FEATURE

LATEST NERC REQUIREMENTS: GETTING ON THE PATH TO COMPLIANCE

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One need only recall the 2003 electric power blackout across the Northeast United States and Ontario, Canada, to understand the importance of grid stability. Ensuring the reliability of the bulk electric system (BES) has been a national priority for many decades. To that end, the North American Electric Reliability Corporation (NERC) was established in the 1960s to develop and enforce mandatory standards for the maintenance and testing of all transmission and generation protection systems affecting the reliability and operation of the BES.

Recently, NERC handed down several new power system protection standards, including PRC-019, PRC-024, and PRC-025, each with impending compliance deadlines for generator owners and generator operators. Navigating these standards can be more time consuming than a facility's management might realize.

The NERC compliance process starts with understanding the requirements, developing and implementing a compliance plan, and ultimately, reporting actions and efforts to NERC. When generator owners or operators comply with NERC, they are not only doing their part to improve grid reliability, but simultaneously, they are improving their own generator stability and infrastructure performance while avoiding costly fines.

THREE NERC STANDARDS EVERY GENERATOR OPERATOR AND OWNER NEEDS TO KNOW

In 2015, NERC published PRC-019 and PRC-024 to help ensure reliable protection schemes for generating unit facilities. NERC quickly followed up with PRC-025, which included additional requirements for various components of protection schemes. Facilities must demonstrate full compliance with all three standards over the next 12 to 18 months.

COMPLIANCE DEADLINES

NERC PRC-019
Coordination of Generating Unit or Plant Capabilities, Voltage Regulating Controls, and Protection

Compliance Due Dates:

40% complete – March 2016
60% complete – March 2017
80% complete – March 2018
100% complete – March 2019

NERC PRC-024
Generator Frequency and Volatge Protective Relay Settings

Compliance Due Dates:

40% complete – March 2016
60% complete – March 2017
80% complete – March 2018
100% complete – March 2019

NERC PRC-025
Generator Relay Loadabilitility

Compliance Due Dates:

100% complete – October 2019
100% complete if a retrofit is required to comply – October 2021

Figure 1: *NERC Compliance Deadlines*

NERC PRC-019 COORDINATION OF GENERATING UNIT OR PLANT CAPABILITIES, VOLTAGE REGULATING CONTROLS, AND PROTECTION

The purpose of the PRC-019 standard is to verify coordination of a generating unit and protective relays. It applies to all controls and relays that impact the voltage regulation of the generator. Essentially, this standard ensures coordination between the generator's automatic voltage regulator (AVR) and the exciter controls and protective relay systems to ensure safety and reliability. This coordination allows the generator to function appropriately under various conditions, but without causing damage to the generator equipment.

Per the standard, at least every five years, generator owners must verify coordination of the voltage regulating system controls (including in-service limiters and protection functions) with the applicable equipment capabilities and with the settings and functions of applicable protection system devices. Owners may be required to change voltage regulating settings or equipment, protection system settings or components, and generating or synchronous condenser equipment capabilities to ensure compliance with the standard. In other words, owners must adjust device settings to comply with the standard, and if those devices cannot accept the required settings, then the devices must be replaced.

NERC PRC-024 GENERATOR FREQUENCY AND VOLTAGE PROTECTIVE RELAY SETTINGS

The purpose of the PRC-024 standard is to ensure generating units remain connected during defined frequency and voltage excursions. The standard ensures that the generator meets voltage and frequency ride-through requirements during switching transients, and that it will remain online for an event that it is intended to support. The standard requires generator owners to either:

1. Set its installed generator frequency protective relaying so as not to trip during defined frequency-related operating conditions and to set its installed generator over- and under-voltage protective relays (including volts per hertz relays evaluated at nominal frequency) so as not to trip during defined steady-state and voltage-related operating conditions.
2. Document and report the unit's limitations if the required settings cannot be accommodated.

NERC PRC-025 GENERATOR RELAY LOADABILITY

The purpose of the PRC-025 standard is to ensure that load-responsive protective relays associated with generation facilities are set at a level to prevent unnecessary tripping of generators during a system disturbance that does not pose a risk of damage to associated equipment. Studies show that generators have tripped for conditions that did not apparently pose a direct risk to those generators and associated equipment within the time period when the tripping occurred. This tripping can expand the scope and/or extend the duration of a disturbance unnecessarily. In fact, this very scenario contributed to the August 2003 blackout.

PRC-025 establishes criteria for setting load-responsive protective relays that handle load transfer from one generation site to the next, such that individual generators may provide reactive power within their dynamic capability during transient time periods to help the system recover from the voltage disturbance. Generator owners must apply the settings and provide evidence that the settings have been applied. Such evidence may include summaries of calculations, spreadsheets, simulation reports, or setting sheets.

ACHIEVING COMPLIANCE STARTS WITH UNDERSTANDING THE RULES

By now, most generator operators and owners are aware of NERC and have a general understanding of the consequences for non-compliance, which can include stiff penalties. Companies have already been assessed fines as much as $500,000, depending on the violation. Yet, many facilities fail to demonstrate compliance with the enforceable standards. Why? Often, it's because they lack awareness of a specific standard and its enforcement date. Perhaps the person responsible for compliance is no longer with the company. In some cases, the facility engineer in charge of understanding and applying NERC standards misinterprets the standard and believes it is not applicable to his or her facility.

The point is that someone needs to be responsible for paying attention to NERC standards and changes by making a list of standards applicable to their facility. Sometimes, owners and operators become aware of the need to comply with a specific standard because they receive a notification from a transmission owner or operator or because a maintenance professional points it out. Relying on these sources of information can be risky, yet experience shows that most facilities lack the internal resources or focus to dedicate someone to the task of staying on top of the latest NERC requirements. It's simply too much work for in-house teams to take on. Sometimes, partnering with compliance experts who take a proactive approach to understanding NERC standards can help.

It's important and beneficial to address NERC compliance right now. While it can be tempting to delay addressing these technically challenging issues until the deadline gets closer, planning ahead is the best way to ensure any required changes have the least impact on a business. For example, some changes can be scheduled during a regularly planned maintenance shutdown when they will have virtually no cost impact. It's important to get a solid grasp on how NERC will affect the facility so that you can plan ahead.

Once generator operators or owners understand which standards apply to their facility, it's their job to determine the facility's current level of compliance as quickly as possible. They should assess the frequency and voltage protection relays and load-responsive protective relay settings to determine whether their facility is falling short of requirements and by what margin, and ascertain the level of effort needed to meet and demonstrate requirements.

GETTING ON THE RIGHT PATH TO COMPLIANCE

If you discover non-compliance, the next step is further evaluation and analysis. While there are helpful tools to reveal non-compliance for a particular relay setting, understanding the process of achieving compliance can be technically demanding. For example, if the deviation from the required setting is not significant, it may be possible to use computer modeling and analysis to demonstrate compliance. But if the deviation is large, the relay setting change should be coordinated with transmission operators and other entities that can be affected by this change.

You might need expert help to know how to interpret the results of the go/no-go tools and use them to define the right road to compliance. For example, a Fortune 500 integrated power company pursued PRC-019 compliance at its Los Angeles-area plant. The company found expert help for gathering data and applicable documentation for the existing protective relay system, generator unit, and generator excitation system to support analysis and demonstration of compliance. Protection engineers also helped determine which protection relays were subject to complying with the standard.

The team analyzed the settings of the in-service limiters to verify that they were set to avoid disconnecting the generator unnecessarily. It

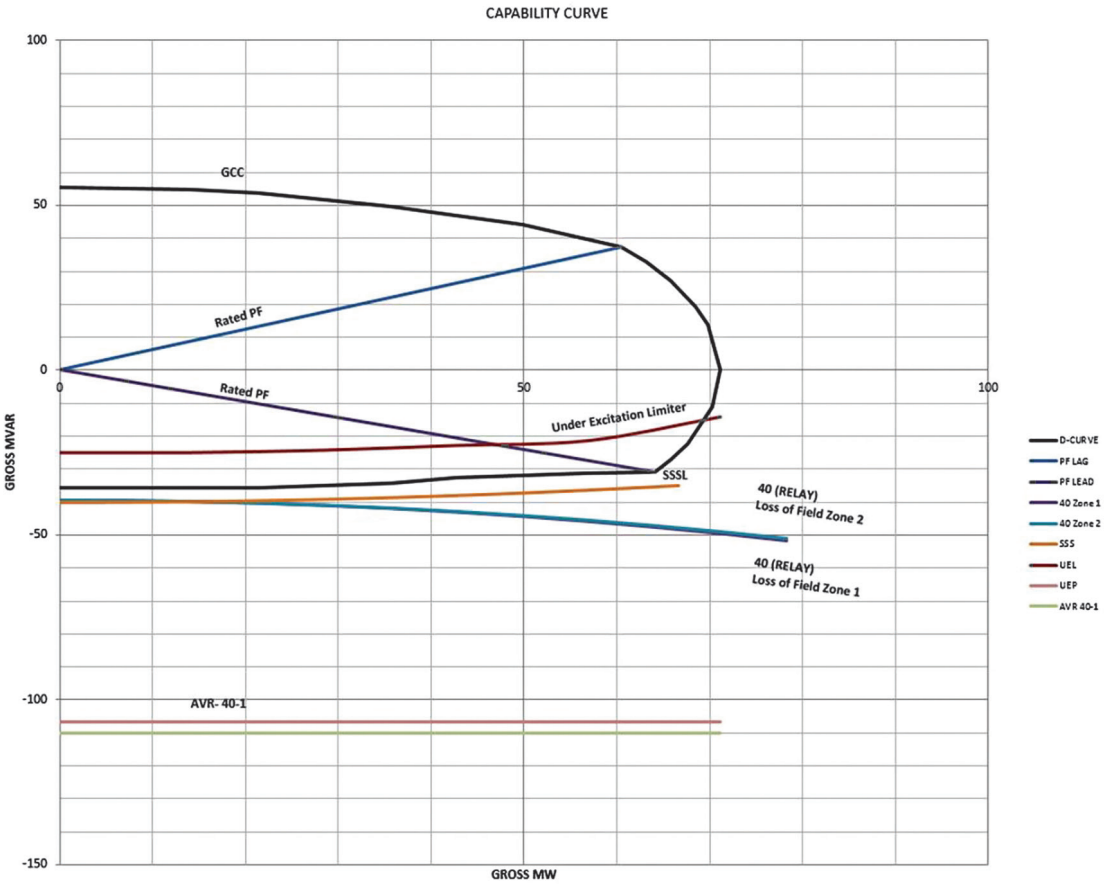

Figure 2: *Sample P-Q Diagram (SEL)*

also analyzed in-service protection system devices, verifying that they were set to operate, isolate, or de-energize equipment to limit the extent of damage when operating conditions exceed equipment capabilities or stability limits. To demonstrate compliance, protection engineers provided P-Q diagrams to illustrate the generator's capabilities, operating limits, and protective functions. R-X diagrams as well as time current curves explained rotor thermal limits. The engineers also plotted permissible volts per hertz limits for the generator and generator step-up (GSU) transformer with the protection and limiting functions to ensure proper coordination.

Per NERC standards, a generation unit can be evaluated under field-forcing simulations using power system modeling software or by conservative loadability evaluation criteria. If the relay setting fails the conservative evaluation by a margin of 30 percent or less, there is a good possibility that the computer modeling option sets accurate limitation for modeled equipment and shows compliance with standards. A complete NERC-approved mathematical proof was created for each load-sensitive relay studied, along with a comprehensive report including detailed recommendations and corrective actions required for ensuring compliance. In the end, the power company had a solid plan for compliance that could be cost-effectively and efficiently implemented prior to the deadline, allowing the business to avoid significant fines.

IMPLEMENTING CORRECTIVE ACTIONS REQUIRES ONGOING SUPPORT

Taking the necessary steps to address protective relay settings and conform with NERC standards is a process that requires coordinated

activities, potentially a planned outage, testing activities, and budgeting. And of course, it all must be documented and accomplished within the compliance deadlines set by NERC.

Generator operators and owners must select, schedule, and implement the most cost-effective and appropriate compliance solutions, including testing, commissioning, and reporting. Generally, if the system is not in compliance with NERC standards, compliance solutions include either changing the settings of some protective relays, or upgrading or replacing some of the relays protecting a facility's generation plant. In both cases, after changes are made, testing, commissioning, and coordination studies/verification for all affected devices are needed to ensure the system functions correctly.

In the Los Angeles-area plant example, an engineering analysis revealed the need for several changes to the ANSI 40 loss-of-excitation function of two different relays. During a short, planned outage, the protective relays were set to comply with the standard, new settings were tested, and documentation was updated within the outage window. System compliance was achieved by modifying the protective relay settings, completing necessary testing, and compiling all data, calculations, and analysis in an easy-to-search electronic report that fully demonstrates compliance.

UPGRADING AND RETROFITTING PROTECTIVE RELAYS

In some cases, a generator's existing protective devices may not be capable of accepting the settings required to comply with NERC requirements. For example, in one generating facility, an engineering analysis revealed that a field overcurrent relay was not compliant with PRC-019 at its present setting. Specifically, the report stated, "At the lower end of its range, the relay does not coordinate with the excitation limiter, and at the upper end of its range, it does not act quickly enough to protect the rotor against thermal damage." In fact, this relay was not capable of both protection and coordination for the installed generator.

In this instance, the AVR manufacturer developed a new relay that was capable of providing adequate protection as well as the coordination required by the NERC standards. The new relay was designed, tested, and installed, bringing the facility into compliance and also improving grid stability for the transmission owner.

DEMONSTRATING COMPLIANCE

Whether a generating facility needs to adjust protective relay settings or upgrade or replace protective relays, the facility must demonstrate to NERC that its solutions meet the requirements laid out in the standard. Facilities will need to create a well-structured report that clearly presents the data and the sources of data used during the studies. The report should make the information easily assessable to auditors. If the facility needs to make any setting adjustments or relay changes based on the assessments, the report should outline the recommended solutions and plan of action.

NERC conformance reports and compliance documentation should be designed with the auditor's needs in mind. Use standardized terminology and equations from the NERC standards to ensure clear interpretation of the results. Include comprehensive engineering analysis that is searchable and linked for ease of navigation and full demonstration of compliance. Reports should allow for the easy addition of updated or cyclic information, such as relay maintenance test data, which must be added every five years. Learn how to complete these updates for long-term compliance.

START THE COMPLIANCE PROCESS NOW

NERC developed its standards to ensure generation plants can manage disturbances in

the best way possible to balance protection with reliability. Complying with NERC's latest regulatory standards is essential to the protection of the nation's grid and the safe and efficient operation of power generation equipment.

With deadlines approaching for compliance with several critical standards, now is the time for generator operators and owners to assess their protective relay settings and make a plan for compliance. It is important to conduct a reliable power system analysis and perhaps obtain expert recommendations while streamlining the process of changing relay settings and/or replacing protective relays. The key is for facilities to make the right choices for their operations and the BES.

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