DO YOU KNOW THE STATUS OF THE STATION DC SUPPLY FOR YOUR BULK POWER SYSTEM? A UTILITY'S PERSPECTIVE ON THE UPCOMING CHANGES OF NERC PRC-005

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ABSTRACT

There has been some confusion between the utilities and the North American Electric Reliability Corporation (NERC) as it relates to Protection and Control (PRC)-005. This reliability standard is intended to assure transmission and generation protection systems are maintained and tested so as to provide reliable performance. Stationary batteries and the dc power system play a large role in these protection systems and the reliability of the Bulk Electric System (BES). As a result, maintenance and testing of the station dc supply that can have an effect on the reliability of the BES has taken on new significance. NERC Standard PRC-005-1 took effect on June 18, 2007, and applies to transmission owners, generator owners, and distribution providers. Since then, these entities have been trying to understand and comply with the standard. This paper will familiarize the reader with the history of the standard, penalties for non-compliance, and an update on the upcoming changes to the standard.

INTRODUCTION

The NERC guidelines outlined in PRC-005 govern the maintenance requirements for control and protection devices. PRC-005 contains requirements for all equipment inside a substation in addition to batteries. This paper should prepare the reader for the upcoming changes to the NERC standard, as it relates to the batteries in a BES. The information for the maintenance requirements for batteries is found in multiple places on the NERC website and is compiled in this paper for the ease of its use. This paper was written using the latest draft of PRC-005-2, and it is possible further changes will be made prior to the document being published.

NERC'S HISTORY

NERC is an agency that was formed on June 1, 1968, under the name of National Electric Reliability Council in response to a series of blackouts that took place in 1965. At the start of the organization, the standards it produced were only voluntary and were considered as recommendations. In 1981, the name was changed to North American Electric Reliability Council because of Canada's participation in NERC. The Federal Energy Regulatory Commission (FERC) and the National Energy Board of Canada recognized and certified NERC as an "electric reliability organization" by the end of 2006. On June 18, 2007 the NERC Reliability Standards became mandatory and enforceable in the United States[1].

BULK ELECTRIC SYSTEM

NERC's charter is to protect the BES, which is sometimes referred to as the Bulk Power System (BPS) on their website. The BPS is defined as: The part of the overall electricity system that includes the generation of electricity and the transmission of electricity over high-voltage transmission lines to distribution companies. This includes power generation facilities, transmission lines, interconnections between neighboring transmission systems, and associated equipment. It does not include the local distribution of the electricity to homes and businesses[2]. NERC has set that any substation with a primary voltage of 100 kV or greater and generation is considered part of the BES.

COMPLIANCE

Since 2007, NERC has the legal authority to enforce the compliance of all its reliability standards. The fines issued by NERC can be as large as $ 1 million dollars per incident and per day. NERC uses the eight regional entities:

- Florida Reliability Coordination Council (FRCC)
- Midwest Reliability Organization (MRO)
- Northeast Power Coordinating Council (NPCC)
- ReliabilityFirst Corporation (RFC)
- SERC Reliability Corporation (SERC)
- Southwest Power Pool, RE (SPP)
- Texas Regional Entity (TRE)
- The Western Electricity Coordinating Council (WECC).

With the help of these agencies, NERC prepares reports and records all disturbances on the BES. The results of the investigation, and the amount of the fines, are then published on NERC's website. NERC has also instituted standards to protect the electrical infrastructure from cyber and physical threats, and is in communication with other government agencies when possible threats exist to the electrical grid.

HOW NERC STANDARDS ARE WRITTEN

Industry experts and compliance personnel get together and form a work group to write the standards. The work group meets regularly to write the standards from an objective, and technically sound standpoint. Once these standards are agreed upon they are opened to a wider audience for comments. The committee then meets to address the comments, and after comment resolution, they are filed with FERC for approval. Once FERC issues its approval, the standards are then legally enforceable by NERC through the eight regional entities. These standards will then be benchmarked to utilize the best practices from the utility industry and can be changed as new information is gathered across North America. The standards are also accredited by the American National Standards Institute (ANSI) and North American Energy Standards Board (NAESB)

MONITORING LEVEL

Each department having a battery system on the BES will need to provide NERC a Protection System Maintenance Program (PSMP). The minimum maintenance requirements for the PSMP will be impacted by the level of monitoring that is used at the facility. The maintenance requirements for the three monitoring levels are different, so it is important to correctly identify your level at the site. Each BES provider will need to evaluate their station and determine what level of monitoring is at the site. NERC defines, in the current draft of PRC-005-02, the monitoring levels as:

- Level 1 Monitoring: Protection System components which do not have self-monitoring alarms, or if self-monitoring alarms are available, the alarms are not transmitted to a location where action can be taken for alarmed failures.

- Level 2 Monitoring: Protection System components whose alarms are automatically provided daily (or more frequently) to a location where action can be taken for alarmed failures. Detected maintenance-correctable issues for Level 2 Monitored Protection Systems must be reported within 1 day or less of the maintenance-correctable issue occurring, to a location where action can be taken to initiate resolution of the maintenance-correctable issue.

- Level 3 Monitoring: Protection System components in which every function required for correct operation of that component is continuously monitored and verified, and detected maintenance-correctable issues reported. Level 3 Monitored Protection Systems also includes verification of the means by which alarms and monitored values are transmitted to a location where action can be taken. Detected maintenance-correctable issues for Level 3 Monitored protection Systems must be reported within 1 hour or less of the maintenance-correctable issue occurring, to a location where action can be taken to initiate resolution of the maintenance-correctable issue. Level 3 Monitoring includes all attributes of Level 2 Monitoring, with additional monitoring attributes as listed below for the individual type of component.

LEVEL 1 MAINTENANCE REQUIREMENTS

The maintenance activities for all levels of monitoring have a maximum maintenance interval not to be exceeded by their calendar date. These maintenance activities have been taken from the latest draft of PRC-005-02, and will necessitate corrective action if an abnormal issue is found during the routing inspection intervals. Level 1 maintenance requirements are:

Every 3 Calendar Months Check:

- Electrolyte level (all batteries except Valve Regulated Lead Acid Batteries [VRLA])
- Station dc supply voltage
- Check for unintentional grounds
- For VRLA batteries there are two options to perform an activity at 3 months or 3 years. They are:

    - Every 3 months verify that the station battery can perform as designed by evaluating the measured cell/unit internal Ohmic values to station battery baseline.

    Or

    - Every 3 years verify that the station battery can perform as designed by conducting a performance or service capacity test of the entire battery bank

Every 18 Calendar Months

Inspect:

- Cell condition of all individual battery cells where plates are visible
- Measure battery cell/unit internal Ohmic values when the plates are not visible
- Physical condition of battery rack
- The condition of non-battery-based dc supply

Verify:

- State of charge of the individual battery cell/units
- Float voltage of battery charger
- Battery continuity
- Battery terminal connection resistance
- Battery cell-to-cell connection resistance
- Vented Lead-Acid Batteries (VLA) have two maintenance options; either to perform an activity at 18 months or 6 years. They are:

    - Every 18 months verify that the substation battery can perform as designed by evaluating the measured cell/unit internal Ohmic values to a station battery baseline

    Or

    - Every 6 years verify the station battery can perform as designed by conducting a performance, service, or modified performance capacity test of the entire battery bank

Every 3 Calendar Years Verify:

- For VRLA batteries if no internal Ohmic values are taken, at the 3 month interval, then verify that the station can perform as designed by conducting a performance or service capacity test of the entire battery bank

Every 6 Calendar Years Verify:

- For VLA batteries if no internal Ohmic values are taken, at the 18 month interval, then verify that the station can perform as designed by conducting a performance or service capacity test of the entire battery bank
- For all Nickel-Cadmium (Ni-Cd) batteries verify that the substation battery can perform as designed by conducting a performance service, or modified performance capacity test of the entire battery bank. This will be a requirement since Ni-Cd batteries cannot have internal Ohmic measurements accurately performed on them.

LEVEL 2 MAINTENANCE REQUIREMENTS

A station will be considered Level 2 if it meets specific monitoring requirements. If the requirements for Level 2 are not met, the maintenance required will revert to a Level 1 monitored station. A Level 2 station will require additional maintenance for the monitoring system. The calendar interval for the monitoring system maintenance requirements has not been determined as of yet, but it will require verifying the monitoring devices are calibrated (where necessary) and the alarms will be received at the location where action can be taken. The requirements to be considered for Level 2 monitoring are:

- Station dc supply voltage
- Unintentional dc grounds
- Electrolyte level of all cells in a station battery (except VRLA batteries)
- Individual battery cell/unit state of charge
- Battery continuity of station battery
- Cell-to-cell and battery terminal resistance

If it is determined that the station is a Level 2 the maintenance requirements are:

Every 3 Calendar Months Check:

- VRLA batteries have two maintenance options. They are:
    - Every 3 months verify that the station battery can perform as designed by evaluating the measured cell/unit internal Ohmic values to station battery baseline

      Or
    - Every 3 years verify that the station battery can perform as designed by conducting a performance or service capacity test of the entire battery bank

Every 18 Calendar Months

Inspect:

- Cell condition of all individual battery cells where plates are visible
- Measure battery cell/unit internal Ohmic values where the plates are not visible
- Physical condition of battery rack
- The condition of non-battery-based dc supply
- VLA batteries have two maintenance options; either to perform an activity at 18 months or 6 years. They are:
    - Every 18 months verify that the substation battery can perform as designed by evaluating the measured cell/unit internal Ohmic values to station battery baseline

      Or
    - Every 6 years verify that the station battery can perform as designed by conducting a performance, service, or modified performance capacity test of the entire battery bank every 6 calendar years

Every 3 Calendar Years Verify:

- For VRLA batteries if no internal Ohmic values are taken, at the 3 month interval, then verify that the station can perform as designed by conducting a performance or service capacity test of the entire battery bank

Every 6 Calendar Years Verify:

- For VLA batteries if no internal Ohmic values are taken, at the 18 month interval, then verify that the station can perform as designed by conducting a performance or service capacity test of the entire battery bank
- For all Nickel-Cadmium (Ni-Cd) batteries verify that the substation battery can perform as designed by conducting a performance service, or modified performance capacity test of the entire battery bank. This will be a requirement since Ni-Cd batteries cannot have internal Ohmic measurements accurately performed on them.

LEVEL 3 MAINTENANCE REQUIREMENTS

Level 3 stations have the same maintenance requirements for the batteries as Level 2. However, there are different maintenance requirements for other pieces of equipment for the site for Level 3. Level 3 monitored stations need to meet the requirement of Levels 1 and 2, and if any of these requirements are not met, Level 1 maintenance will be required. The requirement for a Level 3 station is to have continuous monitoring with alarming to a remote location upon any failure of the monitoring device or when sensors for the devices are out of calibration for the following:

- Station dc supply voltage
- Unintentional dc grounds
- Electrolyte level of all cells in a station battery (except VRLA batteries)
- Individual battery cell/unit state of charge
- Battery continuity of station battery
- Cell-to-cell and battery terminal resistance

Every 3 Calendar Months Check:

- VRLA batteries have two maintenance options. They are:
    - Every 3 months verify that the station battery can perform as designed by evaluating the measured cell/unit internal Ohmic values to station battery baseline

      Or
    - Every 3 years verify that the station battery can perform as designed by conducting a performance or service capacity test of the entire battery bank

Every 18 Calendar Months

Inspect:

- Cell condition of all individual battery cells where plates are visible
- Measure battery cell/unit internal Ohmic values where the plates are not visible
- Physical condition of battery rack
- The condition of non-battery-based dc supply
- VLA batteries have two maintenance options; either to perform an activity at 18 months or 6 years. They are:
    - Every 18 months verify that the substation battery can perform as designed by evaluating the measured cell/unit internal Ohmic values to station battery baseline

      Or
    - Every 6 years verify that the station battery can perform as designed by conducting a performance, service, or modified performance capacity test of the entire battery bank every 6 calendar years

Every 3 Calendar Years Verify:

- For VRLA batteries if no internal Ohmic values are taken, at the 3 month interval, then verify that the station can perform as designed by conducting a performance or service capacity test of the entire battery bank

Every 6 Calendar Years Verify:

- For VLA batteries if no internal Ohmic values are taken, at the 18 month interval, then verify that the station can perform as designed by conducting a performance or service capacity test of the entire battery bank
- For all Nickel-Cadmium (Ni-Cd) batteries verify that the substation battery can perform as designed by conducting a performance service, or modified performance capacity test of the entire battery bank. This will be a requirement since Ni-Cd batteries cannot have internal Ohmic measurements accurately performed on them.

SUMMARY

Events such as the Northeast blackout on August 2003 illustrate how important a reliable BES is to North America. BES providers will need to adapt to the upcoming changes, and this may be against their culture if they are slow to react to changes in the industry. NERC's goals are to develop minimum standards that are consistently met across the utilities in the United States and Canada. With NERC and the BES providers working together by networking and benchmarking best practices it will create a more reliable electrical grid. Key players involved in the BES will need to get involved and contribute to writing standards if they are to be effective. As a BES provider, I feel it is more effective to be involved with developing the standards rather then finding out about them after the fact. This makes it much easier to comply with them rather then having to respond to an inspector on the site asking for your maintenance records. The standards outlined in PRC-005-02 will be constantly changing, and as a result, the current standards will not be perfect. However, this is a starting point, and I encourage all of the utilities to get involved to help steer these standards into a document that will achieve the ultimate goal of a robust reliable Bulk Electrical System.

REFERENCES

[1] Web. <http://www.nerc.com/page.php?cid=3|249>.

[2] Web. <http://www.nerc.com/page.php?cid=1|15|122>