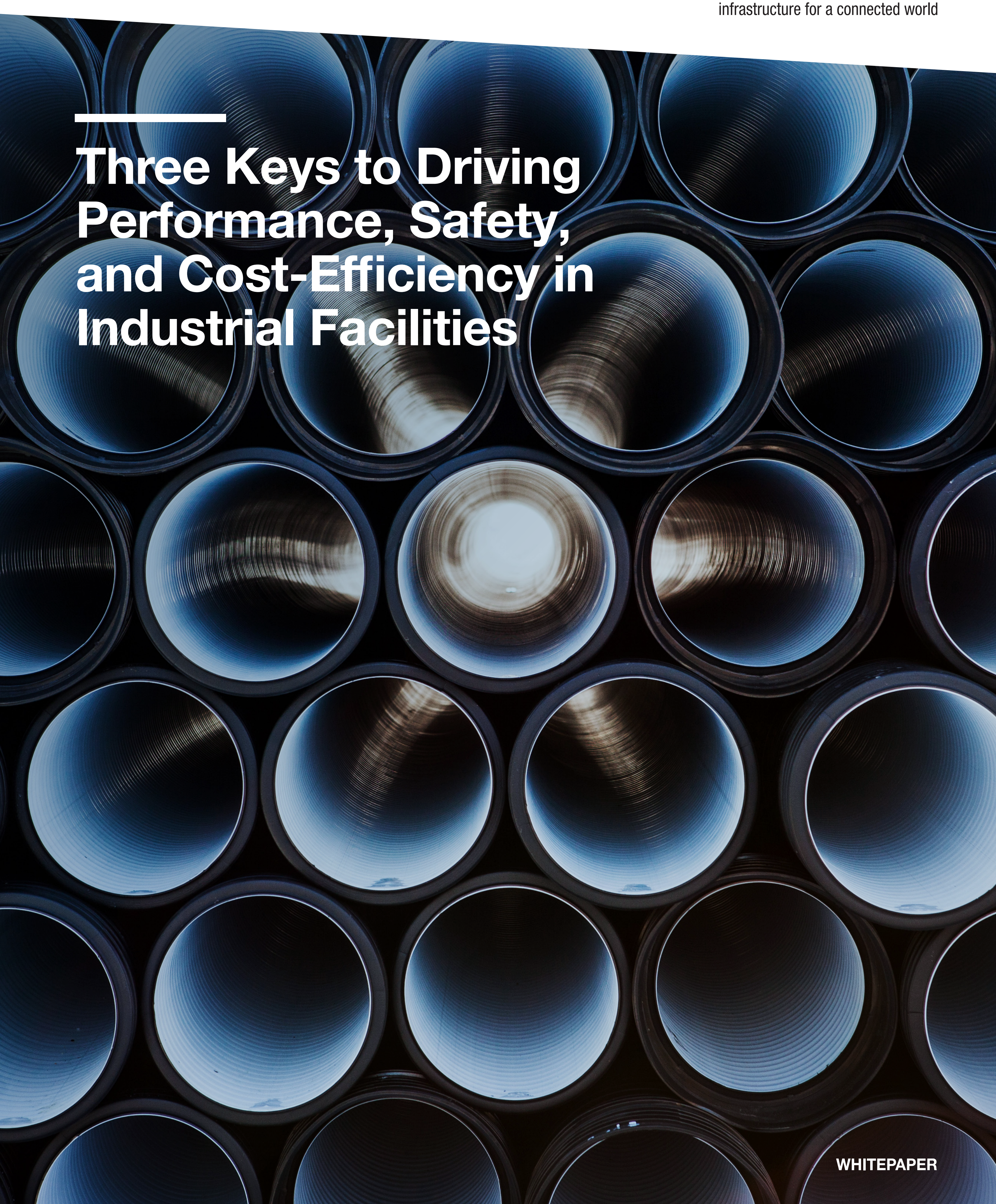
infrastructure for a connected world

Three Keys to Driving Performance, Safety, and Cost-Efficiency in Industrial Facilities



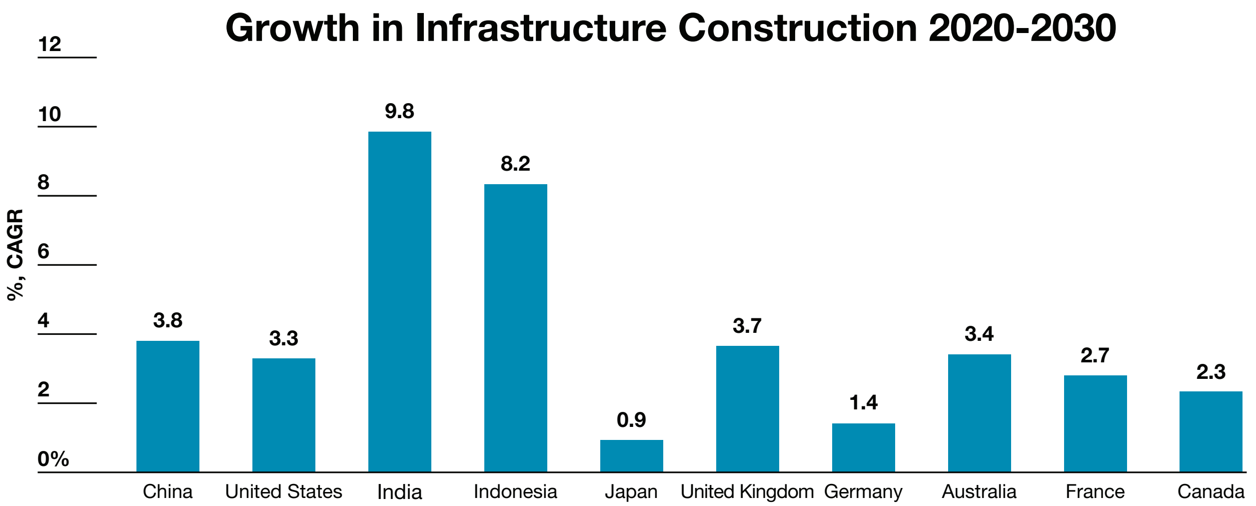
WHITEPAPER

Successful infrastructure projects have the power to shape the future of communities, industries, and the individuals that make up both. Sewage and wastewater treatment systems can keep disease at bay. Mass transit makes cities more efficient, productive, and less congested. Oil refineries and power generation plants power our daily lives. Capital infrastructure projects are not only monetary investments in which investors expect a financial return, but they also provide social impact. When done right, they create a positive return on investment and make a lasting impact on society.

When done wrong, projects have cost overruns and unmet deadlines, burden investors with losses, taxpayers with higher taxes, and break down earlier than expected. A variety of factors determine whether a project will be successful. Understanding and implementing the right electrical standards and partnering with the right manufacturers helps ensure they are.

When Things Go Wrong in Infrastructure Development

Major infrastructure projects have the power to be globally transformative. Imagine the standstill that would ensue if bridges, tunnels, highways, railways, airports, seaports, power plants, dams, wastewater projects, oil and gas projects, and canals never came to existence. To enable the anticipated levels of GDP growth globally, the McKinsey Global Institute has explored that the global infrastructure investment needs to hit $94 trillion by 2040, which is 19% higher than the current trend ($3.2 trillion per year) and would need to average $3.7 trillion per year. This will be fueled by emerging economies looking to develop energy, transport networks, sewage and waste systems, and other large-scale projects[1].



Graham Robinson, Jeremy Leonard, and Toby Whittington, 2021. "Future of Construction: A Global Forecast for Construction to 2030. Marsh, Guy Carpenter & Company, and Oxford Economics.

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

How the Proper Design and Installation of Electrical Infrastructure is Paramount to Project Execution and On-Time Delivery

It doesn't have to be this way. Electrical infrastructure is a critical component of capital projects and its proper design and implementation should be a priority. Alignment to rigorous and proven product standards and installation procedures will put the projects on the right path from the start, help avoid costly rework, and deliver projects on-time.

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 42 precent. Bridges and tunnels, meanwhile, incur an average 31 and 33 percent cost overrun. For roads, it's 25 percent. These projects have expected returns on investment. Cost overruns leave disappointed investors and often taxpayers to pick up the tab. Front-end engineering design is often avoided, opting instead to break ground and start construction due to the fear that, once construction begins, design changes will be made anyway, deeming the early-stage engineering costs a waste of money. But, spending the time on early-stage engineering design results in more on-time and on-budget projects.

Complicated issues, such as technological decisions and environmental factors, can oftentimes not be taken in to deep enough consideration before launching a project. Project execution, from the initial design to the desired outcome, can be ripe with complexity and setbacks when developing a plan and project scope. And, when it comes to productivity, proper preparation from the start pays for itself.

The proper design and installation of electrical grounding and cable cleats help increase productivity, profitability, reliability, and worker safety. One of the keys to the success of any design and installation of electrical grounding and cable cleats are product standards. Product standards compliance provides 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.

Value Delivered: Specifying an Electrical System to Meet Today's Critical Application Needs

Struggling with deployment times from using non-standardized products that fueled decreased productivity and unsafe conditions, a large industrial company was contracted to provide its construction

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Three Vital Electrical Standards for Capital Infrastructure Projects

While standards are always changing, three are considered to be the most critical within electrical grounding and bonding and cable cleats for electrical installations—UL 467, IEEE 837-2014, and IEC 61914-2015.

UL 467

UL 467 is a general safety standard used in grounding and bonding. In order to meet it, various tests are conducted and requirements provided as a baseline of quality for grounding and bonding equipment. It provides requirements for:

1) Tensile strength

2) Short time current

3) Direct burial rating, or whether a grounding connection can be buried in earth or concrete

4) Markings—such as DB for direct burial rated

All reputable manufacturers of direct burial compression grounding connectors comply with UL 467.

IEEE 837-2014

A much more stringent requirement than UL 467, IEEE 837 has had only two revisions since 1989 with the latest being IEEE 837-2014. Unlike UL, it is not subject to a third-party testing agency, but is, instead, self-proclaiming by the manufacturer, who should provide test data to show that they comply. The key elements of IEEE 837-2014 include:

1) The UL 467 pull-out test rating is acceptable, which is about half as stringent as the 2002 edition of IEEE 837.

2) Short time current test with a stricter requirement than UL that is used to emulate a utility-scale fault. This short time current rating is about twice as stringent as the IEEE 837-2002 edition.

3) Sequence testing is used to emulate harsh and heavy environmental conditions. This includes:

(a) A current temperature cycling test, which emulates temperature change due to fluctuating currents.

(b) A freeze-thaw test to emulate burial too close to ground in a cold environment. The freeze-thaw test is an attempt to work water into the joint between the connector and the conductor, and if water gets into this area when the system is frozen, the water will expand as it turns into ice, which will result in opening the joint between the conductor and the connector, which potentially causes increase in electrical resistance.

(c) Splitting up the samples in to two groups and hitting them with another short time test after either a salt spray or acid bath corrosion test has been applied.

As you can tell, IEEE 837-2014 testing is much more stringent than UL 467 and is required in the harsh and heavy environments often seen in industrial applications like offshore oil rigs, mining, and coastal environments. If a direct burial grounding connection is IEEE 837-2014 compliant, it meets the highest standard for direct burial grounding applications.

IEC 61914-2021

IEC 61914-2021, the third edition updated from the 2015 version, provides testing standards for cable cleats and intermediate restraints, which provide resistance to electromechanical forces resulting from a short-circuit event. These testing standards include:

1) Temperature ratings

2) Impact resistance

3) Lateral and axial load/retention

4) Corrosion and UV resistance

5) Resistance to flame propagation

6) Resistance to electromechanical forces by withstanding two short-circuit events at the manufacturer's declared values of peak short-circuit current. Level 1 - passes a first short-circuit event. Level 2 - passes a second short-circuit event in succession, after verifying the cleat passed the first short-circuit event. Passing this second short-circuit demonstrates that a cable cleat is able to remain in place and continue to be used after a short-circuit event occurs.

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expertise for a three-year, $14 billion LNG export facility project. Meeting the IEEE 837-2014 and UL 467 standards was required to deploy a solid grounding solution that provided connection reliability and the ability to withstand corrosive elements, and replacing existing crimping tools with more reliable ones was necessary to minimize downtime.

Based on the highlighting of its differential benefits, the company chose Panduit's grounding system, specifically the Panduit StructuredGround™ Direct Burial Compression Grounding System, to provide a dedicated below-floor grounding path to maintain system performance, reduce intermittent failures, and protect the customer's equipment and personnel. It 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 used the system to bond copper conductors, the reinforcing bar (rebar), ground rods, and building steel.

Leveraging the success of the grounding solution, Panduit developed its BlackFin™ installation tools. The company used the BlackFin battery-powered hydraulic crimping tool to install the grounding system and Panduit's connectors and lugs. The tool allows for many more crimps on a single battery charge while providing the crimping force tonnage necessary to achieve certified connections.

This crimping tool was the first in the industry to meet Occupational Safety and Health Administration (OSHA) and international safety standards for battery-operated hand tools.

This innovative tool leads the industry in safety and reliability and has a quick motor stop for high-use safety, along with automatic retraction when crimping is complete. There is also an integrated pressure measurement with a visual and audible signal if full crimp force is not attained.

By adopting technology that includes fully compliant tools that meet the strictest standards, the company now enjoys less downtime and improved speed to installation. This helps the company meet its aggressive construction schedules and project ROI goals.

Panduit Solutions Hold a Variety of the Most Common Heavy Industry Certifications and Approvals Worldwide

There are two commonly accepted methods for connecting wire-to-ground rods, wire-to-rebar, or wire-to-wire in direct burial grounding applications.

The first is exothermic grounding, which uses weldmetal which when ignited creates a combustible exothermic reaction with a temperature of up to 3,000°F in a contained enclosure to weld two elements together, such as wire-to-ground rod, wire-to-rebar, or wire-to-wire. Although this is the most commonly used method and has been around for decades, it has limitations in that it is not UL 467 compliant, can be dangerous for workers, requires hot permits, is difficult to perform in wet environments, is time consuming, and is not visually inspectable.

Compression grounding, a method offered by Panduit, is a safer and quicker alternative, as well as a visually inspectable UL 467 and IEEE 837-2014 approved method for making direct burial grounding connections. Using a compression-style grounding connector that can be crimped using an ergonomic manual or battery-operated tool, it ensures a long-lasting connection in harsh environments. A pre-applied conductive antioxidant compound on the connector provides a high quality electrical and mechanical bond, and cable ties act as a third hand to hold the connector and elements to which they are being connected in place while their free hands operate the crimping tool. Although less commonly used than the exothermic method due to it being a newer solution, it is gaining preference as engineers and contractors learn its benefits.

Stainless steel strap cleats feature inherent cable range-taking capabilities, suitable for single/multicore, trefoil, and quadrafoil cable configurations. These cable cleats are installed with polymer cushion sleeving, to prevent damage to cables, and mounting brackets are available to secure them to various styles of ladder rack. The locking tie variations are suited for lower to medium peak short-circuit current requirements, while the buckle strap versions are suited for a broad range of peak short-circuit current requirements, including those higher on the kA spectrum. The cable cleats can be installed utilizing manual or battery-operated installation tools, resulting in reduced installation times.

Clamp-style cable cleats are widely used cleat solutions, suited for a broad range of peak short-circuit current requirements. These cable cleats are available in various materials such as polymer, aluminum, and stainless steel. In addition, they feature differing geometries to accommodate single/multicore, trefoil, and quadrafoil cable formations. The cleats can be installed using bolt-on hardware or utilizing cable cleat brackets for certain parts. For the highest kA requirements, stainless steel clamp-style cleats are the most durable option.

Electrical Standards Help Improve Communities and Provide Positive Impact

Understanding and implementing the right electrical standards and partnering with the right manufacturers helps ensure the success of capital infrastructure projects. 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 should be expected.

When capital infrastructure projects are successful, society wins. Communities are improved, industries and their innovation advance, and the individuals that make up both are positively impacted. Even though the electrical infrastructure may not be visible, successful infrastructure projects create a lasting, positive impact on society that is easy to see.

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

Visit us at www.panduit.com

Contact Panduit North America Customer Service by email: cs@panduit.com
or by phone: 800.777.3300

PANDUIT US/CANADA
Phone: 800.777.3300

PANDUIT EUROPE LTD.
London, UK
cs-emea@panduit.com
Phone: 44.20.8601.7200

PANDUIT SINGAPORE PTE. LTD.
Republic of Singapore
cs-ap@panduit.com
Phone: 65.6305.7575

PANDUIT JAPAN
Tokyo, Japan
cs-japan@panduit.com
Phone: 81.3.6863.6000

PANDUIT LATIN AMERICA
Guadalajara, Mexico
cs-la@panduit.com
Phone: 52.33.3777.6000

PANDUIT AUSTRALIA PTY. LTD.
Victoria, Australia
cs-aus@panduit.com
Phone: 61.3.9794.9020