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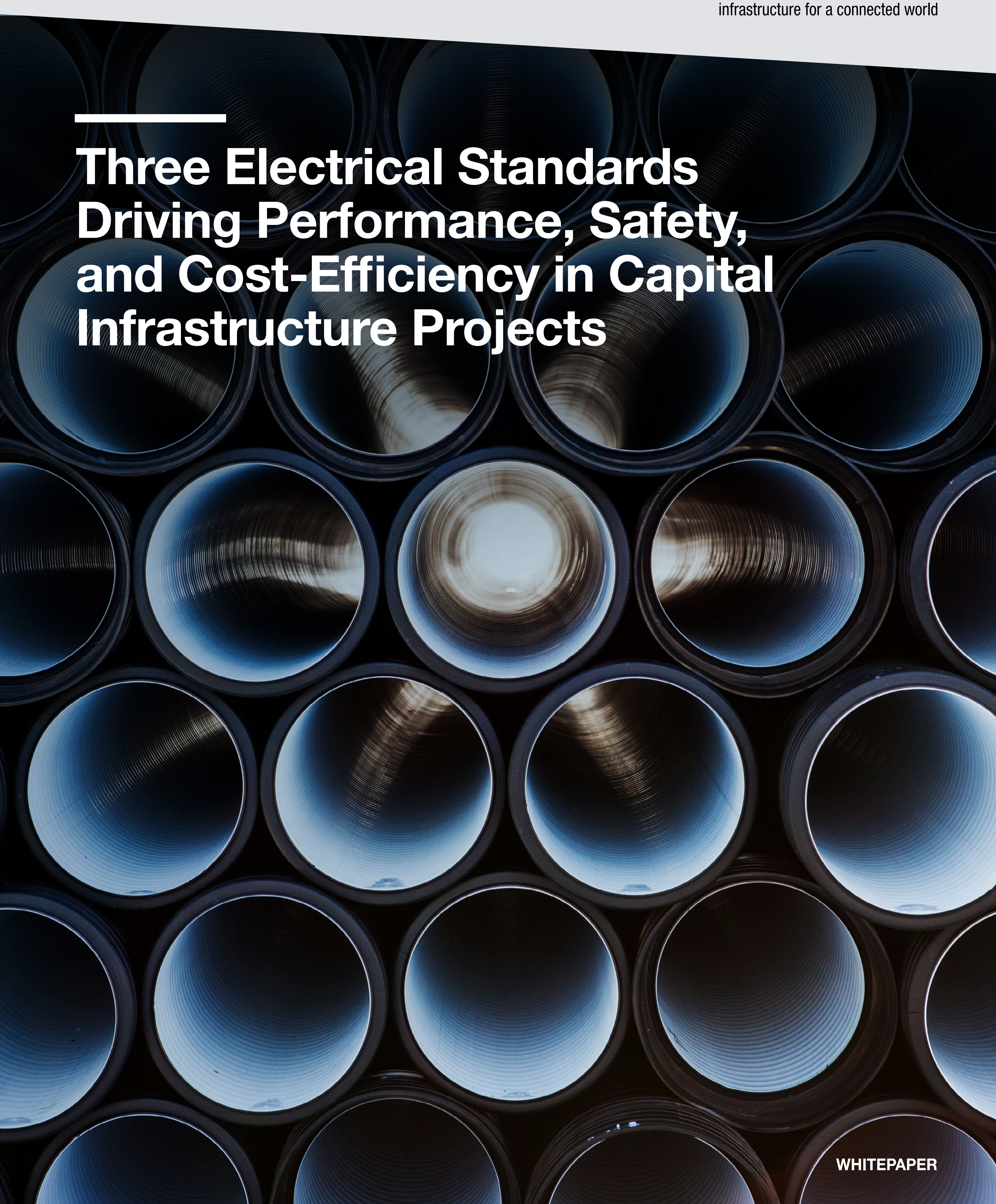
Three Electrical Standards Driving Performance, Safety, and Cost-Efficiency in Capital Infrastructure Projects



WHITEPAPER

To enable the anticipated levels of GDP growth globally, the McKinsey Global Institute estimates that the world needs to spend roughly $57 trillion on infrastructure by 2030, about two-thirds of which will be required in developing markets that are seeing a rising middle class, population growth, urbanization, and increased economic growth.[1]

Successful infrastructure projects have the power to shape the future of communities, industries, and the individuals that make up both. For example, sewage and wastewater treatment systems can keep disease at bay, mass transit makes cities more efficient, productive, and less congested, while oil refineries and power generation plants provide the energy people need to live and work.

But too often years and decades will pass without promised highway, power plant, and rail projects ever materializing. The impact of these unrealized projects is significant. When they do finally happen, the rush to complete them means higher budgets without necessarily higher performance.

When done right, capital infrastructure projects create a positive return on investment and make a lasting impact on society. But when done wrong, these projects, burden investors with losses and taxpayers with higher taxes. The projects don't fully achieve what they set out to do and begin breaking down sooner than expected.

[1] Nicklas Garemo, Stefan Matzinger, and Robert Palter. "Megaprojects: The good, the bad, and the better." McKinsey & Company. https://tinyurl.com/y8qr9wgt.

Where Things Go Wrong in Infrastructure Development

Most megaprojects—those that cost $1 billion or more—go over budget. According to the McKinsey Global Institute, rail projects go over budget by an average of 44.7 percent, bridges and tunnels incur an average 35 percent, and for roads, it's 20 percent.[2] These projects have expected returns on investment and cost overruns leave investors disappointed and taxpayers picking up the tab.

In such large projects, there are a variety of factors that determine whether they will be successful or not. Complicated issues, such as technological decisions and environmental factors, can oftentimes not be taken into deep enough consideration before launching a project. Project execution, from the initial design to the desired outcome, can be filled with complexity and setbacks when developing a plan and project scope. Proper preparation from the start can pay for itself by smoothing these speedbumps.

Front-end engineering design is often avoided, opting instead to break ground and start construction due to the fear that once construction begins, enough design changes will be made, that front-end design costs would be a waste of money. For example, a March 2020 survey by Panduit and EC&M found that 17 percent of electrical contractors and 18 percent of electrical engineers reported working on a project that originally did not specify cable cleats only to find out that they were required well after the project was underway.[3]

Spending the time on early-stage engineering designs can put a capital project on the right path from the start. Making sure those designs and their implementation align with proven product standards will help avoid costly rework and keep projects on schedule.

[2] Ibid.

[3] EC&M/Panduit, Cable Management: Reality vs. Best Practice, March 2020.

Three Key Electrical Infrastructure Safety Standards

Nowhere is standards compliance more important than with a project's electrical infrastructure. Short circuit events can occur at any stage of a project, resulting in downtime, rework, and potentially deadly injuries to workers and equipment.

Standards provide engineers and procurement with a baseline to read beyond a supplier's marketing and compare like products from various suppliers. They highlight a product's ability to get the job done, having been rigorously tested to prove reliability. With the global scale of projects, product standards ensure there is seamless integration of these products when work is performed across borders.

The three most critical international standards governing electrical infrastructure and safety are UL 467, IEEE 837-2014, and IEC 61914:2015. Any grounding and bonding equipment should meet the general UL 467 standard. But for critical capital infrastructure projects to be successful, higher standards are required. IEEE 837-2014 is that higher standard for direct burial grounding applications, and IEC 61914:2015 is the higher standard when it comes to using cable cleats for short circuit protection.

Something as seemingly insignificant as using a manufacturer's lugs with a different manufacturer's tool can cause a crimp to not be UL certified and thus not pass inspection, leading to costly re-work, budget, and time overruns. Meanwhile, the majority of electrical engineers and electrical contractors are still unfamiliar with these higher international standards and the importance of specifying and installing products that meet them.

CABLE CLEATS FOR SHORT CIRCUIT PROTECTION: IEC 61914:2015

Compared to traditional pipe and wire electrical systems, cable tray systems provide more design flexibility and ease of installation. But without including cable cleats for short circuit and overload protection, cable tray designs can add risk to a project.

In North America, NEC standards require cables to be secured against short circuit events but the requirements do not include specifications for cable cleats. IEC 61914:2015 is a more globally accepted standard for ensuring that cable cleats can withstand the electromechanical forces resulting from a short-circuit event, including:

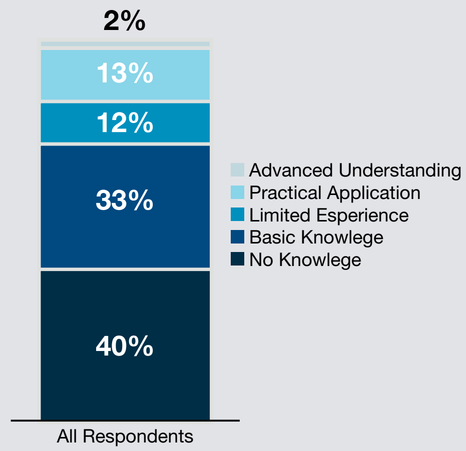
- Temperature rating.
- Resistance to flame propagation.
- Lateral and axial load testing.
- Impact resistance.
- Corrosion resistance.
- The ability to withstand one or more short circuit events at the manufacturer's declared values of peak short-circuit current. The standard specifies two certification levels:

  Level 1—Passes a short-circuit event.

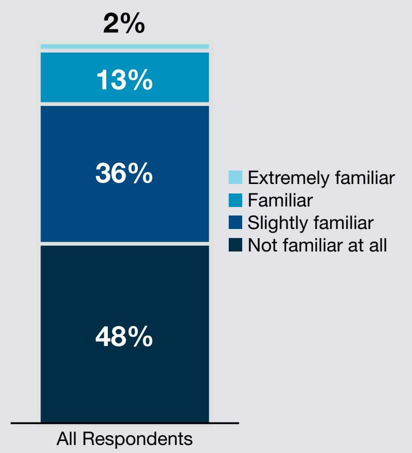
  Level 2—Passes a second short-circuit event after an inspection showing that the cleat passed the first. Passing this second short-circuit event demonstrates that a cable cleat is able to remain in place and continue to be used after a short-circuit event occurs.

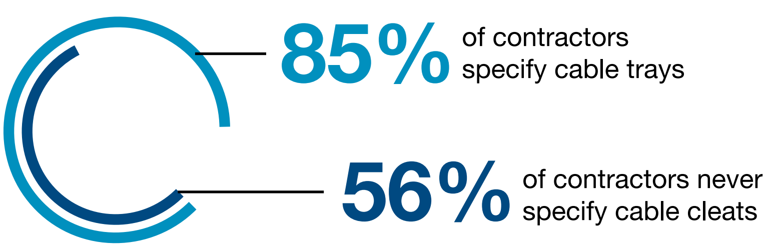
Unfortunately, almost half of all electrical engineers and contractors are not familiar with IEC 61914:2015. Despite the growing use of cable trays, 48 percent of engineers and 56 percent of electrical contractors surveyed by Panduit and EC&M indicate that none of the power cable they specify is currently protected by cable cleats. Instead, 72 percent of contractors reported using non-IEC compliant plastic zip or cable ties—or even string—to secure cables. This puts the safety, productivity, ROI, and future scalability of entire projects at risk.

Knowledge of Cable Cleat Design and Installation



Familiarity with IEC 61914:2015





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ELECTRICAL GROUNDING AND BONDING: UL 467 AND IEEE 837-2014

There are two commonly accepted methods for connecting wire-to-ground rods, wire-to-rebar, or wire-to-wire in direct burial grounding applications: exothermic and compression. In exothermic grounding, an exothermic chemical reaction is used to weld the two elements together. Although exothermic grounding is more common than compression grounding, it has limitations. In addition to being a time-consuming process, exothermic grounding can be dangerous for workers and requires hot permits. It is also difficult to do in wet environments and not visually inspectable.

Compression grounding is a safer, quicker, and visually inspectable alternative. A compression-style grounding connector is crimped using a manual or battery-operated tool with a pre-applied conductive antioxidant compound on the connector providing a high-quality electrical and mechanical bond. Because compression grounding ensures a long-lasting connection in harsh environments, this newer method is quickly gaining in popularity with engineers and contractors.

UL 467

Whether compression or exothermic, the general safety standard governing direct burial compression grounding connectors is UL 467. It requires third party testing to certify that grounding and bonding products meet four baseline requirements:

1) Tensile force strength, in other words, how much force can be applied before any movement is detected between the connector-wire connection.

2) Short time current test to simulate a ground fault to make sure the connectors are doing what they are intended to do.

3) Direct burial rating, or whether a grounding connection can be buriedin earth or concrete.

4) Markings such as DB (direct burial rated), AL (for use with aluminum wire only), and AL-CU (for use with both aluminum and copper wire).

IEEE 837-2014

In contrast, IEEE 837-2014 is one of the most difficult standards for grounding connections to pass. It outlines testing requirements for direct burial grounding connections in harsh and heavy industrial applications like offshore oil rigs, mining, and coastal environments. IEEE 837-2014 does not require third-party testing, but a manufacturer should be able to provide test data showing a product has passed. IEEE 837-2014 testing requires:

1) An acceptable UL 467 pull-out test rating.

2) A short time current test (stricter than that required by UL 467) to simulate a utility-scale fault.

3) Sequence testing that simulates harsh and heavy environmental conditions:

- A current temperature cycling test to simulate temperature change due to fluctuating currents.
- A freeze-thaw test to simulate burial too close to ground in a cold environment. If water gets between the connector and the conductor, it expands as it turns into ice, opening the joint between them and potentially increasing electrical resistance.
- A second short time current test completed after either a salt spray or acid bath has been applied to test samples.

Case Study: Grounding Systems and Tools that Deliver Value

A large industrial company was contracted to provide its construction expertise for a three-year, $14 billion LNG export facility project, but the non-standardized electrical grounding products it was using were decreasing productivity and jeopardizing safety and the company was struggling with deployment times.

The project required a grounding solution that met UL 467 standards and IEEE 837-2014 standards for withstanding corrosive elements, and the company needed to replace its existing crimping tools with more reliable ones in order to minimize downtime.

To meet the first challenge, the company employed Panduit's StructuredGround™ Direct Burial Compression Grounding System. The system combines the installation efficiencies of a compression system with the long-term reliability of connections that meet IEEE 837-2014 and the UL 467 standard for grounding and bonding.

The company replaced its existing tools with Panduit's BlackFin™ installation tools. The BlackFin battery-powered hydraulic crimping tool provides the force tonnage necessary to achieve certified connections, while integrated pressure measurement provides a visual and audible signal if full crimp force is not attained. It is also is the first in the industry to meet OSHA and international safety standards for battery-operated hand tools thanks to a quick motor stop and automatic retraction when crimping is complete.

By adopting the latest grounding technology and tools that meet the strictest standards, the company now benefits from less downtime and improved speed to installation—which in turn helps it meet its aggressive construction schedules and project ROI goals.

Setting Up Future Success

When capital infrastructure projects are successful, communities are improved, industries advance, and the individuals that make up both are positively impacted. Even though the electrical infrastructure may not be visible, it is an important part of the lasting, positive impact of such projects—if properly designed and installed.

In order for that to happen, electrical engineers and electrical contractors need a solid understanding of the right electrical standards and the products that meet them. Carrying out the design and installation of a project with a focus on electrical product standards sets the project up for the best possible outcome by preventing cost overruns, missed deadlines, and disappointed investors. It means a safe work environment is provided for installers and contractors, and that long-term reliability, productivity, and profitability can be expected.

Since 1955, Panduit's culture of curiosity and passion for problem solving have enabled more meaningful connections between companies' business goals and their marketplace success. Panduit creates leading-edge physical, electrical, and network infrastructure solutions for enterprise-wide environments, from the data center to the telecom room, from the desktop to the plant floor. Headquartered in Tinley Park, IL, USA and operating in 112 global locations, Panduit's proven reputation for quality and technology leadership, coupled with a robust partner ecosystem, help support, sustain, and empower business growth in a connected world.

For more information

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