UPS APPLICATION PAPER

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UPS Battery Reliability

The two predominant types of batteries used today in UPS applications are Flooded (or "wet") cell and Sealed Valve Regulated Lead Acid (VRLA or "sealed") batteries. Flooded batteries are very reliable but are also extremely expensive, require separate battery rooms and high maintenance. VRLA battery types are currently used in 90% of all UPS applications so this paper will focus on this design.

VRLA batteries are routinely ½ to ¼ the cost of their flooded counterparts. They take up less room and don't require (or allow) water refill maintenance. But VRLA batteries have well-documented reliability limitations. The most common types typically carry ten year "pro rata" warranties but only five year design lives. In the great majority of cases, they will not even make their target five year life. Mean-Time-Between-Failure (MTBF) ratings of VRLA cells are just 2100 hours* compared with 20 to 50 times that for other energy storage solutions. The inherent problem is the sealed, valve-regulated design used along with cost-driven construction techniques mandated by market pricing. The idea is to "recombine" the hydrogen and oxygen generated during charge/discharge and regulate the pressure buildup with mass produced plastic valves. Unfortunately, much of the gases produced from charge/discharge escape and dryout occurs just a few years after installation. Since the cells are sealed, there is simply no way to add water.

Following is an excerpt from a significant paper (by MGE*) which provides additional evidence of the certainty of premature VRLA UPS battery failure in <u>open</u>* circuit mode. The paper correctly indicts possible overcharging as a major failure factor, but high cycle counts, high temperatures, high AC ripple current, undercharge and leaks/mechanical problems all add to the same end. Note especially the bar graph under figure 3 (pg 3). Essentially, it documents that **<u>1 in every 5 VRLA batteries will likely fail just 2.5 years out</u>**. Since the typical (i.e. 160 KVA) UPS battery system is comprised of one or more strings of 240 - 250 such cells in at least 40 jars per string, it is just a statistical crapshoot as to whether or not sufficient cells fail in open mode in one or more paralleled strings to drop the load. Without rigorous maintenance, expensive monitoring, redundant strings and regular jar replacements, it is a practical certainty that typical loads will be lost as string life exceeds this two to three year period.

Regardless of maintenance efforts, it is well established that it is impossible to completely assure UPS load acceptance by any battery string as it ages. Even full rundown testing can only prove the battery performed for that particular

event. Since UPS batteries are essentially chemical controlled corrosion products, subject to both age & cycle limitations, you can pass a full load rundown today and drop the load tomorrow. In fact, excessive rundown testing will actually cause premature open circuit failure.

If you must use sealed or VRLA batteries, plan on redundant strings, impedance or conductance monitoring after the second year, and complete string changeout no later than 3 to 4 years after commissioning (earlier if cycling or temperature is higher than normal). Unfortunately, monitoring systems typically cost as much or more than the battery string itself. When all costs are considered over the life of a UPS, the “cheap” VRLA battery system will almost certainly run more than an “expensive” higher reliability wet battery or flywheel alternative.

*Increasing UPS Battery Life: Main Failure Modes, Charging, and Monitoring Solutions,” written by members of the R&D Advanced Technologies Team of MGE UPS Systems

**open circuit failure means no current can pass through any batteries in a given string and, therefore, string power is not available to load.