



Protection System Reliability: Enabling Your Teams for the Digital Paradigm

STRATEGIES FOR TAKING ON AND OVERCOMING
CHANGES IN MODERN RELAYING



DOBLE ENGINEERING COMPANY



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Protection systems are undergoing significant transformations. Utility and industrial companies are modernizing with intelligent electronic devices (IEDs) that offer more functions than ever. Substation Protection and Control (P&C) systems based on the IEC 61850 standard and energy sources from inverter-based renewables are coming online every day.

Investments in digital protection systems are producing tangible benefits around the world, but sophisticated cyberattacks, novel technologies and regulatory compliance mandates hinder the day-to-day activities of engineers and technicians. The strategies, tools and skills required of those working with protection systems are shifting to accommodate the new digital substation environment.

Navigating the evolving power delivery landscape requires a new playbook. Here's what utility and industrial companies can start doing today to set their protection engineering and testing teams up for success.

BENEFITS OF THE DIGITAL SUBSTATION



Enhanced reliability



Greater efficiency and productivity



Real-time information and insights



Increased safety



Reduced construction and operating costs



Faster restoration



More flexibility



Standardization



TRENDS FUELING NEW PROTECTION SYSTEM COMPLEXITIES

The same industry developments that aim to combat climate change and boost grid reliability also bring new protection engineering and testing complexities for utility and industrial companies to address.

The rise of renewables

Wind and solar power are making impacts on the grid. New fault characteristics introduced by renewables are disrupting conventional [protection system engineering](#) and testing orthodoxy. Personnel must develop practical knowledge of new technology standards and interpret analytics effectively to adapt philosophies around new concepts and implement new approaches.

Engineering and testing teams can cut through complexities with protection asset and test management systems that emphasize consistency and sustain familiar work methodologies. Team members are enabled when settings data and other mission-critical details they need are available across facilities where renewables and substation automation systems are coming online.

Growing cybersecurity concerns

Cyberattacks on the grid's critical infrastructure are happening every day. It's not uncommon anymore for a utility to fend off tens of thousands of attempts at malicious code incursions each month. The rate of these attacks is increasing as criminals become more sophisticated and deploy new methods of generating threats. Hackers are highly skilled and can learn and adapt to an organization's defenses.

Cybersecurity is one of the highest priorities in all aspects of protection testing. Modern protective relays are computer devices – cyber assets – that need be tested periodically, yet doing so raises the risk of malware being inadvertently introduced into substation networks. Security measures surrounding company-issued field computers – transient cyber assets – can prevent malicious code from being transferred into relays and other substation devices during tests, but they could also introduce restrictions on work and cause inefficiency.

Cybersecurity can be seamless and transparent to workers when the tools they use incorporate controls and protocols effectively. Digital infrastructures such as utility protection systems must be defended against coordinated cyberattacks and preventive measures must be in place against risks of subsequent cascading failures. Settings and configuration data associated with relays and other cyber devices can be secured during maintenance activities with hardened field computers that maintain the isolation of substation networks from internet traffic. Ongoing workforce training that reinforces new expectations on personnel puts utilities in the optimal position to defend the grid against malicious players, securely perform commissioning and maintenance testing, and maximize the return on digital investments.



Limited availability of adequate training

A well-trained workforce is more crucial today than ever but approaches to training in the utility and industrial environment can be unsystematic and complex. Instruction on protection system theory, applications and testing concepts can be sourced from relay and test equipment manufacturers as much as from internal resources or industry short courses. Growing knowledge when time and budgets are tight can come down to learning what you can while you can, then figuring out the rest through trial and error.

For example, digital substations based on the IEC 61850 standard introduce concepts and situations that workers must translate in order to commission and maintain protection schemes over Ethernet topologies. They must discern network anomalies as attributable to power system conditions, corrupted data traffic, or even devices themselves. They also must stay abreast of advancements in substation automation and protection engineering technologies to handle impacts from inverter-based renewables, heightened cybersecurity and other modernization initiatives.

As the power industry brings on new workers, nothing less than strategic [workforce training](#) will be acceptable. Strategic training considers the expected learning outcomes upfront and puts managers in a better position to sufficiently and consistently [upskill their workforce](#).



LATEST NERC REQUIREMENTS TO PAY ATTENTION TO:

PRC-027-1 Coordination of Protection Systems for Performance During Faults: Requires sound evidence of relay settings development processes and proof of adherence to those processes when performing coordination studies. Additionally, ongoing coordination studies across the reporting entity's entire network are required at least every six years or upon instances when fault levels deviate from baseline by 15%. Every reporting entity must also document communications as evidence that proves intertied utilities are informed and have accepted new settings or settings changes within their protection system coordination at affected regions.

PER-006-1 Specific Training for Personnel: Requires specific training on protection systems and remedial action schemes for personnel performing or supporting real-time operations at generating facilities. The training must be documented and demonstrate that such personnel understand the effects protection systems may have on grid reliability in real-time situations.

PRC-025-2 Generator Relay Loadability: Requires protective relays that are associated with generation facilities to be set at levels that allow generators to provide reactive power in response to frequency disturbances. Such load-responsive relays must offer set points that ensure reliable fault protection yet prevent tripping generators offline prematurely or unnecessarily during transient voltages that pose no risk to equipment or grid reliability.

Compliance with regulatory standards

NERC Protection and Control (PRC) standards concern the reliable performance of utility protection systems across the interconnected North American power grid. Compliance with these standards can be a headache for utilities due to the variety of relay records and data that can be found in different systems and formats.

Relay testing practices and relay maintenance itself can undermine reliability by causing misoperations. The most common issues are that either settings are misapplied to the relay device during maintenance, or the settings are improperly calculated from the outset. Under NERC PRC-004-6 Protection System Misoperation Identification and Correction, reporting entities have a 120-day time limit to identify and report to other affected protection system owners whether their protection system components caused a misoperation. Further, they must develop and implement a corrective action plan to prevent such equipment failures from ever repeating.

NERC standard PRC-027-1, which went into effect April 1, 2021, addresses protection system misoperations that could occur due to relay settings being incorrect, and relay operations becoming out of sequence due to changes in system fault levels over time. This standard requires reporting entities to substantiate formal settings development and revision processes, and to perform ongoing studies for maintaining and verifying system coordination. NERC is looking for consistency in the practices of protection engineers when calculating relay settings and wants to see that the computations performed during coordination studies use correct settings values. Additionally, utilities must produce evidence that proactive communication occurred with owners of electrically joined facilities concerning each instance of new or revised settings affecting system coordination.



LEVELING UP: STRATEGIES FOR THE FUTURE OF PROTECTION TESTING

New approaches and tools can help cut through the growing complexity of protection testing. From implementing more robust cybersecurity programs to zeroing in on workforce training and development, here are five tangible ways power and utility companies can elevate their protection testing performance.

1. Boost your cybersecurity defenses.

According to Utility Dive, [two-thirds of utilities](#) have increased security budgets in response to the rising risks of cyberattacks, but 38% of companies still have issues to address. While it may seem basic, zeroing in on fundamentals, which can get overlooked in the daily shuffle, is one of the best ways to invigorate a utility's cybersecurity program.

Verizon data shows [80% of hacking-related breaches](#) are the result of weak or compromised passwords. Prevent access into a device altogether with a password refresh. To make passwords harder for hackers to guess, include several different character sets and aim for 8-12 characters in length. Avoid auto saving your passwords and change your passwords at least every 90 days to limit hackers' ability to infiltrate your network. Implementing multi-factor authentication (MFA) is also recommended to significantly reduce the likelihood that a stolen password can access company assets.

Investing in the right technology also goes a long way in bolstering cybersecurity. Look for testing and field devices that minimize cybersecurity risks by design. Tap tools that [automatically patch and update](#) software and operational systems so you never miss a beat. Transient devices, such as testing laptops and tablets, which have regular contact with critical assets, are prime spreaders of malware. Tap a partner to help you [configure your controls to limit this risk](#) across your work processes and maintain compliance with critical infrastructure protection standards, such as NERC CIP-003-8 which expands transient cyber asset requirements to low impact substations.





SynchroGrid Collaboration

Doble has [collaborated with SynchroGrid](#) to automate PRC-027-1 compliance and ensure teams have a well-defined and documented relay settings development and revision process. We've developed an API that enables Doble PowerBase™ to provide SynchroGrid's SARA (Setting Automation Relay Assistant) software with relay settings data. SARA utilizes the settings from PowerBase in templates that also pull system model data from ASPEN OneLiner™ and PSS®CAPE. Our teams are available to consult and help you develop full-spectrum PRC compliance programs.

2. Automate burdensome compliance processes.

All too often, ensuring compliance comes at the expense of other work. To satisfy PRC-027-1 requirements, protection engineering teams will need to swiftly produce reports, revisit system models, pull the latest settings data, and individually document and validate protection schemes across all NERC-reportable electrical facilities. Without the right approach, completing those steps can be incredibly time consuming and error prone, not to mention diverting focus from other engineering priorities.

If keeping up with compliance mandates overwhelms your operations, then consider tapping automation to help streamline processes. For PRC-027-1 specifically, there are tools out there that can automatically perform computations and analyses that validate short circuit models and settings data, and generate documentation. It's worth finding a system that does the leg work for you and ensures it is error-free.



3. Train and proactively develop your workforce.

The best way to counteract current piecemeal training approaches is to ensure your team has [a strong and holistic technical foundation](#). Technical training programs that cover relay protection philosophy, new and old technologies, and evolving implementation strategies lay this valuable foundation. Specific training that teaches substation network concepts and communication protocols is also becoming mission critical.

Utilities can only build out their digital infrastructures as much as they have the people internally to [support those investments](#). Data analytics, for example, is becoming a key skillset for the future of energy, but [only 23% of organizations](#) say this role exists internally, according to quality assurance and risk management company DNV. Graduates coming into the power industry have degrees that go beyond engineering to include computer science, data science and more. Give them the space to put those skills to good use. The smarter, more capable and empowered your team gets, the better and faster you can evaluate new technologies and modernize your operations.

4. Think big and consistently look toward the future.

Utilities are already adapting to changes brought on by digital substations and renewable energy technologies. But most efforts related to renewables to date have been focused on where there's a connection between a renewable facility to the grid. Where can you speed progress and make similar investments on the transmission corridor? Where can you apply technology and energy storage to increase hosting capacity on distribution feeders?

Other trends – the Internet of Things (IoT), rise of 5G, electric vehicle batteries, and skyrocketing electricity consumption – will also use high-speed transactions and increase demand and load on the grid. What can you start doing today to prepare? Are your line ratings strong enough to handle an influx? Where do you need to invest in your existing infrastructure, or upgrade your facilities, to boost capacity? Are the instruments you're using to test your range of assets compliant with the latest digital and high-speed standards? If you're unsure of the answer to any of these questions, now is the time to start making moves. Find a partner who can enable you on your journey and position your team to be able to take advantage of these opportunities.



5. Focus on data management, control and standardization.

Every power and utility team needs to be confident in the accuracy and reliability of their testing and maintenance equipment, data and reporting. Companies can face an array of challenges in managing diverse test equipment, software applications, device and test configurations, and data formats. A data management software that integrates with disparate systems, spreadsheets and files can alleviate the burden of organizing and consolidating critical information.

A well-implemented, quality asset and test management system automates information sharing across applications, enabling better tracking of maintenance across assets. Look for comprehensive work management features and reporting that supports the needs of key stakeholders. The right system will offer configurability for your data organization needs and preferences. At the end of the day, clarity over asset health metrics should be provided by built-in analysis tools that present inspection and test result trends and other important details. Tools that administrators need for user access privileges, data clean up, mass updates and so forth should be in their hands and available directly from the interface.



GOING FURTHER WITH TECHNOLOGY

This transitional time in the power industry calls for automated solutions. Protection engineers and relay test personnel must be properly equipped for improving reliability, modernizing, and driving organizational performance to a higher level. Here's what to look for when selecting the right tools for the job.

- 1. A configurable test platform built for an evolving technology environment.** Changes to relays and relay testing will only continue. You can overcome the limits of conventional test sets and the expense of investments in specialized equipment by adopting a universal platform that is flexible and modular. An ideal platform provides test set configurations that align to the testing you do most while offering functionality that prepares you for advancing protection technologies. Look for tools that provide a user experience with the same look and feel across instruments regardless of their configuration.
- 2. Holistic solutions that meet various applications.** Choose test instruments that deliver performance across both conventional and digital testing environments. Should your investments in digital substations continue to grow, not having to make additional investments in different test sets will preserve your budget and prevent headaches from the time and effort otherwise expended on test equipment fleet management.
- 3. Features that make daily work easier on your team.** Digital substations are pushing the limits of workforce experience. The right tools can close the knowledge gap and overcome skills shortages when testing over digital networks. Look for intuitive features that include real-time information surfacing, data visualizations, automated test plan creation, and more to remove guess work and ensure easier troubleshooting, test set up, and execution.
- 4. A partner to work alongside your team.** Evolving your protection testing program toward the digital substation environment invokes new concepts, practices, and considerations. The right solutions will come from a provider who drives value by helping you implement changes in your program around your goals, budgets and timeframes. Tapping solutions that are backed by a team of experts can help you stay ahead of change and feel better [prepared in an evolving landscape](#).



READY FOR WHAT'S NEXT?

The expectations and demands placed on protection and control teams today are quickly increasing. The pace of change in the electric power industry will only continue to accelerate. When the next compliance mandate, new technology or trend comes, will your team be prepared, or disrupted?

Harnessing the power of substation automation shouldn't be elusive. Tools and strategies already exist to help you move forward confidently.

Ready to take the next step? Learn how Doble can help you with your [protection system data](#) and your [protection testing](#) needs.

ABOUT DOBLE ENGINEERING COMPANY

The team at Doble Engineering Company ensures reliable, safe and secure power for all. We do this by providing comprehensive diagnostics and engineering expertise for the energy industry.

Founded in 1920, Doble is committed to the continuing education of our customers, and the support and training of the next generation of power industry workers – uniting the utility sector for an innovative future.

Doble is part of the Utility Solutions Group of ESCO Technologies Inc. (NYSE: ESE). For more information, visit: www.doble.com, follow us on Twitter [@doble](https://twitter.com/doble) and connect on [LinkedIn](#).

