

Data Center Best Practices: Benefits of Having Charged and Ready to Use Spare Battery Cells in the Data Center

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Whether you have a large Data Center with thousands of battery cells or multi-cell units or a single UPS with one or two strings, Data Center Managers and UPS owners are always looking to minimize the risk of downtime, avoiding unscheduled maintenance visits and reducing maintenance costs. One action you can take to minimize these events is to have spare units on site that are charged and ready to use. (A battery single cell unit or multi-cell unit will be referred to as units in this paper)

There are several benefits in having spare units on site:

- **Minimize downtime risk.** When a bad unit is discovered during a maintenance visit or you are alerted to a failing unit from your battery monitoring system, the failed unit should be removed as soon as possible to avoid downtime risk. Having spare units onsite will allow for quick replacement of a failed unit or units. If you do not have spares on site then you will be faced with the following decisions:
 - Can I leave the unit in the string and replace it later without risking load loss? If yes then you will need to schedule another maintenance window to replace the unit which will add costs to the maintenance budget. Keep in mind this decision can still add an element of risk to your system.
 - If the unit is “open” or has to come out immediately, you can remove or jump out the unit but without a spare unit on hand in addition to scheduling another maintenance window you will need to adjust the float voltage of the UPS, when the unit is removed, to keep the remaining units at the proper float voltage. This adds another element of risk to the task. If you have multiple strings connected in parallel to the UPS, you will need to open up those strings as well and jump out an equal number of units to match cell counts across all strings to keep the remaining units at their proper float voltage. Again, adding more risk.
 - Once the replacement unit(s) has been received, it should be given a freshening charge to ensure the unit is at full state of charge (FSOC), prior to installation in the string. This adds additional time to the replacement process. Once installed on the return visit, the float voltage of the UPS must be adjusted again to match the proper float voltage per the manufacturer’s spec. If any additional units were jumped out in parallel strings, those units will need to be re-connected as well. Again, opening up additional cabinets and adding unnecessary risk.

Float Voltage Examples

String Size	Number of Cells	Manufacturers recommended Float Voltage	System Float Voltage	1 jar Removed with no float adjustment	2 jars Removed with no float adjustment
40ea 12v VRLA Units	240	2.25 v/cell	540v	2.30 v/cell (234 cells)	2.36 v/cell (228 cells)
30ea 16v VRLA Units	240	2.25 v/cell	540v	2.32 v/cell (232 cell)	2.41 v/cell (224 cells)

- When jumping out or removing units you need to limit the number you take out to ensure you still maintain an adequate number of cells to provide adequate backup power. Be cognizant of the coup de fouet effect on the overall string during discharge so you don't experience an immediate load loss upon the start of a discharge. There are several factors to consider, age of the string, number of units remaining in the string, load on the UPS, low voltage disconnect settings, UPS requirements for total cell count, etc.
- It is beneficial to have fully charged spare units on hand. They will be at a full state of charge when placed into an existing string. These units will have aged the same and exhibit similar internal resistance characteristics as the existing units in the string preventing potential voltage imbalance issues.
- If you receive a new replacement unit it will probably require a freshening charge prior to placing it into the existing string to help minimize voltage imbalance issues. Does your site have the necessary charging station to provide this freshening charge?
- Avoiding unforeseen long lead times
- Most VLA units have a minimum 8-10 week lead time. From time to time the manufacturers might have a few units available for a quicker turnaround. A complicating factor could be trying to match the exact jar material, separator and specific gravity options of the existing string.
 - Some VRLA units are not a typical stock item and lead times could extend out 6-8 weeks depending on model and quantity needed.
- Avoiding the practice of “sprinkling” in good units into an old string. Customers have made the decision to replace one string and cannibalizing the “good” units and placing those into an existing string because they have failing units and no ready spares on site. In this scenario you might be throwing good money after bad money. This practice does not guarantee the performance of the rebuilt string or the overall capacity of the string. You also need to look at the criteria you are using to base your decision on which units you are going to move and which units you are going to replace. If basing your decision on what units to remove or keep by using the current PM findings, you will only be looking at the current “State of Health” of the units not their capacity or ability to provide the necessary back up power when needed to support the load. You might get a false sense of security of the stability of the rebuilt string. This is a band-aid fix at best but keep in mind you will not be able to avoid the inevitable, replacing the string. You can perform a load test after rebuilding a string to verify the capacity of the string but that will add additional cost and risk to the system.

- Another advantage with having ready spares on site is avoiding potential damage to the replacement units being shipped to the site and then moved to the battery room. Freight damage and accidents do happen. If you have been waiting 6-8 weeks for a replacement unit(s) to arrive and they were accidentally damaged en-route to the site then you might need to wait an additional 6-8 weeks. With spares on hand you can replace the failed unit right then. You can decide whether or not to order another unit to replace the one just used and have it installed during the next PM visit by your service company. The remaining units are not affected if the unit is replaced or not.

Now that you have decided to add spare units to your site there are a few more decisions to make.

- For spare units installed in a cabinet:
 - Size of the cabinet. Spare cabinets come in a variety of sizes to fit your needs. Most of the manufacturers of these cabinets offer a range of sizes from small, 2-4 VRLA units up to cabinets that can accommodate 40 units.
 - Location of the cabinet and available electric supply.
 - What type of charger do you require? Cabinet manufacturers offer UL & non-UL listed chargers.
 - Ease of use. Cabinets can arrive on a wooden pallet with a built in ramp so you can roll the cabinet off the pallet to its location. Units within the cabinet are connected in parallel and can be installed and removed without tools or making adjustments to the charger.
- For spare units installed on an open rack:
 - Location of the rack and type of charger, wall mount or standing?
 - If placing VLA units on the rack, do you require a spill containment system?
- Don't forget to include your spares in your Preventive Maintenance program!

Spare cabinets have become more innovative over the years allowing mixing and matching of units. If you support or manage a data center with multiple cabinets, containing units from different manufacturers you can get by with a single spare cabinet. The units are charged in parallel so, as long as the units in your spare cabinet have the same cell count, are of the same technology, and have similar per cell float voltages, you can mix and match units of different capacity and from different manufacturers.

In summary, this paper was developed after working with hundreds of different customers over the years and seeing situations where having spares on site would have avoided additional problems and in some cases actual loss of critical loads. Having spare units on site is a good practice in the overall management of today's data center. Keeping 5-10% spares on hand (2 to 4 units on a 40 unit string) will allow for more efficient maintenance of your battery strings in your data center.