Using Economical Sensors to Constantly Monitor Energy Reserve (UPS) Systems

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Summary

Lead-acid batteries are the most widely used method of energy reserve, or uninterruptible power supply, defined as an electrical apparatus that provides emergency power to a load when the input power source or mains power fails. Ensuring the environment around the batteries remains optimal is vital not only for life safety, but also the performance and longevity of the UPS investment.

Introduction

Common types of batteries

There are two distinct categories of lead-acid batteries typically used in modern UPS systems: sealed, which include both valve regulated lead acid (VRLA) batteries and modular battery cartridges (MBC); and vented, or flooded, which include lead calcium batteries. VRLA batteries in general are more economical but have a shorter life span when compared to flooded batteries. Flooded batteries require additional maintenance, but their lifetime can be up to 20 years, which is four times greater than a typical VRLA solution.

This paper explains the importance of monitoring the environment where the batteries are stored to maintain a safe and efficient reserved power supply.

Problem

Looking at temperature degradation, humidity concerns, hydrogen outgassing, and risk of fire and cost of using traditional alarms

UPS battery designs are most efficient when the battery is charged in an optimal environment. The operation specifications cover a wide **temperature** range, but the life expectancy of a battery can be severely shortened at high temperatures. For example, continuous operation at 33°C (91°F) would cut the life expectancy of a VRLA battery in half, and a vented battery by about one-fourth. The optimum temperature for air around a stationary battery is 22° + 5°C (72 + 9°F).

Battery environments should be kept dry and free of static electricity. The optimum relative **humidity** is in the range of 35% to 55%. It is critical for UPS areas to have immediate notification if water is detected near or around the UPS systems to prevent accidental electrical failure of charging or discharging system.

Gassing is the production and release of bubbles of **hydrogen** and oxygen due to hydrogen evolution in the electrolyte during the charging process, particularly due to excessive charging, causing loss of electrolyte and early failure of the battery. In large battery installations, this can cause an explosive atmosphere in the battery room. Because of the loss of electrolyte, lead acid batteries need regular topping off with water. Sealed batteries, however, are designed to retain and recombine these gases internally to the battery.

Hydrogen is highly explosive when accumulations become > than 2% (20,000 ppm) of the total air volume in the area where the batteries are being charged and discharged.   In fact, most regulatory bodies mandate a maximum concentration of only 1% (10,000 ppm). The point at which hydrogen can combust is 4% (40,000 ppm). This is defined as the lower explosive level (LEL). The gassing rate of the battery system can vary significantly based on applied charge voltage, temperature and battery type. For example, flooded batteries are designed to provide gassing into the atmosphere, while VRLA batteries and MBC do not vent unless they are forced into a failure mode. Since most UPS systems are designed specifically for use with VRLA, any

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change in concentration of hydrogen in the atmosphere — which is normally around 0.5 ppm — may indicate an impending problem with the UPS.

In a typical battery room, although the probability of **fire** is low, the risk is substantially greater due to an uncontrolled energy release during a fire, or explosion. A significant failure during a fire occurs when the ability to control the heat is lost, which leads to a thermal cascading failure.

The **cost** of monitoring the UPS environment is significant when using traditional one-time alarms. These devices can approach $500 for a single hydrogen sensor. They're expensive because alarm devices are made to be extremely sensitive, repeatable and resilient. The industry trusts them to alarm once or twice during the alarm's life, and a single failure in an alarm during a critical point is unacceptable. Manufactures over-design their products to reduce the mean time between failures sufficiently enough to ensure a single fault failure can never occur.

Failures in data centers don't care if you're on holiday. These threats and issues can occur at any time of the day and any day of the week. The situation gets worse in buildings with audible alarms. In this condition, the audible alarm is extremely dependent on someone being within hearing distance of the UPS to be alerted to a situation that is already in progress, and may trigger a destructive fire extinguishing system, such as a sprinkler, that could have been prevented by a remote-acting, preventative warning system.

Solution

What OneEvent Offers Over Traditional Systems
OneEvent's new OnePrevent system is a cloud-based software solution that continuously collects, integrates and analyzes sensory data about a location using permanent monitoring devices. By collecting and analyzing data over time, these advanced technology solutions recognize normal occupancy and environmental patterns in any single location. Significant changes in these normal patterns can warn of trouble in advance; potential emergencies can be addressed proactively and averted. Simply put, the OnePrevent system puts a revolutionary environment safety panel in the pocket of anyone concerned with the well-being of the data center's UPS by communicating all events to their mobile device.

The OnePrevent system is comprised of a full line of economical, battery-operated, wireless sensing devices constructed to constantly measure and report on environmental metrics including water presence, humidity level, temperature level, obscuration level, volatile gas level (carbon monoxide and hydrogen), occupancy and ingress/egress events. These devices are connected to the cloud using the OneEvent gateway, which has a secure, VPN cellular connection and is AC powered, with a four-hour battery backup. The system is scalable because it's very easy to add sensors once the initial gateway system is installed.

Predictive Analytics
Collecting and analyzing data is the OneEvent platform's strength. The data is what provides the ability to sense and learn what is normal about any environment in 30 to 35 days. Once normal is statistically calculated, every next measured parameter is continuously compared with the learned range to determine if an out-of-bounds condition has just been measured. If that measured parameter is in bounds, it is aggregated with the last 30 days of knowledge, and the process continues. If the condition is out of bounds, the analytics will wait for one additional measured parameter to ensure the condition is still out of bounds, and if so, will immediately generate a mobile alert message.

Today, OneEvent can provide advance predictive and preventative warnings on parameters such as obscuration, temperature, humidity and volatile gases, including carbon monoxide and hydrogen. This can be a significant indicator of impending disaster, or need for periodic maintenance. The system also helps managers learn normal ingress/egress patterns within either the data center or UPS rooms, and cabinets by using simple motion and door sensors. The system does this by capturing every piece of data from these sensors and providing visual dashboards showing when rooms and cabinets are normally entered. Having this knowledge lets you automatically arm and disarm these sensitive locations, and cabinets, when activity is not supposed to be occurring.

The truly valuable part of the system is that it's software as a service (SaaS). The OneEvent SaaS model means improvements are deployed almost instantaneously, so customers continuously receive new features, capabilities and updates with zero

effort. The OneEvent SaaS solution is based on a multi-tenant architecture, which means a single version of the application — with a single configuration — is used for all customers. To support scalability, the application is installed on multiple, geographically dispersed AWS and Azure cloud-based servers.

Temperature and Humidity

Maintaining the temperature and humidity in any UPS room is critical to the performance and longevity of the batteries and surrounding equipment. The OneEvent humidity and temperature multi-sensor utilizes state-of-the-art sensor IC technology, offering incredibly accurate measurements. Its wide operating range and excellent stability make it suitable for most harsh areas where accuracy is a must. The radio board interface allows the OneEvent transmitter to share environmental data with the OneEvent gateway, providing state-of-the-art predictive analysis, health checks and mobile client notification.

Featuring a rugged case and a wide temperature operation range of -40ºC to 85ºC, the humidity and temperature sensor has been designed for commissioning, maintenance and daily end-user interface. Under normal conditions, the sensor transmits data to the OneEvent gateway every 180 seconds, but once a rapid increase or decrease in either humidity or temperature is measured (humidity changes > 0.7% in a 4-second period or temperature changes > 0.5°C in a 4-second period), the sensor switches to sending data every 4 seconds. The unit includes a tamperproof feature that sends an alert to the user if there is an unauthorized attempt to interfere with the sensor, and two replaceable CR123 batteries power the unit for over 10 years. The sensor also transmits battery voltage and alerts the user when the batteries are low in power.

Water Presence

You and your staff will receive immediate water alerts when water is sensed in your UPS battery room. The use of OneEvent's water sensor and weather information can also provide valuable data to OneEvent's algorithms to learn normal sump pump operation and alert you ahead of potential water damage.

Volatile Gas Levels

You can't see, smell or taste carbon monoxide (CO). But if you breathe too much of it, it can become deadly within minutes. Carbon monoxide can come from any source that burns fuel, and OneEvent exploits the characteristics to predict potential fires early in their evolution. The OneEvent volatile gas sensor utilizes state-of-the-art patented sensor technology to accurately measure CO levels from 0 to more than 1,200 ppm (parts per million) in the environment, and alerts you when CO levels have elevated to unsafe levels. The radio board interface allows the OneEvent transmitter to share critical data to the cloud for live predictive analysis, health checks and mobile client notification.

Another unique characteristic of the volatile gas sensor is its sensitivity to hydrogen by a factor of 5-to-1. For example, 10 ppm may indicate either a value of 2 ppm of hydrogen or 10 ppm of CO. This ability provides an economical way of continuously sampling, reporting and learning the normal gas levels within the UPS room. When abnormal conditions arise due to car exhaust, smoldering conditions or battery gassing, the OnePrevent system will send an immediate notification to your mobile devices.

Risk of Smoke and Heat

A fire either on the floor above or below, in an adjacent room or in the room itself is a substantial risk to any area containing lead-acid batteries. The OneEvent obscuration and heat sensor utilizes state-of-the-art photoelectric technology coupled with a fast-acting thermistor–based temperature-sensing technology. It offers excellent measurement of environmental temperatures and detection of typical fires, including smoldering fires that other devices may only detect after a delayed period. The radio board interface allows the OneEvent transmitter to share critical data to the cloud for live predictive analysis, health checks and mobile client notification. Research testing at UL has shown OneEvent analytics can predict a smoldering fire up to 20 minutes before a standard smoke alarm. The OneEvent obscuration and heat sensor is designed for easy, intuitive installation, commissioning, maintenance and daily end-user interface. Two CR123 batteries power the unit for over 10 years. The batteries are replaceable and the detector cannot be reaffixed to the base unless both batteries are installed. The obscuration and heat sensor can be made tamperproof to prevent unauthorized removal of the sensor. The OneEvent obscuration and heat sensor has a large center test button that allows for device testing.

Remote UPS Alarm Monitoring

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The dry contact switches on the OneEvent door sensor allow for remote monitoring of all your alarming devices. The dry switch outputs can be used to remotely monitor things going on inside the charge manager including On Normal, On Battery, Alarm, On Bypass, Battery Low, etc., by sending mobile device alerts when states change.

This is very desirable information from the UPS system that many times (especially in older models) only shows on the UPS data LCD panel. This has further value for the battery chargers connected to the battery system, because you know if the system is on charge or not, and to what capacity or time the batteries were being charged indicating battery health.

Reliable and Fault Tolerant

The OnePrevent system provides all alerts and information directly to your manager's or support staff's mobile devices, and within web applications and email alerts. This greatly improves your staff's ability to be notified in the event of an abnormal warning or alarm condition over a traditional audible alarm.

All sensor health metrics are immediately reported to the OneEvent messaging cloud, including low battery voltages, tamper alerts, low RF signal strength, sensor faults and offline conditions. This creates a reliable sensor network where system weaknesses can quickly be identified and taken care of.

The OneEvent gateway receives transmitted data from the wireless sensors within the building environment. The gateway is designed to capture wireless information from up to 150 unique sensors in buildings with up to 10,000 square feet of space. In larger buildings, additional gateways can easily be added. The OneEvent gateway has a secure cellular connection with either an internal or external antenna for those locations with poor cellular reception. A four-hour backup battery provides device communications in the event AC power is lost inside the building. If the connection to the internet is lost, the gateway continues to store sensor data to its internal flash memory and transmits the data once the connection is self-restored. When critical software updates are needed, the gateway receives these patches over the cellular connection, removing the inconvenience of having the gateway serviced.

Economical

The OnePrevent system can be installed for a fraction of the cost of typical alarm and fire suppression systems. The system remains reliable because component resilience, accuracy and connection are continuously being monitored by both by your team and our backend system. When compared with a single stationary alarm that may be actuated once per year, the OnePrevent system receives messages from every critical sensor **20 times per hour**, providing a significant statistical improvement in detecting environmental changes, or system faults, while at the same time creating peace of mind by learning, and adapting to the building's normal environment.

Takeaway

As cloud computing continues to displace traditional enterprise systems, the challenges data centers present will require more sophisticated levels of environmental monitoring to ensure proper performance, reliability and long-term life of expensive equipment. The OnePrevent system by OneEvent can greatly enhance the traditional alarms system by providing a predictive analytical engine to your UPS and data center, and deliver the necessary learnings to help manage these spaces.

Benefits include:
1. All system information readily available on any number of mobile devices through the OnePrevent app, which becomes your personal UPS panel
2. Quickly alerts to abnormal changes in temperature and/or humidity caused by faulty heating/cooling/AC units
3. Prediction of early battery failure with advanced hydrogen-sensing capabilities
4. Immediate notification if water is detected
5. Early notification in the event of a smoldering condition, which could lead to a fire
6. Remote alerts concerning your UPS or generator system
7. Economical
8. Easy to install and maintain

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