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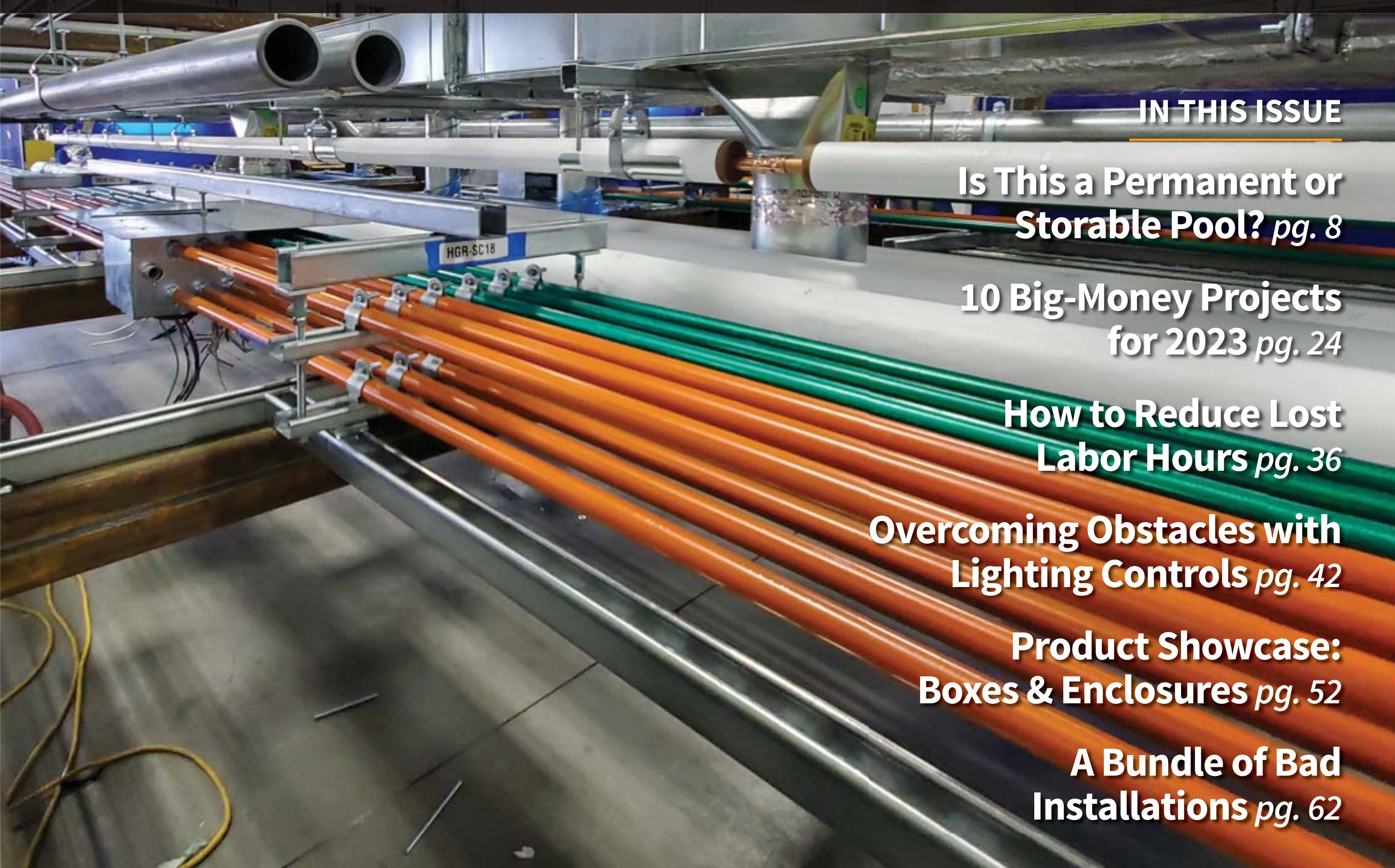
THE EVOLUTION OF PREFAB

How this concept went from criticism to skepticism to industry standard in the electrical construction market. Read more on ***pg. 14***



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Taking Building Lessons from Bees?

By Ellen Parson, Editor-in-Chief

What do honeycombs and prefabrication of construction materials on job sites have in common? Based on new research from Purdue University, the answer is more than you might think. When preparing content for this issue, which focuses on job-site productivity, I couldn't help but remember a rather peculiar yet fascinating report that recently crossed my desk. According to the press release, research from engineers/entomologists at Purdue suggests that the way in which honeybees build their honeycombs could actually lead to new fabrication techniques in the construction industry. This work demonstrates a discipline called biomimicry, in which humans can draw important lessons from the plant/animal world and apply them in the human world.

Nikhilesh Chawla, the Ransburg Professor of Materials Engineering at Purdue, is harnessing the power of 4D imaging technology to study the complexities of honeycombs, which provides a time-lapse view of the bees' work without cutting into their home. "It's a lesson in materials utilization that could lend itself to new ideas and practices in structures," said Chawla, explaining that some of the junctions between the honeycomb cells were created using less material, with the resulting porous connections resembling Swiss cheese. "Their honeycombs are still perfectly fine. From that perspective, humans may not actually need as much material in some areas that are not quite as important from a structural point of view."

Chawla went on to explain that people don't truly comprehend how bees construct honeycombs. "Most theorize the honeycomb chambers start as cylinders and then are molded by the bees into the well-known hexagonal shape. But a sophisticated three-dimensional (3D) X-ray microscopy technique combined with a time lapse provided an unprecedented means of studying and quantifying the honeycomb's microstructure," he explains in the report. "The resulting 4D imaging showed chambers are built with panels. Research also found bees go to great lengths to strengthen the honeycomb structure by first creating a vertical spine for support and then building the hexagon cells out horizontally."

What does this have to do with the electrical construction industry? Basically, this tells me that bees could potentially be the first prefab pioneers. Who knew?

To learn more about the evolution of prefabrication in the electrical industry, turn to the cover story on page 14. Written by Dr. Perry Daneshgari (an actual human prefab pioneer) and Dr. Heather Moore of MCA, Inc., this piece explains how the concept of prefab has gone from criticism and skepticism to industry standard in the construction market. Don't miss this comprehensive article, which not only shares exclusive research from the electrical contracting field and projections for the future of prefab but also outlines the industry's first prefab standard from NEIS (NECA 5-2022) and offers up a free prefabrication litmus test for readers. According to Daneshgari, more than half of all electrical work currently done on site could be done off site — a trend he believes is where the industry is headed.

A related feature article, written by Freelancer Tim Kridel, takes an inside look at the problem of lost labor hours in the construction industry. Read "Loss Cause," starting on page 36, to see why supply chain shortages, project creep, inadequate planning, and finger pointing are just a few of the reasons full-time electrical professionals often have the productivity of a part-timer. According to sources interviewed for this piece, oftentimes more than half of an electrician's day can be chalked up to lost labor hours. This article demonstrates the real-world consequences of wasted time — electrical contractors must pay their help regardless of whether the work gets done or not. Don't miss the lessons learned in these two articles on the power of prefab — and don't be surprised if we learn more from our buzzing little honeybee builders in the future, thanks to ongoing developments in biomimicry research.

Ellen Parson

Is This a Permanent or Storable Pool?

Learn which NEC rules apply to each definition.

By L. Keith Lofland, IAEI

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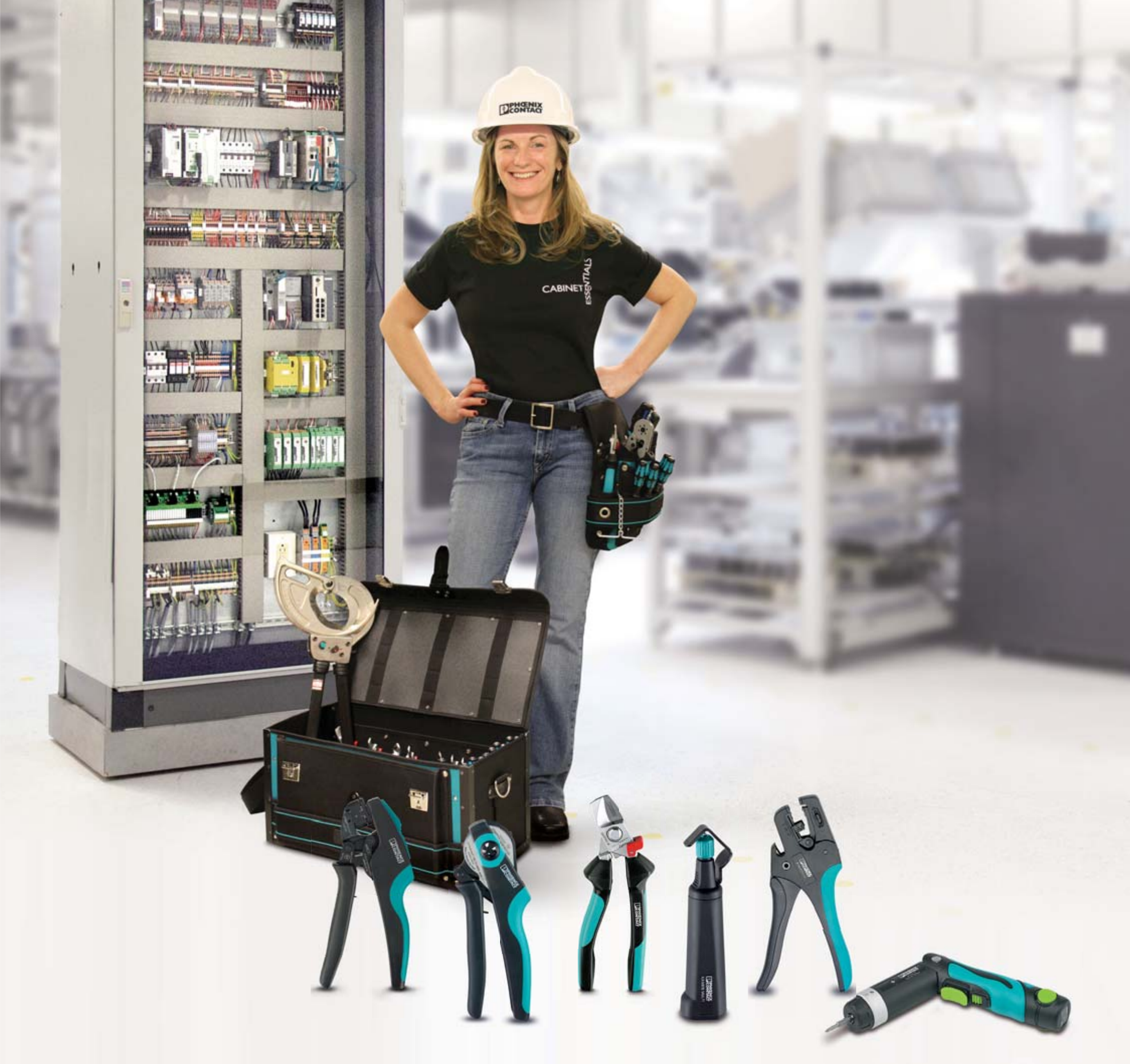
Photo 1. Here's an example of a storable pool installed above ground that is capable of holding water to a depth of 42 in. (or greater) in some cases.

As an electrical contractor, electrician, or installer, before you start a job, it is always critical to know which set of National Electrical Code (NEC) rules are going to be applied to your specific installation. The same can be said for your local electrical inspector. Which set of NEC rules am I obligated to enforce on this particular job site?

Until changes that occurred in the 2023 edition of the NEC, this was not an easy, cut-and-dry answer when it came to a permanently installed swimming pool versus a storable pool. For years, what mainly distinguished a storable pool from a permanently-installed pool was its water depth. In past Code cycles (including the 2020 NEC), a storable pool (**Photo 1**) was defined as a pool intended to be stored when not in use that was constructed on or above the ground and capable of holding water to only a depth of 42 in. On the other hand, a permanently installed swimming pool (**Photo 2** on page 10) has historically been defined as a pool constructed in the ground or partially in the ground or any other pool capable of holding water at a depth greater than 42 in.

As clearly indicated in these definitions, there seems to be a dividing line and something magic about this 42-in. depth of water when it comes to a storable pool versus a permanently installed pool. With that in mind, let's take a look at the origin of this seemingly magic number.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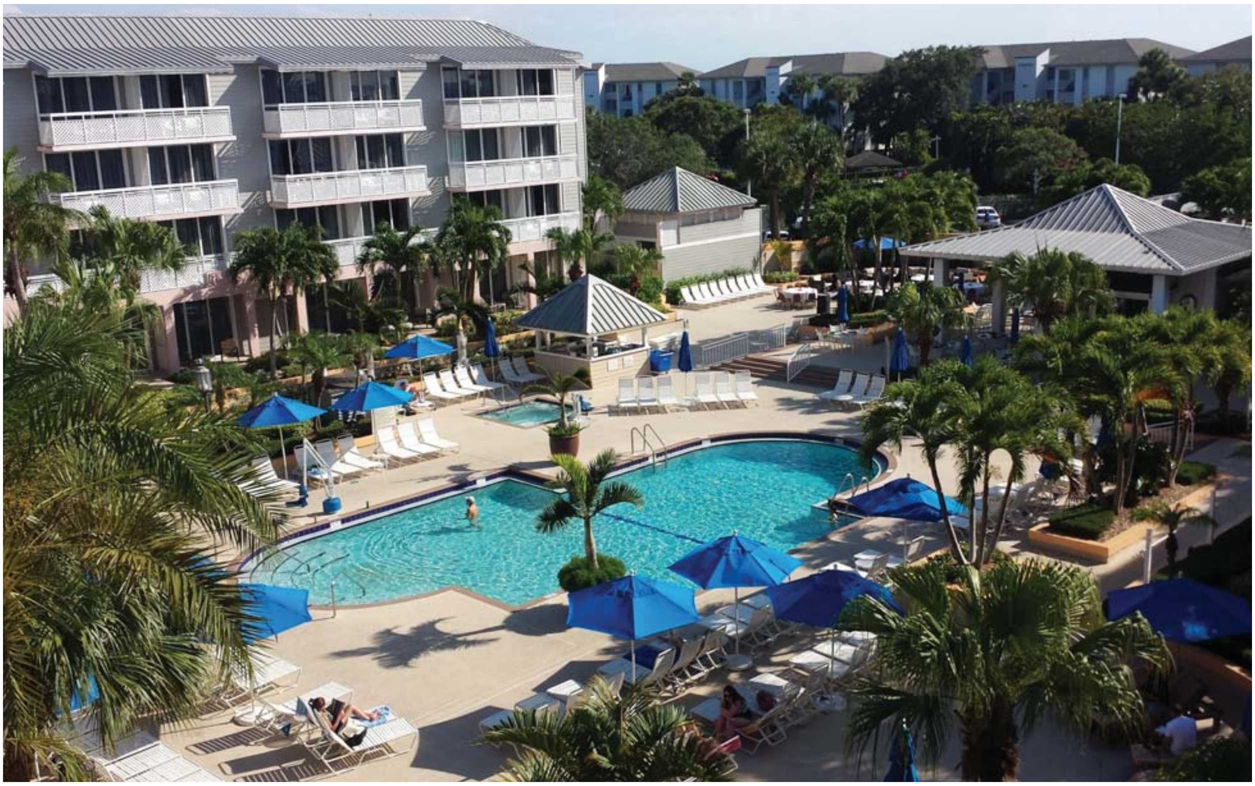

Photo 2. The shot shows a permanently installed pool constructed in the ground capable of holding water at a depth greater than 42 in.

A LOOK BACK

Prior to the 1975 edition of the NEC, the definition of a storable or permanently installed pool did not contain a prescriptive wall height or water depth. For the 1978 NEC, a proposed wall height of 3 ft was added to the definition of a storable pool. This change was submitted by the NEC Code-Making Panel (CMP-20), which had purview over Art. 680 [Swimming Pools, Fountains, and Similar Installations] at that time. In their Committee Statement for justifying this maximum wall height of 3 ft, CMP-20 indicated that the availability of increasingly larger sizes of above-ground pools made it necessary to clarify the intent of the definition by including maximum dimensions.

During the 1981 NEC revision cycle, a proposal was accepted to revise the definition of a storable pool by increasing the maximum 3-ft wall height limitation for a storable pool to a pool capable of holding water to a maximum depth of 42 in. This proposal was submitted on behalf of the National Swimming Pool Institute seeking to change the definition of a storable pool to "a removable pool of any shape whose frame is located entirely above ground; these pools may be readily disassembled for storage and reassembled to their original integrity." Notice that no depth dimension was proposed. In the substantiation for this proposed revised definition, the submitter stated that the current 1978 NEC definition of storable pool "inaccurately and inadequately describes the current products on the marketplace today." The submitter went on to say that approximately 85% of the above-ground pools sold in 1981 were greater than 3 ft in depth (typically 42 in. to 48 in.), came in a variety of shapes , and may have had a maximum dimension of greater than 15 ft.

To be clear, the submitter's intent (for the 1981 NEC) was to remove the prescriptive maximum wall height of 3 ft for a storable pool. To the contrary, the technical committee took action to increase the maximum height of a storable pool from 3 ft to 42 in. This was done without a whole lot of substantiation as to why the maximum height of 42 in. (and not 48 in. or some other dimension) was chosen. There is some indication that the 42-in. maximum water depth was tied to a storable pool wall height of 45 in. This 42-in.

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maximum water depth has lived on in the definition of a storable pool from the 1981 NEC until the 2020 edition of the NEC.

WHAT IT MEANS TODAY

What does all of this have to do with you, the electrical contractor? Manufacturers have been producing storable pools with wall heights of 48 in. for over 40 years without any negative impact on electrical safety. Today, it is very common to see storable pools that exceed the defined 42-in. water depth, but qualify in every other way as a storable pool. From an electrical safety standpoint, these storable pools capable of holding water at a depth greater than 42 in. (not meeting the previous definition of a storable pool) are no different than pools that has a maximum 42-in. water depth (meeting the previous definition of a storable pool). Providing requirements for electrical safety around a storable pool is not impacted if the maximum water depth is greater than 42 in. However, while enforcing the 2020 NEC, the Authority Having Jurisdiction (AHJ) has no choice but to treat this seemly storable pool as a permanently installed pool if the maximum water depth is greater than 42 in.

A "storable pool" is typically set up on level ground and comes in a complete package that can typically be set up in an hour or so without many tools when the instruction manual identifies it as a storable pool. If this storable pool is also capable of holding water at a depth greater than 42 in. (which many can), under 2020 Code language (and previous editions) and definitions of storable and permanently installed pools, this storable pool would have to comply with Part II of Art. 680 for a permanently installed pool. For one thing, this would mean having to establish an equipotential bonding grid per NEC Sec. 680.26 for what appears to be a storable pool.

Once this defined 42-in. limitation is broken, the AHJ knows that Part II of Art. 680 must somehow be applied. The difficulty comes as the equipotential bonding grid cannot be bonded to this "storable pool" at four points [Sec. 680.26(B)(2)], the pool water cannot be bonded to the equipotential bonding grid [Sec. 680.26(C)], the pool pump for this "storable pool" is double insulated and cannot be bonded [Sec. 680.26(B)(6) and Exception], and a solid 8 AWG copper equipotential bonding conductor cannot be connected to the equipment grounding conductor of the branch circuit supplying the pump motor [Sec. 680.26(B)(6)(a)] — just to name a few.

For the 2023 edition of the NEC, the definitions for a storable pool and a permanently installed pool have been revised to address these issues we discussed to this point. The definition of a "storable pool" now indicates that a storable pool would be installed entirely on or above the ground and intended to be stored when not in use and would be designed for ease of relocation, regardless of the water depth. This revised definition is uncannily similar to the originally proposed definition of a storable pool in the 1981 NEC that was not accepted.

Also, for the 2023 NEC, a "permanently installed pool" is now defined as a pool that is constructed or installed in the ground or partially in the ground and all pools installed inside of a building. The 2023 NEC revised definition goes on to state that these pools would qualify as a permanently-installed pools, whether they are served by electrical circuits of any nature or not.

Notice that both of these revised definitions are void of any qualifying depth of the pool or water level. The technical committee (CMP-17) indicated in their Panel Statement that these definitions were being revised to affirm that any electrical hazards associated with a storable or permanently installed pool are not related to the depth of the said pool. The submitter of the Public Inputs to bring about these revised definitions indicated that these changes were necessary to address multiple adverse impacts created with a prescriptive limitation of a 42-in. water depth. Newer designs in storable pools allow for depths greater than 42 in., and the addition of a few inches of water has no impact on electrical safety. These revised definitions for the 2023 NEC will bring much-needed relief to both the installer and the inspector when it comes to applying the proper parts of Art. 680 and NEC rules to bodies of water — be they storable or permanently installed. NEC definitions are always important in any electrical installation. These revised definitions will make it much easier to comply with or enforce safe and proper electrical rules for both of these different aquatic applications. EC&M

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New Demands Ramp Up Urgency for Electric Utility Distribution System Modernization

Why increasingly complex electrical needs will require better designed/managed distribution systems

By Adam Rehfeld, Burns & McDonnell

As more distributed energy resources (DER) — primarily solar — are connected to electric utility power distribution systems, the equipment that makes it all work safely and reliably is under increasing stress. Compounding this, much of this equipment — conductors, transformers, relays, breakers, etc. — is reaching or even beyond its intended end of life.

As solar generation is installed in distributed locations, traditional planning and distribution power system management assumptions are being challenged. Additionally, increased load in traditionally off-peak times from electric vehicle (EV) charging is adding complexity. Bidirectional power flows on aging infrastructure are causing thermal overload of the primary conductors farthest from the source station, limiting the hosting capabilities of the lines.

INCREASING COMPLEXITY

For many decades, electric utility distribution systems could be designed and managed with a great deal of predictability. Historically, most distribution systems have been configured in a radial pattern with circuits originating at distribution substations. Distribution planners were able to assume that power would flow predictably one way over the lines and that voltage would decrease as it moved farther away from the substation. In this model, transformers and other equipment would cool overnight as load could be expected to decrease.

Now, as new DER sources are connected to the distribution system, those assumptions are no longer as valid. Voltage will be higher near a source of solar generation, and this power is likely to fluctuate multiple times each day as cloud cover and other factors come into play. Further, EV charging shifts demand from the more traditional load curves.

As the penetration level of DER rises, it causes a couple of issues that potentially lead to grid and distribution system instability. The first is that voltage levels are increasing beyond the limits set by safety codes and standards. When power reaches the meter at homes or businesses, voltage levels must be consistent to be sure all mechanical systems, appliances, motors, and devices are not damaged. Voltage regulation is now increasingly required throughout the distribution power system.

The second issue is that sudden upsurges or losses of solar power can affect frequency of the alternating current, creating power quality issues. These sudden fluctuations can knock power out of phase.

Distribution planners increasingly must assume that power supply and load can appear anywhere, requiring protective devices and voltage settings to be adaptive to fluctuations that can sometimes move up to 100 times a day on a single circuit. Phase imbalances can appear and disappear in minutes as sources of DER come online.

SUPPLY CHAIN CHALLENGES

Of course, many electric utilities undertaking system upgrades are facing the same supply chain and labor challenges that are slowing projects in many other sectors. For example, a 10-mile distribution system upgrade now underway for one of our clients will take at least eight months to build, but the schedule is further delayed as cable material lead times have increased from eight weeks to roughly 22 weeks, with equipment and components up to six months out. With many thousands of miles of circuits needing upgrades, this pace will certainly become problematic as many distribution system sections already are facing stress.

The obvious solution will be a staged approach, with projects addressing the most urgent needs first and including upgrades that will enable system planners to anticipate and manage sectors that are likely to experience the most DER connections and load growth.

As electric utilities grapple with the surge in needed upgrades for both transmission grids and distribution systems, some adjustments in filings for regulatory approvals for large capital programs will be needed.

THINKING LONG TERM

The need for a broader, holistic planning approach is gaining momentum as more electric utilities begin to realize the full scope of today's challenges. Still, these long-term planning needs are sometimes taking a back seat to other priorities.

For one Midwest electric utility currently undergoing a large capital program to harden existing distribution assets against severe weather impacts, the budget does not allow capacity additions that could truly prepare this power distribution system for the future. Though the program will reduce duration and number of customers impacted by outages, the system will be ill-prepared for DER connections and the inevitable increase in EV charging demand. To alleviate issues like these, electric utilities will need to work closely across departments and functions, communicating clearly with their regulators about the relatedness of various in-flight programs. EC&M

Adam Rehfeld is business line manager for distribution grid modernization at Burns & McDonnell. With more than 15 years of experience, Adam specializes in leading teams to transform increasingly complex power grid challenges into safe, reliable and cost-effective solutions.

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Courtesy of Staff Electric

THE EVOLUTION OF PREFABRICATION

How this concept has gone from criticism to skepticism to industry standard in the construction market

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

Think back 10 years ago. In 2013, were you:

- Prefabricating total electrical systems?
- Prefabricating easy/repetitive items?
- Trying to get started with prefab?
- Unaware or unsure of what prefab would do for you or your business?
- Against prefab?

Over the course of a decade, the electrical construction industry has not only made prefab the norm, but also an expectation. Customers now prequalify, require, and measure/compare the amount of prefab electrical contractors (ECs) will do on their jobs. As a result, many ECs have expanded into their second or third prefabrication facility, after seeing the results of what prefab can do for them. So what is next?

In an effort to connect the dots forward, this article provides an overview of the evolution of prefab, including examples and data proving the benefits of prefabrica tion. MCA, Inc. is also pleased to announce the industry's first standard on prefabrication: NECA 5-2022, *Recommended Practice for Prefabrication of Electrical Installations for Construction*, part of the National Electrical Installation Standards (NEIS®) series published by the National Electrical Contractors Association (NECA). Just as MCA contributed to the industry's first productivity measurement standard (ASTM E2691-20: *Standard Practice for Job Productivity Measurement Annual Book of ASTM Standards Vol 4-12*, ASTM International, West Conshohocken, PA 2022), it has turned research and clinical application into an industry-wide standard practice. A key objective of NECA 5 is to assure quality in the process and products of prefabrication by ECs, bringing confidence to their customers and owners.

Independent of where you were 10 years ago, after reading this article, you should be thinking 10 years ahead about things like:

- Prefab Building™: building the project with prefabricated assemblies and sub-assemblies. In other words, rather than building the job at the site with individual components and sometimes installing prefabbed items, Prefab Building means building with prefabricated assemblies for the majority (50% plus) of the work at the job site itself. Getting to this point requires more planning for the prefabrication and its production; but more critically, it requires a plan for job-site handling and installation of mostly prefabbed elements. The key differences here include:
    - Material handling and tools to accommodate assemblies/subassemblies.
    - Field crew install instructions.
    - QA/QC at field interfaces with feedback loop to the prefab production.
    - Change management process to handle both job site and prefab shop schedule changes.
- Prefab Thinking™: planning the entire project with prefab in mind. This takes Prefab Building to the next level with the objective to avoid any manipulations at the job site with every system ready for final connections and installation. Getting to this point requires a different approach to planning and executing the work that does not rely on the time and space of the job site. For example:
    - Vendors are utilized for sub-assemblies and all on-site logistics (no trades are used to move or handle material).
    - Shift in resources, from job-site manpower doing majority of the work to off-site manpower doing majority of the work.
    - Shift in decision-making, from the job site to the project team, prefabrication, and, ultimately, standardized processes and the supply chain all informed by the trades' knowledge and experience.
- Externalizing Work®: challenge yourself/your project teams to answer what can't be done away from the job site.
- Process of Prefabrication™ that goes beyond any single project or production operation.
- Agile Intelligence™: using the data from the estimating, operations (on-site and off-site) and accounting to model prefabrication, productivity, and profitability well before the job begins and during the job for feedback.
- Increasing throughput: putting more electrical construction put in place (ECPIP) per electrician by doing more work independent of time and space of the job site.

THE EVOLUTION OF PREFAB

Photo 1 and **Photo 2** (on page 16) illustrate some classic prefab images from the early 2000s — where pioneers used prefabrication sometimes out of necessity to do large and fast-pace projects but then realized the benefits — and kept expanding. Despite these initial sparks, many ECs and electricians were opposed to prefab. In fact, while teaching a class to more than 120 electrical contracting firm owners, managers, project managers (PMs), and field leads, MCA, Inc. asked the group for their current paradigms about prefab. With more than 100 reasons for why "not to prefab" (shown in summary in **Fig. 1** on page 16), needless to

Courtesy of Staff Electric

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Courtesy of Mojave Electric

Photo 1. This photo shows the wire paralleling prefab concept in action. This early pioneering prefab concept should no longer be done in a prefab shop, as wire manufacturers and distributors provide this service at better time, cost, and quality.

Photo 2. This shot demonstrates how electrical components/equipment can be packaged in advance for job delivery, using very simple materials but ensuring the packages carry information needed to get them delivered to the right location at the right time.

say, it was a challenge to continue pushing for prefab with such a pushback from the industry. However, Dr. Perry Daneshgari (along with other pioneers such as Kevin Lytle, who is now with Allfab Group) continued the charge with simple advice:

- Ask your electricians in the field about their needs.
- Identify the types of work.
- Identify the types of prefab.
- Set up the structure to support:
    - Prefab shop
    - Processes and procedures
    - Inventory management
    - Procurement management
    - Vendor relationship management

A key challenge to overcome was (and still is) measuring the benefits of prefab, many of which are not easily quantified by most ECs. When work is done in a controlled environment, there are fewer obstacles than would be encountered on the job site. Even if the same crew mix is doing the work at the shop, they have less trade interference, less time looking for material, shorter distances to break, and a safer environment to work in.

How do you measure those? MCA, Inc. has used SIS® (read "The Secret to Short-Interval Scheduling" at

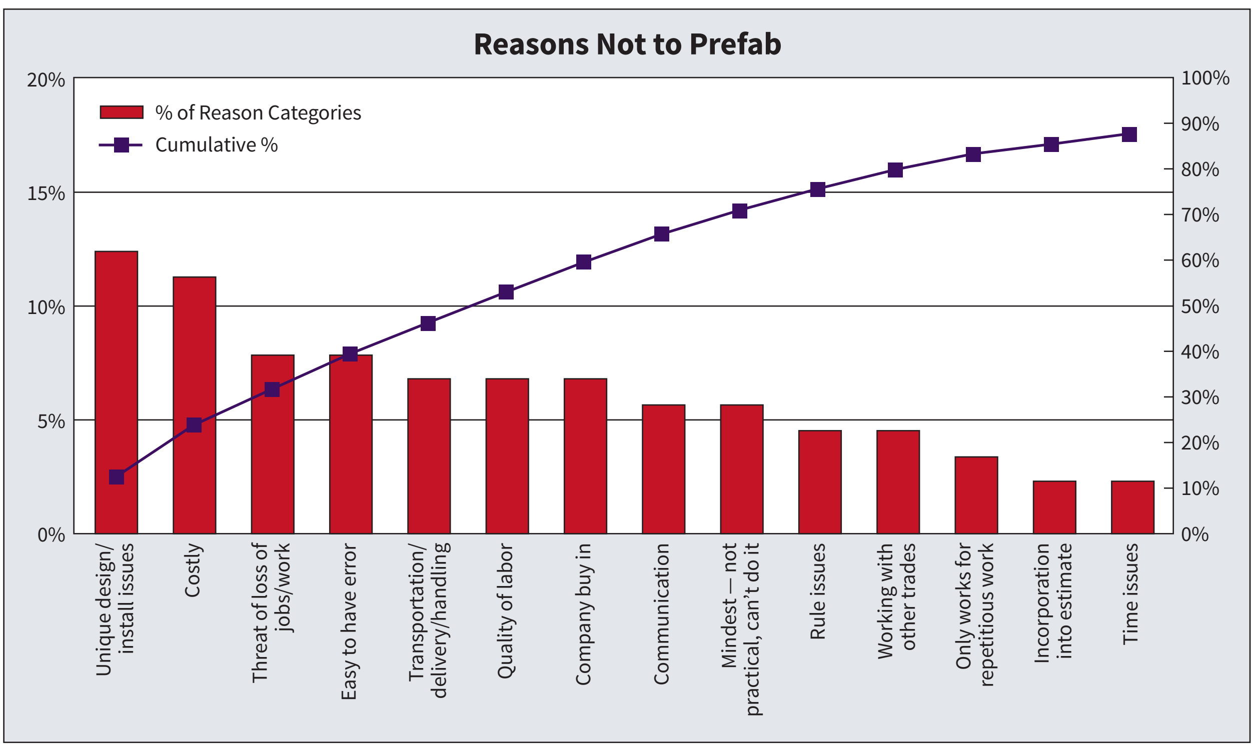

Fig. 1. The chart demonstrates the early criticisms of prefab, from 2011.


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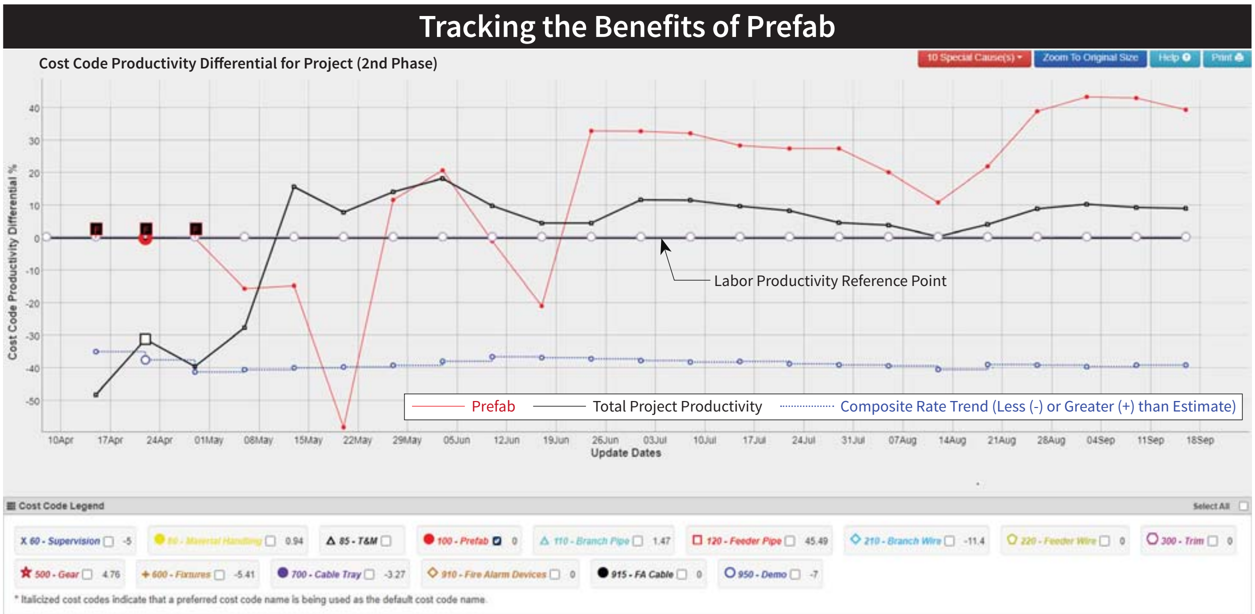


Fig. 2. This chart reflects positive job productivity (about 10% better than planned) with positive prefab productivity (about 30% to 40% better than planned), as an example of quantifying the benefits of prefab.

https://bit.ly/3H9ebO0 for more information) as one mechanism, proving that obstacles to scheduled work are less present on jobs that use more prefab. Measuring the impact of prefabrication on productivity is also challenging. Many companies attempt comparative time studies of work done in prefab versus on site. While this method provides some production data (units per time), it is not an apples-to-apples comparison of the conditions and environments. Therefore, it will not provide a full view of impact on productivity.

Figure 2 provides an example of JPAC® (based on E2691) measuring prefabrication as a separate cost code (accounting for 9.6% of the project's work, showing early productivity struggles but eventually stable and 20% to 30% better productivity than planned, with the overall project showing the same stable productivity differential and 10% better than planned.

A reliable indicator of prefab's impact on a project — and company-wide — is to measure composite rate and throughput. Both measures compare how effectively highly skilled, highly trained, and highly paid electricians are being utilized. The less they're used for installation, material movement, simple builds, and dealing with obstacles either internal to their crews or external to the job site, the more effective their training and brainpower can be used for quality outcomes. **Figure 3** (on page 20) shows a study within one company proving that more prefabrication leads to exponential reductions in composite rate.

In 2021, MCA, Inc. conducted a research focus group to see "what's next after prefab." Following is a summary of predictions Dr. Daneshgari expects to materialize as a result of Prefab Thinking and Prefab Building, which goes beyond a single order, single job, single assembly, and single shop:

1. New breed of contractors will be forming to replace traditional ones.

2. New breed of distributors will be forming.

3. Digitalization, commonization, and interconnection (DCI construction™) will connect the distributors, manufacturers, and contractors seamlessly.

4. Current distributors with very low first time pass in their warehouse, which focus on project management only with brute force, will give way to the ones that will use Toyota Production System or completely disappear.

5. A global architecture, engineering, and construction consortium will replace current segmented industry.

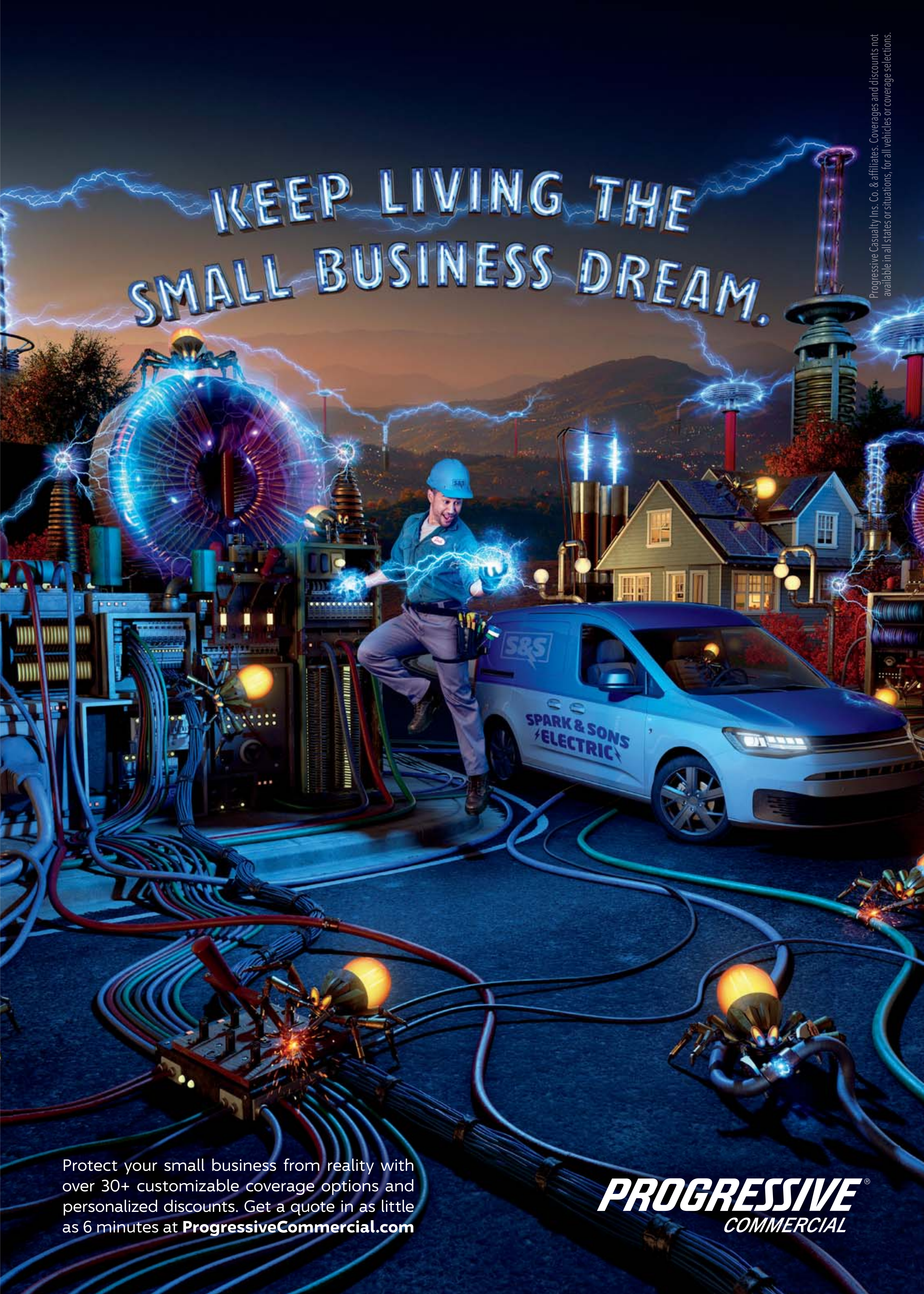
6. Cost, time, and quality of shelter, which is the main objective of construction to satisfy the basic human needs, will be reduced to affordable levels of 25% to 30% of annual income vs. 300% to 600% at the current time.

In the same research, 45% of participants in the focus group had been doing prefabrication for less than five years, and 82% of participants were prefabbing less than 10% of their work. More than half of electrical work currently done on-site can be done off-site. Once the industry gets to that level, a new ecosystem will be needed. To see where you stand, feel free to complete the Prefabrication Litmus Test by visiting this link: https://forms.gle/q5eWnJ4f12b7L1e76.

INTRODUCING THE INDUSTRY'S FIRST PREFABRICATION STANDARD FROM NEIS

When Henry Ford envisioned the assembly line, he may not have foreseen the need for gas stations. When Guttenberg envisioned the printing press, he probably did not have libraries in mind. When Eli Whitney built the first musket, he was not considering the need for bulletproof vests. Each of these pioneers that transferred tacit to explicit knowledge brought unforeseen expansion that required new regulations, infrastructure, and operating models.

As the industry moves forward with the evolution of prefab, the need for standardization increases. With this in mind, NECA's Codes & Standards Department worked with MCA, Inc. over the past two years to develop NECA 5-2022. The National Electrical Installation Standards (NEIS®) are used by construction owners, specifiers, and contractors to clearly illustrate the performance and workmanship expectations,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Progressive Casualty Ins. Co. & affiliates. Coverages and discounts not available in all states or situations, for all vehicles or coverage selections.

Prefab Impact on Composite Rate				
Percent of Job Hours in Prefab	**Field CR (Average)**	**Overall CR (Average)**	**$ Impact on CR (Weighted Average)**	**Percent Reduction from Field CR to Overall CR**
No Prefab	$81.30	$81.30	—	0.0%
0%-1%	$73.16	$73.03	$0.13	0.2%
1+%	$72.14	$71.74	$0.40	0.6%
2+%	$75.35	$74.38	$0.97	1.3%
5+%	$76.30	$73.73	$2.57	3.4%
15+%	$80.17	$71.33	$8.84	11.0%
Any Prefab*	**$74.41**	**$73.20**	**$1.21**	**1.6%**
**Weighted values*				

Fig. 3. This graphic tracks one company's success with prefabrication and how it led to exponential reductions in composite rate.

in this case of Prefabrication. In MCA, Inc.'s research on The Industrialization of Construction®: Signal or Noise? Threat or Promise?, we outlined an Advanced Model for industrialization, with a key component being new boundaries in the form of regulations, standards, and technology and innovation. NECA 5-2022 is one step in the right direction. The standard recommends practices and processes for assuring outcome of prefabrication installations, with focuses on three things:

1. Material
2. Work
3. Information

A key (and often unspoken) concern for electricians to do more prefab is loss of control or assurance in the outcome that their license must uphold. In other words, once a Model T was no longer built one at a time by one single mechanic, the assurance of quality in its outcome went out the window. Ford had to design and use a process that replicated the tacit knowledge of its mechanics, standardizing the work to the extent that every car could be produced by multiple people the same way it would have been produced by a master mechanic. We need the same thing in electrical construction, and it requires standard process and procedures for material, work, and information flow. Do any of the following sound like your current prefab operation:

1. The field calls in orders to the shop for next-day production and delivery.
2. Prefab can't move forward with production because it doesn't know where the material stands that was ordered by the PM.
3. The field receives prefab assemblies just like it receives anything from a supplier — by surprise and without look ahead.
4. You can't prefab until the BIM/VDC modeling is far enough along to produce spool drawings/cut sheets.

If you answered "yes" to any of them, you should get a copy of NECA 5-2022 and start digesting/building your processes to get past these roadblocks.

PUTTING IT INTO PRACTICE

The standard practice includes eight steps, each one with guidance on material, information, and workflow. The six key processes are listed below and highlighted in MCA, Inc.'s *Prefabrication Handbook for the Construction Industry*, which includes examples, templates, and forms for all of the following:

1. Pre-construction: Planning & Prefab Identification

Several *EC&M* articles, such as "Why Paying Attention to Branch Circuit Work on Electrical Jobs is So Important" (https://bit.ly/3XI3YPm) can provide background on why and how to do a Work Breakdown Structure™ (WBS). The standard practice includes this process as the means to manage and plan the work for Prefab Building. The outcome of a collaborative WBS should include a prefabrication plan, categorized into three types:

1. Common prefab items
2. Type-of-work-specific prefab items
3. Build-to-order prefab items

Examples of each are shown in **Figure 4** (on page 22). These types will determine how the work, material, and information flow (including BIM and material supplier interactions) will occur.

The practice does not require that prefab was identified, assumed, or incorporated during estimating. MCA, Inc.'s research on "Estimating and Pricing with Prefab" from 2020 outlines a process and calculator for estimating and pricing with prefab, but clearly states that a proven process and standardized procedures for prefabrication (such as NECA 5-2022) and measurement (such as ASTM E2691) be in place before estimating uses embedded prefab pricing or assemblies.

2. Prefab Request Processes

Prefab types 1 and 2 require a prefab order form to varying degrees of standardization. Type 1 items may come from a catalog, where Type 2 likely require more job-specific sketches and measurements. Field-to-shop validation of the request is a critical component of the Standard Practice's Quality Assurance, not only for the "what" will get built, but also for the "when" it will get built to allow for QC in the prefab production. The standard recommends lead times for prefab requests as follows:

1. Type 1 prefab: minimum of 72 hours
2. Type 2 prefab: minimum of 5 days
3. Type 3 prefab: 10 to 14 days for single-trade assemblies, but will vary widely and increase for multi-trade prefab

Naturally, the lead time requires planning and utilization of a WBS process that dedicates time for the project team (field lead, project manager, prefab manager, procurement & logistics team) to do Prefab Thinking, as opposed to just the traditional mindset after award that usually prioritizes "order material" and "get on site to start building."

Fig. 4. Examples of simple prefab practices, work-specific approaches, and build-to-order strategies.

3. Production Process

Similar to the planning and request processes, the production process, including material, work, and information flow, hinges on the type of prefab requested. According to MCA, Inc.'s research, 83% of ECs have a prefab shop, but many of these were set up as "extensions of the job site" — both in terms of their physical layout and work planning/supervision. NECA 5-2022 lays out processes and procedures for the shop to function independently and effectively to ensure safety and strict QA/QC processes.

4. Logistics & Transportation Process

As discussed previously, Dr. Daneshgari laid out "what's next after prefab" with foresight into transformation required in the distribution industry to support expansion of prefabrication. The processes between post-production in the fab shop and installation at the job site are likely the biggest current gap to Prefab Building and improved quality in outcome. Labeling, as one example of what seems to be a "simple" activity, is a key part of NECA 5-2022.

If an individual component of a stick build shows up from a material supplier, such as a bundle of pipe or a box of couplings, they will often get moved to a common laydown area or hopefully a VMI crib. When prefab shows up to the job site, it is built to be installed in a specific area and in a specific way. To ensure that this "assembly" makes it to that destination, some information needs to be added to the "shipping label" either coming from the prefab shop or from a supply house such as:

1. Job-site install location
2. Assembly components/bill of materials
3. Install instructions (for more complicated assemblies)

5. On-Site Installation Process

The final quality assurance of Prefab Building is in the installation of prefabricated assemblies and sub-assemblies. Prefab should be delivered at a justified time and location at the job site with minimal buffers. This requires significant increases in information management across job site, prefab shop, and distributor partners to know what material (including prefab) is where as well as where it is going next.

OVERVIEW

Prefab in the electrical construction industry has evolved — from initial criticism ("it's going to replace us") to skepticism ("I'll try a few things, but it's typically just easier to build it in the field") to where we are today ("prefab has reduced my liability, improved my safety, quality, and on-time delivery through externalizing work").

This is the same path many other industries have taken — sometimes out of innovation; other times out of necessity. The irreversible workforce shortage is providing necessity to do more work with fewer electricians, and prefab is one solution to externalizing work, where the question goes from "what can we prefab?" to "what cannot be done off site?" The ultimate outcome is improved productivity, which will drive a better outcome for construction consumers and more work for electrical contractors. Hopefully, this article can help you see the past, present, and future for not only the electrical industry but also your company. **EC&M**

Dr. Perry Daneshgari is president and CEO of MCA, Inc., Grand Blanc, Mich. He can be reached at perry@mca.net. Dr. Heather Moore is vice president of operations. She can be reached at hmoore@mca.net.


18:35
CHECKLIGHT
options
TIME FRAME
LAST 30 DAYS
kWh
16
14
12
10
8
6
4
2
0

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10 Big-Money CONSTRUCTION PROJECTS *for* 2023

Even in what could be a down year for the construction market, there's still a **surprising number of billion-dollar projects** underway or on the drawing boards.

By Jim Lucy, Editor-in-Chief, *Electrical Wholesaling*

While 2023 may turn out to be a slower year for the construction market, there's still plenty of action with some types of projects in certain fast-growing local markets. Some of this construction activity will be fueled by federal economic stimulus like the Creating Helpful Incentives to Produce Semiconductors (CHIPS) Act to incentivize onshoring of semiconductor manufacturing and the IRA legislation that provides financial incentives/tax breaks for a broad swath of construction activity, including (but not limited to) the revitalization of the United States electrical grid, mass transit, ports, electric vehicle charging stations, and renewables.

Considering the fact that electrical construction accounts for no less than 10% of a typical construction project, when a billion-dollar trophy job breaks ground, it can provide engineering firms doing the design, electrical contractors working on the job, and distributors, reps, and manufacturers providing supply and support services with a nice chunk of change.

Following are 10 billion-dollar projects that highlight the construction niches we believe may offer the most promise in 2023.

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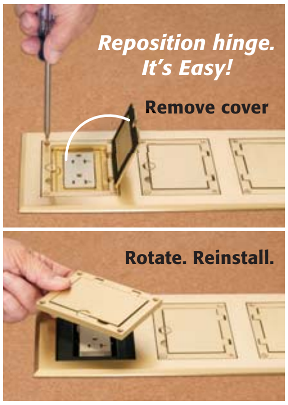

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FLBC8510CA Caramel
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FLBC8520BL Black
FLBC8520GY Gray
FLBC8520CA Caramel
FLBC8520LA Lt Almond

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

TM

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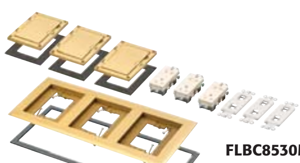
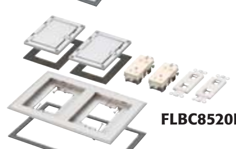
Three-gang **FLBC8530MB**

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





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

SEMICONDUCTOR PLANTS

Skywater-Purdue University Private/Public Partnership
West Lafayette, Ind.

While there's been all sorts of plans announced for multi-billion-dollar semiconductor plants, the public-private partnership engineered by Skywater Technology, the state of Indiana, and Purdue University to jointly develop a $1.8-billion semiconductor factory in Purdue's Discovery Park District is unique. One of the big draws to building a new chip factory adjacent the Purdue campus was the pipeline of engineering talent in the university's technical programs.

Announced in July 2022, the project will be funded in part by CHIPS for America Act financial incentives. "Federal investment will enable SkyWater to more quickly expand our efforts to address the need for strategic reshoring of semiconductor manufacturing," said Thomas Sonderman, SkyWater president and CEO, in a recent press release. "Through our alliance with the Indiana Economic Development Corporation and Purdue Research Foundation, we have a unique opportunity to increase domestic production, shore up our supply chains, and lay the groundwork for manufacturing technologies that will support growing demand for microelectronics."

Discovery Park District

Orsted

OFFSHORE WIND

South Fork Wind & South Wind Offshore Wind Farms
Off the coast of Long Island, N.Y.

The first of several wind farms that will be built off the New York coast has started construction. The South Fork Wind project being built by Orsted and Eversource will have 12 Siemens-Gamesa 11MW turbines that will generate approximately 130MW of power — enough to power more than 70,000 homes. It's expected to begin producing power for Long Island by the end of 2023.

In addition to construction jobs for the offshore wind farm, New York state is building a new operations and maintenance hub in Port Jefferson, N.Y., which will create up to 100 new and permanent full-time jobs, and the $10-million National Workforce Training Center on Long Island. This facility will offer training programs that will create job opportunities in offshore wind industry. A larger wind offshore wind farm, Sunrise Wind, will generate 924MW and have the potential capacity to power nearly 600,000 homes. It's expected to begin power production in 2025.

Offshore wind farms like South Fork Wind and Sunrise Wind offer the electrical industry a variety of new revenue opportunities. Wire and cable manufacturers compete for contracts to supply the massive undersea cables, and the onshore substations and staging areas at ports will offer the electrical construction industry some solid bidding opportunities in the years to come.

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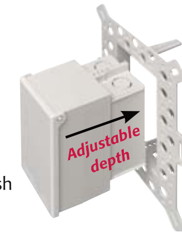

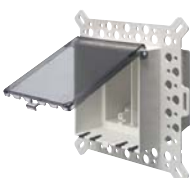

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Greater Atlantic City Chamber of Commerce

MICROGRIDS

Renaissance at Bader Field

Atlantic City, N.J.

Microgrids may evolve into a major new decentralized power source — and a new market opportunity for electrical contractors, distributors, reps, manufacturers, design firms, and other electrical professionals.

A microgrid produces local power outside of the conventional electrical grid from solar panels, wind turbines, natural-gas powered turbines, and other power sources. Microgrids often mix and match these power sources to provide power for municipalities and cities, schools or college campuses, military bases, airports, and off-the-grid applications. They can provide primary power or emergency/backup power and are often connected to the grid to provide excess power to a local utility.

The proposed Renaissance at Bader Field development on brownfield site at a former airport in Atlantic City, N.J., is a $2.7-billion project powered in part by a microgrid that would include LEED-certified luxury and affordable multi-family housing, offices, stores, and a 2.44-mile Formula One racetrack and hotel. Deem Enterprises (the developer) and ProtoGen (the contractor) say the microgrid would be powered by natural gas turbines but would eventually be transitioned to clean hydrogen. Solar panels on the roofs of the buildings in the development would provide additional power.

Ken Wright, co-founder and president of ProtoGen, said in a presentation on microgrid opportunities at the 2021 NECA conference that two of the biggest challenges currently restricting the growth of microgrids are a regulatory thicket at the local level that often sparks debates about how to bring the power generated by microgrids to end-users and the perception by some utilities that microgrids installed by commercial customers or third-party power providers are a threat to their primary role of being a provider of electrical power.

MASS TRANSIT

New York's Metro-North Penn Station Access Project

Bronx, N.Y.

Light-rail, and passenger service expansion projects typically require millions of dollars in medium- and high-voltage electrical equipment and draw other businesses to new or renovated stations. The $3.2-billion expansion of New York's subway service in Bronx, N.Y., which broke ground recently, is the Metropolitan Transit Authority's (MTA) largest expansion since 1983 and will add four new stations to an area of the city that historically had poor direct access to Manhattan' Penn Station and the rest of the city's subway system as well as Amtrak.

Metropolitan Transit Authority

The new stations, which will be in Hunts Point, Parkchester/Van Nest, Morris Park, and Co-Op City, are expected to drastically reduce commute times for hundreds of thousands of residents who live near these subway stations.

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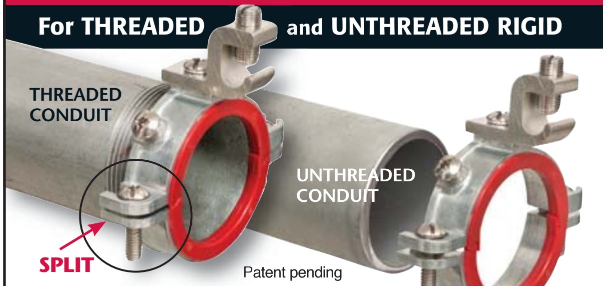

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1. Loosen side screws. Allow bushing to pivot around installed cables
2. Tighten set screw to seat bushing on conduit

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- Ships Assembled – *Multiple sizes*
- Compatible with EMT, 2-1/2" to 4" trade sizes, and EMT threaded fittings

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ONE fitting FITS MULTIPLE cable sizes!

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

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

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URBAN MIXED-USE PROJECTS

Nashville Yards
Nashville, Tenn.


Southwest Value Partners

Although the nonresidential construction segment as a whole may be down in 2023, we still see plenty of activity in downtown revitalization projects. One of the larger urban mixed-use projects now underway is the $1-billion, 18-acre Nashville Yards being developed by Anschutz Entertainment Group (AEG) and Southwest Value Partners. This mixed-used entertainment district will be anchored by a 4,000-capacity, state-of-the-art country music venue; an upscale eight-screen cinema; more than 1,000 hotel rooms, restaurants, and stores; 275,000 square feet of Class A office space; and three residential towers.

Other cities with mixed-use projects underway or planned (and valued at $1 billion or more in total construction value) include Google's plans for the $19-billion Downtown West development in San Jose, Calif.; the $3.5-billion Seaport San Diego project proposal; the $2-billion GreenCity in Richmond, Va.; and Washington, D.C.'s $2-billion Poplar Place waterfront redevelopment. While all of these projects will have a big impact on their cities, none is quite as large as the $25-billion, multi-year Hudson Yards development in the Big Apple nearing completion.

Howard Hughes Corp.

HOMEBUILDING IN FAST-GROWING AREAS

Teravalis Mega-Development
Phoenix

Sure, residential development has hit the skids in many local metropolitan areas. Over the past few years, however, homebuilders in Phoenix have pulled building permits at rates that would amaze folks in most other markets. In 2022, builders pulled 25,831 single-family permits through November — a number that only the Houston and Dallas metros topped. Since 2019, U.S. Bureau of Census data shows that Phoenix builders pulled more than 91,000 building permits.

The truly massive Teravalis development that broke ground near the western edge of Phoenix's Valley of the Sun will make those numbers look like chump change. Over the next few years, the developer intends to build 100,000 homes on 37,000 acres, as well as 55 million square feet of commercial space.

"Since 2015, Arizona has welcomed over 584,000 new residents, and we don't expect that momentum to stop anytime soon," said Arizona Gov. Doug Ducey in a press release. "This increases the demand for housing opportunities, and Howard Hughes is providing quality housing options for current and future Arizonans."

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There's no need to run cable from a panel box *or to cut into the framing members.* Just cut two openings in the wall to access power from an existing, nearby source.

- Fast, easy, convenient; saves time and money!
- **Cables stay hidden behind the wall – no wires running down the wall from TV to components.**
- Plugs stay inside electrical box without protruding past the wall
- Mounting wing screws pull boxes snug against wall
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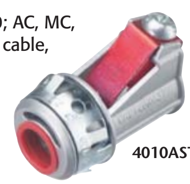
- **Widest variety of cables** AC90 and ACG90; AC, MC, HCF, MC continuous corrugated aluminum cable, MCI-A cables (steel/aluminum)
- **Easiest cable installation**
- **Fast, secure installation** No pullout
- **Removable, reusable** from cable or box



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3838AST	DUPLEX Snap in, 1/2" KO	.405 to .605, 3/8" Flex*
40AST	RED TINT Snap in, 1/2" KO	.485 to .610
4040AST	RED TINT, DUPLEX Snap in, 1/2" KO	.485 to .610, 3/8" Flex*
4010AST	ANGLED CLIP Snap in, 1/2" KO	.405 to .610

* Flex CSA Listed with anti-short bushing

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JFK International Airport

AIRPORTS

JFK Terminal One

New York

While airport renovation projects have been quite common in recent years, the $9.5-billion price tag for JFK International Airport's new Terminal One caught our eye. The project, which broke ground in September, is part of a $18-billion revitalization of JFK that included several other completed terminal renovations.

Airport construction in the New York metropolitan area has been going gangbusters in recent years. The work at JFK follows the $8-billion renovation of nearby LaGuardia Airport as well as Newark's $3-billion Terminal A project, which was completed in late 2022.

According to a press release from the State of New York, when complete, the new JFK terminal will be the largest at JFK Airport and require 6,000 construction workers on-site (and an estimated 780 electrical contractor employees). The release also indicated JFK's New Terminal One will have 23 gates and cover 2.4 million square feet. It's massive — as a point of comparison, it will be nearly the same size as the new LaGuardia Airport's two new terminals combined. Construction of the new terminal will take place in phases. The first phase is expected to open in 2026, and all three phases are anticipated to finish up in 2030.

Georgia Port Authority

PORT INVESTMENT

Port of Savannah

Savannah, Ga.

There's a surprising amount of electrical construction work at ports, including not only lighting, wire, and cable for warehouses and docks, but also plenty of control equipment and cabling for the cranes that handle the shipping containers. This construction segment got a ton of financial stimulus from the federal government's Infrastructure Investment and Jobs Act, which allocated $17 billion in funding for port and waterway renovation.

One of the larger port projects now underway is the Georgia Ports Authority Board's renovations of the Port of Savannah's Ocean Terminal and docks to better accommodate its expanding container operation. According to a press release, construction has started on 360,000 square feet of dockside warehousing that will serve auto processing, three additional buildings, 85 acres of auto storage space, and new cranes.

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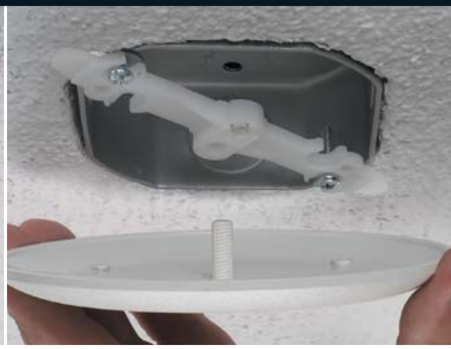


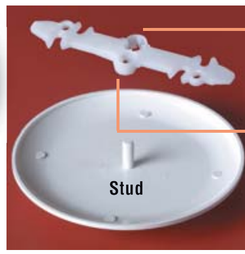

Our non-metallic, paintable **CP3540** Box Cover is the neatest way to cover unused fan/fixture boxes, pan boxes or poorly cut drywall.

- No visible screws on ceiling plate
- Fits 3.5", 4" round or octagonal boxes

Versatile bracket design with 'A' and 'B' openings for use on flat or uneven ceilings.

Versatile Bracket Design

Easy installation. Attach the bracket to the box with #8 or #10 screws. Back the screws out 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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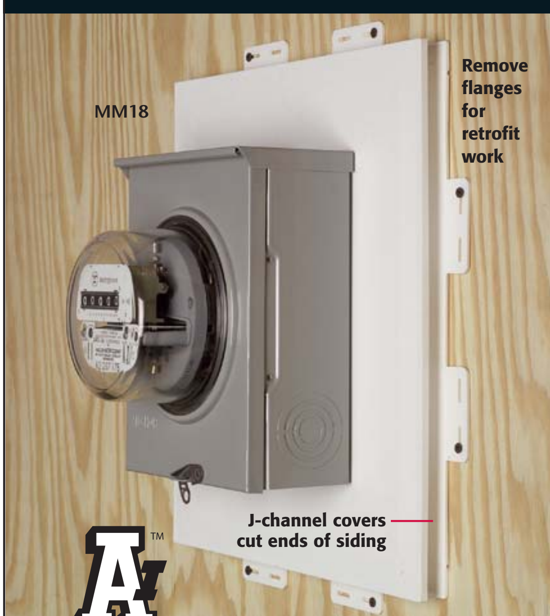

Arlington's one-piece, non-metallic Mounting Bases provide a smooth, flat mounting surface for most electric meters, *including the largest sizes* – as well as a variety of other products such as timers, disconnects, inlet boxes and more.

UV rated, paintable plastic for long outdoor life.

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NEW

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MM10 7" X 10"	MM23 17-5/8" X 23"

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MM7 info aifittings.com/landing/mm7
Other aifittings.com/landing/meter-mounting-bases

ELECTRIC GRID EXPANSION & REVITALIZATION

610-Mile Power Pathway Project

Eastern Colorado

Quanta Services, the Houston-based electrical contractor with a specialty in electric transmission and utility-scale renewable projects, recently won a big bid in Colorado that will help the state get more electrical power from new solar and wind farms. According to a Quanta press release, Xcel Energy selected the company as the prime contractor for the massive Power Pathway project, which will include the construction of approximately 610 miles of 345kV transmission infrastructure, primarily in eastern Colorado.

The project includes the installation of four new substations and the expansion of four existing substations. It's designed to increase the reliability of Colorado's power grid and enable future renewable energy development in the state, including approximately 5,500MW of new wind, solar, and other resources Xcel Energy plans to add through 2030.

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According to the press release, certain segments of the project are expected to be completed in 2025 with others in 2026 and 2027. Preconstruction activities have already begun, and construction on the first segment is scheduled to begin in mid-2023.

BMW Group

ELECTRIC VEHICLE BATTERY PLANTS

Envision AESC Factory to Build EV Batteries for BMW

Florence, S.C.

Over the past two years, EV battery manufacturers have announced plans for tens of billions in combined investment for EV battery factories in the United States. The December 2022 announcement that Envision AESC would invest $810 million in a new EV factory in South Carolina to supply BMW with EV batteries was the latest news about a trend that's juicing up industrial construction nationwide. A press release from South Carolina's Office of the Governor said the new factory would create 1,170 new jobs.

BMW is also investing in its United States EV operations in a big way, recently announcing it will spend $1 billion to add EV manufacturing capacity to its Spartanburg, S.C.-based plant and will invest $700 million in Woodruff, S.C. to build a 1-million-square-foot high-voltage battery assembly facility in nearby Woodruff, S.C. By 2030, the company says it will build at least six fully electric models in the United States.

ADJUSTABLE NON-METALLIC BOX **WITH MULTIPLE COVER OPTIONS** Made in USA

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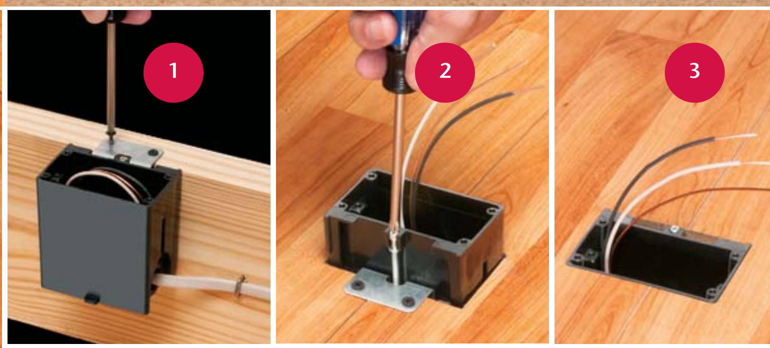

Designed for New or Retrofit work,* Arlington's UL LISTED *ADJUSTABLE FLOOR BOXES fit varying floor heights up to 2".

They're the low cost, *easy way* to install a duplex receptacle flush with the floor.

- **Gasketed covers with ONE or TWO FLIP LIDS** prevent water intrusion and protect the box when not in use
- **Non-Metallic Covers** Black, brown, light almond and **Metal Covers** in brass and nickel-plated brass.

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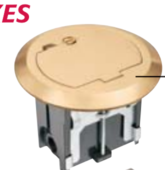

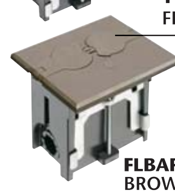

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LOSS CAUSE

Supply chain shortages, project creep, inadequate planning, and finger pointing are among the reasons why a full-time employee often has the productivity of a part-timer. Here's how electrical contractors are tackling the problem of lost labor hours.

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According to industry experts, sometimes more than half of an electrician's day can be chalked up to lost labor hours.

By Tim Kridel, Freelance Writer

More than 711,000 people currently work in the electrical industry, according to the U.S. Department of Labor — or they should be working. Instead, they often spend a lot of time standing around waiting for materials, equipment, colleagues, and even customers to show up so they can do their jobs. Exactly how much time? Sometimes more than half of an electrician's workday is unproductive, according to contractors and consultants who have analyzed the problem of lost labor hours.

"They probably only spend 40% to 45% of their time installing, so there's 60% to 55% waste," says Jamie Sullivan, president of Milwaukee-based Staff Electric.

The reasons vary widely — from longstanding problems like project creep to post-pandemic productivity busters including supply chain shortages.

"We used to get 95% of our material from one supply house," says Rich Shumway, field supervisor at Hyattsville, Md.-based Wilcox Electric. "Now we probably get 75% from that supply house and the other 25% comes from three other supply houses, Amazon, Lowe's, Home Depot, or websites. When our supply houses don't have material we need, we often find the material in stock at home improvement stores. We have to take more time now to search for material or alternative solutions for material that was readily available before the pandemic."

Some electrical contractors are mitigating that problem by using prefab, which does more than just ensure that the right materials are in the right place at the right time.

"It also requires pre-planning," says Neil Davidson, executive vice president at Lincoln, Neb.-based Commonwealth Electric Company of the Midwest. "So, it forces

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MC/HCF/AC Steel & Aluminum	.380 to .600	14/2, and 12/2 with & w/o ground. 14/3, 14/4 12/3, 12/4 10/2	.490 to .600	14/3, 12/2, and 12/3 with & w/o ground. 14/4 12/4 10/2
MCI-A Steel & Aluminum	.440 to .550		.480 to .550	
AC90, ACG90			.480 to .550	
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2. **INSERT CABLE INTO FITTING**
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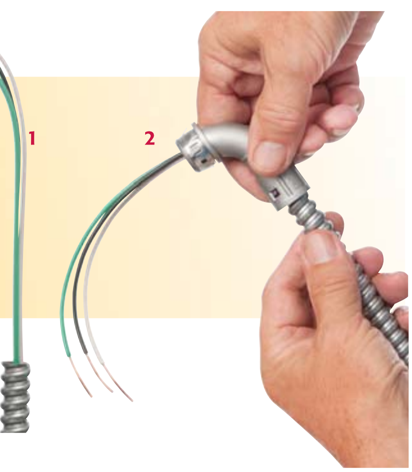

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us to plan ahead and look at things instead of being reactive on the job site. We're looking way ahead ordering material, putting the parts and pieces together, and getting them out there at the right time. It does a lot of things to increase production on a job site."

FAIL TO PLAN? PLAN TO FAIL

A detailed, organized estimate can go a long way toward minimizing lost labor hours.

"One purpose of an estimate is to provide a detailed, organized plan to execute the project profitably," says Don Kiper, an independent electrical estimating trainer and consultant based in Niagara Falls, N.Y. "Most contractors fail right there."

The more thorough the plan, the more likely electricians are to have everything they need — not only materials, but also tools, forklifts, dumpsters, and even a crew to stage materials and collect trash.

"I feel that the biggest factor is not having a plan and working to that plan," Sullivan says. "In a truly utopian world, if an electrician is working on the 18th floor and gets here at 7 a.m., he would have his drawings in front of him. He would have all his material. All he would have to do is install it."

To get as close to that utopia as possible, Staff scrutinizes each project using processes designed to ferret out waste and inefficiency.

"As an example, we've been doing JPAC™ (job productivity assurance and control), SIS™ (short-interval scheduling), and WBS™ (work breakdown structure) for six years," Sullivan says. "You can actually see how our productivity has increased per electrician. If the average is $270,000 or $250,000 per electrician, our average is now $350,000 to $370,000. I believe they're not working harder. They're just working smarter.

"An electrician wants to build. How do we get the material to his point of install? How do we get it so that he doesn't have to worry about the garbage or unboxing light fixtures?"

Some productivity busters are due to traditional ways of assessing progress.

"The risk is passed on to the field versus managed by the company," says Dr. Perry Daneshgari, president and CEO of MCA, Inc., a Grand Blanc, Mich.-based consultancy whose clients include Staff Electric. "Companies measure the progress of the jobs financially only, not by the way the job is being done. So the work and labor are not being managed, and that ends up in labor overrun."

Daneshgari maintains labor overrun has historically been a disease in the construction industry. "Since it's not measured, it's not managed," he says.

Another factor that can squelch productivity is busy work that doesn't move the progress needle much. The reason is ironic, considering the electrical industry has a chronic shortage of people.

"The priority of the people in the job site is to make sure people are busy — in other words, so they don't get laid off," Daneshgari says. "The labor get paid as long as they show up, but the company doesn't get paid as long as they show up. The company gets paid when they perform."

Daneshgari likens project management in the construction industry to horse trading. "They take the money that they may have in their slush funds or unused money in their fixtures-and-gear budget and let the labor use it."

FIXING THE PROBLEM WITHOUT FIXING THE BLAME

Finger pointing between project managers and estimators is common when a project winds up taking longer than it was supposed to.

"There's a famine in the land for quality skilled estimators because the company culture at most places is that as soon as the job starts going south and losing money, everybody immediately wants to pounce on the estimator," says Kiper, who explored this problem in an October 2019 *EC&M* column, "The Estimator vs. the Project Manager."

Finger pointing can lead to even bigger problems down the road if it creates a culture where project managers, estimators, and others instinctively limit their feedback simply to avoid conflict. The result is fewer opportunities to learn from mistakes — theirs and their colleagues'.

Some industry veterans estimate that electrical contractors/electricians spend about 40% of their day doing installation work, which leaves the other 60% as wasted time.

"We're trying to drive a different culture," says Nicholas Hlavinka, Staff Electric executive vice president. "We don't want blame. We want feedback. Everyone knows that our estimating department is not afraid of feedback as long as they come with a positive attitude. We also have a lot of project managers who used to estimate, so they understand that sheet notes can be missed, and details and specs are overlooked."

WHO'S ON THE JOB SITE?

Electrical isn't the only trade struggling with a shortage of skills and supplies these days. That situation only exacerbates the longstanding challenge of trade stacking, where electricians are tripping over or waiting on the plumbers, carpenters, and HVAC techs who were supposed to have cleared out days or weeks before.

"There's always somebody that doesn't have something that they need, so you're working around that issue," says Commonwealth's Davidson. "They either don't have enough people to get their material installed, or they can't get XYZ part that needs to go into the puzzle. So, you have to work around and then come back."

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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**.

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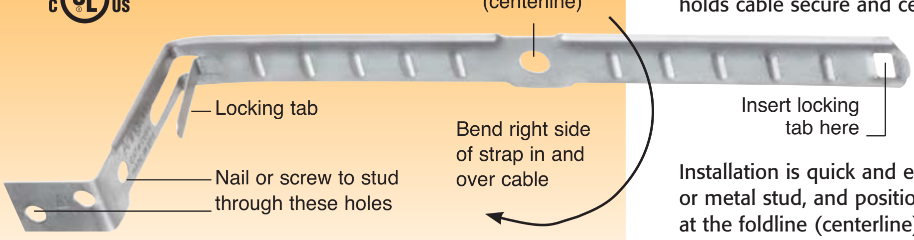
ECONOMICAL...HOLDS UP TO FOUR MC CABLES • EASY TO INSTALL

Nail or screw on **CUS6**



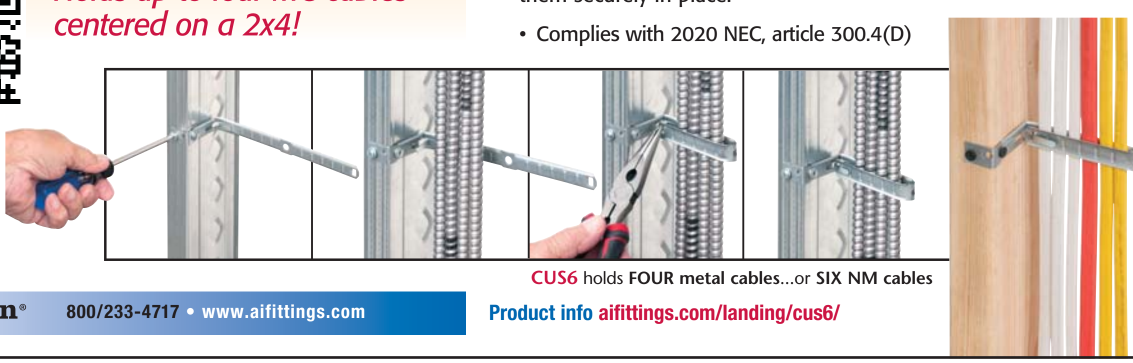
Holds up to four MC cables centered on a 2x4!

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

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

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

- Complies with 2020 NEC, article 300.4(D)



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

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Two other factors are the number of apprentices on a job and their relationships with the electricians, journeymen, and foremen on a particular project.

"Maximizing the apprentices on the job site is key to help combat the shortage of skilled labor," Davidson says. "The electricians and foreman need to know the apprentices' skills to get the most out of them. Preplanning and proper management of apprentices is the key to success when using a higher ratio of apprentices to skilled electricians."

Shumway agrees: "We have nine electricians and six apprentices right now, and the apprentices work with all the electricians. The electricians need to know the apprentices' skills and get the most out of them."

NAVIGATING THE RESIDENTIAL MARKET

Scheduling is key for maximizing productivity, but it's particularly tricky in the residential arena.

"Our guys often do multiple service calls or estimates in a day," Shumway says. "That can be a lot of drive time in D.C. traffic. Traffic decreased a lot during the pandemic but has picked back up. We try to schedule our electricians' days to minimize drive time, but sometimes it is unavoidable. There are some route optimization software [applications] out there, but we do not use one."

Cancellations and postponements are longstanding challenges in the residential market as well.

"We are having cancellations or postponements on a daily basis, so we're scrambling to find jobs to move up on a daily basis," Shumway says. "We [recently] had eight same-day cancellations. That's out of probably 40 jobs. That's crazy."

COVID exacerbated this problem, such as customers calling at the last minute to cancel because they tested positive. But so far, this problem isn't waning along with the pandemic.

"We're still seeing a lot of it," Shumway says.

Vehicle maintenance also directly affects productivity and profitability.

"If we need to get an electrician's vehicle worked on, we have to pay them to transfer his tools/some material to a spare van, pay two men to drop it off, pay two men to pick it up, and pay the electrician to transfer it back into their van," Shumway says. "On top of that, we lost the revenue the electrician would have made had he been doing electrical work. We've found keeping a new fleet cuts down on this time and keeps maintenance bills down."

But supply chain shortages are a problem there, too.

"The pandemic created a vehicle shortage, and replacing our vehicles became much more expensive," Shumway says. "Also, most of our guys prefer the smaller vans due to D.C. parking. But as of right now, after 2023, no manufacturers are planning to sell a small work van in the U.S. market."

LEVERAGING TECHNOLOGY TO MINIMIZE DOWNTIME

Some contractors, large and small, use cellular telematics services to track each vehicle's location and health. For example, the onboard module can send alerts when oil pressure, temperature, and other metrics go beyond recommended parameters.

One way that telematics services can help minimize lost labor hours is by identifying emerging problems so that vehicle can go into the shop the next day. That heads off a breakdown that would leave the electrician on the side of the road for a few hours.

Cancellations and postponements seem to be especially problematic in the residential construction market.

Some contractors use telematics services not only for vehicles, but also for other high-value mobile assets such as equipment trailers, skid steers, and forklifts. One main reason is theft: They can get alerts when an asset moves outside a geofenced area and then tell law enforcement where it is to enable recovery. Another reason is identifying and retasking equipment that's sitting idle because a particular project no longer needs it.

Those location-based capabilities also can be used to ensure that all of the right equipment will be on site when electricians arrive. And if some of it isn't, supervisors and foreman can quickly check to see if there are any nearby jobs that aren't using that equipment.

In fact, some contractors see the most business value in using telematics to maximize productivity rather than thwarting theft. For example, one of MCA's clients has tools ranging from $250,000 to $750,000 apiece.

"If they can save one hour of the labor not moving material, that's $1.2 million," Daneshgari says. "When the owner looks at it, he says: 'I don't care about the tools. I do care about the labor losses.'"

On large, complex projects, another helpful technology is robotic total stations.

"Our engineers lay out points, whether it be hangers for conduit, floor boxes, or core drills," says Commonwealth's Davidson. "Those will be loaded into the computer and then transposed into the robotic unit. Then we go out in the field, set that up, and mark those points out on the floor or the ceiling. In the old days, you'd be out there with the tape measure and some strings. Now you can shoot hundreds of points in an hour. That's really helped our efficiency in the field." **EC&M**

Tim Kridel is an independent analyst and freelance writer. He can be reached at tim@timkridel.com.

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Designed for new work, **easy to install** VB1 and VBR1 fit most **plastic or steel boxes.**

During installation of 1/2" or 5/8" drywall, use the supplied #6-32 screws to hold the **VB1** cover *temporarily* on the box. Or fasten it to the framing member using the holes in the flange.

ECONOMICAL
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REQUIRED

Attach **VBR1** to octagonal plastic or steel ceiling box through the device or flashed-over holes to hold it in place during drywall installation.

Then install fan or fixture.

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Loss and Profit from Today's Lighting Controls

How electrical contractors/designers who truly understand and embrace advanced lighting control solutions can rise above the competition

© Dmytro Varavin | Dreamstime.com

By Ruth Taylor, Pacific Northwest National Laboratory

More than other aspects of commercial lighting, the changing and complex technology of controls can result in lost time and money. When dealing with lighting controls, whether in new construction or a renovation, contracting firms face three characteristic (and potentially expensive) problems:

- Incomplete or ambiguous information about the control system leads to mistakes, time-consuming corrections, and a slow pace of work.
- Uncertainties about the scope and capabilities of the project team (architect, lighting designer, engineer, construction manager) can result in confusion that takes time to

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

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

  Covers also sold separately.

for NEW or existing floors

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

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

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

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Photo courtesy of NGLS

Contractors install a connected lighting system in an NGLS Living Lab.

sort out and may leave gaps in responsibility, contributing to more time lost.

- Mixed or limited experience with connected lighting systems within your installation team slows the workflow and reduces efficiency compared to more familiar areas of expertise.

Issues with lighting controls play out across the various stages of the project whether you are preparing a bid, negotiating the purchase, planning the installation, or configuring the control settings.

For the last five years, the U.S. Department of Energy's Next Generation Lighting Systems (NGLS) program has been researching issues dogging various types of lighting controls. In a 2019 *EC&M* article, I described the "living lab" environment where we work with project managers, installers, and other experts in the lighting world, looking at problems and considering solutions. In this piece, we'll discuss the cost impact of issues from documentation to specialization and share some thoughts on better practices.

DOCUMENTATION

Installers for today's lighting controls typically face a significant problem: Information is inadequate about the system and how it is to be installed, configured, and used.

A document package for lighting controls can include familiar items, such as an electrical plan, single-line diagrams, a controls schedule, and specification language. But complete documentation should also include a written Controls Intent Narrative (CIN) and a Sequence of Operation (SoO).

Photo courtesy of NGLS

An installer studies connected lighting system instructions on the fly in the Living Lab.

The CIN explains the thinking behind the design, detailing the types of controls in each space (e.g., luminaire-integrated sensors), how the controls function (e.g., dimming in response to daylight), where the controls are located (e.g., keypad at the entry point and front of the room), how users operate them (e.g., multi-button keypad with labels for each scene), and what settings are needed (e.g., light output at 80% of maximum for task tuning).

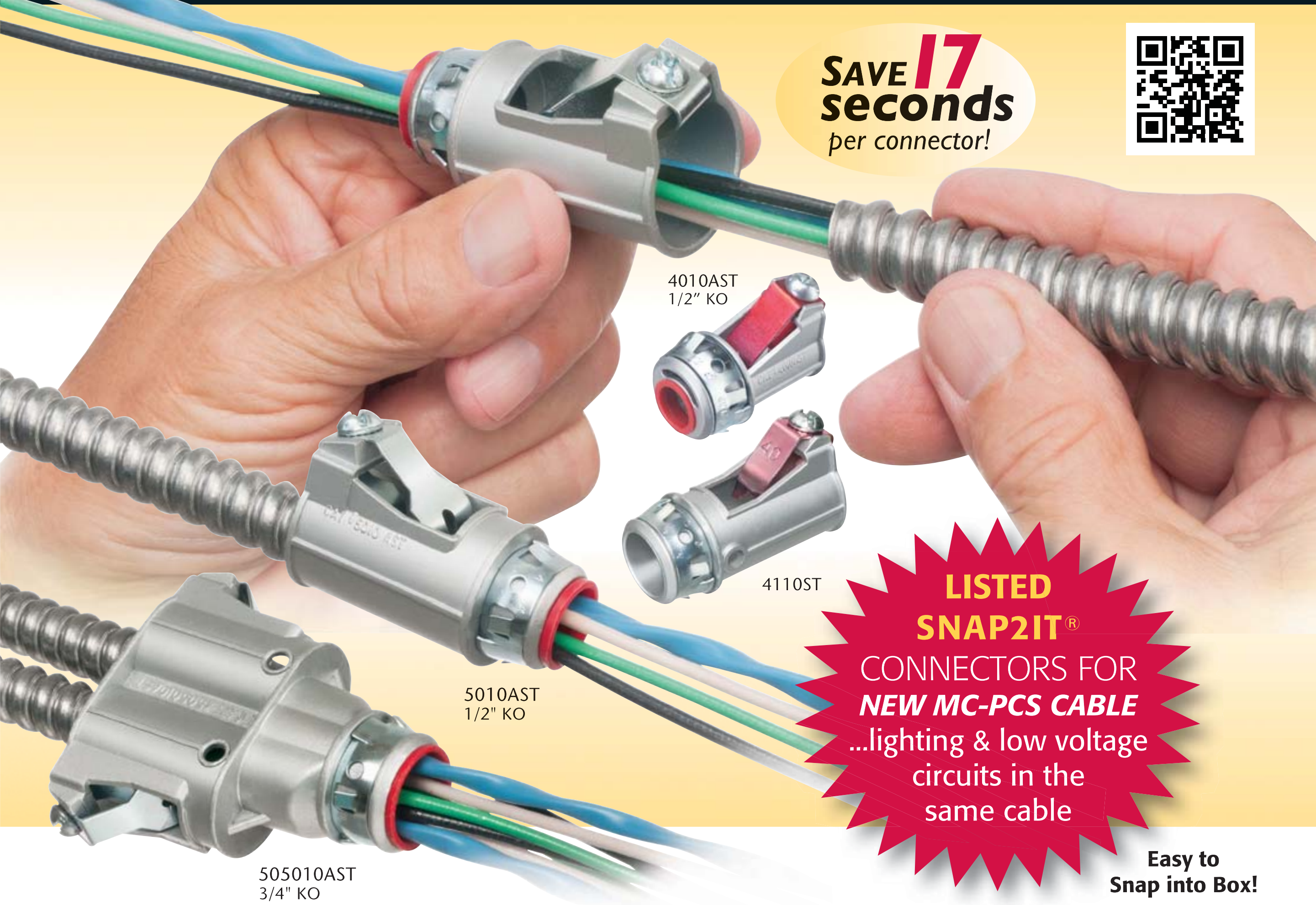
The SoO provides specific settings for each component of the control system. These include, for example, time-out settings on occupancy sensors, specific levels for presets, a minimum dim level for daylight response, and so on. Installers find the SoO to be helpful at initial set-up and critical when configuring the system. Without this information, the configuration will likely need to be redone, or it won't meet customer expectations.

An incomplete CIN often forces installers on a tight schedule to move forward and then backtrack to correct and repeat work. Without the CIN and SoO, your team may be flying blind at critical points in the installation and configuration process.

We often hear that critical information, such as the SoO or wiring diagrams, arrives on the job after

SNAP²IT® CONNECTORS

EASIEST CABLE INSERTION • NO TOOLS • SECURE HOLD



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

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

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

  ANY Snap2It Connectors LISTED for MC cable are also LISTED for MC-PCS cable! *These products offer the greatest time-savings.*
- **Fast, secure snap-on installation**
- **Easy to remove, reusable connector**
  From cable Loosen screw on top. Remove connector from cable.
  From box Slip screwdriver under notch in Snap-Tite® ring. Twist. Remove connector.

Easy to Snap into Box!

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

NEW!
4141107ST

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Patented. Other patents pending.

www.aifittings.com • Scranton, PA 18517 • **800/233-4717** Made in USA

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

installation. This gap may affect the ultimate performance of the system or require re-configuration, perhaps without compensation for those doing the work. Industry standards for the CIN and SoO are beginning to emerge from the specification community, but the practice is spotty and inconsistent.

Recognizing what documentation *should* be on hand (as discussed above) helps you press designers and the supply chain to complete the package.

UNDERSTANDING THE CONTROL SYSTEM

Lighting controls vary significantly from one manufacturer or product family to another. There's no escaping the need to understand the specific product you are going to install and configure. On top of this already complex scenario is the reality that any system can be here today and changed tomorrow — often by upgrades. Some upgrades are welcome; others unhinge previously working functions.

Instructions for installation or configuration rarely stand out for their clarity. They can be overly wordy and contain unfamiliar terms, often for familiar devices, which adds to the confusion. Illustrations from the product engineer's perspective provide little assistance to an installer looking at a device up close and head-on.

When you select the control system, you can favor those systems you know well and prefer. But what if others are doing the choosing? In this case, your team must learn a new and potentially complex product from scratch.

Unfortunately, it's often difficult to pore over instructions, especially lengthy materials that consume time we can't spare. It's worse when a new product *looks* like one we have handled before. We tend to approach these casually, assuming we know what it's all about, then blunder into errors that might have been avoided with a closer reading of the instructions. One of my colleagues says an instruction sheet should clearly state right at the top of the page: "So, it isn't working, huh?" That's when many installers finally reach for the installation sheet — *after* they have already tried and failed to get the controls working.

Photo courtesy of NGLS

Working through existing wiring in a retrofit project is an unknown and potentially time-consuming variable.

Photo courtesy of NGLS

Lengthy and unclear instruction manuals can challenge installers.

Wherever complex systems of any type run aground, a checklist of basic steps has proved the most effective way to instill a disciplined and successful work process. Interestingly, those who resist the checklist for themselves often find it useful in training others.

Finally (or, better yet, at the beginning), take advantage of the supply chain *before* problems arise. Most supply chain controls specialists eagerly introduce their products during bid preparation (they may have had a major role in project design) and at a pre-install conference. The good ones recognize that any lack of clarity or thoroughness on their part will result in problems that cost *them* time and money, too.

THE TEAM

Problems at the team level can result from a lack of clarity about who is responsible for what in a complex project. Are you a team or just a collection of players? Is each professional's scope of work clearly defined to match the needs of the project? Does everyone

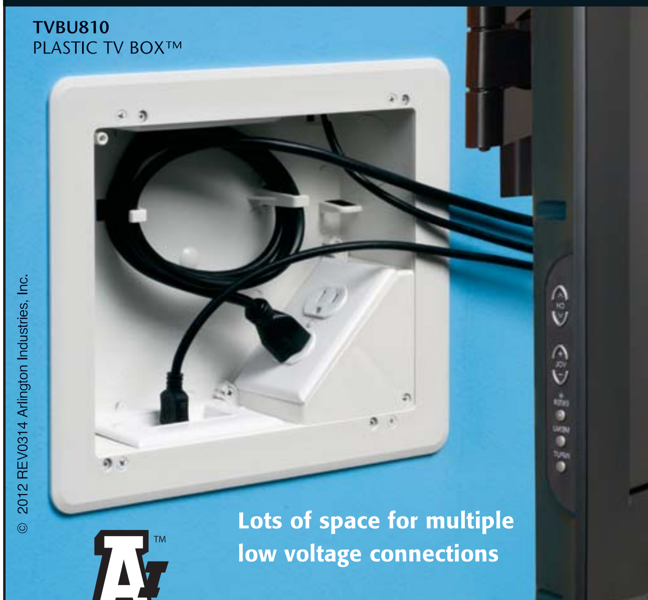
VERTICAL OR HORIZONTAL • RETROFIT & NEW WORK INSTALLATIONS

Made in USA

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

Mounts to stud in NEW work

Secure installation in RETROFIT

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

c UL us

Product info aifittings.com/landing/TVBU810

PHOTOVOLTAIC

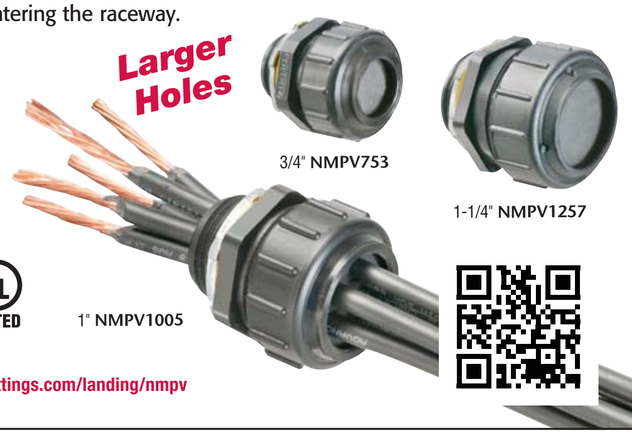
NEW CABLE CONNECTORS

CONNECTS, PROTECTS MULTIPLE PV1000 CABLES

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

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

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



Larger Holes

3/4" NMPV753

1-1/4" NMPV1257

1" NMPV1005

UL LISTED

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

Product info aifittings.com/landing/nmpv understand who is doing what? Areas like the control of emergency lighting can become "not my job" situations, often resulting in lost time and mistakes.

Lighting controls (more than other aspects of lighting) offer the potential for misunderstanding and miscommunication among project team members and installers. An ambiguous or contradictory design generally means lost time that you may not be able to recoup.

I think it helps when you *push* the team — designers, engineers, consultants, and integrators — to resolve conflicts on a timely basis. While this may feel like *their* business and not yours, you have a lot at stake in the successful resolution. Otherwise, any collateral damage may fall on you. You don't need to tell others how to do their jobs; just make sure that all the jobs necessary for a successful project are assigned.

SPECIALISTS

Complicated controls — especially systems marrying components from different manufacturers — require knowledgeable specialists. Bringing in a system integrator often can save time and material that justifies the fee involved. If an integrator is specified, all bidders can compete on a level field. Even when there's no specification, engaging an integrator can pay off for you.

Increasingly, we see firms developing their own specialized capabilities. A team of specialists can perform system-specific tasks faster and more accurately than generalists. And the division of labor can improve the efficiency of installers now focused on more familiar light and power.

Controls expertise — ranging from energy code compliance to advanced system performance — plays an essential role when you are responsible for system design and selection, or even if your scope is just costing, installation, and setup. Specialized capabilities also open marketing opportunities in both service and construction.

THE SILVER LINING

Yes, connected lighting controls are complicated, and they often cost more than budgeted, especially in time and rework. The reward for this risk is twofold: capability and marketing.

By embracing modern lighting controls, you can acquire expertise ahead of your competition, identify better practices and workflows, develop more efficient troubleshooting, and build more reliable supply networks. Together, these three "assets" can deliver a cost-effective business platform with the ability to adapt to changing technologies. Equally important, young talent is more likely to join such a dynamic and connected enterprise.

In terms of marketing, lighting controls can symbolize a successful, forward-thinking business model. Advanced, multi-purpose systems present building owners with critical questions about system type, capability, complexity, and cost. Companies that can answer these questions based on experience and savvy will hold more appeal than those stuck in the known world of older building technologies.

The Next Generation Lighting Systems program focuses on making lighting controls more successful, reducing wasted energy and environmental resources, and improving the building experience for occupants. While helping you make money is not my goal at NGLS, increasing the chance of your success with advanced lighting controls and the improved profitability that goes with it are happy outcomes in alignment with the objectives of NGLS.

If you have thoughts on lighting controls, or if this article has prompted some ideas, I would like to hear from you (contact me through the email listed below). **EC&M**

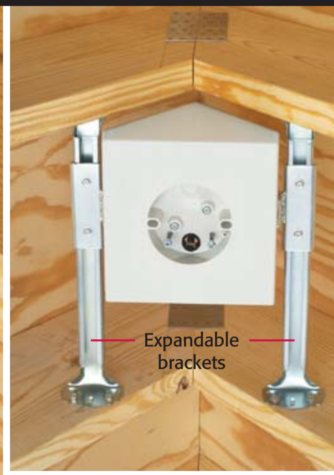
Ruth Taylor serves as a project manager on the Advanced Lighting Team at the Pacific Northwest National Laboratory where she contributes to multiple projects, including the management of Next Generation Lighting Systems (NGLS), a highly successful, nationally recognized program that encourages technical innovation and promotes excellence in the design of energy-efficient LED luminaires and connected lighting systems. She can be reached at ruth.taylor@pnnl.gov.

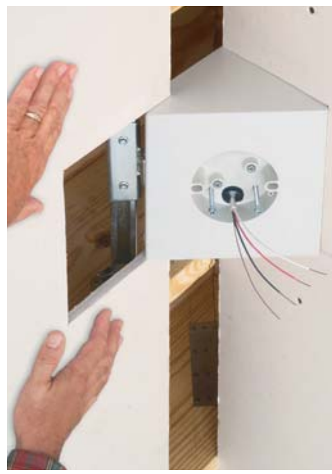
FOR CATHEDRAL CEILINGS IN NEW CONSTRUCTION

CENTERED. SIMPLE.

WITH ARLINGTON'S FAN/FIXTURE BOX

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

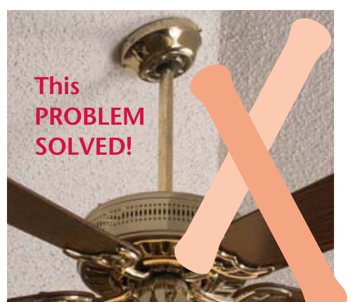




Get a centered, safe installation with Arlington's one-piece FBX900 Fan and Fixture Box. *Save time and money too.*

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

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

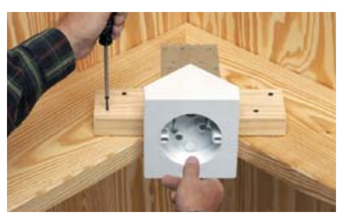


UL Ratings

FBX900 Fan/Fixture: 70 lbs

FB900 Fan: 70 lbs, Fixture: 200 lbs

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



Arlington®

Product info aifittings.com/landing/fb900-series

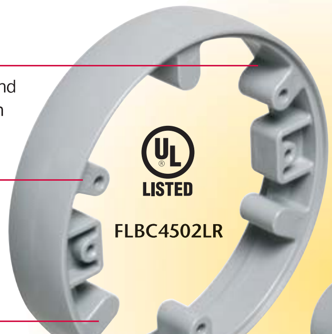
NEW CONCRETE

FLOOR BOX

NEW FEATURES!

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

SIDE A
Fits 6" round covers with a 3-1/2" screw hole pattern



SIDE B
Fits 6" round covers with a 3-3/8" screw hole pattern

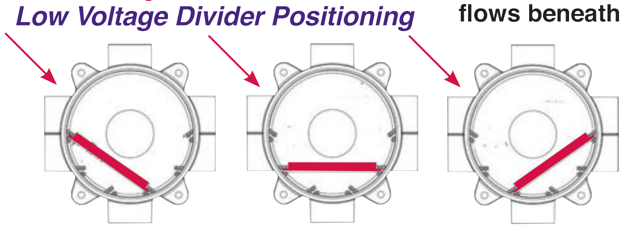
NEW!
REVERSIBLE Leveling Ring

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

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

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

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



Openings for optional screws
to raise box so concrete flows beneath

ARLINGTON Cover KITS for FLBC4502, FLBC4500 boxes

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

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

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

FLBC4520BR Brown
FLBC4520W White
FLBC4520BL Black
FLBC4520CA Caramel
FLBC4520GY Gray

PLASTIC SINGLE FLIP COVERS in 6 COLORS

FLBT6620NL

FLBT6620MB
TR receptacle

FLBT6620GMB, FLBT6620GNL
TR, decorator-style GFCI

FLBT6620UMB, FLBT6620UNL
TR receptacle, two USB ports

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

PRODUCT INFO aifittings.com/landing/flbc4502/

Patented. Other patents pending.

ULTRA THIN FLANGES, METAL COVERS

RECESSED IN BOX® COVER KITS

FOR 4.5" CONCRETE BOXES

FLBC4580MB
brass-plated covers
stamped steel flange

FLBC4580NL
nickel-plated covers
stamped steel flange

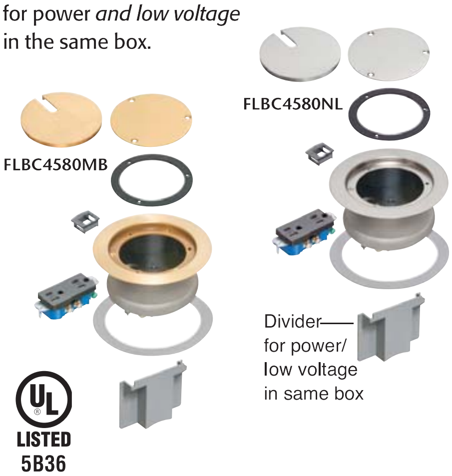
IN BOX® with Ultra-Thin Stamped Steel Flange

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

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

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

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



TM
Arlington®

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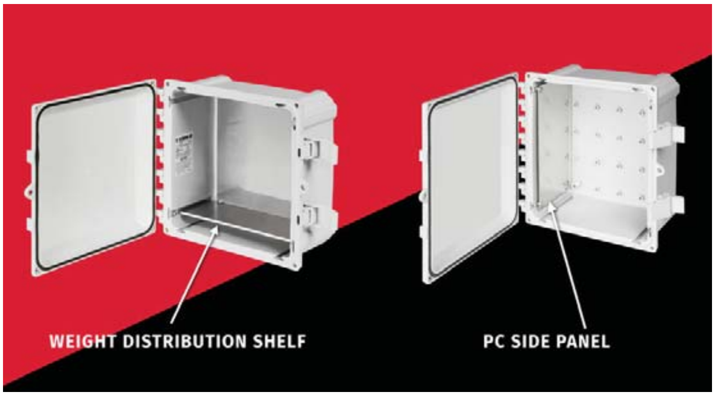
PRODUCT INFO aifittings.com/landing/flbc4580

Patent pending

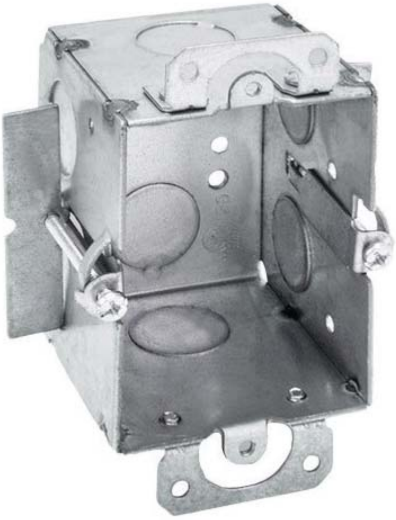
Focus on Boxes and Enclosures

Interior Mounting Solutions



The company has added new side panels and weight distribution shelves that aid in interior mounting and support of heavy equipment. Designed for OEMs and installers, these are used with the company's polycarbonate enclosures to add installation flexibility, increase mounting space, and solve challenges during customer installation of heavy components in non-metallic enclosures. The side panels and weight distribution shelves are suited for diverse markets and applications, including non-hazardous industrial and commercial/OEM design and manufacturing market segments, as well as industries such as oil and gas, electrical control, and water/wastewater.

Stahlin Enclosures



Switch Box

The TGW switch box is designed for use with mid-size or jumbo wall plates. The product features a non-gangable wide old-work switch box that is designed for easy installation of GFCI or other large devices. In addition, the product is equipped to grip onto a finished wall for old work installations. The switch box is constructed from galvanized steel and comes pre-assembled with 10-32 ground screws and a 7-in. solid #12AWG pigtail.

Orbit Industries

Wall Rack Enclosure

The ERWEN-6E 19-in. wall rack enclosure is designed for both form and functionality with adjustable front and rear rails, a removable hinged back panel, and a reversible glass front door. The product ships fully assembled and features welded steel construction. The ERWEN-6E works with all standard 19-in. rack equipment and accessories, has 16 in. of usable depth, and the rails have numbered spaces with standard 10-32 threading. The load capacity is 120 lb, and the product dimensions are (W × D × H): 24.3 in. × 21.9 in. × 14.5 in.

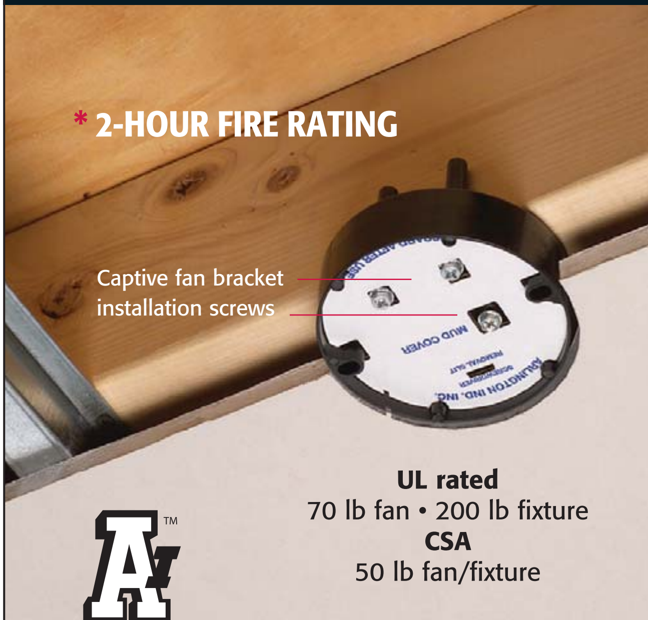
Video Mount Products

SECURE, JOIST-MOUNT INSTALLATION

Made in USA

FAN/FIXTURE PAN BOX

FOR 1/2" OR 5/8" DRYWALL WITH FURRING STRIPS OR HAT CHANNEL



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

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

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

FB412

FB412 with 5/8" double drywall

Patented

ADJUSTABLE • NON-METALLIC

Made in USA

IN/OUT™ BOX for Fans & Fixtures

EASY TO INSTALL... IN NEW CONSTRUCTION

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

Arlington's IN/OUT BOX ***for fans and fixtures*** adjusts up to 1-1/2" to accommodate varying ceiling thicknesses, like single or double drywall.

- Pre-set for 1/2" ceiling...use depth adjustment screw *after the ceiling's in place* to position the box flush with the ceiling
- Complies with 2020 NEC, 314.20 for set back boxes
- (4) screws attach box securely to joist in new work
- **2-Hour Fire Rating** ***Listed for fans up to 70 lbs; fixtures up to 100 lbs***

Product info aifittings.com/landing/fba426

1

2

1 Cutaway: Box set back in double drywall

2 After ceiling's installed, (if necessary) use the depth adjustment screw to position box flush with ceiling.

Patented

Working Clearances

Don't let adequate working space be "the final frontier" at your facility.

By Mike Holt, NEC Consultant

For the safe operation and maintenance of equipment, access to and egress from working space must exist around all electrical equipment [Sec. 110.26]. Spaces around electrical equipment (width, depth, and height) consist of working space for worker protection [Sec. 110.26(A)] and dedicated space to provide access to, and protection of, equipment [Sec. 110.26(E)].

Equipment that may need examination, adjustment, servicing, or maintenance while energized must have working space provided per Sec. 110.26(A)(1), (2), (3), and (4). NFPA 70E, *Standard for Electrical Safety in the Workplace*, guides us in determining the severity of potential exposure, planning safe work practices including establishing an electrically safe work condition, arc flash labeling, and selecting personal protective equipment.

The depth of working space, which you measure from the enclosure front (not the live parts), cannot be less than the distances in Table 110.26(A)(1). These distances are determined by voltage-to-ground and three different conditions:

- **Condition 1**. Exposed live parts on one side of the working space and no live or grounded parts (including concrete, brick, or tile walls) on the other side of the working space. Concrete, brick, tile, and similar surfaces are considered grounded.
- **Condition 2**. Exposed live parts on one side of the working space and grounded parts on the other.
- **Condition 3**. Exposed live parts on both sides of the working space.

If the working space is a platform, size it to the working space requirements.

Working space is not required at the back or sides of equipment where all connections and all renewable, adjustable, or serviceable parts are accessible from the front (dead-front equipment) [Sec. 110.26(A)(1)(a)]. Sections of equipment that require rear or side access to make field connections must be marked by the manufacturer on the front of the equipment [see Sec. 408.18(C)].

If electrical equipment is being replaced, Condition 2 working space is permitted between dead-front switchboards, switchgear, panelboards, or motor control centers located across the aisle from each other. But only where conditions of maintenance and supervision ensure that written procedures have been adopted to prohibit equipment on each side of the aisle from being open at the same time, and only authorized, qualified persons will service the installation [Sec. 110.26(A)(1)(c)].

The width of the working space must be at least 30 in., but in no case less than the width of the equipment [Sec. 110.26(A)(2)]. The width of the working space can be measured from left to right, from right to left, or simply centered on the equipment. It can overlap the working space for other electrical equipment.

The working space must be of sufficient width, depth, and height to permit equipment doors to open at least 90 degrees (**Fig. 1**).

The height of the working space must be clear and extend from the grade, floor, or platform to a height of 6½ ft or the height of the equipment, whichever is greater [Sec. 110. 26(A)(3)]. Other equipment, such as raceways, cables,

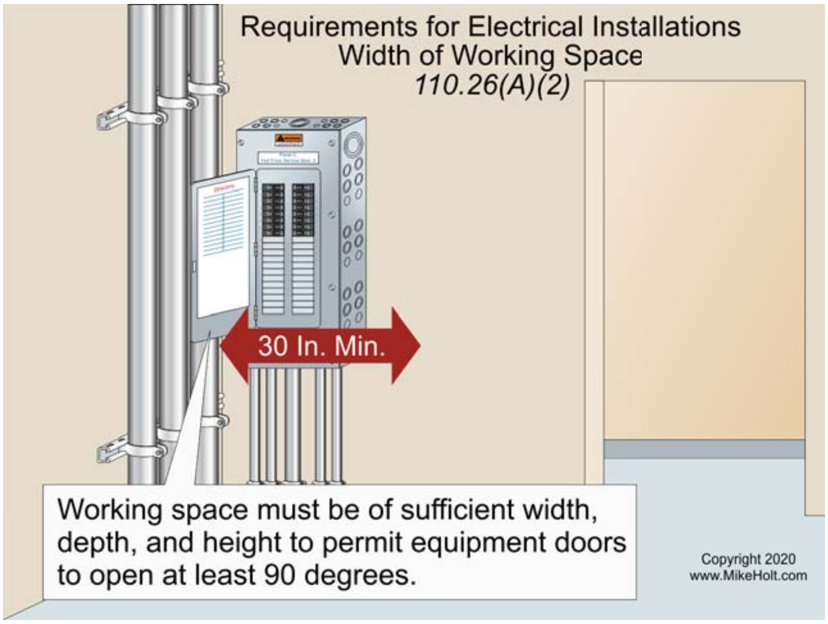


Fig. 1. The width of the working space can be measured from left to right, from right to left, or simply centered on the equipment.

ONE-PIECE. SAVES TIME – LOOKS GREAT!

Made in USA

RECESSED IN BOX®

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

DBVMA1C
clear cover

DBVMA1W

ADJUSTABLE Depth

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

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

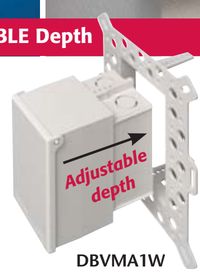
- Non-metallic, 22.0 cu. in. box with EXTRA-DUTY weatherproof-in-use clear or white cover
- Accepts single-gang devices; no gaskets required

for Help in Maintaining **CONTINUOUS INSULATION** in foam sheathing applications

DBVME1W

Built-in FIXED FLANGE

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



DBVMA1W
white cover

Product Info aifittings.com/landing/db-series

Arlington®

800/233-4717 • www.aifittings.com

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

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

DBVME1W
white cover

Patented/Additional patents pending

LOW PROFILE • 4" DIAMETER

Made in USA

SCONCE BOX

FOR SHALLOW WALL CAVITIES OR OBSTRUCTIONS

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

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

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

FSC405R
Sconce Box

Patented

Product info aifittings.com/landing/sconce-box

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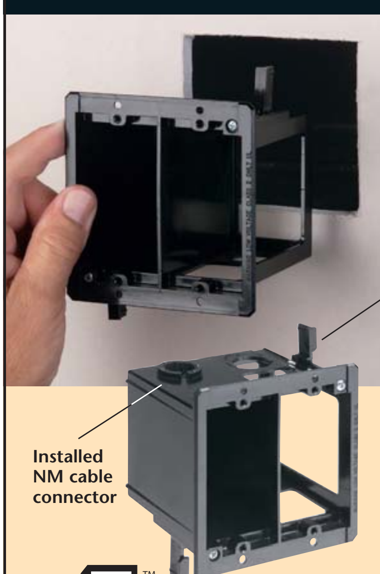
POWER & LOW VOLTAGE

COMBO BOX

FOR RETROFIT PROJECTS



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

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

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

LVDR2

Patented

Product info aifittings.com/landing/combo-boxes

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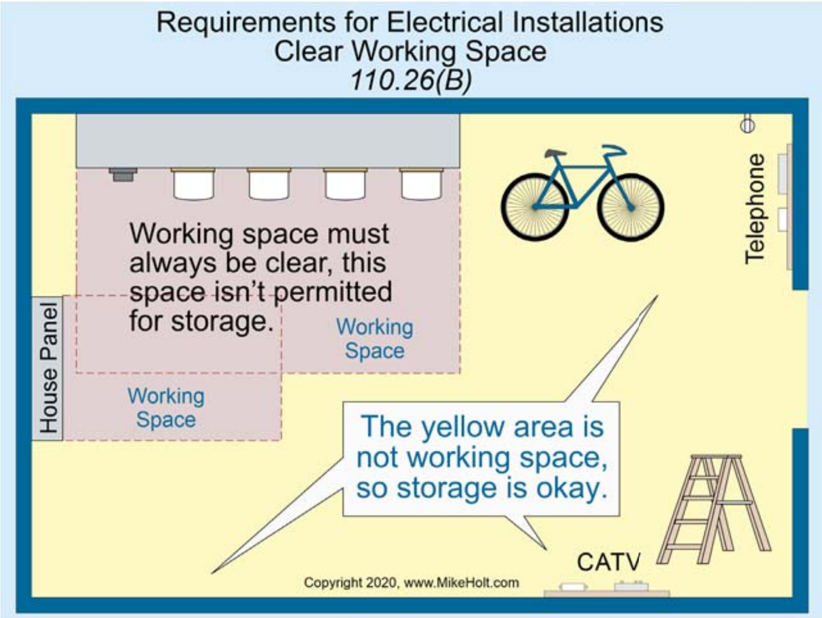

Fig. 2. It is inherently dangerous to service energized parts. It is unacceptable to be subjected to additional dangers by working around bicycles, boxes, crates, appliances, and other impediments.

wireways, transformers, or support structures (such as concrete pads) can extend no more than 6 in. beyond the front of the electrical equipment.

Exception No. 2: The minimum height of working space does not apply to a service disconnect or panelboards rated 200A or less located in an existing dwelling unit.

Exception No. 3: Meters can be installed in the required working space. Where equipment likely to require examination, adjustment, servicing, or maintenance while energized is above a suspended ceiling or crawl space, all the following conditions apply [110.26(A)(4)]:

(1) Equipment installed above a suspended ceiling must have an access opening at least 22 in. × 22 in., and equipment installed in a crawl space must have an accessible opening at least 22 in. × 30 in.

(2) The width of the working space must be at least 30 in., but in no case less than the width of the equipment.

(3) The working space must permit equipment doors to open 90 degrees.

(4) The working space in front of the equipment must comply with the depth requirements of Table 110.26(A)(1). Horizontal ceiling structural members are permitted in this space.

CLEAR WORKING SPACE

The working space must always be clear; therefore, this space can't be used for storage [Sec. 110.26(B)] (**Fig. 2**).

It is inherently dangerous to service energized parts. It is unacceptable to be subjected to additional dangers by working around bicycles, boxes, crates, appliances, and other impediments. Don't work in such an area until these items are removed.

When working in a passageway and live parts are exposed for inspection or servicing, the working space should be guarded against use by occupants. When working on electrical equipment in a passageway, be mindful of the potential for a fire alarm. If one occurs, you may need to secure equipment covers and clear the passageway of ladders, tools, and other items that impede egress by the occupants.

You must install signaling and communications equipment in a manner that does not encroach on the working space of the electrical equipment.

At least one entrance large enough to give access to (and egress from) the working space must exist [Sec. 110.26(C)(1)]. Find out what the authority having jurisdiction considers "large enough" based on the conditions of use. Building codes contain minimum dimensions for doors and openings for personnel travel, but certain assumptions are made, and those might not apply to your application.

For large equipment containing overcurrent, switching, or control devices, an entrance to (and egress from) the required working space at least 24 in. wide and 6½ ft high is required at each end of the working space [Sec. 110.26(C)(2)]. This requirement applies to either of the following conditions:

(1) Any of the equipment is over 6 ft wide and rated at least 1,200A.

(2) The service disconnecting means installed per Sec. 230.71(B) has a combined rating of 1,200A or more and is over 6 ft wide.

Open equipment doors must not impede entry to or egress from the working space. A single entrance for access to and egress from the required working space is permitted if the egress is unobstructed or if the working space depth is doubled. What does "doubled" mean? The edge of the entrance is no closer than the required working space distance required by Sec. 110.26(A)(1).

This next requirement applies where the equipment is rated 800A or more and includes overcurrent, switching, or control devices. If a personnel door is less than 25 ft from the nearest edge of the working space, the door must open in the direction of egress and be equipped with listed panic or listed fire exit hardware [Sec. 110.26(C)(3)] (**Fig. 3** on page 58).

A poorly lit work area means people will be forced to use up some of their working space with portable lights. So for that and other reasons, illumination is required for all working spaces about service equipment, switchboards, switchgear, panelboards, or motor control centers installed indoors [Sec. 110.26(D)]. At least some of the illumination within the working space must not be controlled by automatic means.

Additional lighting outlets are not required where the working space is illuminated by an adjacent light source, or as permitted by Sec. 210.70(A)(1)

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8418 for **1000 Mcm wire** and **TECK90**

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

NEW

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

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- Vents keep wet pipe sleeves from sticking together
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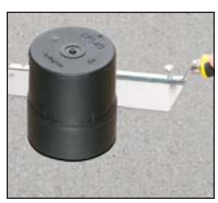
CPS40

Nail sleeve to form.



After concrete sets, cut sleeve flush with surface.

Insert conduit into sleeve.

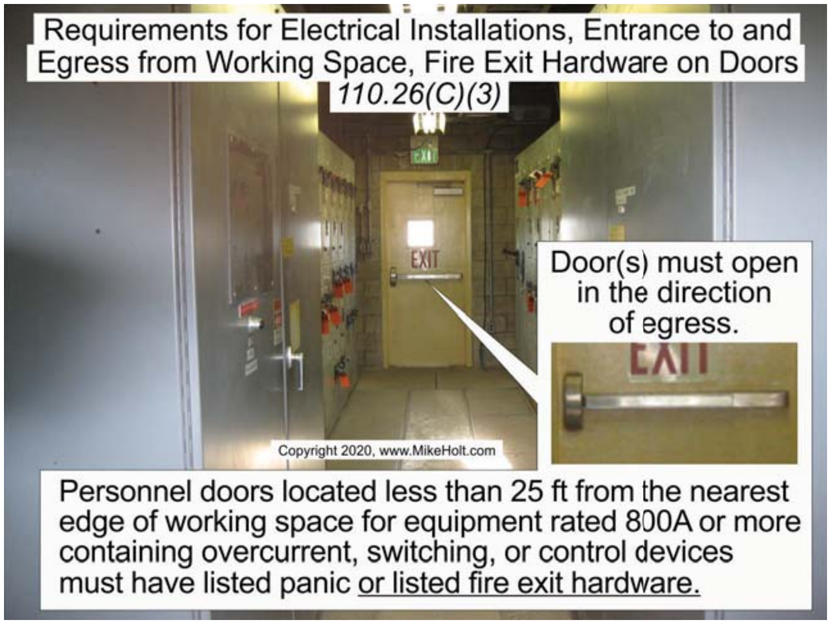


Fig. 3. Illumination is also required for all working spaces about service equipment, switchboards, switchgear, panelboards, or motor control centers installed indoors.

Exception No. 1 for switched receptacles. This, however, doesn't mean you can't provide additional lighting if doing so would likely make people safer. Use good judgment.

Service equipment, switchboards, and panelboards must have dedicated equipment space and be protected from damage that could result from condensation, leaks, breaks in foreign systems, and vehicular traffic. Specific requirements exist for indoor applications [Sec. 110.26(E)(1)] and outdoor applications [Sec. 110.26(E)(2)].

For example:

- For indoor installations, the footprint space (width and depth of the equipment) extending from the floor to a height of 6 ft above the equipment or to the structural ceiling, whichever is lower, must be dedicated to electrical equipment. No piping, ducts, or other equipment foreign to the electrical system can be installed in this dedicated electrical equipment space.
- For outdoor installations, switchboards and panelboards must be installed in identified enclosures and protected from accidental contact by unauthorized personnel or by vehicular traffic. The working clearance space includes the zone described in Sec. 110.26(A). Architectural appurtenances or other equipment are not permitted within this zone.

Rooms or enclosures containing electrical equipment controlled by a lock are considered accessible to qualified persons [Sec. 110.26(F)].

THE RIGHT DISTANCE

Remember, the NEC and OSHA give the minimum working space distances for various types of conditions. Those are not the average, maximum, or target distances. The NEC specifically uses the language "…to permit ready and safe operation and maintenance…" [Sec. 110.26].

The distance in your particular application might conform with Table 110.26(A)(1) and still fall short of the "ready and safe" standard. And though this aspect is not covered by the NEC [Sec. 90.1], good engineering requires consideration of what additional distance would improve efficiency for operation or maintenance. **EC&M**

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

Stumped by the Code?

By Mike Holt, NEC Consultant

The aluminum core of a copper-clad aluminum conductor must be made of an AA-8000 series electrical-grade aluminum alloy conductor material.

All questions and answers are based on the 2023 NEC.

Q. What are the rules related to minimum conductor sizing and material?

A. Conductor material types and sizing requirements are outlined in Sec. 310.3 [Conductors, Minimum Size and Material] of the NEC.

As noted in Sec. 310.3(A) [Minimum Size Conductors], the minimum sizes of conductors are 14 AWG copper or 12 AWG aluminum or copper-clad aluminum, except as permitted elsewhere in the Code. There is a misconception that 12 AWG copper is the smallest conductor permitted for commercial or industrial facilities. Although it is not true based on NEC rules, it might be a job specification or local code requirement. Conductors smaller than 14 AWG are permitted to be installed for Class 1 power-limited circuits [Sec. 724.43], fixture wire [Sec. 402.6], and motor control circuits [Table 430.72(B)].

As noted in Sec. 310.3(B) [Conductor Material], conductors must be copper, aluminum, or copper-clad aluminum. Aluminum and copper-clad aluminum conductors must comply with the following:

(1) Solid aluminum conductors 8 AWG, 10 AWG, and 12 AWG must be made of an AA-8000 series electrical-grade aluminum alloy conductor material.

(2) Stranded aluminum conductors must be made of an AA-8000 series electrical-grade aluminum alloy conductor material.

(3) The copper of a copper-clad aluminum conductor only makes up 10% of the cross-sectional area. The aluminum core of a copper-clad aluminum conductor must be made of an AA-8000 series electrical-grade aluminum alloy conductor material (see **Figure**). According to Art. 100, "Copper-Clad Aluminum Conductor" is drawn from a copper-clad aluminum rod with the copper metallurgically bonded to an aluminum core.

As noted in Sec. 310.3(C) [Stranded Conductors], conductors 8 AWG and larger installed in a raceway must be stranded to be solid, unless specifically permitted or required elsewhere in the Code. A grounding electrode conductor is an example of where an 8 AWG and larger solid conductor can be installed in a raceway when it is required to be protected from physical damage [Sec. 250.64(B)].

Lastly, Sec. 310.3(D) requires conductors to be insulated unless specifically permitted to be bare.

Q. What Code rules address conductor construction types and use?

A. The requirements for conductor construction and application are outlined in Sec. 310.4 [Conductor Construction and Application, Minimum Size and Material] of the NEC. Table 310.4(1) provides information on conductor insulation properties such as letter type, maximum operating temperature, application, insulation, and outer cover properties.

When a "–2" is found at the end of an insulation type (such as THWN-2), the conductor has a maximum operating temperature of 90°C and is suitable to be installed in a dry or wet location. **EC&M**

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Practically Speaking: An AFCI Epiphany

Sometimes the Code language does not always say what we think it says.

By Russ LeBlanc, NEC Consultant

One thing I've learned since becoming an electrical instructor more than 20 years ago is that the Code language does not always say what we think it says. I regularly find myself being humbled by Code wording that I have read thousands of times — and that I thought I fully understood — only to read it one more time before noticing that something just doesn't jive.

Case in point: The AFCI protection requirements in Sec. 210.12 were introduced into the Code beginning in 1999. I've been teaching and discussing those requirements for more than 23 years, but I recently realized it does not say what I thought it said. Based on the literal wording, we've probably all been installing AFCI protection on circuits that were not required to have it.

Article 100 provides several different definitions for voltage including "voltage, nominal" and "voltage, of a circuit". But is the "120V" specified in Sec. 210.12(A)-(D) a "nominal voltage" or the "circuit voltage"? The word "nominal" is never used in any of the AFCI protection requirements of Sec. 210.12, and Sec. 110.4 tells us that the "voltage considered shall be that at which the circuit operates." So, when we put all these Code pieces together, it appears that AFCI protection is not required for any branch circuit operating at a circuit voltage other than 120V. It does not require AFCI protection for branch circuits operating at 115V, 118V, 122V, or any voltage other than 120V. Several other rules in Art. 210 specify "nominal voltage" rather than "voltage of a circuit," including Secs. 210.1, 210.5(C)(1), 210.6(A)-(D), and both exceptions to Sec. 210.9.

> It appears that AFCI protection is not required for any branch circuit operating at a circuit voltage other than 120V.

I certainly don't think the intent of Sec. 210.12 is to exclude AFCI protection for branch circuits operating at 115V, 118V, or 122V. I believe the intent is to apply the AFCI protection requirements to "120V, nominal" branch circuits. Similar voltage conundrums exist in other Sections of Art. 210, too, including Secs. 210.11(C)(3) and (4), 210.13, 210.19, and 210.20. Are the voltages specified in each of these requirements "nominal voltages" or the "voltage of the circuit"? I've submitted several Public Inputs for the 2026 Code cycle to help improve the usability of some of these rules. Until some clarifications are made to the Code language, I suggest discussing this with your AHJ to try and figure out exactly what the Code language is trying to say. **EC&M**

Illustrated Catastrophes

By Russ LeBlanc, NEC Consultant

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

A BUNDLE OF BAD INSTALLATIONS

There are several problems to discuss here. We can start with the missing covers from the junction box and PVC conduit body (i.e., LB). For completed installations, Sec. 314.15 requires each box to have a cover, faceplate, lampholder, or luminaire canopy. That same section in the Code requires conduit bodies, such as the LB, to be installed with a cover, lampholder, or device. Next, let's focus on the broken rigid PVC conduits. For areas where rigid PVC conduit is exposed to physical damage, Schedule 80 PVC conduit should be installed as specified in Sec. 352.10(K). Installing expansion fittings where these conduits emerge from grade was a great idea and is now a requirement of Sec. 352.44(B), but even the expansion fittings could not prevent all types of damage to the conduits. Lastly, you can't use liquidtight flexible nonmetallic conduit (LFNC) with PVC conduit fittings. Section 356.42 restricts fittings used with LFNC to only those fittings listed for use with LFNC. PVC conduit fittings are not listed for use with LFNC. Using fittings with the wrong wiring method is also a violation of Sec. 300.15 and Sec. 110.3(B).

POOR CHOICE OF TRANSFORMER PLACEMENT

I'm not sure why the installer of this transformer and panelboard chose to put the transformer right in front of the panelboard instead of installing it in that space to the right. Whatever the reasons were, the present layout for this installation is a violation of the working space requirements of Sec. 110.26(A). While Sec. 110.26(A)(3) permits encroaching a maximum of 6 in. into the working space for this panelboard with electrical equipment associated with the panelboard, this transformer extends a little too far beyond the front of the panelboard and into the working space. Leaning against a grounded transformer enclosure while their hands are inside the enclosure of the energized panelboard significantly elevates the risk of shock for electrical workers. Another Code-compliant option could have been to install the transformer above the working space by hanging it from the structure using anchors with threaded rods and strut or similar hardware. I regularly see this method used in electrical rooms where space is at a premium. In a bit of irony, if you look closely at the cover of the panelboard enclosure, you may notice a label notifying persons to keep the space in front of the panel clear.

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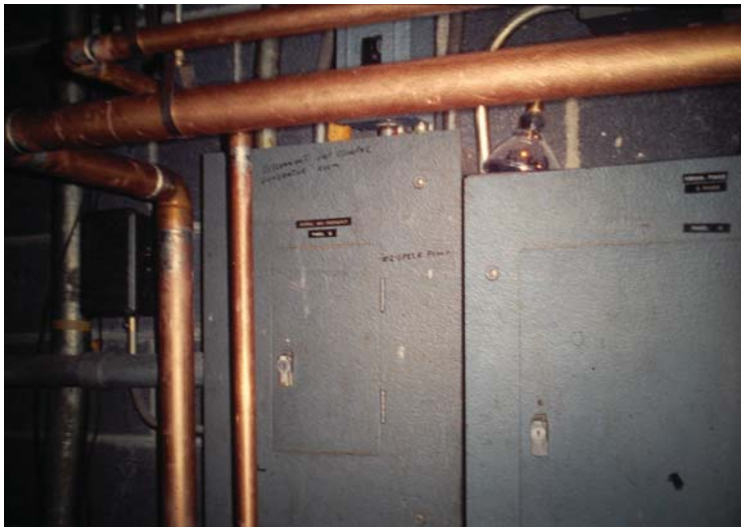
What's Wrong Here?

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 2023 NEC.

Hint: The never-ending "space war" continues.



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

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

DECEMBER WINNERS

Our lone winner this month was Ken Cunningham, an electrical design engineer for Moore Consulting Engineers, LLC, Shamong, N.J. He knew using extension cords as a substitute for the fixed wiring of a structure is not Code compliant.

Section 400.12(1) specifically prohibits this type of installation. Sec. 400.12(4) prohibits flexible cords, flexible cables, cord sets (extension cords), and power supply cords from being attached to building surfaces. Section 400.10(A) permits using flexible cords and flexible cables for only 11 applications, which are further restricted by Sec. 400.12. The use shown in this photo is not one of the uses permitted by Sec. 400.10(A). Chapter 3 wiring methods should be used here to provide a permanent wiring solution for providing power to the desired location.