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IT Infrastructure Case Study: BTECH Monitoring Captures Classic Failing Battery

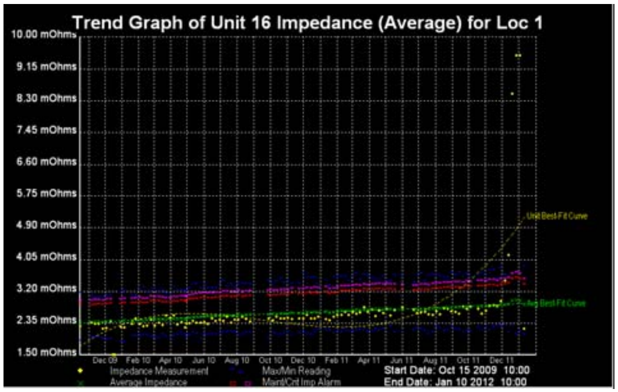
Most IT Centers are supported by Uninterruptible Power Systems (UPS) that rely upon one or more strings of batteries to power equipment during utility outages or bridge power gaps between utility failure and generator startup. The batteries are often the weakest part of a UPS system. Users handle this weakness by using different strategies.

- Some do nothing with their batteries: *Low cost but highest risk.*
- Some run routine load tests on the UPS in a manual or automatic fashion and hope they can discover weak batteries during the test: *Low cost but not very informative except in the case of a totally failed battery system.*
- Some elect to replace batteries frequently, perhaps as frequent as every three years: *High cost every replacement and unknown reliability throughout each period between replacements.*
- Some have the batteries checked out for individual battery voltage on an annual, semi-annual or quarterly basis: *Medium cost with exposure to failure in between the testing dates, battery voltage is a lagging indicator of battery health.*
- Some go a step further and include impedance (internal battery resistance) readings along with voltage readings on an annual, semi-annual or quarterly basis: *Medium cost with exposure to failure in between the testing dates, impedance is a leading indicator of a failing battery.*
- Some elect to install automated battery monitoring equipment which routinely checks individual battery voltage and impedance, on a schedule the user selects with weekly monitoring being the most common: *Significant initial cost but low life cycle cost as battery replacements can be delayed with proper management based upon the battery health information obtained.*

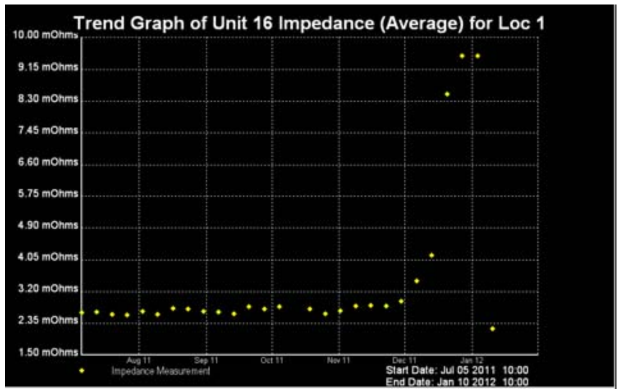
Many UPS users express they want high reliability but cost is a great concern in selecting which of the above strategies to follow. Also, they acknowledge they are not experts in batteries. Since UPS battery systems are comprised of multiple batteries many users believe they have redundancy. Most UPS systems have batteries connected in series to allow 12 volt individual batteries to support the much higher overall battery voltage in the UPS. The most common battery voltages range from 240 to 480 Volts DC, with 480 being most common. This means the UPS has 20 to 40 batteries in a string to reach the overall voltage. A single battery failure affects all the other batteries in the string. A battery string is only as strong as its weakest link. Many sites do have multiple strings of batteries, however this is most often to ensure there is sufficient reserve time for a given load, not redundancy.

A key determinant in selecting the best strategy is knowing how quickly a battery goes from being good to failing. In general, batteries age and fail at a steady pace over several years and many of the above strategies will somewhat work. However, a single battery can fail quickly thus weakening or causing an entire string of batteries to fail.

The following battery chart shows a classic battery failure path. The battery chart is for battery 16 in a string of 40 batteries that were installed in April, 2006. The batteries have been continuously monitored since installation with a BTECH Battery Monitoring System. The battery chart below shows the impedance of battery 16 since December, 2009. The yellow dots indicate weekly impedance values. The green X's show the weekly average impedance values for all batteries in the system comparing battery 16 to all other batteries. The general upward slope of the green X's depicts the gradual aging of the batteries over time. The yellow marks for battery 16 generally follow the average trend until December 6, 2011 when the impedance became 22% above the average.



The more detailed graph below is the weekly impedance value for the last six months to make reading easier. The rise in impedance pushed this battery into alarm status and it became necessary to watch it closely. On December 13, 2011 the impedance was 45% above the average. An alert was issued to those involved that battery 16 was weakening and trending toward failure. The impedance value on December 20, 2011was 189% above the average and replacement of the battery was scheduled for January 3, 2012. The next two readings prior to replacement show the battery at 320% of the average. The chart was set with this value as a maximum display value. The actual impedance value continued to rise as battery 16 drifted toward further toward total failure. When the new battery was installed, the reading for January 10, 2012 is back to normal, in fact lower than the original trend. The lower impedance is expected with a new battery. The battery in this case was 5½ years old but this same pattern can occur in new batteries during the first few months or years.



A previously good or average battery can begin to fail and become virtually useless within 3 to 6 weeks. While this timeframe may seem like watching paint dry, the failure is way too fast to be caught in time by annual, semi-annual or quarterly testing. Without the knowledge this monitoring provided, the battery would have remained in the string blocking both the charging and discharging current. Blocking the charging current to the other 39 batteries in the string would have caused those 39 batteries to begin to fail. Similarly by blocking discharge current, this battery would have reduced or eliminated the reserve capability of the entire battery string. Unless there were parallel strings the result would have been an IT Center outage. Changing out one battery proactively saved the high cost replacement of the entire 40 batteries at this time.

Given the knowledge that batteries can fail in a 3 to 6 week period, we can look at the six strategies outlined earlier to see if each strategy would be effective.

- Do nothing with their batteries: *Site is at risk for battery failure at any point in time.*
- Run routine load tests of the UPS in a manual or automatic fashion and hope they can discover weak batteries during the test: *Failing battery won't show until virtually failed, particularly if parallel strings exist. Dependent upon interval between tests, a battery may go from good to failed between tests. Site is at risk for battery failure.*
- Change batteries frequently, perhaps as frequent as every three years: *Site at risk for battery failure at any point in time.*
- Having batteries checked out for individual battery voltage on an annual, semi-annual or quarterly basis: *Given the limitations of battery voltage, only testing the site is generally safe for 1 to 3 weeks after testing, remainder of time site is at risk for battery failure.*
- Including impedance (internal battery resistance) readings along with voltage readings on an annual, semi-annual or quarterly basis: *Site is generally safe for 1 to 3 weeks after testing, remainder of time site is at risk for battery failure.*
- Automated battery monitoring equipment routinely checking individual battery voltage and impedance, on a scheduled the user selects with weekly monitoring being the most common: *Site is generally protected from battery failure.*