EAGLE EYE TECHNICAL NOTE

Title	**Differing Maintenance Requirements of IEEE 450 and PRC-005-6 for Vented Lead-Acid (VLA) Batteries**
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Revision History

Date	Revision	Change Description	Author(s)
10/1/18	0	Initial Release	JAB
9/28/18	1	Updated Issue Numbers.	JAB
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Vented Lead-Acid (VLA) Batteries
Differing Maintenance Requirements of IEEE 450-2010 and PRC-005-6

Overview.

In 2005, the North American Electric Reliability Corporation (NERC) released the Protection System Maintenance Standard PRC-005. NERC comes under the Federal Energy Regulatory Commission (FERC). The mission of NERC is to ensure the reliability of the bulk power system in the USA and Canada. This standard has been revised several times since and is currently PRC- 005-6. The battery maintenance requirements have not changed since PRC-005-2.

FERC is an independent government agency that is part of the U.S. Department of Energy (DOE). The purpose of the FERC is to protect the public and energy customers, ensuring that regulated energy companies are acting within the law.

The purpose of PRC-005 is to document and implement programs for the maintenance of all Protection Systems affecting the reliability of the Bulk Electric System (BES) so that these Protection Systems are kept in working order. Compliance is mandatory. NERC defines reliability as Ensuring that the Bulk Power System (BPS) or Bulk Electric System (BES) is able to meet the electricity needs of all end-user customers, even when unexpected equipment failures reduce the amount of available electricity.

Batteries that are used in conjunction with protection systems fall under the requirements of PRC-005. The maintenance requirements for protection system dc supply using Vented Lead-Acid (VLA) batteries are detailed in Tables 1-4(a) and 1-4(f) of the document.

There are considerable differences between the requirement of PRC-005-6 and IEEE 450-2010, *the IEEE Recommended Practice for Maintenance, Testing, and Replacement of Vented Lead-Acid Batteries for Stationary Applications*. This Technical Note details these differences.

PRC-005-6

The contents of Table 1-4(a) are as follows:

For Protection System Station dc supply using **Vented Lead-Acid (VLA) batteries** not having the monitoring attributes of **Table 1-4(f).**

Maximum of every 4 months:

Verify:
- Station dc supply voltage.

Inspect:
- Electrolyte level.
- For unintentional grounds.

Maximum of every 18 months.

Verify:
- Float voltage of the battery charger.
- Battery continuity.
- Battery terminal connection resistance.
- Battery inter-cell or unit to unit connection resistance.

Inspect:
- Cell condition of all individual battery cells where cells are visible - or measure battery cell/unit internal ohmic values where the cells are not visible.
- Physical condition of the battery rack.

Verify that the station battery can perform as manufactured by evaluating cell/unit measurements indicative of battery performance (e.g. internal ohmic values or float current) against the station battery baseline.

Or:

Maximum of every 6 years.
Verify that the station battery can perform as manufactured by conducting a performance or modified performance capacity (load) test of the entire battery bank.

Table 1-4(f) lists the **exclusions** for Protection System dc Supply (having) **Monitoring Systems and Devices.**

The contents of Table 1-4(f) indicate as follows:

- Any station dc supply with high and low voltage monitoring and alarming of the battery charger voltage to detect charger overvoltage and charger failure.
  - No periodic verification of station dc supply voltage is required.

- Any battery-based station dc supply with electrolyte level monitoring and alarming in every cell.
  - No periodic inspection of the electrolyte level for each cell is required.

- Any station dc supply with unintentional dc ground monitoring and alarming.
  - No periodic inspection of unintentional dc grounds is required.

- Any station dc supply with charger float voltage monitoring and alarming to ensure correct float voltage is being applied on the station dc supply.
  - No periodic verification of float voltage of battery charger is required.

- Any battery-based station dc supply with monitoring and alarming of battery string continuity.
  - No periodic verification of the battery continuity is required.

- Any battery-based station dc supply with monitoring and alarming of the intercell and/or terminal connection detail resistance of the entire battery.
  - No periodic verification of the intercell and terminal connection resistance is required.

- Any Valve Regulated Lead-Acid (VRLA) or Vented Lead-Acid (VLA) station battery with internal ohmic value or float current monitoring and alarming and evaluating present values relative to baseline internal ohmic values for every cell/unit.
  - No periodic evaluation relative to baseline of battery cell/unit measurements indicative of battery performance is required to verify the station battery can perform as manufactured.

- Any Vented Lead-Acid (VLA) station battery with monitoring and alarming of each cell/unit internal ohmic value.
  - No periodic inspection of the condition of all individual units by measuring battery cell/unit internal ohmic values of a station VRLA or Vented Lead-Acid (VLA) battery is required

IEEE 450-2010

The maintenance requirements are detailed in Section 5 of the document and are as follows:

Monthly.

Inspection of the battery on a regularly scheduled basis (at least once per month) should include a check and record of the following:

a) Float voltage measured at the battery terminals
b) General appearance and cleanliness of the battery, battery rack or battery cabinet, and the battery area
c) Charger output current and voltage
d) Electrolyte levels

e) Cracks in cells or evidence of electrolyte leakage
f) Any evidence of corrosion at terminals, connectors, racks, or cabinets
g) Ambient temperature and ventilation
h) Pilot cells (if used) voltage and electrolyte temperature
i) Battery float charging current or pilot cell specific gravity (For lead-antimony cells, specific gravity is preferred. Contact the manufacturer for specific recommendations.)
j) Unintentional battery grounds
k) All battery monitoring systems are operational (if installed)

Quarterly.

At least once per quarter, a monthly inspection should be augmented as follows.

Check and record the following:
a) Voltage of each cell.
b) For lead-antimony batteries, specific gravity of 10% of the cells of the battery and float charging current.
c) For technologies other than lead-antimony, if battery float charging current is not used to monitor state of charge, specific gravity of 10% of the cells of the battery.
d) Temperature of a representative sample of 10% of the battery cells (Example for a sixty-cell string, measure the temperature of every tenth cell for a total of six cells.)

Yearly.

At least once each year, the quarterly inspection should be augmented as follows:

Check and record the following:
a) For lead-antimony batteries, specific gravity of all cells of the battery.
b) For technologies other than lead-antimony, if battery float charging current is not used to monitor state of charge, specific gravity of all cells of the battery.
c) Cell condition (This involves a detailed visual inspection of each cell in contrast to the monthly inspection. Review manufacturer's recommendations.)
d) Cell-to-cell and terminal connection resistance.
e) Structural integrity of the battery rack and/or cabinet.

Special Inspections.

A complete set of specific-gravity readings should be recorded upon initial installation and after two years of service on all cell types.

Performance Testing.

a) A performance test of the battery capacity should be made within the first two years of service. It is desirable for comparison purposes that the performance tests be similar in duration to the battery duty cycle.
b) Batteries should undergo additional performance tests periodically. When establishing the interval between tests, factors such as design life and operating temperature should be considered. It is recommended that the performance test interval should not be greater than 25% of the expected service life.
c) Annual performance tests of battery capacity should be made on any battery
d) that shows signs of degradation or has reached 85% of the service life expected for the application.

In view of the above, it is noted that the requirements of PRC-005-6 are much less stringent than those of IEEE 450-2010. In particular:

IEEE 450-2010 recommends that a visual inspection be carried out monthly. PRC-005-6 only requires visual inspections every 4 months. If electrolyte level monitor and unintentional grounding monitor is installed a visual inspection is only required every 18 months.

IEEE 450-2010 recommends these monthly measurements:

- Overall float (charge) voltage measured at the battery terminals.*
- Charger output current and voltage.*
- Ambient temperature.^
- DC float (charge) current per string.^

* PRC-005-6 only requires these every 18 months.
^ PRC-005-6 does not require these.

IEEE 450-2010 recommends that these quarterly measurements in addition to these taken monthly:

- Cell/unit internal ohmic values.*
- Temperature of the negative terminal of each cell/unit.^
- Voltage of each cell/unit.^
- Electrolyte temperature of 10% of the battery cells.^

* PRC-005-6 only requires this on an 18-month basis.
^ PRC-005-6 does not require these.

IEEE 450-2010 recommends these yearly measurements in addition to those taken monthly and quarterly:

- Structural integrity of the battery rack or cabinet*
- Cell-to-cell and terminal connection resistance of the entire battery. Retorque if any readings are outside manufacturer's specifications.*
- AC ripple current and/or voltage imposed on the battery.^
- Specific gravity readings of all Lead-Antimony cells.^

* PRC-005-6 only requires these every 18 months.
^ PRC-005-6 does not require these.

IEEE 450-2010 recommends that a complete set of specific-gravity readings should be taken and recorded upon initial installation and after two years of service on both lead-calcium and lead-antimony.
PRC-005-6 does not require this.

IEEE 450-2010 recommends that performance (load) testing be carried out within the first two years and at periods of not greater than 25% of expected service life.
PRC-005-6 only requires a performance test every six years and only if ohmic measurements are taken every 18 months and/or float current is monitored. There is also no requirement for a performance test if the battery has degraded to 85% of service life.

Summary

In view of the above, Eagle Eye Power recommends that in order to properly and adequately maintain a VLA battery plant, the requirements of IEEE 450-2010 be followed. PRC-005-6, while a step in the right direction, in the opinion of this author, does not adequately provide for satisfactory battery maintenance. If a permanent monitor is installed, then this is a big improvement as charger and battery degradation can be observed in a real-time basis. However, to do this, any alarms must be analyzed by knowledgeable personnel in order to routinely interpret the monitored data.

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Notes regarding Eagle Eye Power Solutions Cost Saving Calculator for the use of a permanently installed battery monitor system.

The Eagle Eye Cost saving calculator is based on the fact that PRC-005-6 states in Table 1-4(f) that basically, any battery system that has a permanently installed monitoring system that fulfills the requirements of tables 1-4 (a) (b) and (c) negates that fact that the maintenance requirements of these tables are necessary.

The calculator does not take into account the cost of capital equipment that needs to be used in manually testing a battery system in accordance with complying with PRC-005. This can Include the following:

- A 3 ½ Digit Multi Meter
- A Hydrometer
- An Ohmic Tester
- An infra-red heat gun

The calculator allows the user to allocate maintenance costs that are not usually considered such as travel costs and time into the overall cost analysis.

Should any user of this calculator have any questions or comments please do not hesitate to contact Eagle Eye where an expert on PRC-005 and IEEE battery standards will be available to help you.