Batteries Are A Single Point Of Failure

Who's Monitoring Yours?

The War Story

It was a dark and stormy afternoon. All of the employees in a major financial institution were fervently working away on their computers executing trades, updating databases, and sending email.

Suddenly, lightning struck nearby. By the time the thunder rolled through, the lights went out. Three loud clasps of thunder came from within the building, and sounded like a 12-guage gun. Immediately, the entire building was evacuated, the data center went down, and no one could figure out why the emergency generator did not save the data center.

Several hundreds of thousands of dollars were gone forever due to the loss of the data center that afternoon, and it was a mystery why this happened.

Turns out that one jar in each of three strings of batteries supporting the UPS went "open" in a matter of weeks after the last scheduled manual preventive maintenance on the system. In other words, the UPS went to battery, and each string failed, literally creating a small explosion in each of the three bad jars. The generator never had a chance to take over. It was a good thing no one was in the battery room at the time.

The Problem

What happened?

A preventive battery maintenance visit was recently conducted at this facility, but just weeks later, these three battery jars had rapid rising ohmic resistance. This is actually a common occurrence in many battery strings.

The very nature of battery strings is part of the problem. Battery strings are like light strings. For example, many times one battery jar in the string becomes a resistor - it won't let the energy through the system to power the UPS. Individual battery jars are like people. Each jar has its own voltage, ohmic resistance tolerance, and "personality shifts", so they must be watched closely and constantly. In other words, *every battery in a string is a single point of failure!*

An interesting fact - according to UPS manufacturers, 2% of all UPS failures are due to UPS electronics. Care to guess the % of UPS failures due to battery-related failures? That's right, it's ***98%***.

The Solution

This particular enterprise immediately put into place a battery monitoring system and an ongoing battery monitoring program to make sure that none of their data centers went down again due to bad battery jars. It worked. They adopted IEEE standards for preemptive battery replacements by utilizing the battery monitoring equipment combined with outsourced battery monitoring services. Many bad jars have been regularly replaced with good ones on all of their UPS systems to keep the overall strings healthy and ready. In the ten years since this event, none of the 60+ UPS systems have ever gone down due to battery related failure.

What YOU Can Do

Perhaps your area of responsibility can be affected by the failure of a UPS system, or other critical battery system such as telecom batteries, emergency lighting batteries, emergency generator starter batteries, DC power plants, and many other applications.

You can go a long way to eliminate these single points of failure by doing the following:

- ***Schedule comprehensive, regular preventive maintenance*** activities on battery systems – once per 90 days. The focus is visual inspection, manual measurements and analysis of the "snapshot" of those measurements.
- ***Install a battery monitoring system*** – Battery monitoring systems ensure that data is collected regularly on the battery system so trouble can be spotted before failure occurs. The battery monitor measures the state of health of the battery system at all times. Make sure the battery monitoring system you choose takes ohmic measurements in addition to voltage measurements, so you can be sure you are testing the batteries on both key levels.
- ***Evaluation of collected data*** – The data battery monitors collect is worthless unless it is looked at regularly (at least weekly), and most importantly trended over time to develop predictive analysis of which jars need to be replaced and when. If you don't have internal resources or expertise within your company, you can find it outside.

More on Manual Battery Maintenance

Physical battery maintenance is proven, defined by IEEE standards, and goes a long way toward establishing battery health at the time of the maintenance action. Let's look at some of the things involved with this important maintenance process.

Typical PM (preventative maintenance actions) include accurately checking and recording battery voltages. In addition, you need to do connection resistance checks with an accurate micro-ohm meter. Periodically, you must check all connections and repair as needed.

In flooded or vented batteries, you need to check the specific gravity for each cell. While doing that, you perform a visual examination--which can reveal quite a bit of important information. Good maintenance includes accurate checking of Ohmic values with instruments designed specifically for that purpose.

Load tests are the "gold standard" measurement of a battery system's health (but only at the time of the load test). While doing a load test, you must log individual cell or jar voltage readings several times to determine individual unit health. You should do this test per IEEE recommended standards and practices (IEEE 1188 for VRLA, and IEEE 450 for Vented). Again, if you don't have the resources or expertise in house, get it from outside.

More on Remote Surveillance

As an enhancement to physical battery preventative and corrective maintenance, remote battery surveillance keeps the battery user informed and enhances prediction. This helps ensure you'll have a healthy battery system that is ready to perform on demand.

A good system will record voltages typically one week apart to two decimal point accuracy. You can change the interval frequency, if the situation dictates.

Good systems will also measure and record ohmic values. You can change the interval frequency (usually weekly), if the situation dictates. Interconnect ohmic values are typically a component within the ohmic check process. Simple diagnostic procedures determine ohmic exceptions or changes relating to the battery or to the connections.

The system should check ambient and battery temperatures each minute for unacceptable differences (usually 15 degrees F or greater) and for unacceptably high or low temperatures.

The system must log hits (discharges) with time, date, and duration. Hit information, including discharge scan data, is always logged. Whoever performs your remote monitoring should have the ability to analyze all collected data with a combination of intelligent software and the judgment of trained and experienced battery monitoring experts.

More on Trends

Battery Voltage trends are an important tool to predictive analysis, especially true for wet cells. However, we have learned that ohmic trends tell us a lot more and give us more early warning--regardless of battery type. This is particularly true when connections start corroding or giving up, or internal battery mechanisms show signs of failure.

Regardless of voltage and Ohmic value exceptions or trends, the tried and true discharge test will get us from 90% predictive data to 100% (at the time of the discharge test). Remember, the load test is costly to the unit--it's a destructive test that leaves the battery with less capacity than it had before the test. The other tests are not destructive, and they enable you to apply the load test when it is truly merited.

Why Remote Monitoring?

Sophisticated remote monitoring software eliminates the need for copious manual records, and provides many other advantages. Yet, there's a problem here. Why, for example, did a data center with such a system not see an impending failure before it happened? They had a top notch system but were caught completely by surprise when their batteries didn't provide sufficient backup for a power loss. Nobody was watching the monitoring system!

Like any other monitoring system, the investment is worthless unless qualified individuals watch and interpret the information. Outsourced battery monitoring specialists can determine battery state of health quickly and can predict future problems, which require maintenance and/or replacement. Example: Rather that replace a whole string of batteries, you can replace individual units--thus extending the useful life of the battery string. Typically, when approximately 20% of battery units have been replaced, it is time to consider a new battery string due to unacceptable battery capacity variances within the string. In addition, you can see aging trends of the whole battery system, and recommendations can be made regarding battery string replacements in time to prevent a failure.

You can enhance many manual tasks by outsourcing remote monitoring. You can do the preventive maintenance when you need to, rather than by an arbitrary calendar. This saves time and materials. Service organizations using these methods can cut battery maintenance costs. Facility managers who oversee such testing over multiple locations can reduce “windshield time."

Remote Battery Monitoring should be done by experts, who have proper training and experience for this task. This significantly cuts back on user training in specialized maintenance and interpretation tasks.

Four Points to Remember

1. Battery monitoring equipment is only as effective as the people who interpret the data or information provided by that equipment.

2. When evaluating battery monitoring, consider the significant and un-budgetable costs of downtime versus the budgetable cost of predictive monitoring.

3. Ensure that all monitors are accessible from anywhere at any time, because whoever is assigned as the designated expert is going to need universal and uninterrupted access to the collected data or processed information.

4. Battery monitoring is a 7x24x365 proposition. Ensure that when you commit to this capability, you have a solid program to rely on internal and/or outsourced experts.

About the author:

Bart Cotton is a Senior Member and past San Francisco Chapter Chairman of the Institute of Electrical and Electronics Engineers (I.E.E.E.), Industry Applications Society. These societies lead and educate engineers on the latest technology advancements and applications in the power conversion, control, distribution, and power electronics area. He is also a member of the IEEE Standards Coordinating Committee 29, which generates and maintains IEEE battery standards.

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