Achieving NERC Compliance

With the Vigilant Battery Monitor

Which NERC Standards?

- Currently there are two NERC standards which reference batteries as part of a DC Supply within the BES.
- **PRC-005-6** defines a calendar-based maintenance schedule for the DC supply in which the frequency of the onsite visits and the maintenance requirements are dependent on the type of batteries installed.
- **TPL-001-5** Identified the single charger single battery type of DC supply as a potential single point of failure. In recognition that it may not be possible to add redundant chargers and batteries at many locations, if the dc supply voltage and battery continuity are monitored on a 24/7 basis that will be acceptable.

PRC-005-6 Mandated Requirements

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- PRC-005-6 Requires the following parameters to be measured and recorded
- Every 4 months
- Verify
  - DC Voltage
- Inspect
  - Electrolyte Level (if applicable)
  - Ground Fault
- Every 6 months
- Inspect
  - Ohmic Value (VRLA only)

PRC-005-6 Mandated Requirements

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- Every 18 months
- Verify
  - Float voltage of battery charger
  - Battery continuity
  - Battery terminal connection resistance
  - Battery intercell 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 (Not Nickel Cadmium)
  - Physical condition of battery rack

PRC-005-6

- Every 18 months
  - 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-

- Every 6 years VLA, Nickel Cadmium and 4 years VRLA
  - Verify that the station battery can perform as manufactured by conducting a performance or modified performance capacity test of the entire battery bank.

Table 1-4(f)

Table 1-4(f) Exclusions for Protection System Station dc Supply Monitoring Devices and Systems		
Component Attributes	**Maximum Maintenance Interval**	**Maintenance Activities**
Any station dc supply with high and low voltage monitoring and alarming of the battery charger voltage to detect charger overvoltage and charger failure (See Table 2).	No periodic maintenance specified	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 (See Table 2).		No periodic inspection of the electrolyte level for each cell is required.
Any station dc supply with unintentional dc ground monitoring and alarming (See Table 2).		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 (See Table 2).		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 (See Table 2).		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 (See Table 2).		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 (See Table 2).		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 Valve Regulated Lead-Acid (VRLA) or Vented Lead-Acid (VLA) station battery with monitoring and alarming of each cell/unit internal ohmic value (See Table 2).		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.

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DC Supply

"Any station dc supply with high and low voltage monitoring and alarming of the battery charger voltage to detect charger overvoltage and charger failure"

- Although this capability may already be available within the charger in order to provide an integrated compliance report the monitor should measure and report any deviations to the DC Supply voltage under normal operation.
- The monitor should read the voltage at the battery terminals and not add the individual unit voltages to calculate the DC bus voltage
- As the setting of the charger voltage is determined by the type of battery installed. The correct location to validate the DC buss is at the battery terminals.

Electrolyte Level Sensing

"Any battery-based station dc supply with electrolyte level monitoring and alarming in every cell"

An Electrolyte Level Sensor will typically be attached to the cell wall adjacent to the level markings on the cell case.

The integration of the level sensor with the individual cell monitor allows any changes in the water usage to be tracked on an individual cell basis.

Ground Fault Detection

"Any station dc supply with unintentional dc ground monitoring and alarming"

- At many locations there will be an existing ground fault monitor often integrated within the charger.
- In many cases the method used by the charger will be a balanced resistor network which limits the use of a similar system in the battery monitor.
- If that is the case the battery monitor should either employ an alternative detection method or be able to accept a signal from the existing ground fault monitor to ensure all the common reporting structure for standard compliance.

Float Voltage Monitoring

"Any station dc supply with charger float voltage monitoring and alarming to ensure correct float voltage is being applied on the station dc supply"

- Although specified as a separate measurable parameter within the standard.
- Providing the High and Low level DC alarms limits used to meet the four monthly inspection compliance are set using the battery manufacturers limits the same alarms will demonstrate compliance with this element of the standard

Interconnection Resistances

"Any battery-based station dc supply with monitoring and alarming of the intercell and/or terminal connection detail resistance of the entire battery"

- Some battery monitors include the terminal resistance of the interconnect to the next unit in the preceding unit ohmic measurement.
- This is not acceptable because the standard requires that the individual connections are measured, and a value recorded.
- Because the connection values for the unit interconnections, inter tier and terminal connections will be different they should be listed separately to ensure these values are not misinterpreted.
- The use of a correction factor to eliminate the variance's is not recommended.

Battery Continuity

"Any battery-based station dc supply with monitoring and alarming of battery string continuity"

- In order to measure continuity in any electrical circuit a current must pass through the circuit and be measured the battery is no different.
- All lead acid batteries require a small charging current to compensate for self discharge.
- This is typically in the milliamp range and cannot be measured accurately with a typical current transducer sized to measure Discharge/Recharge currents.
- The resistance of the intercell connections is measured as part of the ohmic measurement sequence using a defined level of current. That resistance measurement allows the interconnects to be used as shunts

Ohmic Measurement

"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 "

- During a manual maintenance inspection the standard allows for the edges of the plates to be inspected to assess the batteries condition.
- That requires a person with a great deal of battery knowledge to do so accurately.
- As a result most companies collect the ohmic and other battery data and use the vendor software to store and then view the data to determine the battery's condition.

Battery Condition Assessment

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"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"

- In Table 1-4(f) the requirement to manually evaluate the collected battery status is removed possibly in the belief that the monitor software will carry out that function.

- For most monitors, the software is the same as that used to analyze the manually collected data and still requires human interpretation.

- The perception that any of the measured parameters can be a single definitive determinant as to the battery condition is not true.

IEEE 1491 A Guide to Battery Monitoring

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- IEEE 1491 identifies all the battery parameters that should be measured and analyzed in order to determine a battery’s condition. They Include;
- Voltage – String and Unit, operating under open circuit, float, discharge and recharge conditions.
- Current – System and string, operating under float, discharge and recharge conditions.
- Temperature – Ambient and unit, operating under open circuit, float, discharge and recharge conditions.
- Specific Gravity – Cell, the battery should be fully charged.
- Ohmic value - Cell, the battery should be fully charged.

Interpreting the Data

- For each of the data points listed in IEEE 1491 the value measured at any point in time will be dependent on the value of at least two of the other parameters.
- In a multi unit battery the change in values should be relatively consistent between the individual units whether the battery is open circuit, on float, during discharge and in recharge.
- Any unit in which the measured parameters differ from other units is a clear indication of a change in the electro chemical reaction within that unit and a possible precursor of eventual failure.
- It is the analysis of the number and rate of these changes that can be used to determine the battery’s State of Health and it’s Potential Risk of Failure.

Doing the Analysis

- Unfortunately, most monitors in service do not have that level of analysis.
- They are still based on the original premise that they were data collection tools for the battery technician to do the analysis.
- The latest versions of the supporting software will typically provide the ability to set limit-based alarms to identify parameters that are outside acceptable limits.
- There is also the ability to trend the data from the individual parameters , but the focus is almost always on the ohmic values.
- While a change in an individual units ohmic value can indicate a potential point of failure that should be investigated.
- It does not accurately establish the ability of the battery to support the load for the required time if placed under load .

To Conclude

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- To compensate for the lack of analysis in the software some of the monitoring companies provide an analysis service as an option.
- The ability to transmit operational data outside the secure environment is going to be severely limited in order to comply with the CIP Standards.
- The CIP standards are going to impact every aspect of implementing a monitoring program.
- The key is to add analysis to the software and in todays environment the obvious solution is to implement AI.
- AI requires a lot of data and it is best analyzed at the source to minimize the amount of data transmitted on the network.

Any Questions