EAGLE EYE
TECHNICAL NOTE

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Ohmic measurements and IEEE Standard 1188-2005 - *IEEE Recommended Practice for Maintenance, Testing, and Replacement of Valve-Regulated Lead-Acid Batteries for Stationary Applications.*

Overview

The above referenced document discusses ohmic measurements and the use of this data in determining battery state-of-health (SOH). While a very useful tool, full reliance on ohmic measurements in determining the condition of a battery cell/unit can often be misleading and can give inaccurate "good" and "bad" indications. Also, in many cases, the ohmic value of a particular cell/unit indicated on a data sheet is not accurate. This is because this value has been determined using a newly manufactured cell/unit in a laboratory and not a cell/unit that has been fully formed by having been placed in service for a period of time.

Taking the Measurements.

The key to obtaining the most reliable results lies in the method of testing and in the trending of the test data.

- All measurements should be made under normal float conditions if possible.
- Baseline data should be established approximately six months after the battery has been in service. This is to ensure that the battery has been fully formed.
- The same test instrument should be used for the initial and all subsequent tests.
- The same method of test should be employed, i.e. the type and placement of the test probes should be consistent.
- The test probes should always be in direct contact with the cell/unit posts and not the post hardware.
- If it is not practical to place the test probes directly on the call/unit posts, then the proper torque of the battery and inter-cell connections should be verified before ohmic testing.
- Test readings that appear to be erroneous should always be retested.
- Charge voltage and current, and battery ambient and string temperature should be recorded with all ohmic measurements and submitted with any warranty claims.
- Trending data should always be used to substantiate any warranty claims.

Manufacturers' Requirements.

Almost all manufactures require a 50% or more deviation from baseline readings as grounds for a warranty claim.

Some manufacturers are requiring a 50% deviation from "string average" rather than baseline as an out-of-tolerance reading.

All manufacturers require trending data, and as an example, one manufacturer's requirements are indicated below:

- Baselines are to be established after battery has been in service for 6 months.
- A minimum history of 3 periodic readings with an established baseline, with the same ohmic tool and method, is required when evaluating ohmic variance to baseline. These records are required to support the warranty claim.
- All ohmic values from the battery string averaged together will be used when evaluating ohmic variance to string average.
- For the most effective data, periodic maintenance ohmic readings are to be taken with the same meter.
- New cell/units added to a string may require additional evaluation.
- Individual voltage and ohmic readings for a full battery string are required documentation to support the warranty claim.
- A second, repeat reading should be taken of any cell/unit that fails the ohmic criteria to ensure that there was not a measurement error.
- Actual float voltage of the system must be supplied. This reading should be taken before any ohmic testing is conducted, as loads placed on the battery by some ohmic testers will affect the float voltage.
- Battery cell/unit surface temperature is required. If the battery is on float, the best place to measure the temperature is at the negative post or termination.
- As with all warranty considerations, application and battery maintenance may impact the life of the battery and warranty coverage.

Ohmic Readings Reference Values

Manufacturers' ohmic values are typical averages performed on new, off-the-shelf, cells/units and are meant to be used as general guidelines only. Ohmic tester manufacturers encourage customers to establish their own relevant testing values.

Manufacturers' values are subject to change through tester and battery manufacturers' refinements.

Generally, a sample of around 30 new or healthy cell/units should be tested to obtain a value representative of a new battery on-line after 180 days from installation.

Test data should be obtained at or adjusted to a nominal 25°C (77°F) for consistency. Temperature variations strongly affect measured ohmic readings.

Sizable differences between the ohmic value of a specific cell/unit and its listed value can result from many variations in the way a battery string (system) was treated, installed and/or maintained. It is imperative that all site data should be recorded and made available for future on-site visits and long-term site reference and trending

What the IEEE says.

The following are some extracts from IEEE Std 1188-2005, *IEEE Recommended Practice for Maintenance, Testing, and Replacement of Valve-Regulated Lead-Acid Batteries for Stationary Applications.*

"5.2 Inspection.

All inspections should be made under normal float conditions if possible."

"C.4 Cell/Unit internal ohmic measurements

These measurements provide information about circuit continuity and can be used for comparison between cells and for future reference.

The internal ohmic properties of a cell consist of several factors, including the physical connection resistances, the ionic conductivity of the electrolyte, and the activity of the electrochemical processes occurring at the plate surfaces. With multicell units, there are additional contributions due to intercell connections.

The techniques for measuring internal ohmic properties are not standardized, and in many cases, the techniques are proprietary. However, the basic goal of these measurements is to provide some form of consistent method to quantify the ohmic value. The fundamental principal behind the measurement is to apply a forcing function into the cell and measure the resultant response. Different manufacturers use various frequencies and amplitudes and interpret the resultant signal differently. The IEEE endorses no particular technique or manufacturer. Individual users should select equipment based on their particular needs and proven results.

When internal ohmic measurements are taken, the type of test equipment used, the test points selected, cell/unit voltages, and cell/unit temperatures (measured at the negative terminal posts) should be recorded.

Significant changes in the values typically indicate a significant change in the cell that may be reflected in its performance. However, limited changes in the specific values obtained do not necessarily indicate that the cell is free of defect or deterioration.

Cell/unit ohmic values measured will vary with the specific measurement techniques and the conditions under which the measurements are taken.

Internal ohmic values are useful as a trending tool. To use these readings effectively, accurate baseline readings should be taken after about six months of battery operation. Internal ohmic readings taken without the benefit of baseline data may be difficult to interpret and of limited value.

These readings should be trended over time, and the user should note any significant changes from the baseline. Depending on the degree of the change, a performance test, cell replacement or other corrective action may be necessary.

What constitutes a significant change is dependent on the battery type, the type of meter, and the failure mechanism. Typically, a change of 30% to 50% from a baseline is considered significant. Consult with the battery manufacturer and/or the test equipment manufacturer for guidance.

Replacement criteria are application specific. The timing of further action or replacement is dependent on the type of service the battery supplies. A battery that is used in noncritical, light drain applications may be left in service longer than a battery exposed to critical, high-rate, or long duration applications.

The accuracy of ohmic measurements may be affected by the presence of parallel strings because each parallel string represents an alternative current path for the test signal. This effect is more pronounced for installations in which each string comprises four or fewer units (e.g., a 48 V string comprising four units of 12 V). The impact can be quantified using the standard formula for parallel resistances. The most accurate readings can be obtained by taking the string to be measured offline."

Conclusion.

Eagle Eye Power Solutions (EEPS) recognizes that accurate ohmic measurements when examined in conjunction with other pertinent data can a useful trending tool in determining battery cell/unit state-of-health. Data submitted to EEPS should contain all relevant information detailed above so that EEPS can, with some accuracy, decide if a battery cell/unit is defective.

For further information please contact: Eagle Eye Power Solutions

Note: The author, Allen Byrne, is currently Vice Chair of IEEE 1188, *IEEE Recommended Practice for Maintenance, Testing. And Replacement of Valve-Regulated Lead-Acid (VRLA) Batteries for Stationary Applications.*