WHATEVER HAPPENED TO DOING THINGS RIGHT?

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AUTHOR BIOGRAPHICAL NOTES

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ABSTRACT

This presentation deals with the fallacies of letting initial costs be the most important consideration when building a critical backup power system. The "high cost of price reductions" does not seem to be understood by the people responsible for the purchasing decisions. Cost savings on the front end of a project can lead to reliability and maintainability problems as well as high replacement costs.

Some of the major issues affecting backup power systems are discussed, such as: battery quality, maintainability, personnel and equipment safety, and monitoring. The presentation does not provide any detailed cost analysis but, rather, discusses the philosophy of "doing things right."

The paper concludes with recommended practices that can help guarantee a reliable battery system, and suggests solutions to the problems discussed.

1. INTRODUCTION

Modern business depends on fast, accurate, easy-to-access information. Thanks to advances in communication, along with the ongoing improvements in computer hardware and software, our modern data centers and communication systems have grown in sophistication at an incredible rate over the last 20 years.

Any unscheduled interruption that results in downtime of these systems can cost several million dollars per minute. That being the case, it would seem logical that every effort would be taken to protect the critical systems from ever having an unscheduled power outage.

What is really puzzling or, should I say, frustrating, is that the backup power systems that support today's multi-billion dollar industries have not improved at all. In fact, since the reliability of any system is only as good as its weakest component, it can be argued that the reliability of these systems has actually decreased in the last 15 to 20 years

Battery failures, especially VRLA battery failures, are a common occurrence today. The fact that they have not resulted in more expensive system failures has a lot more to do with luck than good preventive practices. UPS users should be thankful for reliable power companies that have kept them from having to find out just how poorly their backup systems would perform if called on.

Why would anyone in their right mind spend millions of dollars on the electrical / electronics part of the backup system to guarantee 7x24x365 uptime and then ignore the energy source that powers it? Ignoring or neglecting the batteries is exactly what is happening around the world in critical applications.

2. BATTERY RELIABILITY ISSUES

QUALITY – Most battery users, specifying engineers included, believe that a battery is a battery, and that it does not make a lot of difference which one is selected as long as it has the right ampere-hour rating. Selecting and sizing a battery for an application is a lengthy process that is outside the scope of this presentation, but some of the important selection criteria are:

- RELIABILITY – It is a proven fact that VRLA batteries, even though they have improved, do not provide as many years of reliable service as the equivalent size vented battery. Pure lead plates last longer than lead alloy plates.

- TEMPERATURE ENVIRONMENT – For extreme temperature applications, Ni-Cad is a better choice than lead-acid. At high temperatures, avoid VRLA. Make sure to size the battery for the coldest operating temperature expected.

- CYCLING – Antimony and Selenium are better choices than Calcium for cycling applications.

- APPLICATION – Short duration UPS or long duration Telecom? They require different plate designs.

- SPECIFIC GRAVITY – High specific gravity yields higher capacity and better high rate performance, but shorter life.

A sad commentary on battery quality today is that high quality Plante batteries are no longer manufactured in the United States and are losing popularity in other parts of the world because of high initial cost.

If a backup power system is supposed to last 10 to 12 years, does it make sense to buy two or three VRLA batteries installations over that time versus one high quality vented battery?

3. MAINTAINABILITY ISSUES

The reliability of a system depends on detecting and correcting problems before they can affect system performance. That means implementing a maintenance / monitoring program that detects problems at an early stage.

In order for the maintenance program to be effective, the proper test tools must be used, and maintenance personnel must have easy, safe access to the batteries. Unfortunately, the people who design batteries, design battery rooms, decide on installations, and specify the batteries are not the same people who have to maintain the systems after they are installed.

Some common maintainability problems are due to:

1. Battery design

2. Battery installation

3. Battery cabinet design

A lot of battery designs, including recently introduced models, have not allowed for the fact that batteries need to be maintained. Battery manufacturers have been told at various technical conferences that they need to make their terminals more accessible for capacity and internal ohmic testing. Obviously that message never got back to the design department.

Figures 1a and 1b below are typical VRLA designs, where access to the terminal posts is impossible because it is covered up by the connecting hardware.

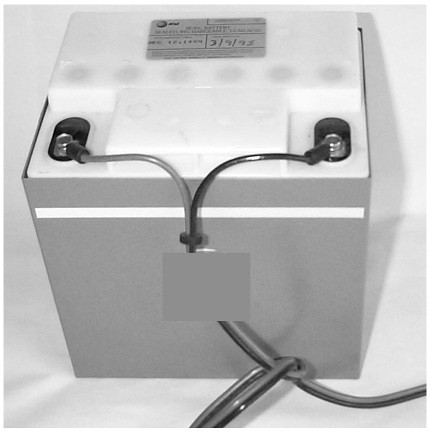

Figure 1a

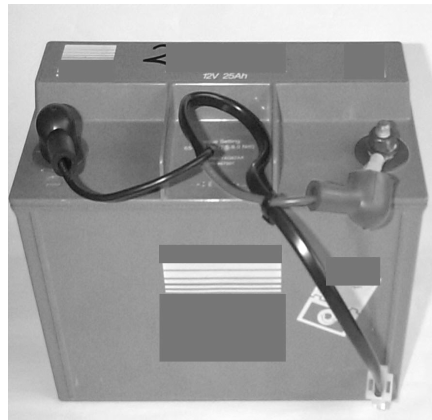

Figure 1b

Installation problems are sometimes due to lack of user knowledge, but often times are also motivated by misguided cost savings efforts. Cramming batteries in too small a space, building racks of three tiers or higher, not having temperature controls, and not supporting interconnecting cables are just a few examples. One of the worst crimes committed in the interest of saving money is shown in Figure 2. Three parallel strings have been connected in parallel by cells rather than by string. This makes it impossible to isolate one string at a time for test purposes.

This practice, which is common in the communications industry, should be outlawed.

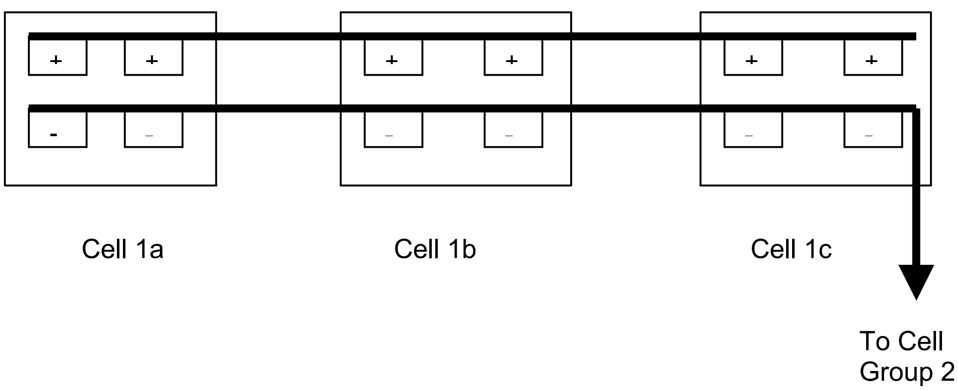

Figure 2

Does it make sense to save a small amount of money while destroying the ability to detect developing problems?

Both UPS and telecom equipment manufacturers have designed battery cabinets that are impossible to maintain. Figures 3a and 3b below shows a typical UPS cabinet with no access to the battery terminals.

Figure 3a: Full Cabinet

Figure 3b: Close up

The typical UPS cabinet requires that maintenance be performed off-line, which leaves the user vulnerable for that period of time. Because of the physical layout, the proper maintenance, which must include internal ohmic measurements, takes a long time. The only way to live with a cabinet design is to include a full function monitor with it that minimizes human involvement.

4. SAFETY ISSUES

In the interest of brevity, this presentation will only deal with the most flagrant safety problem faced by maintenance personnel today. In an effort to save money, UPS systems are being installed without an input isolation transformer. That means that the typical input source of 480 volts ac, 3-phase is applied to the battery through a rectifier control circuit. The result of this is a connecting of high ac voltage, with high current capability, between every battery terminal and earth ground. Figure 4a shows the oscilloscope presentation of the voltage present in a 240 cell system. Note that the peak-to-peak voltage is almost 400 volts. Figure 4b shows the actual rms voltage present.

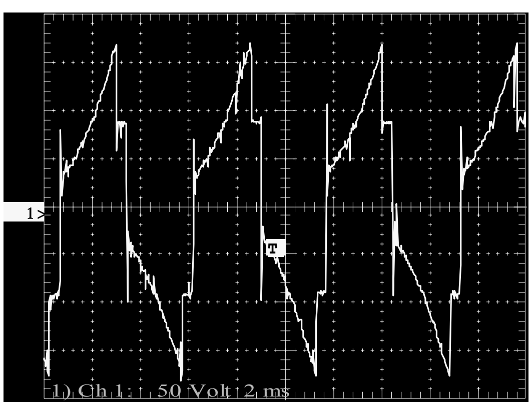

Fig. 4a: Actual voltage waveform (50 volts per division)

Fig. 4b: AC voltage to ground 140 v rms

Every time maintenance technicians accidentally touch one of the battery terminals and the rack or cabinet, there is a risk of their getting electrocuted. Also, from a reliability standpoint, the system is in jeopardy every time it is serviced. Should a maintenance technician accidentally drop a tool or a test lead that bridges between any battery connection and the battery rack, the system will shut down abruptly.

Saving money is great, but does the average user really understand what has been sacrificed with respect to personnel and system safety? This practice should not be permitted but, if it is, then a permanent full function monitor must be used.

5. WHAT STEPS ARE NECESSARY TO ENSURE A RELIABLE SYSTEM?

Here is a brief list and discussion of five important steps to help guarantee that the battery will not be the cause of system failure:

1. Select and size the right battery for the application.

2. Buy the battery using a procurement specification that spells out the minimum acceptable requirements. Do not let the purchasing department make the battery decision.

3. Receive and store the battery per the battery manufacturer's instructions. Many batteries are dead before the arrive at the job site, due to lack of proper storing/charging.

4. Install the battery, using properly trained installers, in a temperature controlled environment and connect it to a low ripple, stable output voltage charger.

5. Maintain and test as follows:

   General Recommendations - Follow the recommended practices set forth in IEEE Standard 450-1995 for vented batteries and IEEE Standard 1188-1997 for VRLA batteries.

   Specific recommendations -

   - Capacity test all new battery strings following installation as part of the final acceptance test.

   - Resistance test all flooded cells annually and VRLA cells quarterly.

   - Establish resistance baseline values (value of known good 100% capacity cell) for all battery types used. Equipment manufacturers maintain a database of these numbers.

   - Replace all cells, without any further testing, that have a resistance 50% or greater than baseline value. Single cell capacity test all cells that have resistance between 20% to 50% greater than baseline.

   - If a test program has not been in existence, then load test all flooded batteries over 12 to 15 years of age and VRLA batteries over 4 years, and take action as follows:

     1. Replace if less than 80% of capacity.

     2. Retest flooded batteries annually and VRLA batteries semi-annually if less than 90% of capacity.

3. Retest flooded batteries in three years and VRLA annually if greater than 90% of capacity.

- To increase system reliability and save labor time, install a full function battery monitor that includes proactive testing.

6. SO . . . WHATEVER HAPPENED TO DOING THINGS RIGHT?

Why buy the cheapest battery available, especially when it only represents a small fraction of the total power system cost?

Why buy batteries that cannot be properly maintained?

Why buy battery installations that are unsafe and almost impossible to maintain?

Why install a backup system that protects millions of dollars worth of services and not test it properly to make sure it is going to work when needed?

Why buy a useless battery monitor, such as a midpoint monitor or a simple voltage monitor?

Why not buy a real battery monitor, complete with proactive testing, for those unsafe battery cabinets?

The questions could go on and on, but they can all basically be summarized in the following single question: Why do we do things that do not make sense, from either a technical or business standpoint?

6.1 Think about it

Is it cost effective to install two sets of lower cost, lower quality batteries instead of one single, high quality, higher initial cost battery?

Try factoring in the extra maintenance cost of VRLA batteries over the cost of flooded batteries. According to the standards, the VRLA requires at least four times more maintenance.

Why was a backup system installed in the first place? It was to protect against multi-million dollar losses. So why do we want to risk a major loss by saving money on the batteries and the follow up maintenance?

6.2 Who is to blame anyway?

It would be very easy to blame the bean counters and the equipment manufacturers for all the problems, but the reality of it is that the user is squarely to blame for all these problems. Equipment manufacturers have the expertise to manufacture much higher quality products but, in order to stay in business, they have to produce what the customer asks for. Unfortunately, the customers are asking for low price at the expense of quality.

Low price is what the user's purchasing department is after, and that is their job. What is missing in most purchases is a specification or clear direction from the user, spelling out the minimum acceptable requirements.

Is the user's problem a lack of knowledge, a lack of interest, or a matter of being just too busy? Who knows? But it is time for the users to recognize that they are the ones that have to initiate some action. And won't it be great to get back to basics and **start doing things right again?**