ST	Duplex Snap in, 3/4" KO	(2) .525 to .705



4010AST
1/2" KO

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Patented.
Other patents pending.

2021 TRUCK & VAN PREVIEW

A surge of electric models and an OEM re-entering the medium-duty market after a 20-year absence highlight this year's offerings.



By John Hitch, Senior Editor, *Fleet Owner* magazine

The compelling question for those in the market for a new pickup truck in 2021 will be: to electrify or not to electrify? Electrification is also on the menu for the light-duty cargo van front. However, the battery-electric market is still quite new, with many questions surrounding charging and total cost of ownership still unanswered.

Because the medium-duty segment (Classes 4-6) is so diverse, with a wide range of duty cycles and applications, the changes on new models made from year to year are also diverse. They are the ultimate role players, with some trucks out there to meet the niche needs of any fleet.

For 2021, several OEMs have added electrified powertrains to address impending regulations and customer demand, while some have introduced new gasoline engines. Meanwhile, the demand for medium-duty trucks in general, which typically do not require a commercial driver's license, has motivated Mack to come back into the segment for the first time in almost 20 years. There is no telling how this decade will play out, but it's likely there will be a bevy of medium-duty trucks available to meet those changes.

The following pages reveal what OEMs are offering this year for their light- and medium-duty trucks and vans.

RAM

Ram has injected more power into its pickup portfolio with the Ram 1500 TRX, powered by a 702-hp, 650-lb-ft Hellcat V8 engine. It provides a 0 to 60 acceleration of 4.5 sec. Overall, the 1500 model can accommodate 2,300 lb of payload and tow up to 12,750 lb. That power is complemented by technology responsible for safety, including adaptive cruise control, forward collision warning, blind-spot monitoring, ready-alert braking, and trailer reverse steering control. A 9.2-in. digital rearview mirror is also an option. The digital mirror is optional on the ProMaster van as well, along with blind-spot monitoring with rear cross path detection and forward collision warning with emergency brake assist. Crosswind assist, which aids drivers in staying in their lane despite the weather, now comes standard.



RAM 1500 TRX

FORD

FORD F-150



After 43 years, Ford Motor's F-150 has undergone a major refresh as an all-in-one work hub. Incoming CEO Jim Farley calls it a "workhorse, not a show horse." The 2021 model exudes productivity, from the expanded flat workspace and an 8-in. or 12-in. touchscreen in the interior to the front trunk (or "frunk"), and Pro Power Onboard outlets supplying 2kW to 7.2kW, and liftgate tailored for action at the back. The F-150 offers added safety features with pedestrian automatic

emergency braking and active driver assist. Over-the-air updates will continuously improve functionality. The long-awaited 3.5L PowerBoost full hybrid V6 powertrain, available for XL and Limited models, offers 430 hp and 570 lb-ft of torque, will provide an estimated 700-mi one fuel tank fill-up, and the ability to tow 12,000 lb. The company projects the PowerBoost suite will offer improved horsepower and a faster 0-60 mph time as well. This paves the way for the all-electric version in 2022.

GENERAL MOTORS



CHEVY SILVERADO

For 2021, Chevrolet upped the Silverado 3500 HD's max towing to 36,000 lb, an increase of 500 lb. This will be available on the 3500 HD work truck, regular cab, dual-rear-wheel, 2-wheel-drive models equipped with the Duramax 6.6L turbo-diesel V8, Max Trailering Package, and gooseneck hitch. GM engineers added several trailering tech improvements to make towing safer and more efficient. As part of the new trailer length indicator function, a red overlay, twice the length of

the compatible trailer, appears on the dash screen when the turn signal activates to show vehicles coming up from behind. Another trailer alert warns if the trailer angle is approaching a jackknife situation. Cameras also assist in aligning a fifth-wheel trailer, indicating the trailer angle when backing up, and showing a split view of the rear sides when in reverse as well as going forward. These features are also available on the Silverado 1500 and GMC Sierra.

HONDA



HONDA RIDGELINE

Honda has redesigned the front end of its Ridgeline pickup for a brawnier look. Wheel backspacing was reduced by 10 mm, and track width has been expanded slightly to 20 mm for a broader stance. The squarish LED headlight design was swapped for a more subtle

configuration with the fog lights under the headlights and separated by a crossbar, which Honda says increases illumination. Other noticeable changes to the body include broad side vents designed to route air through the bumper and around the front tires, and wheels

to create air curtains and improve aerodynamic performance. The Honda Performance Development package is also available with a special grille treatment, black fender flares, and bronze-colored wheels. Other packages include Utility, Function, and Function+.

SNAP²IT[®] CONNECTORS

NO TOOLS! • EASY CABLE INSERTION • WITH and WITHOUT INSULATED THROAT

40900ST
EASY TO
INSTALL...

1
BEND
CABLE
AS SHOWN
FOR EASY
INSERTION

2
INSERT
CABLE
INTO
FITTING

3
SNAP
ASSEMBLY
INTO BOX



Arlington[®]

SAVE
1 Minute
per connector

40900AST

...over 90°
2-screw MC
connectors!



2-screw
850

AT THE SAME COST
PER CONNECTOR!

- Easy snap-in cable installation...SAVES A MINUTE each over 2-screw 90° styles
- Handles widest range & variety of cables:
14/2 to 10/2 AC, MC, HCF, MC continuous corrugated aluminum cable, MCI-A cables (steel and aluminum), AC90 and ACG90
- Fast, super-secure installation No pullout!
- Easy to remove from box... reusable!



with and without insulated throat

90° SNAP2IT[®] CABLE RANGES

Patent pending

CABLE TYPE	38900AST 38900ST		40900AST 40900ST	
	Dia. Range	Cable Range	Dia. Range	Cable Range
MC/HCF/AC Steel & Aluminum	.380 to .600	14/2, and 12/2 with & w/o ground.	.490 to .600	14/3, 12/2, and 12/3 with & w/o ground.
MCI-A Steel & Aluminum	.440 to .550	14/3, 14/4	.480 to .550	14/4
AC90, ACG90	.450 to .550	12/3, 12/4 10/2	.480 to .550	12/4 10/2
Flexible Metal Conduit Steel & Aluminum (RWFMC)	3/8" Flex* *CSA Listed w anti-short bushing ONLY			



38900AST



40900ST

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HYUNDAI



HYUNDAI SANTA CRUZ

South Korea-based Hyundai Motor Co. will join the pickup segment with the Santa Cruz crossover pickup, teased in 2015 and planned for a 2021 launch. Specs have not been released, but the powertrain was speculated to share a lot in common with the company's Tucson SUV and offer a comparable

performance to the Honda Ridgeline. A spokesperson for Hyundai could not share any specific details but says the Santa Cruz may excel best for mixed-use, handling light deliveries around town Monday through Friday and then enabling weekend getaways.

LORDSTOWN MOTORS



LORDSTOWN MOTORS ENDURANCE

The all-electric Endurance from Lordstown Motors will be one of the first zero-emission pickups to hit the market in 2021. The new model will reportedly have a 250-mi range, 600 hp, and 7,500-lb towing capacity. Each of the four in-hub motors will have its own computer, so the tires should endure with positive traction even on muddy and

slushy roads. An auxiliary power export provides access to power for operating or charging power tools. The hub motors are the only moving parts and should help reduce the maintenance cost. According to the company, 40,000 non-binding preorders have been received since the vehicle's debut in September.



ARLINGTON

VERTICAL OR HORIZONTAL • RETROFIT & NEW WORK INSTALLATIONS

Non-Metallic 8x10 TV BOX™

PERFECT FOR HOME THEATER SYSTEMS

TVBU810
PLASTIC TV BOX™



Lots of space for multiple
low voltage connections



Arlington®

800/233-4717 • www.aifittings.com

Arlington's PLASTIC 8X10 TV Box™ delivers the *ultimate in versatility* for installing flat screen TVs in new *and* retrofit projects. There's more room in the box for wires and it installs horizontally or vertically to properly position low voltage connections behind the TV.

- Ideal for home theater systems: multiple connections for sound systems, satellite TV, CATV, DVRs
- Brackets for neater cables, with a 1-1/2" knockout for ENT and other low voltage wiring
- Box mounts to stud in new work; for retrofit, mounting wing screws secure box in wall

includes box, trim plate, duplex receptacle, line voltage box, wall plates, cable entry device, knockout plugs



Mounts to
stud in NEW work



Secure installation
in RETROFIT



Patented

Made in USA

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LOW VOLTAGE • NON-METALLIC

Made in USA

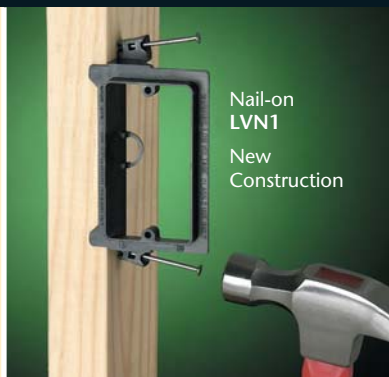
MOUNTING BRACKETS

FOR CLASS 2 LOW VOLTAGE WIRING

LV1
for Existing
Walls



Nail-on
LVN1
New
Construction



LVMB2

Screw-on
LVS1



Arlington's non-metallic mounting brackets offer the best way to install Class 2 wiring! They seat wall plates flush with the mounting surface, install faster and cost less than metal!

In *existing* construction, centered mounting wing screws pull the bracket securely against the wall. The LV series – LV1, LV2 and multiple gang brackets – adjust to fit 1/4" to 1" wall thicknesses.

For *new construction*, the nail or screw-on LVN series brackets attach to a wood stud. They cost less than extension rings and install faster than mud rings.

For *screw-on, steel stud* installations, try the LVS or LVMB series.

We also offer a variety of low voltage brackets for specialty applications.



LV2



LVS2



LVMB1



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MERCEDES-BENZ



MERCEDES-BENZ SPRINTER

Since its 1995 inception, more than 4 million Mercedes-Benz Sprinters have been built globally to fulfill the cargo, crew, passenger, and custom-upfitted needs of fleets. While the eSprinter will eventually emigrate from Dusseldorf,

Germany, to help fleets reach their zero-emission targets, the biggest addition to the market currently is the 2L, 4-cylinder diesel engine paired with a 7-speed transmission for the Cargo variant. The powertrain provides 161 hp and 266 lb-ft

of torque. The digital fleet tool to increase uptime and efficiency, Mercedes PRO connect, comes standard. Safety options include distance assist, active brake assist, and active lane keeping assist. A 360° camera is available with the parking package.

WORKHORSE



WORKHORSE C-650

The C-Series of all-electric step vans from Workhorse is available with 650 cu ft, 1,000 cu ft, and 1,200 cu ft of space (C-650, C-1000, and C-1200, respectively). The C-1000, which was rolled out in a Ryder leasing program in 2020, weighs 13,000 lb fully loaded and has a 100-mi range using the 4-battery configuration. By using six batteries, the range increases to 150 mi. Workhorse used a composite frame lighter than aluminum to achieve this range. Other features include a low-floor platform for easier ingress and egress, and the company's Metron telematics system, which tracks and monitors the performance of vehicles in a fleet to optimize route planning and monitor maintenance and fuel costs throughout their service life.

SAVE MONEY! • IN BOX® FLOOR BOX KIT

RECESSED FLOOR BOX

FOR EXISTING FLOORS



Here's the solution for cost-savings and easy installation of a receptacle and low voltage connections in an *existing* floor.

Arlington's FLBR5420 series RECESSED **FLOOR BOX KITS** have *two* low voltage openings, an ultra-thin stamped steel flange, and flush-to-the-floor in-use and blank covers.

The thin flange and **recessed wiring device** reduce the trip hazard caused by plugs protruding from the box. And you can have power and low voltage in the same box without a divider. That's convenience!

- Easy installation with hole saw – 24.5 cu inch box mounts to floor with four mounting wing screws
- UL Listed 20A tamper-resistant decorator-style receptacle
- SIX cover finishes/colors

Plated Diecast Zinc
Cover and steel flange



FLBR5420MB
Brass-plated



FLBR5420NL
Nickel-plated



FLBR5420AB
Antique Bronze-plated

Powder-coated Diecast Zinc
Cover and steel flange



FLBR5420BL
Black



FLBR5420BR
Brown



FLBR5420LA
Light almond



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Patented

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RIVIAN



RIVIAN R1T

The Rivian R1T electric truck's most notable stat is its acceleration — with a reported 0 to 60 mph in 3 sec. Rivian's quad motors can also generate 750 hp and pull 11,000 lb. Another benefit of independent wheel motors: tank turns, which allow the truck to spin in place. That power is balanced by a conservative approach to energy, with regenerative braking on downhill

slopes returning 50% of the energy expended to climb the same hill. The 180kWh option, due out next summer, will provide a 400-mi range. Additional options to follow include the 135kWh option and the 105kWh option, which will be offered at a later date. The truck also features 14 in. of ground clearance and the ability to drive in 3 ft of water.

TOYOTA



TOYOTA TACOMA

The Toyota Tacoma is available with a 4-cylinder or V6 engine, and the Tundra features a V8. Both come equipped with Toyota Safety Sense, which includes the expected functionality to prevent collisions and lane departures. The

five-seater Tacoma's performance is about the same as the 2020 model, with a typical 1,155-lb payload capacity and 6,400-lb towing capacity for the V6, with a 400-lb boost with the tow package. Meanwhile, the Tundra, which can have up

to six seats, has a 1,660-lb payload and 10,100-lb towing capacity. In addition, dual-zone climate control has been added. The Tacoma Trail Special Edition's bed includes a 120V power outlet, along with a secure storage compartment.



ARLINGTON

ADJUSTABLE • NON-METALLIC • 2-HOUR FIRE RATING

Made in USA

IN/OUT™ BOX for Ceiling Fixtures

EASY TO INSTALL... IN NEW CONSTRUCTION



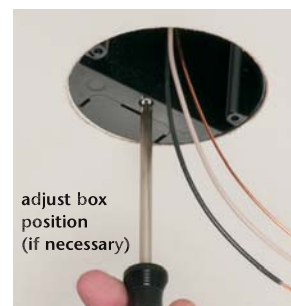
FA426
Adjustable
Ceiling Fixture Box

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®



Patent pending

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ADJUSTABLE BRACKET • EASY INSTALLATION IN EXISTING CEILING

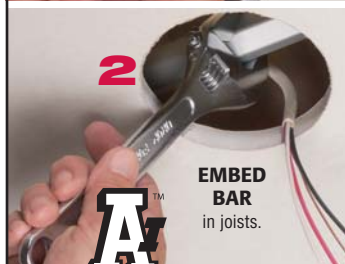
FAN/FIXTURE BOX

HIGHER WEIGHT RATINGS

**EASY
TO INSTALL
1-2-3!**



1
REMOVE BOX
from bar.
Insert in opening.



2
EMBED BAR
in joists.



3
REATTACH BOX
to bar.

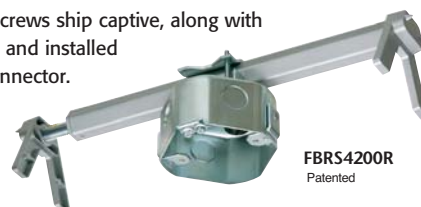
Arlington's extra heavy-duty, plated steel fan/fixture box with adjustable bracket has **higher UL Weight Ratings**:
at 24" on-center: **70 lb Fan, 90 lb fixture**
at 16" on-center: **70 lb Fan, 150 lb fixture**

The 20.0 cu. inch FBR54200R 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.



FBR54200R
Patented

Arlington®

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

Circle 25 on Reader Service Card

GENERAL MOTORS



The Chevy Express and Low Cab Forward have received upgrades with the direct-injected 6.6L V8 gas engine. With it, the Express now has 17% more horsepower and 24% more peak torque than the 6.0L V8, providing 401 hp and 464 lb-ft of torque. The Low Cab Forward now has 350 hp, an 18% increase, and 425 lb-ft of

torque, a 14% uptick. The Silverado trio — the 4500 HD, 5500 HD, and 6500 HD chassis cabs — have also added a max gross combined vehicle weight rating of 37,000 lb. Other additions include a new mechanical locking rear axle for better traction on slick surfaces and extended mirror arms for better visibility.

FORD



The 2021 F-650 and F-750 models feature Ford's new 7.3L V8 gasoline engine, which generates 350 hp and 468 lb-ft of torque. The overhead valve architecture allows trucks with heavier loads to move from a stop faster by creating power lower in the rev range. Piston

cooling jets help prevent overheating. The Power Stroke V8 turbodiesel engine is also available. Cold weather fleets may want to stick with the diesel powertrain for the optional rapid-heat supplemental cab heater. On the technology side, hill start assist to prevent rollbacks comes

standard, while the optional driver-assist package includes pre-collision assist with automatic emergency braking, auto high-beam headlamps, and lane-keeping alert. To make upfitting easier, the fuel tanks, wiring harnesses, and diesel exhaust fluid reservoirs are located under the cab.



ARLINGTON

UV RESISTANT • 100% RECYCLED MATERIAL

Made in USA

ROOF TOPPER®

RELIABLE ROOFTOP SUPPORT OF CONDUIT, CABLE TRAY



ROOF TOPPER® supports raise conduit/raceway 4" or more off the roof surface, meeting the requirements of section 310.15 of the 2017 NEC for temperature adjustment for circular conduit.

The heavy-duty base, made of 100% recycled material, sits on the roof deck. There's no need to mount ROOF TOPPER to the surface with mechanical fasteners.

Offered in a variety of sizes and configurations, ROOF TOPPER supports stand up to extreme rooftop conditions – while protecting and elevating your conduit or raceway above the roof deck.



RTSE409 9" w



STRUT ATTACHED w END CLAMPS

RTSE1209 9" w x 12" h



5-5/8" H



RTS421 21" w



12" H



RTS12 9" w



RTS1221 21" w



Patented

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FOR INSTALLATION OF OUTDOOR FIXTURES AND DEVICES

Made in USA



GARD-N-POST™

UL/CSA LISTED ENCLOSURES & SUPPORTS



Arlington's Gard-N-Post™ enclosures and supports offer the attractive, safe, and easy way to install a light fixture and/or one or two devices outdoors!

- Non-metallic, heavy-duty UV rated plastic
- Damage resistant
- No chipping... 4 permanent colors
- GARD-N-POST... a variety of styles, 9" to 73" tall

POWER



Voltage separator



LOW VOLTAGE

Install power and low voltage outlets outside, in the same post

GPD19



GP19



FOUR COLORS!



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FREIGHTLINER CUSTOM CHASSIS CORP.

FREIGHTLINER CLASS 6 MT50E



The all-electric Class 6 MT50e from Freightliner Custom Chassis Corp. (FCCC) has a gross vehicle weight rating of 16,000 lb to 23,000 lb and was designed to perform as well as a diesel or gas chassis. The MT50e uses a Meritor e-axle and two Proterra batteries to provide 226kWh of energy capacity, equating to a range of 125 mi. Proterra has accrued 10 million miles of testing on its batteries.

HINO

For 2021, Hino Trucks' Class 4 and 5 (155 and 195) became the M4 and M5 and M5 Hybrid, while Class 6 and 7 (238, 258, 268, and 330) became the L6 and L7, respectively. The Class 8 is now the XL. Hino modernized the cabover engine (COE) trucks' exterior with a chrome grille design and options, and the interior with a seatbelt sensor, steering wheel controls to enable hands-free calls, and a dashboard that includes a 4.2-in. LCD information display. Customers can also spec a lane departure warning system. The COE-style M-Series (14,500 lb to 19,500 lb GVWR) is powered by a 210-hp 5L J05 Hino engine and 6-speed Aisin automatic transmission (440 lb-ft torque) with a gear hold feature. The L6 and L7 (23,000 lb to 33,000 lb GVWR) are equipped with an 8L Hino J08 engine for up to 260 hp and 660 lb-ft of torque and offer 6-speed Allison transmission.



HINO M5



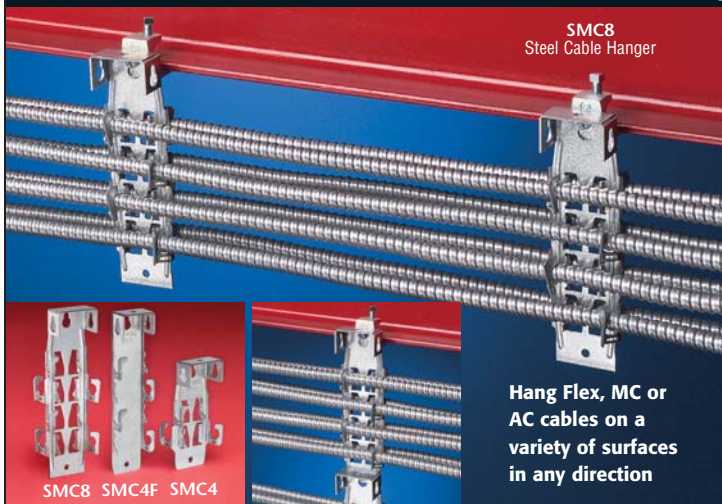
ARLINGTON

ONE-PIECE SMC SERIES GALVANIZED HANGERS • FOR STEEL CABLE

CABLE HANGERS

SUPPORT, SECURE UP TO EIGHT 14/2 TO 10/4 CABLES

**MEETS
NEC**



SMC8
Steel Cable Hanger

Hang Flex, MC or
AC cables on a
variety of surfaces
in any direction

SMC8 SMC4F SMC4



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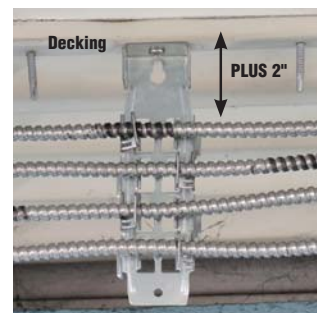
Meets NEC 2020
300.4(E), 320.30,
320.30(A), 330.30(C)
and 348.30(A, B)

The outer surface of MC or AC metal jacketed cables installed *under* corrugated metal roof decking **must be 1-1/2" from underside of decking.**

Our SMC hangers exceed this requirement, keeping cable away from the deck surface by more than 2".

- Supports cables independently
- **Saves money**
Use SMC Hangers in place of cable tray
- **Secures cable**
Bend tabs over cable to lock it securely in place
- **Listed** to support, secure up to eight 14/2 to 10/4 cables as required by NEC 2020 (330.30)

SMC4 holds up to 4 cables. **SMC8** holds up to 8 cables. **SMC4F** mounts flat, holds up to 4 cables on one side.



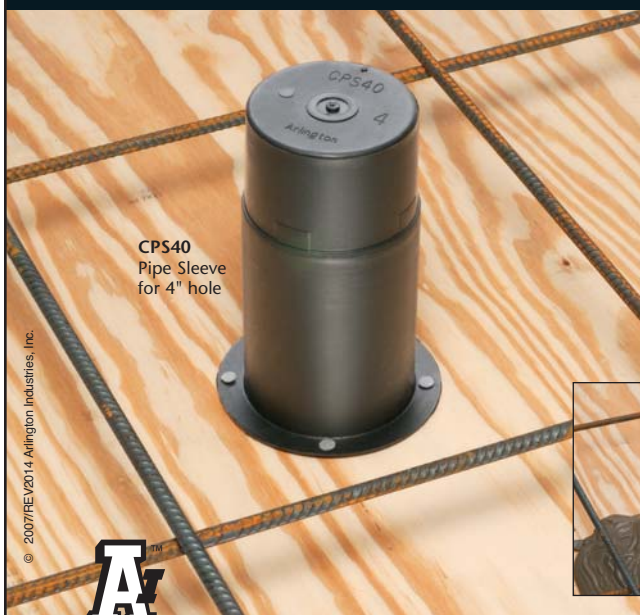
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NON-METALLIC • VENTED FOR EASIER STACKABILITY

CONCRETE PIPE SLEEVE

THE EASY, ECONOMICAL WAY TO SLEEVE THROUGH CONCRETE POURS!



CPS40
Pipe Sleeve
for 4" hole

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

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

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



CPS40



Nail or
screw sleeve
to form.



After concrete sets.
Cut off sleeve
flush with surface.



Insert conduit into sleeve.



Arlington®

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Made in USA

Circle 29 on Reader Service Card

ISUZU



ISUZU NRR

The N-Series from Isuzu Motors offers two new gasoline engines: a 6.6L V8 for the Class 3 NPR and Class 4 NPR-HD, as well as a 6.0L V8 for the Class 5 NQR with a 17,950-lb GVWR and the Class 5 NRR with a 19,500-lb GVWR. This makes the NRR the first gas-powered low cab forward truck in its class and GVWR. The 6.6L provides 350 hp and 425 lb-ft of torque at 3,800 rpm. The engine was designed to last 200,000 mi and

includes features to reduce emissions and productivity without sacrificing durability, including direct injection for more precise fuel control, variable valve timing, and variable displacement oil pumps. The 6.0L V8 gas engine is a first for Isuzu's Class 5 segment and produces 311 hp and 353 lb-ft of torque at 4,150 rpm, aided by a 6-speed Allison 1000 RDS transmission. Seating options for all models include the standard 3-seater or a crew cab that fits seven.

KENWORTH



KENWORTH K270E

Kenworth Trucks' zero-emission long-haul future may be steeped in hydrogen, but its local delivery vehicle is fully battery-electric, as the Class 6 K270E and Class 7 K370E trucks are now available for order. Developed with Dana Inc. and using high-density battery packs, these electric cabover trucks are designed to get 100 mi with the 141kWh configuration and 200 mi with the 282kWh option. The direct-drive motors will provide 355 hp or

469 hp, depending on the application. Wheelbase options include: 206 in. for 24-ft box bodies, 218 in. for 26-ft box bodies, and 274 in. for 30-ft box bodies. The Spicer electrified powertrains offer enough torque to start the load from a stop on a 20% grade and the power to maintain 40 mph on a 6% grade while fully loaded, according to the company. Regenerative braking returns energy to the battery and reduces brake wear and tear.

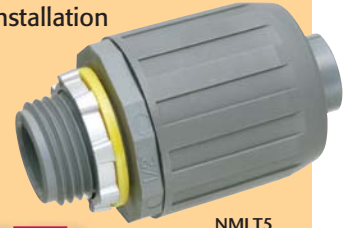
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PUSH ON
installation



NMLT5

17 seconds
per connector
VS

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NMLT50

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

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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"		✓



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MACK

With the launch of the MD Series, Mack Trucks introduced its first new medium-duty trucks since 2001. The MD6 has a 26,000-lb GVWR while the MD7 has a 33,000 lb GVWR. Features include a sloped hood for better visibility; a peep window in the passenger side door; integrated splash shields on the hood and cab to keep the engine compartment free of debris and dirt; and easy-to-replace halogen headlamps. General maintenance is made easy with quick access to the air cleaner, expansion tank, oil fill and check, filters, and electronics. The air suspended cab shields drivers from vibrations to reduce fatigue. Optional bench seating fits an extra crew member in the cab as well. The 120,000-psi frame rails are also 50% stronger than the industry average, according to the company. The MD Series can cover 75% of Class 6 and 7 applications — from van and reefer trucks to flatbeds and vocational vehicles.

MACK MD SERIES



PETERBILT



PETERBILT 220EV

Like Paccar's other brand Kenworth, Peterbilt Motors has released its own medium-duty electric truck, the Model 220EV. It's available as a Class 6 with a HV2600 motor for 154kW of continuous power

(207 hp) and 250kW of peak power (355 hp); the Class 7 uses a HV3500 motor for 259kW continuous (347 hp) and 350kW peak (469 hp). On a full charge, drivers should get a range of 100 mi with the 141kWh option and

200 mi with the 282kWh set up. Using a DC fast-charging system, the dual Li-ion phosphate battery packs, which are mounted outside of the frame rails for optimal weight distribution and performance, will fully charge in 1 hr to 2 hr.

FOR FLUSH-TO-THE-WALL MOUNTING OF LED, HI-DEF TVs

PLASTIC TV BOX™

RECESSED POWER/LOW VOLTAGE COMBO BOXES



LISTED POWER/LOW VOLTAGE BOX

TVBU505 with CED130
CABLE ENTRY DEVICE



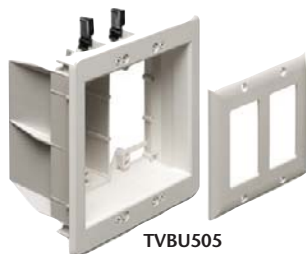
for **NEW WORK** or **RETROFIT**



CED130 with slotted cover
REVERSED for **RECESSED LOOK**



CED135 with brush cover



TVBU505

Arlington's **PLASTIC TV BOX™** – recessed combination power/low voltage boxes offer the secure, easy way to mount TVs flush against a wall.

The job looks great. Plugs and connectors stay inside these Listed boxes without extending past the wall. Available in 2-, 3- and 4-gang styles for retrofit or new work. Each offers power and/or low voltage in one or more of the other openings. There's a box to fit nearly any application!

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CED135



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2-GANG TVBU505



3-GANG TVBU507



4-GANG
TVB613



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Clamping Down on Energized Work Risk

Contractor program that seeks to train, qualify, and authorize select workers highlights dilemmas surrounding a task that's drawing more scrutiny.



A Sturgeon Electric energized work trainer acquaints trainees with the ground-up knowledge needed to perform work safely.

By Tom Zind, Freelance Writer

It's one of the top safety concerns for electrical contractors: knowing whether, when, and how to deploy staff to work with or near energized electrical equipment.

Repair, installation startup, commissioning, and maintenance tasks that can or must be performed with circuits in a known or potentially energized state come with the territory many contractors occupy; some routinely do it, others occasionally do it. All, however, are expected to understand how to mitigate potentially fatal shock and arc flash risk by following established, detailed, and exacting safety procedures and guidelines articulated in NFPA guidelines and OSHA workplace safety rules. Moreover, with a proliferation of mission-critical and health care client environments that prioritize 24-7/365 uptime, pressure on contractors or in-house maintenance teams to avoid or limit power shutdowns — and perform a broader scope of work in electrically live settings — might only be building.

Whether working “hot” in some manner is more commonplace or is largely relegated to special situations, there are signs the trade may be stepping up efforts to more closely examine and better understand this practice and increase the margin of safety for those who carry it out.



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- Competitively priced with LBs – **NO EXTRA COST for the normally more expensive T** – UL/CSA Listed
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CP3540 Box Cover

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- No visible screws on ceiling plate
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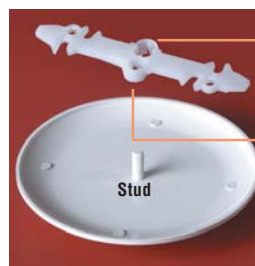
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Easy installation. Attach the bracket to the box with #8 or #10 screws. Back the screws out far enough to slip the bracket on.



'A' for flat ceilings
Push stud into opening to seat cover

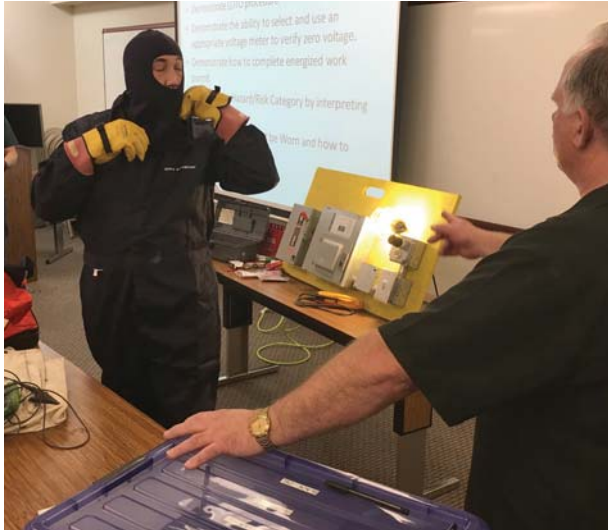
'B' for uneven or textured ceilings
Thread stud into opening until tight

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A Sturgeon Electric employee dons a balaclava as he prepares to work with an electrical panel mock-up in an energized work training session.

LEADING BY EXAMPLE

Exhibit A might be what Sturgeon Electric Company, Inc., Henderson, Colo., has been refining for the last several years and recently showcased at the National Electrical Contractors Association (NECA) virtual safety conference. It runs a program that periodically puts a select group of employees through an intensive 12-hour, in-house-developed course of learning on how to approach and perform work in energized settings. The emphasis is on safety: understanding and following protocols that reduce the chance of someone getting hurt while performing tasks that can carry high risk of serious injury or death. Those include working de-energized whenever possible, a priority approach that adheres to OSHA rules that seek to limit worker exposure to danger.

Billed as an electrical energized work competency and authorization course, the Sturgeon program consists of three modules, each building on the other, designed to fully train, authorize, and designate — to the company's standards — participants to perform energized work. Each class of typically no more than 20 employees, who must be first aid trained and either licensed journeymen or apprentices with more than 6,000 hours to participate, is filled through nominations of the operations manager or area superintendent.

Spread over several weeks of each quarter's final month, the course, conducted by a safety manager as well as district leadership, first reviews key considerations in preparing for and performing energized work. The initial chalk talk module covers basics such as arc flash/electric shock hazards and awareness; approach boundaries; energized work permitting; lock-out/tag-out procedures; writing of methods of procedure; NFPA 70E requirements for workplace electrical safety; daily safety briefings; and emergency action plans. The second four hours are devoted to applying what was taught, with participants tasked with demonstrating competency in areas like

PPE selection and donning/doffing; completing an energized electrical work permit (EEWP); voltage meter selection and use; and techniques for releasing electrical contact victims. The final training phase exposes PPE-outfitted participants to proctored virtual work, including putting them in front of actual, but de-energized switchgear wired with alarms and buzzers to safely show consequences of specific manipulations.

Upon completion, employees who pass become authorized to perform energized work and constitute the only group of Sturgeon employees permitted to do so. They subsequently continue to learn the finer points of the work through additional education and on-the-job learning, advancing to become go-to experts in safely handling any energized work the company may be tasked to perform.

A SOUND INVESTMENT

Though a costly undertaking factoring in regular workday scheduling, training materials and supplies, and worker downtime, Sturgeon leadership says the program is warranted because energized work is laden with big potential costs — both human and financial. It represents an investment with significant payback potential, given the incidence of energized work — broadly defined to include many routine inspection and assessment activities — and the significant damage that mishaps can inflict. Working to better ensure that all energized work scenarios are fully vetted and performed only by highly trained and trusted workers is the best way to reduce risk, given issues like workforce turnover, evolving understanding of best practices, and shifting client needs and perceptions, they say.

Don Egan, president of Sturgeon's commercial and industrial operations, says the need for a laser-focused training program became apparent as the company grew, and worries mounted about whether worker safety might be inadvertently compromised as a consequence. Of all the worker safety areas, energized work was identified as the one with the most glaring need for attention.

"When we were a smaller contractor, we operated in a more controlled environment where we all maybe knew one another better and knew who in the company had the capability to do energized work," says Egan, noting Sturgeon has grown rapidly in the last half-decade. "Growth has put more stress on our leadership and field management operations, and there's also the reality that we have a very different workforce than we did 20 years ago. Teaching younger craft labor how to use tools and to think for themselves has grown more difficult. Add that all up, and we took a step back and said, 'We're putting our employees at risk, and we're also sometimes working with customers who may not be all that aware of what they're asking us to do.'"

While the course has a heavy focus on following procedures to perform energized work safely, it also trains workers in the process of determining, in concert with the client, whether de-energized options are available in different scenarios. Up front, participants are instructed that workplace safety rules dictate energized work should be a last resort — that it should only be done after exhaustive analysis deems de-energized work "infeasible" because it would compound or introduce other safety hazards or cause costly, unavoidable disruptions.



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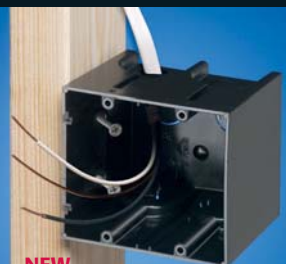
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* 2-HOUR FIRE RATING

PLASTIC ONE BOX™

FOR NEW OR OLD WORK

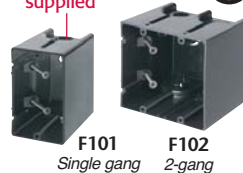


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NM cable connector supplied



F101

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F102

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F101H

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“Our first line of defense is getting the client to shut the power off if it’s feasible,” Egan says. “We’re working to try to educate people now about the different ways to perform tasks safely, de-energized, and part of that is putting the onus back on the customer, having them more involved in the process, and getting them to understand and acknowledge the risk. In many instances, the owner agrees there’s a way around that, and they end up not authorizing it.”

ADDRESSING MISCONCEPTIONS

But potential energized work scenarios still arise plenty often enough to warrant the program, says Bryce Perkins, Sturgeon district manager. It’s justified, he explains, because misunderstanding of what qualifies as energized work is all too prevalent. Too few workers, he asserts, come to the company adequately trained in the nuances of energized work, either from direct experience or specific instruction. They may lack the understanding, for example, that much routine evaluation/inspection/assessment work qualifies as energized work, even though it doesn’t involve “manipulation” tasks that bring workers into intentional, planned contact with energized parts, he says. By training and authorizing only a select few for energized work, the company minimizes worries about unqualified workers finding themselves in energized work situations.

“Non-manipulative work is often misunderstood and not properly categorized as a hazard,” Perkins says. “It may not be energized activity, per se, but hazards still exist. Performing certain functions, like IR scanning where you do live load inspections by opening up a cabinet, exposes workers. Awareness and education are needed to evaluate those situations and apply the right protective measures if something goes wrong.” Aiming to keep about a quarter of its Colorado workforce trained and authorized, Sturgeon executives are confident that decisions routinely made in the field about approving and performing energized work are in competent hands. With extensively trained and authorized workers, Perkins says, the company is better-positioned than average to factor safety into work with clients, notably data centers and hospitals that present the most energized work issues. He maintains that its in-house program ensures employees working in the most potentially dangerous settings meet the spirit and letter of the NFPA 70E definition of a “qualified person” for electrical work purposes, someone with not only skills and knowledge to work around electrical equipment, but also one who has “received specific safety training on the hazards involved.”

Licensing, Perkins says, only gets an electrician part of the way to being able to handle the most potentially dangerous situations. “To rely on that as a qualification for anyone jumping into this type of work, we said ‘no,’ that we needed to take it a few steps further.”

CRITICAL ACCLAIM

As Sturgeon’s program has matured, it has drawn the attention of other contractors and safety watchdogs. It came up in discussions at a 2019 NECA safety professionals conference, which led the company to invite NECA officials to visit and learn more about the program. That led to NECA incorporating



Sturgeon Electric’s energized work training puts trainees in front of de-energized equipment.

a continuing education breakout class on Sturgeon’s program, led by regional safety manager, Zachary Valdez, into this year’s virtual safety conference.

OSHA, too, has weighed in on the program in the course of closely observing Sturgeon workplace safety practices monitored through the agency’s Voluntary Protection Program (VPP). According to Perkins, the VPP evaluation team, in a recent formal Mobile Workforce Participation Evaluation Report on Sturgeon, classified the program as one of several company “areas of excellence,” stating, “permitting, training, simulators, and stop work authority all work together to contribute to an exceptionally strong program in this area.”

NECA’s Safety Director Wes Wheeler, who traveled to Sturgeon headquarters to assess the program alongside association president, Larry Beltramo, says the company’s stance on not accepting any risk recognizes the problems that can easily arise when pressure to do energized work meets workers ill-equipped to do the job.

“Contractors can feel the pressure of client needs related to production and service interruptions, and may choose to take risks and shortcuts to increase productivity or preserve client relationships,” says Wheeler, adding that mishaps can have far-reaching downside consequences. “The truth is that many (contractors and workers) feel they’re more qualified and experienced than they actually are. This is the dangerous reality.”

Wheeler senses the contractor community is becoming more acutely aware of the dangers and the need to better educate and train workers. Few, however, are copying Sturgeon’s approach, which stands out for its extensive hands-on component, especially those that are smaller and lack the resources. Their size, smaller employee base, and lower employee turnover, however, may lessen the need for such a thorough, ongoing qualification program.

REPLICATING THE PROGRAM

Elements of the Sturgeon approach could be integrated into programs offered through the NECA-IBEW electrical training alliance, says Justin Thayer, director of safety for NECA’s Puget



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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!

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entry device
w slotted cover



CED1
facing OUT



CED1
facing IN



CED2
facing IN



CED2
facing OUT



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Sound chapter. Thayer has studied Sturgeon's program and sees some potential for training programs offered at the joint training center in Portland, Ore., to incorporate a hands-on, interactive approach to energized work training. Thayer also hoped to discuss the program with safety managers at a Sturgeon branch in Auburn, Wash., which is poised to begin replicating the course offered in Sturgeon's Colorado division.

Barry Moreland, safety director at the Portland training center, likes the general idea of offering more immersive and focused energized work training but hesitates to endorse the center going as far as formally qualifying or authorizing trainees to perform the work, saying that responsibility must rest with employers.

"We could take on some risk offering that simulated environment and having employers then assume they've been trained on everything they need to know," Moreland says.

Shouldering that entire responsibility is the essence of Sturgeon's approach, but it's far from the only model for navigating energized work's challenges. Other contractors have done a "180," taking the stance that energized work is mostly off the table.

Marty Rouse, vice president of safety at Rosendin Electric, San Jose, Calif., says that's been the company's standard policy for several years, a stance that has allowed it to convince clients that safer, workable alternatives exist in most cases thanks in part to emerging technologies. He lauds Sturgeon for its effort to ensure that energized work, when unavoidable, is performed only by experts, but says the future lies in contractors coming to the realization that they can and should avoid it whenever possible.

That might be a tall order, however, in the view of Terry Becker, owner of Canada-based TW Becker Electrical Safety Consulting, Inc. As mission-

critical operations proliferate and the need for maintenance and troubleshooting activities grows, energized work will be a front-and-center issue that won't produce easy answers or ready consensus, he says. Leading companies in that space have made steady progress in curtailing energized work or making it safer through work-arounds, but contractors must continue to be ready to perform energized work and perform it safely.

"Energized work needs to be done with risk managed more than it ever has in the past, because it's going to grow," Becker says. "So, I'm hoping that more companies will do what Sturgeon has done, and put their people through something similar. Probably less than one percent of contractors are doing what they're doing."

EC&M

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



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Wiring Devices

Zigbee-enabled lighting controllers

The Decora Smart family of Zigbee 3.0-certified lighting controls includes an in-wall 600W dimmer, in-wall 15A switch, mini plug-in outlet, and plug-in dimmer — all compatible with popular control systems, including Comcast's Xfinity Home. Designed to allow homeowners to control lights from anywhere, the controllers reduce energy consumption and offer customized lighting by wirelessly connecting to compatible Zigbee hubs for remote lighting control, scheduling, inclusion in scene-based lighting, and other home automation activities.



Leviton



USB outlet

The adorne 6A ultra-fast USB outlets are designed to deliver up to 40% faster charging and can replace a standard outlet in as little as 15 min., according to the company. Available in various options, including newer USB Type-C connection and traditional USB Type-A, the outlets provide a quick and convenient built-in charging solution and provide a designer-quality outlet for residential spaces with 40 different colors and finishes.

Legrand

Receptacle

The Twist-Lock Edge Series of receptacles with screwless terminations is designed to speed installation by more than 80%, according to the company. Instead of using screws at termination points, the receptacle includes a strong levered spring that continues to apply pressure as strands relax over time, keeping wires tight. Features include availability in a variety of amps and volts and no exposed metal on receptacles, which allows more devices to be installed closer together. In addition, no torque screwdrivers are required for wiring.

Hubbell Wiring Device-Kellems



LED dimmer

The Dalia dimmer is designed as a classic rotary control built with the company's LED+ Advanced Technology and a SoftGlow locator light. Offering a variety of wall plate and knob color choices, the dimmer is controlled by a turn of the knob, can be installed in 15 min., and works with existing wiring without requiring a neutral wire, according to the company. The product is also designed to control up to 150W of LEDs and 600W of incandescent/halogen loads, with an easily adjustable dimming range and low-end trim lever to enhance bulb performance.

Lutron

Smart in-wall timer

The Ascend smart in-wall timer is designed to allow homeowners to manage lighting schedules, improve security, and boost home energy efficiency via the cloud through the Ascend Smart Timer app, available for an Apple or Android device. Features of the timer include Amazon Alexa and Google Assistant compatibility for voice-activated programming commands, including ON/OFF and status check, as well as standalone automation that does not require a hub.

Intermatic





Isolated power tool accessories

The eSHOK-GUARD isolated bit holder and socket isolators are UL-classified for isolation of up to 1,000VDC and 1,500VAC. The isolated bit holder features a magnetic tip to keep fasteners securely in place. A retaining ring lets users easily secure and replace bits seamlessly, and the ¼-in. hex shank is compatible with impact drivers and drills. The ¼-in., ⅜-in., and ½-in. socket isolators offer a compact, impact-rated design for heavy use in impact applications, while the ball detent makes securing and replacing sockets easy. *Crescent APEX*



Electric scissor lift

The all-electric DaVinci AE1932 scissor lift has zero hydraulics to help eliminate job-site leaks and zero emissions to help control job-site pollution. According to the company, the 19-ft, 3,450-lb scissor lift reduces energy consumption by up to 70% as compared to traditional models, allowing for the use of a single, Li-ion battery. Featuring a distributed architecture, the product can transmit data back to operators, fleet managers, and service technicians via Bluetooth and cellular networks. Other features include an indoor/outdoor 606-lb capacity rating, travel speed of 4 mph, 25% gradeability, load sensing system, self-closing gate and the company's QuikFold rail system. JLG Mobile Control comes standard, allowing users to drive, steer, and load from any iOS or Android mobile device. *JLG Industries*



Heated workwear

The GHJ12V heated jacket and GHH12V-20 heated hoodie feature three temperature settings for enhanced control and comfort. Strategically placed heat zones in the chest and lower back offer thorough, efficient heating in a lightweight, easy-to-wear package. Both items include a GAA12V-21 12V Max Portable Power Adapter, which allows users to employ the company's 12V Max Battery to deliver heat as well as 2.1A of accessory power for mobile devices, phones, tablets, and more. In addition, the jacket includes six pockets for storage while the hoodie offers a large adjustable hood. *Bosch Power Tools*



Work gloves

SmartCut BKCR2403 light-duty work gloves are made from composite yarn that includes a blend of high-strength filament fibers for enhanced cut resistance, upwound with nylon and spandex to create dexterity for tasks that call for very fine motor skills and tactile sensitivity. The 18-gauge high-performance polyethylene (HPPE) and glass-fiber shell is lightweight and provides ANSI cut level 2 protection. A black polyurethane palm coating offers abrasion protection and enhanced grip. *Brass Knuckle*



Reciprocating saw blades

Steel Demon AMPED reciprocating saw blades are design to cut through metals ranging in thickness from ⅜ in. to ⅝ in. The blades feature custom-formulated TiCo carbide and the first-ever Black Industrial Cooling Element (I.C.E.) to deliver up to 100-times longer cutting life in metal cutting applications than standard bi-metal blades, according to the company. Black I.C.E. protects the cutting edge by creating a slick, lubricant like action for a cool cutting edge and enhanced chip evacuation for cleaner cuts. The products also feature an enhanced carbide-tip-to-blade connection to handle extreme impact resistance in thick metals. In addition, the 1-in. oversized blade body provides stability and rigidity needed for straighter cuts with less vibration. *Diablo*



Diesel gen-sets

The company has added 31 models to its Cat GC diesel gen-set product line for stationary standby power applications globally. The gen-sets include 11 models with power ratings ranging from 33kVA to 400kVA for 50-Hz applications globally; 11 models ranging from 40kW to 200kW for 60-Hz applications in North America; and nine models ranging from 30kW to 175kW for 60-Hz applications outside North America. In addition, they can be equipped with Cat Connect Remote Asset Monitoring, which provides data visualization, reporting, and alerts that are globally accessible through an easy-to-use web interface. Select models with commonly specified power outputs and configurations are stocked at larger Cat dealer locations. *Caterpillar*

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The Differences Between Grounding and Bonding — Part 1 of 12

Grounding and bonding serve different functions, use different methods, and have different requirements.

By Mike Holt, NEC Consultant

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

Article 250 provides requirements for the grounding and bonding of electrical installations. It covers two different concepts:

1. “Grounding” is the connection to the earth. The grounding requirements provide a path to the earth to reduce overvoltage from lightning strikes, line surges, or unintentional contact by higher-voltage lines [Sec. 250.4(A)(1)].

Failure to ground metal parts to earth can result in millions of volts induced on those metal parts. This energy seeks a way to the earth within the building, taking whatever paths are available (not just “the one with least resistance,” see Kirchhoff’s Law of Parallel Circuits). This can easily result in a fire and/or electric shock either by direct contact or from a flashover.

2. “Bonding” is mechanically connecting electrically conductive components to ensure electrical conductivity between metal parts [Art. 100]. The bonding requirements establish a low-impedance fault current path back to the source of the electrical supply so overcurrent protective devices (OCPDs) operate if there’s a ground fault [Sec. 250.4(A)(3)].

These two systems overlap, but each serves a different purpose. You need them in both solidly grounded systems [Sec. 250.4(A)] and ungrounded systems [Sec. 250.4(B)].

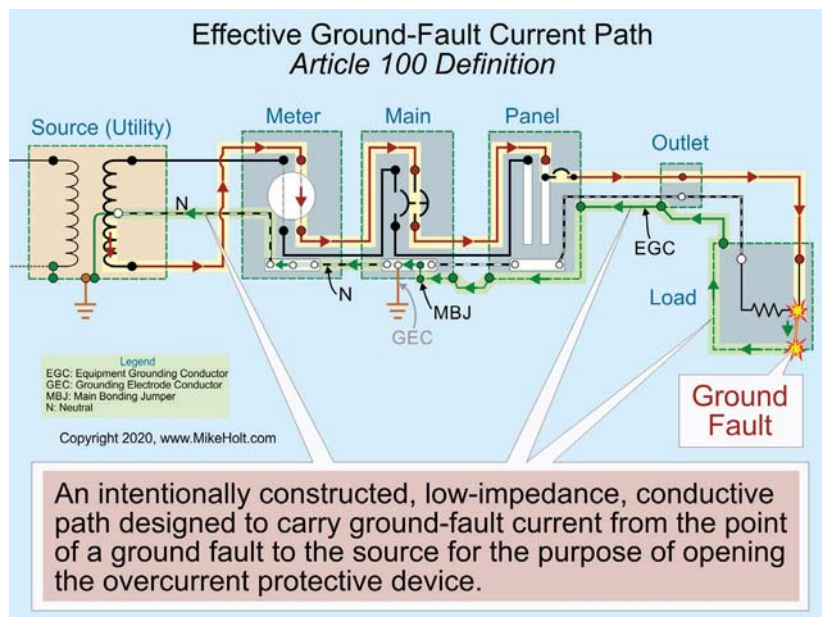


Fig. 1. You can find the definition of “ground-fault current path” in Art. 100 of the NEC.

EFFECTIVE GROUND-FAULT CURRENT PATH

An “effective ground-fault current path” [Art. 100 and Sec. 250.4(A)(5)] is (Fig. 1):

- An intentionally constructed low-impedance conductive path.
- Designed to carry fault current from the point of a ground fault to the source.
- Needed for opening the circuit overcurrent protective device (OCPD).
- Capable of safely carrying the maximum ground-fault current likely to be imposed on it from any point on the wiring system where a ground fault may

occur to the electrical supply source.

- Not the earth.
- A type recognized in Sec. 250.118 and must be installed with all circuits.

Also, it has sufficiently low impedance to the source so fault current will quickly rise to a level that will open the circuit OCPD. The time it takes for an OCPD to open depends on the magnitude of the fault current. A higher fault current value means a shorter clearing time for the OCPD. For example, a 20A OCPD with an overload of 40A (two times the 20A rating) takes 25 sec to 150 sec to open. The same device at 100A

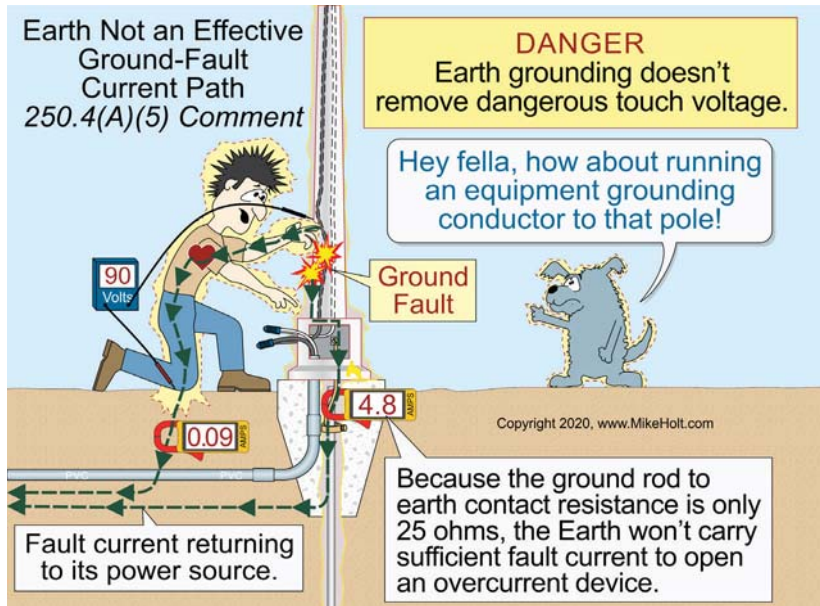


Fig. 2. The earth is not an effective ground-fault current path.

(five times the 20A rating) trips in 5 sec to 20 sec.

During a ground fault, earth grounding does not remove dangerous touch voltage. Because the contact resistance of a grounding electrode (like a ground rod) to the earth is so high, very little fault current returns to the power supply. As a result, the circuit OCPD will not open, and all metal parts associated with the electrical installation, metal piping, and structural building steel will become (and remain) energized (**Fig. 2**).

Electricity will take all paths presented to it in inverse proportion to the impedances. A low-impedance path takes (almost) all the undesired current. Draw a circuit with two 10K-ohm resistors in parallel. Calculate the current flow. Now put a 1-ohm resistor in parallel with those and recalculate. What did you learn about low-impedance paths, such as the effective ground-fault current path, by doing this?

SOLIDLY GROUNDED SYSTEMS

System grounding reduces fire risk. It also reduces voltage stress on electrical insulation, thereby extending insulation life for motors, transformers, and conductors.

Solidly grounded electrical power systems must connect to the earth (grounded) in a manner that limits the voltage induced on the conductors by

lightning strikes, etc. If the source is a transformer, then grounding stabilizes the secondary conductor's voltage to ground during normal operation [Sec. 250.4(A)(1)].

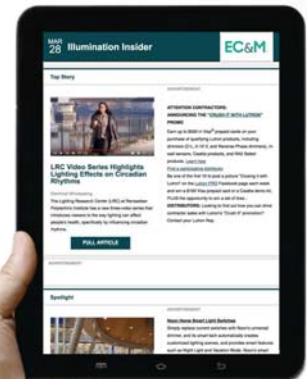
To limit imposed voltage, grounding electrode conductors (GECs) should not be any longer than necessary or have unnecessary bends or loops [Sec. 250.4(A)(1), Note 1].

Metal parts of electrical equipment must be connected to each other and to the earth to reduce the voltage (to ground) on the metal parts from indirect lightning strikes [Sec. 250.4(A)(2)].

Metal parts of electrical raceways, cables, enclosures, and equipment must be connected together and to the supply system in a manner that establishes an effective ground-fault current path [Sec. 250.4(A)(3)].

Electrically conductive materials that are likely to become energized, such as metal water piping systems, metal sprinkler piping, metal gas piping, and exposed structural steel members, must be connected (bonded) to the supply source via an effective ground-fault current path. [Sec. 250.4(A)(4)].

Metal parts of electrical raceways, cables, enclosures, or equipment must be bonded together and to the supply source in a manner that creates a low-impedance path [Sec. 250.4(A)(5)].



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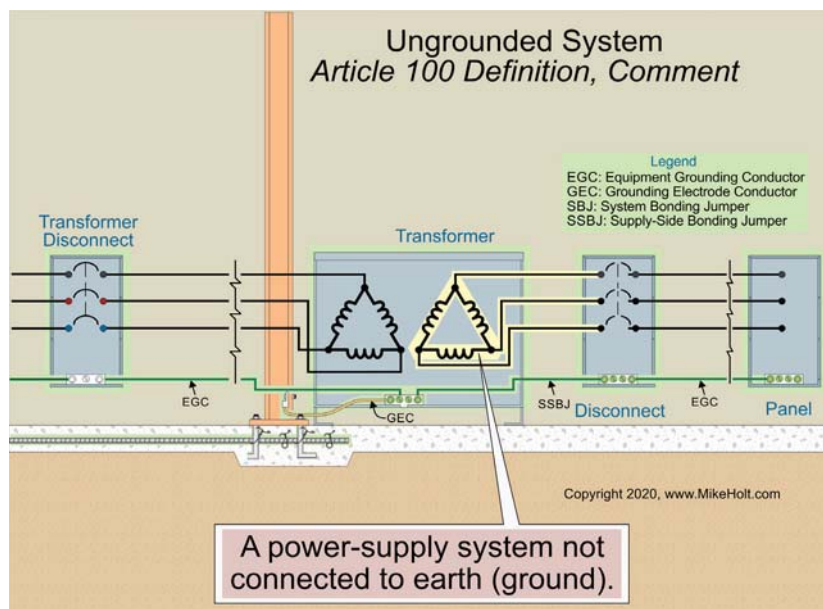


Fig. 3. Per the NEC, an ungrounded system is “a power-supply system not connected to earth (ground).”

UNGROUNDING SYSTEMS

An ungrounded system is “a power-supply system not connected to earth (ground)” [Art. 100]. An example is in the secondary winding of a transformer where there is no connection between the system winding and earth (ground) or to a conductive body that extends the earth (ground) connection (Fig. 3).

Ungrounded systems must still be grounded. Do it per Sec. 250.4(B)(1) through (4). The requirements are like those for solidly grounded systems. In fact:

- 250.4(B)(1) repeats 250.4(A)(2).
- 250.4(B)(2) repeats 250.4(A)(3).
- 250.4(B)(3) repeats 250.4(A)(4).
- 250.4(B)(4) repeats 250.4(A)(5).

The requirements for the effective ground-fault path are the same, so where is the difference?

A solidly grounded system connects to the earth. For example, a delta-wye transformer is connected via grounding conductor at the “Y” point in the transformer drawing. From a normal operating perspective, this merely stabilizes the voltage on the secondary. You could have a relatively puny connection to ground, and it would still work.

But what if there is an induced voltage in the system? That’s where Sec. 250.4(A)(1) comes in. It requires this ground connection to be sufficient for handling the

abnormal induced voltage. Ungrounded systems don’t have this connection, so this requirement does not apply to them. This connection at the source is what differentiates solidly grounded systems from ungrounded systems.

OBJECTIONABLE NEUTRAL CURRENT

Objectionable neutral current occurs because of improper neutral-to-case connections or wiring errors that violate Sec. 250.142(B). Objectionable neutral current on metal parts can cause electric shock, fires, and improper operation of electronic equipment and OCPDs, such as GFPEs, GFCIs, and AFCIs.

Electrical systems and equipment must be installed in a manner that prevents neutral current or circuit current from flowing on metal parts (objectionable current) [Sec. 250.6(A)].

Objectionable neutral current will flow on metal parts if the neutral conductor is connected to the circuit equipment grounding conductor (EGC) at both the transformer and any other location on the load side of the system bonding jumper.

Objectionable neutral current will flow on the EGC if the circuit EGC is used as a neutral conductor, such as where:

- A 230V time-clock motor is replaced with a 115V time-clock motor,

and the circuit EGC is used for neutral return current.

- A 115V water filter is wired to a 240V well-pump motor circuit, and the circuit EGC is used for neutral return current.
- The circuit EGC is used for neutral return current.

Objectionable neutral current will flow on metal parts and on the EGC(s) if:

- The neutral conductor is connected to the metal case of a panelboard on the load side of the service disconnect.
- A generator is connected to a transfer switch with a solidly connected neutral, and a neutral-to-case connection is made at the generator.
- The neutral conductor is connected to the metal case of a disconnect that is not part of the service disconnect.
- The neutral conductor from one system is used as the neutral conductor for a different system.

GROUNDING AND BONDING CONNECTORS

EGCs, GECs, and bonding jumpers must be connected by one or more of the following methods [Sec. 250.8(A)]:

- (1) Listed pressure connectors
- (2) Terminal bars
- (3) Pressure connectors listed for grounding and bonding
- (4) Exothermic welding
- (5) Machine screws that engage at least two threads or are secured with a nut
- (6) Self-tapping machine screws that engage at least two threads in the enclosure
- (7) Connections that are part of a listed assembly
- (8) Other listed means.

BEYOND GENERAL REQUIREMENTS

To avoid confusion, remember that grounding involves connecting to the dirt, but bonding involves providing a metallic path. Drawing out the circuit is a good way to get a clear picture of where the undesired current is flowing, but only if you show grounding as a big resistor and bonding as a small one. **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.

Underlined text indicates revisions made in the 2020 Edition of the NEC.

Q. What Code rule applies to the number of service disconnects allowed on a service?

A. Section 230.71 provides guidance on the number of disconnects allowed on a service.

Each service must have only one disconnecting means except as permitted in Sec. 230.71(B).

(A) General. For the purpose of this section, a disconnecting means installed as part of listed equipment and used solely for the following is not considered a service disconnecting means:

- (1) Power monitoring equipment.
- (2) Surge-protective device(s).
- (3) Control circuit of the ground-fault protection system.

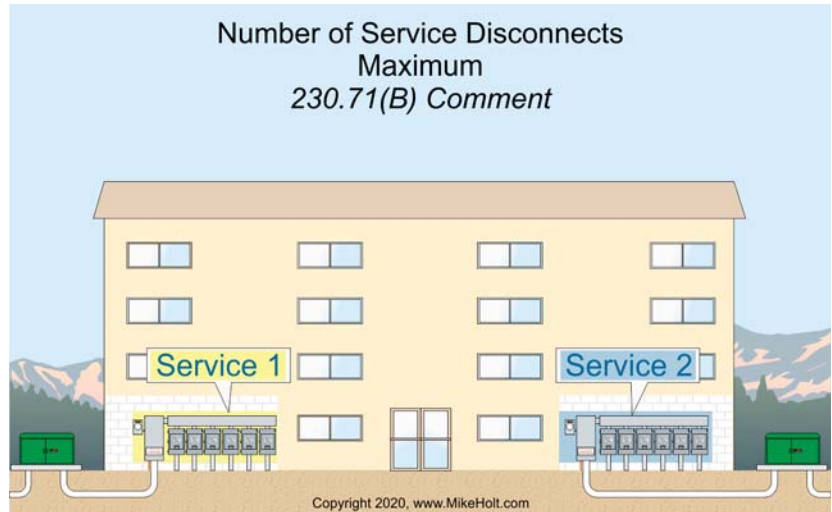
This revision retains the previous permission to have two to six service disconnects for each service or each set of service-entrance conductors but provides the increase in safety that a single service disconnect provides.

- (4) Power-operable service disconnect.

(B) Two to Six Service Disconnecting Means. Up to six service disconnects are permitted for each service allowed by Sec. 230.2, or for each set of service-entrance conductors permitted by Sec. 230.40, Exceptions No. 1, 3, 4, or 5.

The two to six service disconnecting means may consist of a combination of any of the following:

- (1) Separate enclosures with a main service disconnecting means in each enclosure



There must be no more than six disconnects for each service, not for each building.

- (2) Panelboards with a main service disconnecting means in each panelboard

- (3) Switchboard(s) where there is only one service disconnect in each

switches that are suitable for use as service equipment.

The rule is six disconnects for each service, not for each building. If the building has two services, then there can be a total of 12 service disconnects (six disconnects per service) (see **Figure** above).

This revision retains the previous permission to have two to six service disconnects for each service or each set of service-entrance conductors but provides the increase in safety that a single service disconnect provides. The previous six main disconnect rule for a single enclosure made it impossible to work in service equipment when applying electrical safe work practices in accordance with NFPA 70E, unless the line side of the multi-disconnect enclosure was disconnected by the electric utility.

This revision also reflects the electrical hazards inherent while working on service equipment where there is more than one service disconnect in a single enclosure. This, combined with the rule in Sec. 230.62(C) that requires line side barriers, is a significant safety improvement toward reducing the risk to electricians by limiting their exposure to energized parts.

EC&M

Illustrated Catastrophes

By Russ LeBlanc, NEC Consultant

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

LAYERS OF VIOLATIONS

This wall is constructed of three different layers, including gypsum board, plaster, and wood paneling. The person who installed this panelboard enclosure hacked through all those layers and made no attempt at repairing the wall to maintain its fire-resistant ratings. Section 312.4 requires cabinets installed in noncombustible surfaces to be repaired so there will be no gaps or open spaces greater than $\frac{1}{8}$ in. at the edge of the cabinet used with a flush-type cover. The gaps here are at least 3 in. or wider. Flames and smoke can easily spread through these gaping openings. In order to minimize the possible spread of fire, smoke, and other products of combustion, Sec. 300.21 requires openings around electrical equipment — such as raceways, cables, boxes, and cabinets that penetrate into or through fire-resistant-rated walls, partitions, floors, or ceilings — to be firestopped with approved methods to maintain the fire-resistance rating of the assembly. Even small openings can allow fire and smoke to spread from one part of a building to another. It is imperative for these openings to be repaired or otherwise closed to minimize this spread.



A NOT-SO-LIQUIDTIGHT INSTALLATION



The long-term effects of damaging ultraviolet rays from sunlight have resulted in the nonmetallic jacket of this liquidtight flexible metal conduit (LFMC) becoming brittle and cracked. This problem combined with the rusted-out metal connectors and metal raceway leaves this installation in need of major repairs. The definition of LFMC in Sec. 350.2 indicates that LFMC is a flexible metal raceway having a liquidtight, nonmetallic, sunlight-resistant outer jacket. This photo seems to indicate otherwise for this particular installation. For nonmetallic equipment exposed to sunlight, Sec. 300.6(C)(1) requires the materials to be listed as sunlight resistant or identified as sunlight resistant. The mounting means for both the PVC box and the weatherproof aluminum box are snapped off, leaving these boxes less than “rigidly and securely fastened in place,” as required by Sec. 314.23(A). The receptacle covers installed on the outlet box do not comply with the requirements in Sec. 406.9(B)(1). Receptacles rated 15A or 20A, 125V or 250V installed in wet locations are required to have an enclosure that is weatherproof whether or not any attachment plug cap is inserted. These covers are only weatherproof when closed.

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

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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: This burst my "bubble."



'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 FLBT4400SS countertop box kit, which includes a stainless steel trap door cover and a 20A decorator-style, tamper-resistant receptacle. E-mail your response, including your name and mailing address, to russ@russleblanc.net, and Russ will select three winners (excluding manufacturers and prior winners) at random from the correct submissions. Note that submissions without an address will not be eligible to win.

NOVEMBER WINNER

Our lone winner this month was Jennifer E. Kuether, P.E., and chief electrical engineer for Epstein in Chicago. She was able to point out some of the problems with this installation.

The cartoon mascots for Rice Krispies cereal would probably be impressed by the snap, crackle, and pop that this PVC raceway must have made when it broke apart. Perhaps installing a PVC conduit expansion fitting or using a flexible wiring method would have been a better option for protecting these service entrance conductors.

Section 230.43(15) does provide limited use of liquidtight flexible



metal conduit (LFMC) for wiring of service entrance conductors. For

services, LFMC is limited to a maximum length of 6 ft, and a supply-side bonding jumper must be routed with the LFMC.

Thermal expansion may have also played a role in the destruction of this raceway. Section 352.44 requires expansion fittings to be installed in the PVC conduit run where the length change is expected to be ¼ in. or greater "in a straight run between securely mounted items such as boxes, cabinets, elbows, or other conduit terminations."

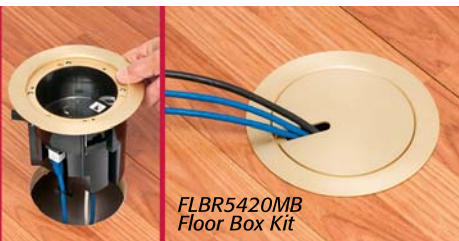
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