Leveraging Lithium-ion for Remote Facilities

Set It and Forget It...

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ABSTRACT

As data storage equipment migrates from traditional office and data center environments, the need for more resilient and intelligent IT equipment is increasing. One of the weakest links in the chain of a successful remote deployment is the uninterruptible power supply (UPS), specifically the lead-acid battery. Lead-acid is prone to rapid capacity degradation, poor high-temperature performance and unpredictable failures. The characteristics make lead-acid batteries and—in turn—UPSs ill-suited for a deployment where personnel is not nearby or access for replacement is difficult and costly.

Lithium-ion batteries address many of the shortcomings of lead-acid. As their use in UPSs becomes more prolific, the comfort level around power reliability in remote locations has increased.

INTRODUCTION

When conjuring the mental image of a data center, what comes to mind most often is the endless rows of server racks with fluorescent lighting in an anonymous cube building tacked to the side of some corporate offices. These facilities host huge troves of centralized data and have tremendous cooling, power and security infrastructure. However, this picture of "data centers" is evolving. Cloud computing, which has led many corporations to outsource the majority of their hosting activity, has been a large contributor of this trend. Companies are hosting smaller data sets, primarily for latency reduction or convenience. There are several other drivers pushing IT infrastructure out of the traditional big box data center. Some companies are operating branch offices in regions with unreliable infrastructure. Some companies are deploying resources in remote areas like oilfields and mountain top cell towers. Some companies are moving their data centers to take advantage of alternative energy sources like hydroelectric dams and methane plants.

As this IT equipment migration occurs, the need for more resilient, less user-intensive equipment increases. Chief among equipment that has resisted this trend is the uninterruptible power supply (UPS). While the power electronics and controls of UPSs have improved dramatically over the years, both in efficiency and longevity, the lead acid batteries used in the majority of them have not. This lack of reliability makes a lead-acid UPS a poor candidate for remote deployment. Lead-acid batteries have high capacity degradation, low thermal resilience, inefficient packaging and poor monitoring capabilities. However, lithium-ion batteries—long a stalwart for personal electronics—are migrating into data center UPSs, addressing these issues, and making the dream of flexible, remote deployments a reality.

Capacity Degradation

Of the many criteria one must consider for a remote deployment, predictable and reliable functionality are among the most important. Practically speaking, this translates to a piece of equipment that must perform the same way every time. Unfortunately, lead-acid batteries tend to have a rapid fall-off rate on capacity, particularly in instances of long and/or heavy discharges. Lithium-ion, on the other hand, offers a consistent run-time under heavy load for hundreds of cycles, and continues to offer up-time long after an equivalent lead-acid battery has failed. Figure 1 below compares the Methode AC6000 lithium-ion UPS (shown in blue) to an equivalently sized lead-acid solution (shown in green).

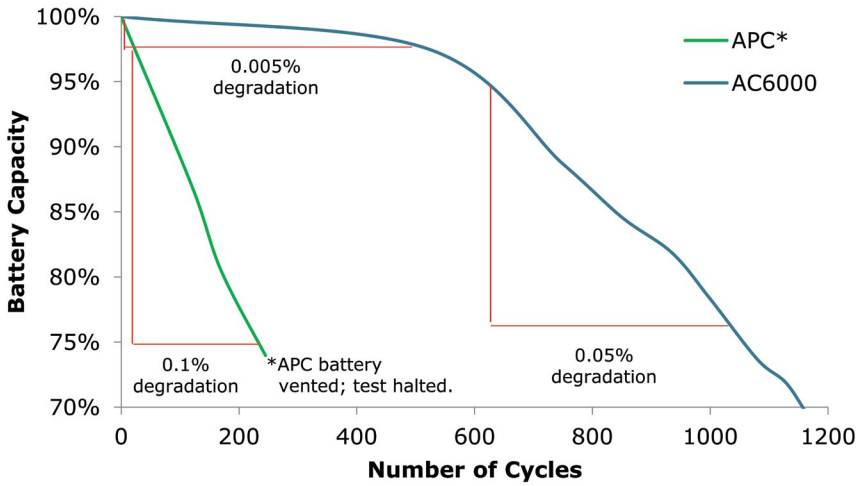

Figure 1. Capacity degradation comparison during full-power discharges at 25˚C.

Figure 1 shows the small initial capacity fade experienced by lithium-ion batteries, meaning this UPS can be relied upon for a consistent and predictable run-time over an extended period of time. Even as the capacity of lithium-ion does begin to fade over time, it does so at a much less precipitous rate than lead-acid. This lithium-ion UPS could be cycled daily for nearly two years while still delivering 95% of rated run-time and capacity, making it an integral part of a reliable remote deployment.

Thermal Performance

Another critical consideration for remote deployments is temperature. It is not uncommon for these types of facilities to have limited climate control capabilities and even a completely sealed environment. A properly designed lithium-ion battery system is actually far more robust to high temperature than lead-acid. While still experiencing the effects of heat-aging, lithium-ion fades at a lower rate than lead-acid. Figure 2 shows the difference between ambient and high-temperature performance of a lithium-ion battery.

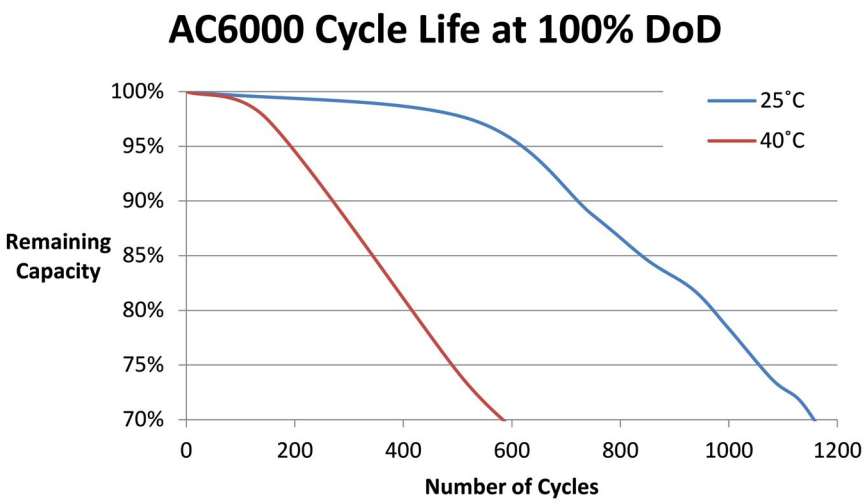

Figure 2. Li-ion UPS at 100% DoD at Ambient and High Temperature.

From a practical standpoint, this means that lithium-ion batteries can be used to run critical equipment, even as non-critical systems like air conditioning go offline. As data supporting a lower than expected mortality rate when operating servers at higher temperatures, a UPS battery that can perform in lock-step with this evolution is crucial.[1] This is even more true in remote deployments where increased temperature is more difficult to avoid.

Lithium-ion UPSs, which monitor the voltage, current and temperature of each battery string, offer the granularity required to separate load power consumption from recharge. This will allow for a more accurate model of facility energy consumption and thus bolster the robustness of a PUE metric.

Packaging Density

Remote deployments typically have a severe limitation in space. Be it a small data closet in a branch office or a need to deploy high-density computing in a shipping container, the value of compact, light-weight equipment is high. A lithium-ion UPS can weigh as little as one-third of an equivalently sized lead-acid system, meaning it reduces the overall need for reinforced floors and heavy-duty racks. In addition, lithium-ion solutions occupy half the rack space of a lead-acid system, either making more space available for value-added equipment or reducing the overall footprint of the remote deployment. These gravimetric- and volumetric-power density advantages make lithium-ion far better suited for small, flexible deployments.

Remote Monitoring

The final and perhaps most obvious need a remote deployment is the ability to check in on the status of off-site equipment. Lithium-ion UPSs are nearly always equipped with sophisticated integrated monitoring and controls. These battery management systems (BMS) monitor the current and voltage of every string in the battery pack, as well as temperature,

over-current and over-voltage and many other critical safety parameters. The BMS is able to send accurate and actionable alerts to a user should any warnings or faults arise. The BMS can also safely disconnect the battery without requiring human-intervention in the event of a more severe fault. This increased transparency into the battery health allows a remote user to better predict required service and replacement without having to deploy a resource in the field for routine status checks. In addition, because the battery is constantly monitored by a microprocessor, the need to perform full capacity discharges required by lead-acid systems to determine state-of-health is eliminated.

SUMMARY

As more companies look to deploy critical computing equipment outside the controlled and well-staffed environment of a traditional data center, all of the constituent components of a server rack system will need to become more resilient. This includes the UPS, which has historically been plagued by lead acid batteries that fail quickly and unexpectedly in the face of frequent use and higher temperatures. Lithium-ion UPSs like the Methode AC6000, provide higher cycle life, advanced monitoring and robust thermal performance, all while maintaining a smaller, more modular package size.

References

1. Kassner. "Why Aren't Data Centers Hotter?" Data Center Dynamics. 2015 13 October 2015.

About Methode Electronics - Active Energy Solutions

Active Energy Solutions (AES), a Methode Company, is a leader in lithium-ion battery systems and power electronics. Since its inception in 2006, AES has designed, tested and produced a variety of customized energy storage systems to deliver greater efficiency in battery energy density, battery life and smaller battery footprint for our data storage, telecom and alternative energy customers.

Designed to integrate flawlessly with Methode's DCIM and PDU solutions, we help clients better manage their power resources with intelligent products and services – delivering more data center real estate while reducing operational expense from day one.

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