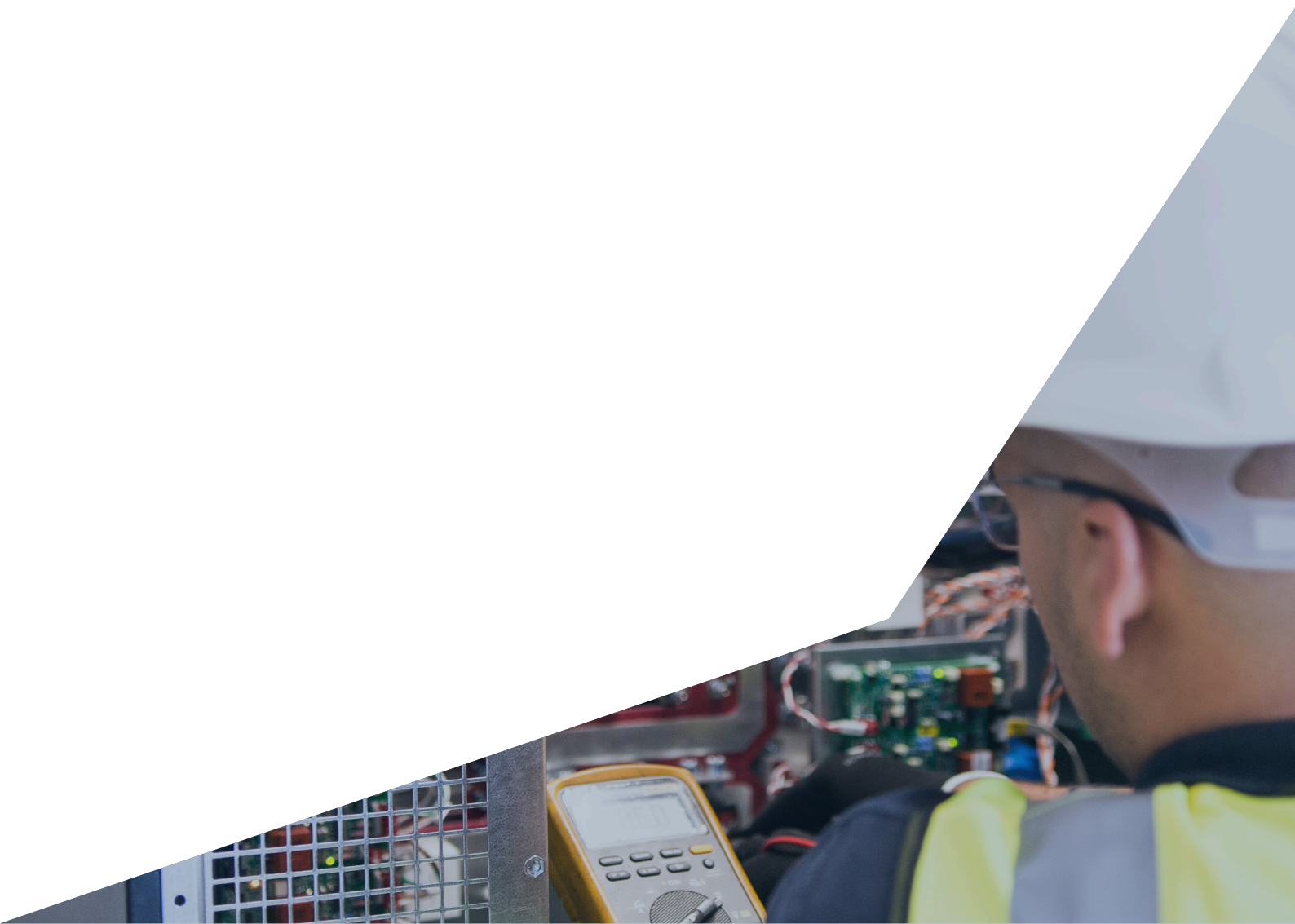


## ADVANCED BATTERY TESTING

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WHITEPAPER



There is a large and rapidly growing mass of valve-regulated lead-acid (VRLA) batteries providing critical backup power to data centres, banks, hospitals, telecom sites and many large commercial and industrial installations. Because of the unexpected and immediate power loss we sometimes experience, without prior warning, it is essential that these batteries remain in optimum condition at all times.

Effective maintenance and battery management requires a timely process to decipher specific information about the condition of each battery cell or block in your system. In order to correctly identify, not only which batteries are failing, but also the reason for that failure, we can now use advanced battery testing equipment. A general test would provide information on reasons for failure and analyse the electrochemical impedance characteristics of batteries over varying AC frequencies.

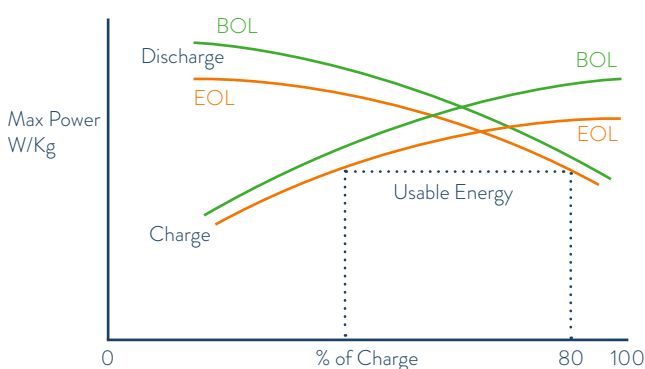
This type of battery testing has historically only been available on large bench sized testing bays, but now with the help of an advanced hand held measurement device our trained engineers can test more than ever before, the entire health of a battery.

The finite lifespan of a battery is determined by its speed of change in characteristics, both mechanically and chemically. Unlike measuring the charge a battery holds, this method of testing can actually determine battery health. This is achieved by taking into account a number of intrinsic and extrinsic factors, such as the type of cell, the cell's beginning of life characteristics, the mode of battery failure, electrical interference, the application in which it is being used and the ambient temperature.

A battery begins to age, as soon as it begins its purpose and continues ageing until it is no longer required or fails. At Power Control we determine not only the voltage and impedance, but with our advanced battery test, we simultaneously measure the electrical and chemical properties of the batteries by measuring sulfation, dryout, voltage and impedance (SDVI).

## WHEN IS A BATTERY END OF LIFE?

The health of a standby battery is normally rated in terms of what percentage of its nameplate capacity, can be delivered at a specified C-rate. (The C Rate being the fraction of the nominal capacity that would be discharged in one hour). A standby battery that can deliver  $\geq 100\%$  of its nameplate capacity at the specified C rate is deemed as BOL (beginning of life) and a battery deemed to deliver  $\leq 80\%$  is deemed to be at EOL (end of life).



Rate of discharge from beginning of life (BOL) to end of life (EOL) and the percentage of usable energy.

## FAILURE OF A BATTERY CAN BE CLASSIFIED INTO A NUMBER OF MODES:

Gradual corrosion of the positive electrode can cause an increase in presence of lead oxide causing a significant increase in spacial capacity required inside the battery, as lead oxide takes up more physical space. This eventually causes short circuits as it pushes the positive and the negative electrodes closer together, which eventually will touch and short out.

**DRYOUT** is a further important cause of battery failure to note. Dryout is defined as the progressive loss of water from the electrolyte. When subjected to normal operating ranges, VRLA or valve regulated lead acid batteries retain adequate amounts of water throughout their design lives. However, when subjected to prolonged overcharging, overheating or valve malfunctions, water loss can occur. Dryout, ultimately causes shrinking internally, causing an increase in resistance and sudden loss of capacity in the battery. The early stages of dryout can go un-detected, which can go undetected by a normal load test as the effect on capacity is small, until very late in the process. However, advanced battery testing from qualified providers such as Power Control can detect a change. The increased heat caused by the dryout process may cause further water loss and in turn, catastrophic failure known as thermal runaway. This is why early detection of this failure mode will not only extend battery life but may also avert a major incident.

**SULFATION** is a further common cause of failure for lead acid batteries, whereby the normal discharge of lead sulphate formation becomes irreversible. During normal operation the lead sulphate forms as crystals, but are normally readily dissolved during the charging process. However, in some circumstances when usage may be unnatural, the crystals grow larger, gradually becoming more difficult to dissolve and therefore causing what is known as sulfation. In the early stages “Soft” sulfation may occur, whereby the batteries are still rechargeable (somewhat slower but still are chargeable) until they eventually fail and the sulphate is totally irreversible as the crystals grow too large and become dense. At this point the batteries must be replaced. This is known as “Hard” sulfation.



## TYPES OF BATTERY TESTING

In order to determine the health and capacity of a battery, a range of tests should be carried out. Used together, the methods below will provide a critical analysis of the batteries lifecycle.

**LOAD BANK TESTING** provides information on a battery's autonomy at the time of the test, as well as the integrity of all the electrical interconnections. The test is carried out when the UPS is under load conditions to ensure the batteries are working optimally or to show whether any of the batteries are approaching the end of their working life or about to fail. The test is carried out with a device, the load bank, which develops an electrical load, applies the load to the UPS or generator and converts or dissipates the resultant power output of the source.

Although there are three main types of load bank, the most commonly used to test UPS systems is resistive in nature and provides equivalent loading for both the UPS or generators and prime movers.

# PowerControl

The conversion of electrical energy to heat via high power resistors creates the load of a resistive load bank. Either by air or water, forced means or convection, this heat must be dissipated from the load bank.

When testing a system, the load bank should be placed no more than 20 meters from PDU or UPS terminals. However, it is important to remember allowances for heat dissipation need to be addressed to allow the load bank fans to cool the system. A resistive load stimulates real-life resistive loads, such as incandescent lighting and heating loads as well as the resistive or unity power factor component of magnetic loads.

**IMPEDANCE TESTING** is a combination of internal resistance and reactance, measuring the opposition that a circuit presents to a current when a voltage is applied. Two components, ohmic resistance and ionic resistance, make up the internal resistance of a battery. Ohmic resistance (electrical resistance) is a measure of the opposition to current flow in an electrical circuit and ionic resistance is a measure of opposition to current flow due to internal factors such as electrode surface area and electrolyte conductivity.

The test is an internal ohmic test (resistance in ac terms), which can help to indicate the overall health of the battery being measured. It is performed by applying an ac test signal to the terminal plates. The total ac current in the battery string and voltage drop of each unit in the string is measured by each cell and intercell connector consecutively until the entire string is measured. Impedance is calculated on the device using the equation 'internal resistance + reactance (L+C) = impedance'. As a battery ages its impedance increases, where a lower internal resistance generally indicates a higher capacity. An increase can indicate declining battery capacity, or degradation.

## CONCLUSION

Power Control's chemical battery testing is crucial to adhering to a strict and solid maintenance prevention strategy for your critical equipment. Detecting battery irregularities and chemical changes early on allows the user to take preventative action before serious consequences arise. By allowing such incredible technical advancements to be freely available to clients Power Control is able to dramatically reduce the cost and risk of battery ownership like never before.

Please contact Power Control's service sales department and speak to our technically trained staff to book in an advanced chemical battery test today to ensure your preventative maintenance schedule is rigid and your equipment is protected properly.

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