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IT'S ALL ABOUT THE MONEY

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IDEA FOR THE TITLE OF THIS PAPER

At Battery Research and Testing, we have been performing the IOVR process to recover lost battery capacity for almost five years now, and it has been frustrating to say the least, to have some of the battery manufacturers' fight tooth and nail to prevent battery users from utilizing our process to extend the useful life of their battery systems. I have ripped my hair out trying to understand what the big deal was with many of the manufacturers' obstructionist position. It wasn't until I was at a conference and having a dinner with an old friend whose company does large data center design and start ups that I learned what the REAL REASON was. I told him about my frustration with the resistance of some of the battery manufacturers to our process, and his reply hit me like a ton of bricks. It was so obvious that I was stunned that I had not realized it. He said to me, without even thinking about it **"It's all about the money."** Talk about words of wisdom. And that in a nutshell is where the title of this paper and the idea for it comes from. I hope that you enjoy reading this paper as much as I did creating it. When I started putting dollars into the mix, it became blatantly obvious that he was right. It really is all about the money.

ABSTRACT

THE IOVR PROCESS = MONEY GAINED VERSUS MONEY LOST. WHOSE MONEY IS LOST OR GAINED DEPENDS UPON WEITHER YOU ARE A BATTERY MANUFACTURER OR A BATTERY USER.

It has been proven over and over, that the VRLA products are uniquely suited to the recovery of lost capacity or capability through the replacement of lost moisture content and the return to proper plate potentials through the addition of a Catalyst. There is success story upon success story from all across North America that this IOVR (Internal Ohmic Value Recovery) process is a viable means of increasing the reliability and run time of capacity challenged installed battery systems, thereby reducing the capital expenditures required for the unneeded early replacement of the battery systems.

Why is it that this process has not been adopted by all of the battery manufacturers? This has been very puzzling to me, since all manufacturers must now realize that their products are susceptible to dry-out or loss of compression, and negative plate potential depolarizing to varying degrees. Why is it that some manufacturers fight tooth and nail to keep users from performing a process that could extend the useful life of their battery systems? Heck, some of them even threaten to void the warranty if the user dares to try to save their investment in their battery systems by performing the IOVR process.

I believe that the answer is that it is really all about profits and losses. I am talking about the profit of the respective battery manufacturer, and about the losses of the user's company. As we all should realize, a profit for a battery manufacturer on a warranty adjustment, is a loss for the company that undergoes that warranty replacement.

This paper will delve into just how severe those losses for the user can be with a variety of examples. And will show reasons as to why users should attempt to prevent accepting the mind set of "It fails to meet specifications so let's replace it". And instead should adopt the philosophy of "maintenance should include taking reasonable actions to make the asset last as long as reasonably economically possible".

DEFINITIONS

First off I will list some definitions that will apply throughout this paper, as these definitions will be referred to frequently during this presentation.

Battery: A series of cells that together are called "A Battery". These batteries are typically 12, 24, 48, 120, or 480 volts nominal. By nominal it is meant that a "48 volt" battery would be float charged at 52 to 55 volts at standard temperature, based upon the individual manufactures recommended float voltage per cell, and a 120 volt battery would probably be float charged at 130 to 137 volts, again based upon the individual manufacturers recommended float voltage range for the individual model cell.

Battery capacity: This is what the battery manufacturer is supplying a warranty upon. If during a capacity test the battery fails to meet 80% of its rated capacity, the manufacturer will issue a warranty for the cell (or battery) if you properly prepared the battery for the load test. If the user has failed to properly charge, or maintain the battery (especially regarding temperature) the warranty may be null or void.

Battery capability: This is the capability of the battery to perform its required function. This is not to be confused with capacity

Battery run time: This is how long the battery will support its required function.

Break even point: That is the point in the warranty period that the manufacturer will break even in its cost to manufacturer the replacement battery. This will vary widely depending upon the price the purchaser paid initially (how deep was the initial price discounted as compared to list). This "break even point" typically will be in the 4 to 6 year period. At any time beyond this the manufacturer will make a profit on replacement cells.

Capacity test: A load test of a battery system to determine if the actual capacity of the battery meets the manufacturer's published rating, to a pre-determined end voltage

Capital expenditure: Money that is budgeted to purchase items that will be listed as assets.

Cell: The smallest individual part that can be replaced in a battery system that is comprised of individual replaceable cells.

Common Sense: Webster's Dictionary defines this as "Sound and prudent but often unsophisticated judgment."

Depreciation: This is the annual charge that a user can charge against earnings based upon a depreciation schedule.

Design life: This is the amount of time that a battery is designed to last in normal operation. There are many factors taken into account, such as plate thickness, grid design, past mix, electrolyte density, etc, etc.

Freight costs: These costs are not included in a warranty. These are the charges that the user incurs whenever a battery is shipped to them. The user pays the freight on every battery (or cell) received.

IEEE 1188 Standard: This is the proper document to follow for performing a load test on a VRLA battery. It includes all pre test requirements, as well as the temperature compensation charts for temperatures away from 25C (77F), at which all lead acid batteries are rated at.

Installation costs: This is the cost incurred when a battery is replaced. This is a cost that is not covered under warranty. Even if the manufacturer did the initial installation as part of the battery sale, replacement labor is not part of the warranty.

Manufacturer required maintenance procedures and documentation: This is the manual that is supplied with every new battery system from each individual battery manufacturer. In this manual are typically directions on how to, properly assemble the battery, initial charge (if required) the battery, maintain the battery, and documentation to fulfill the warranty requirements. Also explained in this document are the operating parameters, such as recommended float voltage, acceptable operating temperatures, and sometimes instructions for running load tests.

Profit: Money that a company has left over after all expenditures are deducted.

Purchase price: This is the actual dollar amount that the purchaser pays the manufacturer when the user buys a new battery string. Also included in this price is the tax, freight and the installation costs.

Warranty period: Time in months that a battery manufacturer will issue a declining value adjusted price for the replacement of a battery if it fails to meet 80% of its rated capacity. With the majority of single cell VRLA products this period is normally 240 months. Depending upon the initially negotiated warranty this may vary slightly. There is usually an initial year or more (1-3) where if the battery fails the new cells are supplied at no charge (you pay the freight and installation costs of course), but the warranty means that for each month you use the battery, you use up one 240^{th} of your purchase price.

MANUFACTURER'S POSITION

Every manufacturer that I am familiar with will honor their published warranty if the user has properly maintained the battery system, and the battery fails to perform according to its published rating. This means that the battery will deliver at least 80% of its published rating. Not 100% as some people might believe. This does not mean that an 800 AH battery string must support a 100 amp load for 8 hours. To meet 80% capacity the battery only has to support the 100 amp load for 6 hours and 24 minutes before it reached end voltage.

If the user has abused the battery, by undercharging, overcharging (either by voltage or due to elevated or reduced temperatures), or through other abuses, the warranty may be null or void. This is only fair.

What must be understood is that every battery manufacturer is in the business to make a profit, just as every other company that I know of is, yours and mine included. It goes without saying that even a small profit is better than no profit at all. Especially in the slow economic times, that we are in right now. So it is financially more beneficial for a manufacturer to give a warranty adjusted price for a replacement battery than it is for that manufacturer to recommend a process that will restore capacity to that battery, and to extend its life. Especially one that they did not discover or create, or that they do not receive revenue from the implementation of. They make no money from allowing you to help yourself. If a manufacturer is not manufacturing cells they are not generating profits.

USERS POSITION

The user purchases a 20 year warranted battery with the expectation that they will need to replace it in 20 years, if they follow the manufacturer's recommended maintenance guidelines as to proper charging and maintenance.

The battery is expected to support a specific load for a required period of time. The primary reason that I know of for a battery to be installed is because it is supposed to be able to support the site load when the AC power goes away, for some specified amount of time. There are some applications where the batteries are solar charged, or the power to recharge the battery is from an alternative source, but generally that source is an AC source.

If the battery is required to be replaced sooner than anticipated there is a negative impact on profit.

If there is a way to extend the life of the battery as a useful battery system it is a financial benefit to the user. The longer that you can make your battery last, the better it is for your corporate bottom line.

It is in the user's best interest to do all that is economically reasonable to make their battery systems last as long as possible. This should include procedures that will extend the useful life of the battery, even if the procedure is not approved or recommended by the respective battery manufacturer.

REMEMBER ---- The user pays all additional freight and labor costs to replace a warranted battery. Be it a single cell or a complete battery system.

YOU CHECK THE FLUID LEVELS IN YOUR CAR DON'T YOU?

This is a very simple comparison, but it works. When you, or a mechanic, check your vehicle periodically and it is discovered that the radiator is down, you don't replace the car do you? No, you replace the lost fluid. The same applies with a car that starts to slightly use oil. Do you replenish the oil, or replace the car? If aside from the slight oil usage, the car is otherwise a perfectly satisfactory car, and able to satisfy your needs, would you replace the car or add a quart of oil periodically to it, or would you just decide that the car is not supposed to leak or use oil, so you refuse to replenish the oil, and you wait until it fails completely? Sound foolish doesn't it, but it is the same as not performing functions that would preserve your investment in your existing battery systems.

THE IOVR PROCESS

What is the IOVR process and how can it help your company preserve its investments in battery systems? In other words, how does it work, and what does it do?

The IOVR process consists of just two parts, even though there is much more that goes into these two parts, I will explain just the two.

Part one is the addition of a specific amount of water. This volume is different for each cell and is based upon the internal ohmic value of the individual cell being serviced. This part of the process restores contact between the plates by replacing the water in the cell that has been lost through off gassing, and re-saturates the mat. This allows the plates to more fully accept a charge, plus it reduces the internal resistance of the cell.

Part two is the installation of a catalyst into each cell. The catalyst works to restore the plate potentials to their proper values, thereby allowing the negative plates to be properly charged, and to reduce the overcharging of the positive plates.

BACKGROUND

First off let's look at a little background to see where the idea of adding water to VRLA cells comes from, and from that history, to see where the idea for the IOVR process comes from.

GNB actually started adding water to all of their Absolyte batteries across the board in approximately 1994. This nationwide program was undertaken because a number of large users had begun to perform load testing and were discovering that they were having a majority of their battery systems fail these load tests. Not all users were included in this process due to a variety of reasons. These batteries by all normal checks (cell voltage) appeared to be in good shape, but when a load was applied, the batteries collapsed miserably.

GNB calculated how much water needed to be restored to each cell size based upon their original fill volume, and implemented a program to go to the users that were requesting a solution to their early failure issues, and they performed this re-hydration process. There were multiple revisions to how much water was added to each cell size, but in ALL CASES the overall capacity of the battery string improved drastically, and it improved almost immediately (overnight). GNB attributed the cause of this problem to their not banding the plates together so as to maintain a good mat to plate contact, and they changed their manufacturing process to include banding of the plates to maintain good plate to mat contact. This was a very logical explanation, and was generally accepted at that time.

During early 1995 we were working with Asa Waters of United Telephone (name prior to acquisition by Sprint) in central Florida, performing follow up load testing on a number of Absolyte battery strings at various sites across Florida. I say "follow up" load testing due to the fact that in the fall of 1994 these battery strings had all failed load tests. Through discussions and negotiations with GNB, United Telephone had agreed upon a course of action that was suggested by GNB. This course of action consisted of GNB visiting each site and adding a specific amount of water to each cell based upon the cell model. Following these water additions we again performed load tests on a number of the sites at the direction of Mr. Waters.

When we performed the follow up load testing after GNB had completed their re-watering process we saw substantial string capacity recovery, but there were still a wide spread in capacity amongst the cells. We noticed from our inspection reports, as compared to the load test results, that the cells with the highest internal resistance values were the weakest cells during the load tests.

We decided that if we used the internal ohmic value of the individual cells and added varying amounts of water based upon these values that we could recover even more capacity from the individual cells, which would increase the amount of capacity in the whole string. We then performed these selective water additions.

After waiting a few weeks we again load tested these “selectively re-hydrated strings” and found that we had been able to restore even more capacity to those cells and thereby increased the string capacity and run time further.

This process of only adding water to the cells worked for about a year, but sadly the capacity again started to drop off again. Plus the charge current continued to increase over what it had been a year previous.

The results of this testing was presented at Battcon97.

If the lack of banding the plates was the only cause of the capacity loss, why is it that their cells that have been manufactured after they started banding their plates continue to loose capacity prematurely? As do many of the cells from other manufacturers. We believe that it is a two fold problem. The cells still have off gassed to the point where they need the water that has been lost to be replaced, but we also have discovered that the addition of water alone is a short term solution, and only part of the solution. The missing link with GNB’s original attempt to recover the lost capacity due to just adding water was a good first step, but we all missed the primary culprit. The negative plate depolarization issue.

It turns out that over time the negative plates become depolarized and because of this the positive plates become over polarized. This is why you will see the positive posts on many cells pushing the covers outward. The positives are being overcharged drastically, and therefore corroding at an accelerated rate.

The people at Philadelphia Scientific discovered the solution to help maintain the healthy balance inside the cells. It is a catalyst that they hold the patents on and that they manufacturer. There are numerous papers that have been presented at this conference and at other conferences that explain actually how the catalyst works, so I am not going to go into any explanation of what the catalyst is made of or how it functions during this presentation. If anyone wants to study the multiple of papers that have been presented over the years, please feel free to contact me and I will gladly supply you with the lists of papers, web sires, links, etc, so that you can study these at your leisure.

C&D DRYOUT DISCOVERY

In 1999 while performing redeployment of numerous strings of C&D 700AH battery strings from one site to another for a major long distance carrier in the US, we would often have a number of the battery strings in our various regional shops across the US.

We decided as an information gathering effort, that we would perform load tests on these battery strings while they were in our shops, since they were only four years old and had never been load tested that we knew of. We were keeping these batteries on float while we were waiting for instructions as to where each one was to be reinstalled to. We discovered that the impedance values were substantially above what we believed were “acceptable” values, plus we found out that the capacity of the strings ranged from the 20 percent range to a high of 58%. This was at the 3 hour rate. Obviously this was not acceptable to the customer and they made the decision to not reinstall any of these strings, unless their capacity could be recovered. These cells were all manufactured before C&D started installing a catalyst assembly to their cells. They started manufacturing their cells with catalysts in May 1998.

With our customers approval we developed a multi-step program where step one was to inject a fixed amount of water into each cell, followed by another load test and recharge cycle. Following that we added varying amounts of water to individual cells based upon their impedance value, and then performed yet another load test. As a final step we added a catalyst assembly to each cell.

With each step we gained additional capacity. With every string we were able to restore the strings to over 95%, with some going to over 100%. Remember the best string capacity originally was just 58%.

All during this process, at the direction of our customer, we were communicating our actions and findings with C&D headquarters. We initially believed that the capacity loss was due to off-gassing, to which they responded that they did not suffer from dry-out. Once we demonstrated our results they changed their position, and in fact have issued our original initial calculations as to how much water to add to each cell, to their field service personnel for usage in recovering capacity in their older cells. We concluded that their cells that were manufactured without the catalyst included also suffered from the same dry-out problems as the GNB cells.

DO ALL VRLA CELLS SUFFER FROM DRYOUT AND NEGATIVE PLATE DEPOLARIZATION ISSUES?

Scientifically it can be proven that it is possible to manufacturer a battery that if properly charged, in ideal conditions can last 20 years and theoretically not need to have water added, without the addition of a catalyst. It seems that the batteries that we have worked with from all different manufacturers have not quite reached that level yet. With every one of them, when we find that they have reduced capacity, we can recover much if not all of that lost capacity through the IOVR process.

Since we can restore lost capacity through this process we have to believe that the answer is YES that they all do suffer from dry-out, and negative plate under polarization for whatever reason, and to widely varying degrees. This wide variety of the amount of dry-out even is present within a specific manufacturer and within the same model and year. It does appear that quality control, or lack thereof has a substantial effect on this, and the individual battery's location and usage impact this also to varying degrees.

MANUFACTURERS THAT ARE PRESENTLY INSTALLING CATALYSTS IN THEIR 20 YEAR CELLS

C&D
EAST PENN
LUCENT
POWER
SEC
GLB

Right now the only two major US manufacturers of large VRLA cells that are not installing catalysts in their products are GNB and Enersys. Both of these companies are doing in house testing with the catalysts, and GNB is in fact installing the Catalyst vent assemblies in some of their products in the field, and also has issued statements to some users that the installation of the aftermarket Catalyst equipped vent assemblies is permissible and will not affect the warranty.

IN SUMMATION

It makes strong financial sense to do all that is economically feasible to extend the useful life of your battery system so that you can obtain the maximum possible return on your investment. To not do everything reasonably possible to preserve your battery systems would be remiss.

The following are just two examples of the dollars that are wasted by not performing the IOVR process on your existing battery strings.

FREE EXCEL DOLLARS SAVING WORKSHEET

For a free copy of our dollars saved worksheet, please send an e-mail request to info@batteryresearch.com, and request the "Dollars Savings Worksheet". This way you can insert your own numbers to determine the actual savings that you can realize, with what you actually pay for your battery systems.

EXAMPLES OF SAVINGS.

Example One.

1. Cumulative effect on profitability as a result of extending the life of the battery system from 6 years to 10 years through the use of the IOVR process.

Estimated installed cost of the battery system	$20,000
Annual amortization deduction given a 6 year life	3,333
Annual amortization deduction given a 10 year life	2,000
Annual savings	1,333
Number of years of useful life	10
Cumulative savings per battery system over the extended life	$13,330

2. Capital expenditure program would be impacted in a positive manner as a result of being able to postpone the actual replacement of the battery system by up to 4 years. This assists with cash flow; return on assets employed, and allows time to plan for the now shorter (10 years) than the originally expected 20 year life span of the battery system.

3. Potential impact on the company's profit in the year of replacement. If the company had originally purchased the battery system for $20,000 with an expected life of 20 years the net book value after 6 years would be approximately $14,000. If the battery system is worthless and needs to be replaced, this $14,000 would result in a current write off of the remaining net book value of the existing battery system. Accordingly, a negative impact on profit.

4. There would be an effect on several financial performance indicators. Each indicator could be improved by extending the life of the existing equipment effected. The following are some of the items affected.

- Return on assets employed
- Net income
- Debt to equity
- Debt servicing

Example Two

Calculation of profits lost by not performing IOVR process on an existing 48 volt 1,500 AH battery system if the battery is replaced every 6.5 years

System Price	Warranty Months	Monthly Credit	Lost Profits Over Battery Life
$15,600	240	$65	$49,146.00

Initial Purchase Price	Monthly Credit	Months of Usage	Warranty Credit Used	Warranty Credit Remaining
$15,600	$65	78	$ 5,070	$10,530
$15,600	$65	156	$10,140	$ 5,460
$15,600	$65	234	$15,210	$ 390

List price increase per month over the 20 year advertised life of the cells, assuming 1.5% per year increase (0.125% a month).

Initial Purchase Price	Monthly Increase %	Number of Months	New Discounted Price
$15,600	0,125	78	$17,121
$15,600	0.125	156	$18,642
$15,600	0.125	234	$20,163

Initial freight and installation costs.	$4,000
Freight, removal and installation costs for replacement strings.	$4,000

Warranty adjusted battery costs every X months.

Months		78	156	234
Initial battery purchase price	$15,699			
Warranty credits used at X months		$ 5,070	$10,140	$15,210
Warranty credit remaining at X months		$10,530	$ 5,460	$ 390
New discounted price at X months		$17,121	$18,642	$20,163
Warranty adjusted cost at X months		$ 6,591	$13,182	$19,773

Total warranty used at 19.5 years	$15,210	
Total battery only expenditures at 19.5 years		$55,146

Costs of battery system over 19.5 years to inc,lude freight and labor

Initial battery purchase price	$15,600
Initial freight and installation price	$ 4,000
Warranty adjusted battery price at 78 months	$ 6,591
Freight and labor costs for replacement at 78 months	$ 4,000
Warranty adjusted battery price at 156 months	$13,182
Freight and labor costs for replacement at 156 months	$ 4,000
Warranty adjusted battery price at 234 months	$19,773
Freight and labor cost for replacement at 234 months	$ 4,000

Total cost for one 24 cell 1,500 AH battery and labor at 19.5 years of life	$71,146
Original battery installed price	$19,600
Cost of IOVR process on 24 cell battery	$ 2,400

Profits lost over 20 year battery life by not performing IOVR process $49,146 each.