RESTORING CAPACITY AND EXTENDING USEFUL LIFE IN VRLA AGM BATTERIES THROUGH THE PROCESS OF REHYDRATION AND CATALYST INSTALLATION

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Abstract

All too often, VRLA AGM battery systems that have failed a capacity test are summarily replaced with no consideration as to any attempt to restore the capacity that has been "lost". Traditionally batteries are replaced when their capacity falls below 80% of their published rating. In addition, some users have adopted a policy where they automatically replace VRLA batteries on a set time frame basis, in some cases in as little as 5 years on a 20 year product, without even capacity testing. With the economic conditions in today's market it seems wiser to spend a few hundred dollars to restore the capacity of the battery, rather than to spend a few (or many) thousand dollars to replace the complete battery system.

The actuality is that the battery system may not need to be replaced. The Re-hydration and Catalyst addition proposed in this paper does not require that the battery string be taken off line, nor does it require any out of normal hours work. It is non-system impacting and can take as little as an hour or two's time to complete. Whereas replacing a battery string often requires work during jeopardy hours and can be system impacting. It may take days to complete, and may require a temporary battery system to support the site during the replacement, depending upon the site requirements.

This paper will provide a method for recovering capacity and extending the useful life of VRLA AGM batteries. This data is compiled from actual field experiences. Use of the methods described in this paper will allow users to reduce their battery replacement costs substantially. The results of this process will be demonstrated by load test improvements, internal ohmic value improvements, charge current reductions, and plate potential improvements.

Introduction

It has long been common knowledge that VRLA batteries lose capacity much earlier in their life than their flooded counterpart. In many cases there are 4, 5 and six year old products, of the 20-year design, that will not deliver their advertised and expected capacity or performance, and are experiencing abnormal positive plate growth. All manufacturers are continuously working to make improvements to increase the performance and life of their individual products, and we expect they always will strive to make improvements to their products. What must be remembered is that the AGM VRLA product is really an infant as compared to flooded lead acid cells. I am sure that everyone that went through the experiences of the introduction, development, and the maturing of the Lead-Calcium grid (cells), can testify that the experience of failed jar to cover seals, post seal failures, nodular corrosion, cover cracking, copper inserted post failures, abnormal shedding, abnormal plate growth, etc, etc can testify that it was not a fun time, but the final results were worth the wait. In most cases in North America when there is a requirement for a flooded battery string, a flooded lead-calcium battery is the industry standard in the Utility industry, UPS industry, and Telecommunications industry. While it is correct that there are some users that prefer a Lead-Antimony battery, a Lead-Selenium battery, or even a Plante' battery, the majority of the users of flooded batteries are purchasing the Lead-Calcium design.

The same continuous learning and improving is occurring with the VRLA products, as has been exhibited from the numerous papers through the years that have detailed the problems, changes, and improvements that have occurred. While it is wonderful that all of the improvements are being made to make the new cells last longer, what about the thousands and thousands of older cells that are already in place out there? What can be done, or is being done in an attempt to obtain the maximum useful life from them? This is where a process of re-hydration and the installation of a Catalyst can be of a major benefit in restoring lost capacity, extending the site run time, and delaying the expenditure of battery replacement dollars.

Of course all manufacturers will honor the warranty if the user proves to the manufacturer that the battery string will not meet 80% of it's published rating, but the user still bears the cost of the adjusted price, the freight, and the labor charges to replace the new battery and dispose of the old battery. Often these costs are greater than the price of the warranty adjusted cells. Why not prevent this premature loss of capacity, or restore the lost capacity, plus prevent over charging of the positive plates, and obtain as much useful life as possible out of the batteries that you already have paid for?

General Requirements and Procedures

The following charts will show the results of four separate programs that demonstrate the viability of this recovery process. Three of these programs are underway with communication companies in which each user has undertaken to first determine the actual capacity of their battery systems, secondly to attempt to recover that lost capacity and thereby extend their reserve time, and thirdly to defer the outlay of money for battery replacements. The third program is with a UPS user that through a normal occurrence of lost off site power discovered that their battery system would not support the load long enough for the emergency generator to start up and have the load transferred to it. They needed to be able to immediately restore enough capacity to at least get the generator up to speed and able to carry the site load. This process allowed this almost immediate recover of lost capability.

With the first communications company program, the user decided to perform conductance readings, followed by a capacity test, followed by a recharge, then the addition of a specific amount of water to each cell, installation of a Cat-Vent assembly, and then following a specific amount of time, follow up Conductance testing and further load testing.

The second and third communications companies elected to perform initial impedance readings, and capacity testing, followed by the addition of water and Cat-Vents or Maximizers, and then following a period of time, follow up impedance readings and load testing, and then further addition of water to selected cells as identified by high impedance readings and lower capacity results. Following this, additional inspections and capacity tests were run.

What needs to be understood is that the three of these programs that were for the communication systems, were either 24 or 48 volt plants, and were being charged with quality communication rectifiers, and all were in climate controlled buildings. This is pointed out strictly to emphasize that these strings were not in some location that underwent severe over temperatures or overcharging. This is not the case with the UPS system though. While it is true that the electronics portion of the UPS was in a climate controlled room, the battery was located in a room off of a parking garage and experienced wide swings in temperature from lows in the 40's to over 100 degrees Fahrenheit, depending on the outside temperature.

The P, and W site load tests were performed at the communication sites by using the existing site load, plus adding load as needed to arrive at the manufacturer's published discharge rate for that specific model, to an end voltage of 1.90 volts per cell. At no time were the site batteries removed from service. Each discharge rate was temperature compensated following the IEEE Standard guidelines so that the most accurate results could be obtained.

With the I, and S site load tests, either there were multiple battery strings and one could be taken off line at a time to be load tested and recharged before being placed back in service, or a temporary battery was supplied to support the site during the testing process. These tests also followed the IEEE Standard guidelines. We fully recharged the discharged battery strings before they were placed back in service.

With the UPS battery, the system was taken out of service, and the site was carried on the emergency generator during the testing process, and the IEEE guidelines were also followed.

With each inspection we first checked over-all float voltage to assure that it was proper for the model of battery, the cell temperatures, the connection resistance between the cells to verify that it was proper for the load being applied, the charge current, the internal ohmic value of each cell, the individual cell voltage, and prior to adding water to any cell we verified that the cell would hold pressure. If they would not hold pressure no water was added to that cell.

Battery Information

Site P	24 cell 1993 GNB 100A-23
Site W	24 cell 1993 GNB 100A-19
Site I	12 cell 1992 GNB 75A-23
Site S	24 cell 1994 C&D HD-700
UPS	182 cell 1993 C&D HD-300

RESULTS

Site P

This 24 cell 1993 GNB 100A-21 battery is rated to supply 211 amps for 180 minutes to an end voltage of 1.90 volts per cell. During the initial load test this battery supplied 211 amps for 72 minutes before reaching the 45.6 volt end voltage (40% capacity). Four days after the addition of the water and the installation of the Cat-Vent assemblies the battery supplied the 211 amps for 90 minutes (50% capacity). One year later the test was run again and the string supplied the 211 amps for 126 minutes (70% capacity). This battery obtained a 175% increase in capacity. With the actual site load which was substantially less than the rate the load test was run at, this battery could now support the site load for the amount of time required by this customer.

Site W

This 24 cell 1993 GNB 100A-19 battery is rated to supply 189 amps for 180 minutes to an end voltage of 1.90 volts per cell. During the initial load test this battery supplied 189 amps for 9 minutes before reaching the 45.6 volt cut end voltage (5% capacity). Four days later following the addition of the water and Cat-Vent assemblies it supplied the 189 amps for 67 minutes (37%). One year later the test was run again and the string supplied the 189 amps for 108 minutes (60% capacity). This battery obtained a 1200% increase in capacity. This battery also had a site load that was much lower than the load test rate, and this battery also now could support the site for an adequate amount of time for this customer.

Site I

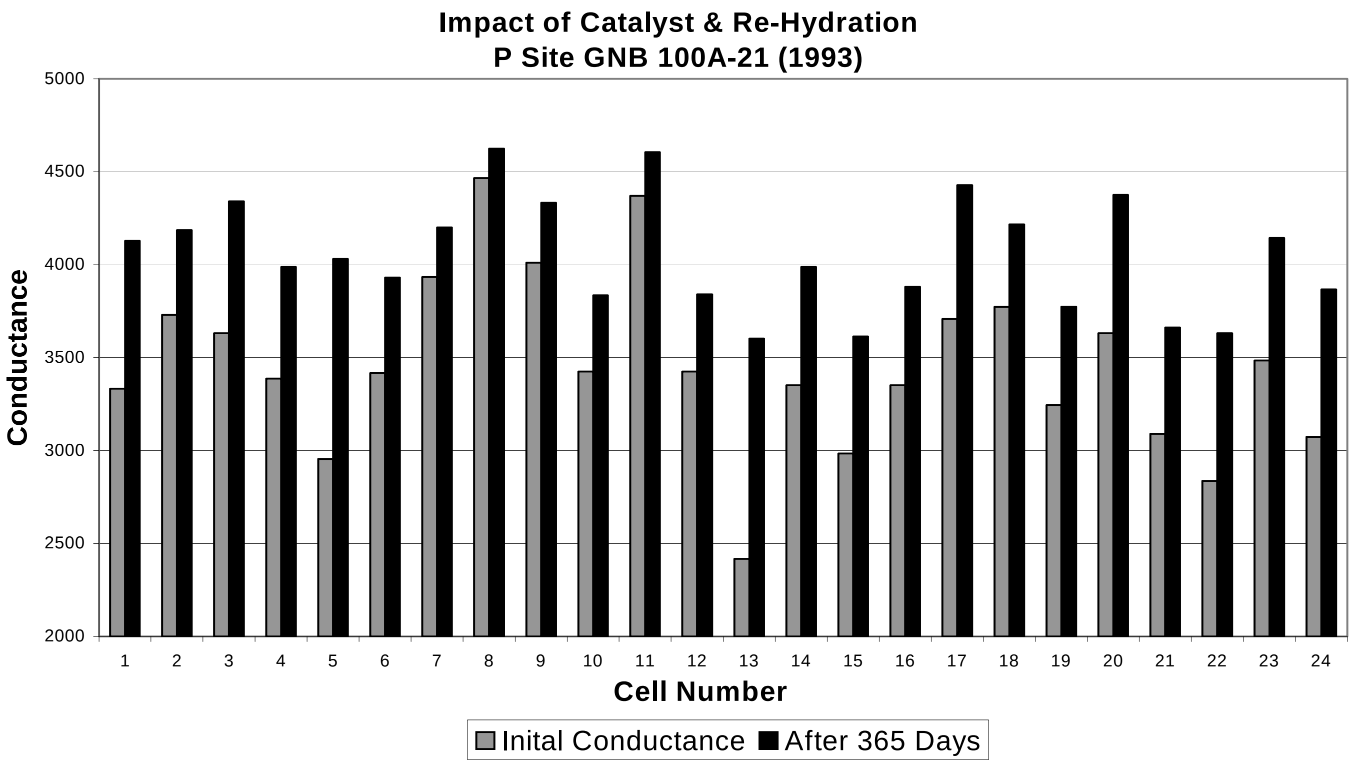
This 12 cell 1992 GNB 75A-23 battery string is rated to deliver 222 amps for 180 minutes to 1.75 volts per cell. During it's initial load test it lasted 57 minutes before it reached 21 volts (32%). One week following the addition of water and Cat-Vent assemblies the battery lasted 119 minutes (66%). Following this second load test we added an additional amount of water to the two weakest cells. One year later we again load tested this battery and it supplied the 222 amp load for 166 minutes (92%). With this site we also measured the plate potentials upon the initial visit and discovered that negative plates were under polarized and that the positives were over polarized. Eighteen months later we again measured the plate potentials to see if there was an improvement, and discovered that the negatives and positives were properly polarized. The negatives had come up to where they should be and the positives had come down to where they should be. This process eliminated the overcharging of the positive plates.

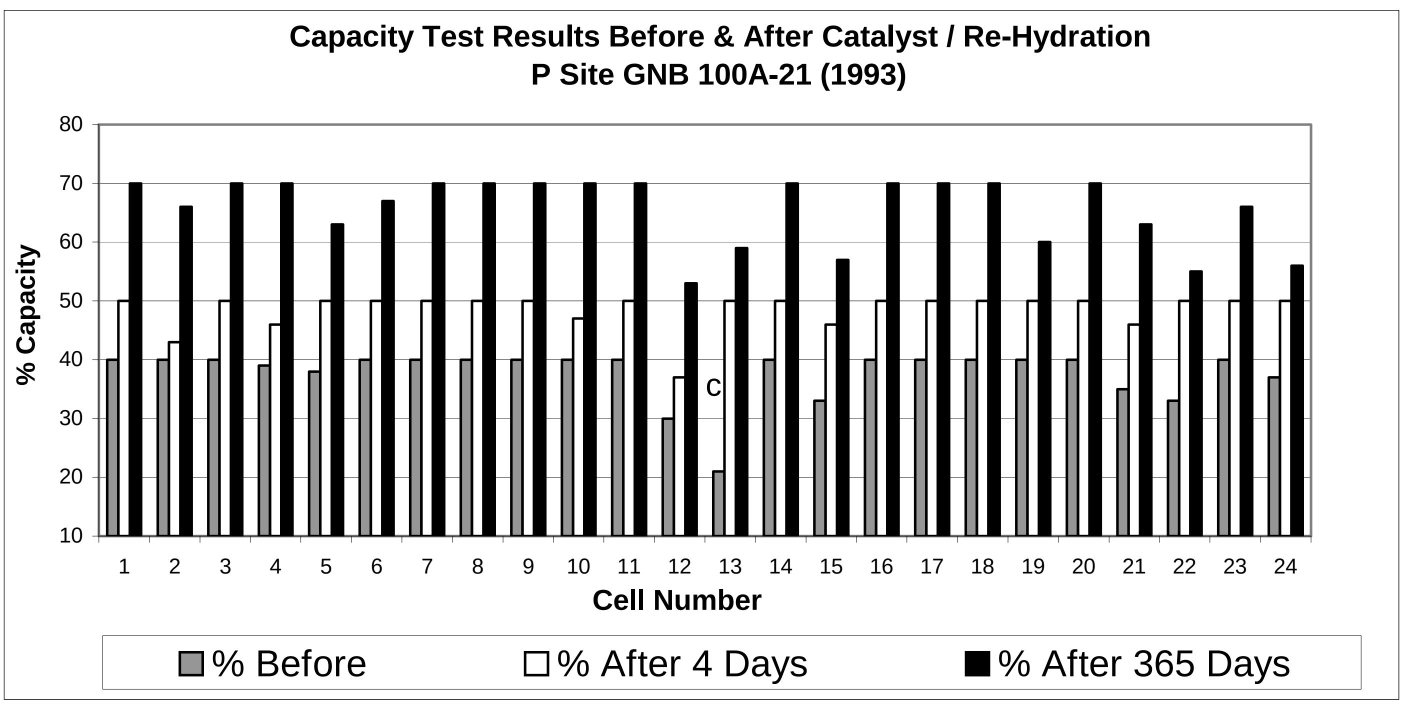
Site S

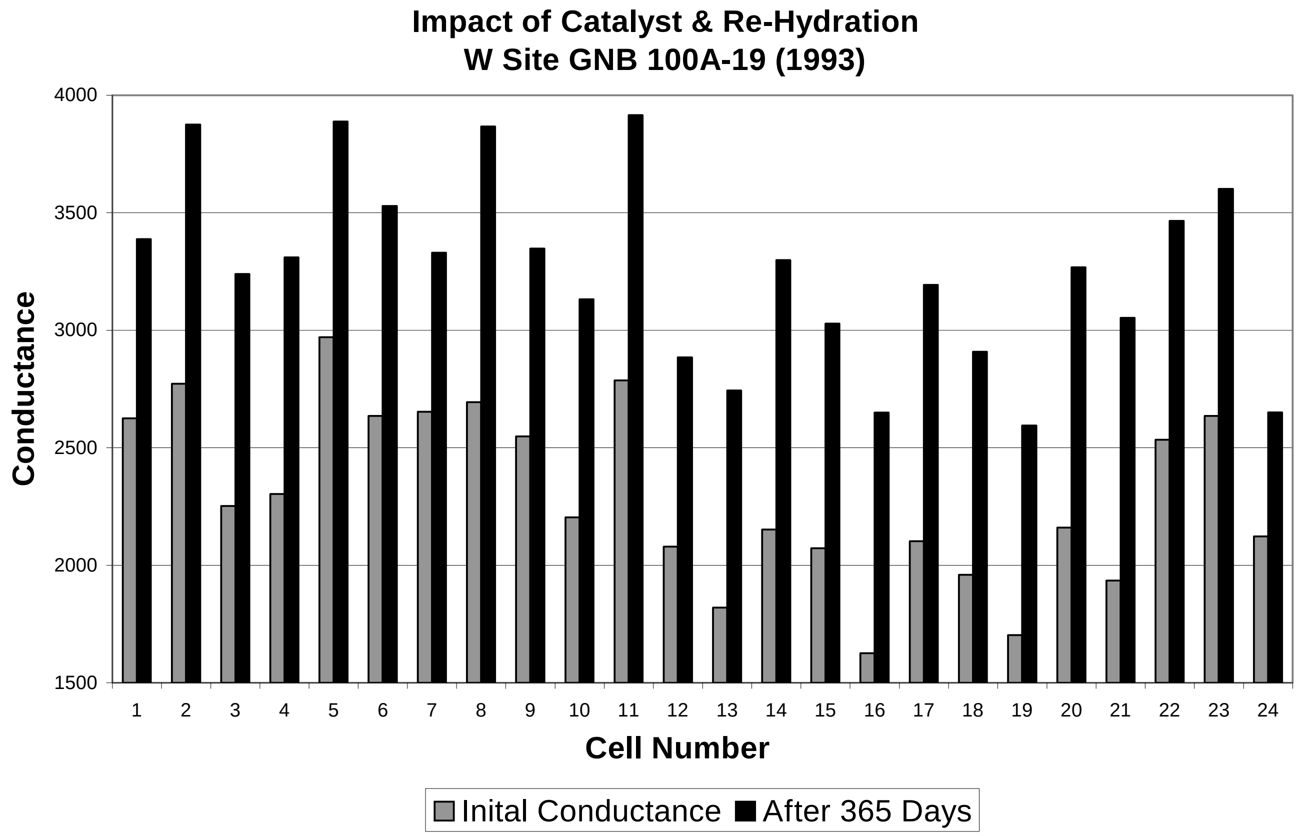
This 24 cell 1994 C&D HD-700 battery string is rated to deliver 196 amps for 180 minutes to 1.81 volts per cell. During it's initial load test it lasted 58 minutes before it reached 43.44 volts (32%). Three weeks after the addition of the water and Maximizer assemblies the battery lasted 168 minutes (93%). Following this load test we added specific amounts of water to selected cells. Ten months later the battery lasted 176 minutes (97%). To determine if we could over water these cells we again added an amount of water to every cell, waited one week and again performed a load test. We gained less than 4 minutes additional time, and were satisfied that over watering the cells was not detrimental to the string capacity.

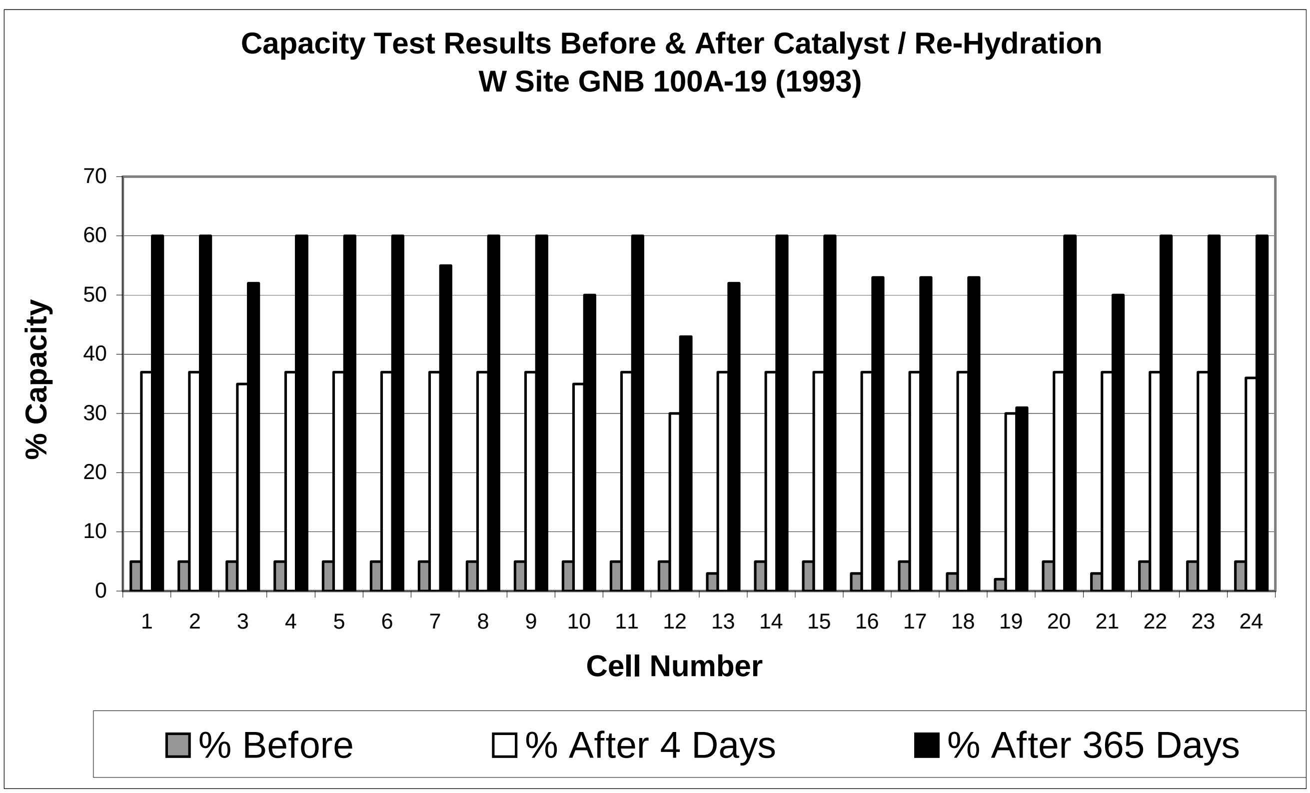
UPS

This 1993 C&D HD-300 battery string is rated to deliver 639 watts per cell for 15 minutes to an end voltage of 1.67 volts per cell. In other words this battery is rated to supply 116,298 watts (116KW) for 15 minutes to an end string voltage of 303 volts. During their first unanticipated "discharge test" which was when they had a loss of off site power and their battery system was supposed to carry the site through until their emergency generator started and assumed the load, the battery failed to perform. Through analysis of the site monitoring equipment it was determined that the site load was 87KW at the time of the event, and that within 45 seconds the battery voltage dropped below the 304 volts that the UPS had set as a low voltage drop out. Following the addition of water and Maximizers, and a wait of five days during which the battery was equalize charged at 427 volts for 24 hours, a controlled load test was run with an artificial load of 110 KW. The discharge test was terminated at 7 minutes and 35 seconds when the string voltage was at 318 volts. This battery improved from unable to supply the site load of 87KW for even one minute to being able to support a load of 110KW for almost eight minutes.

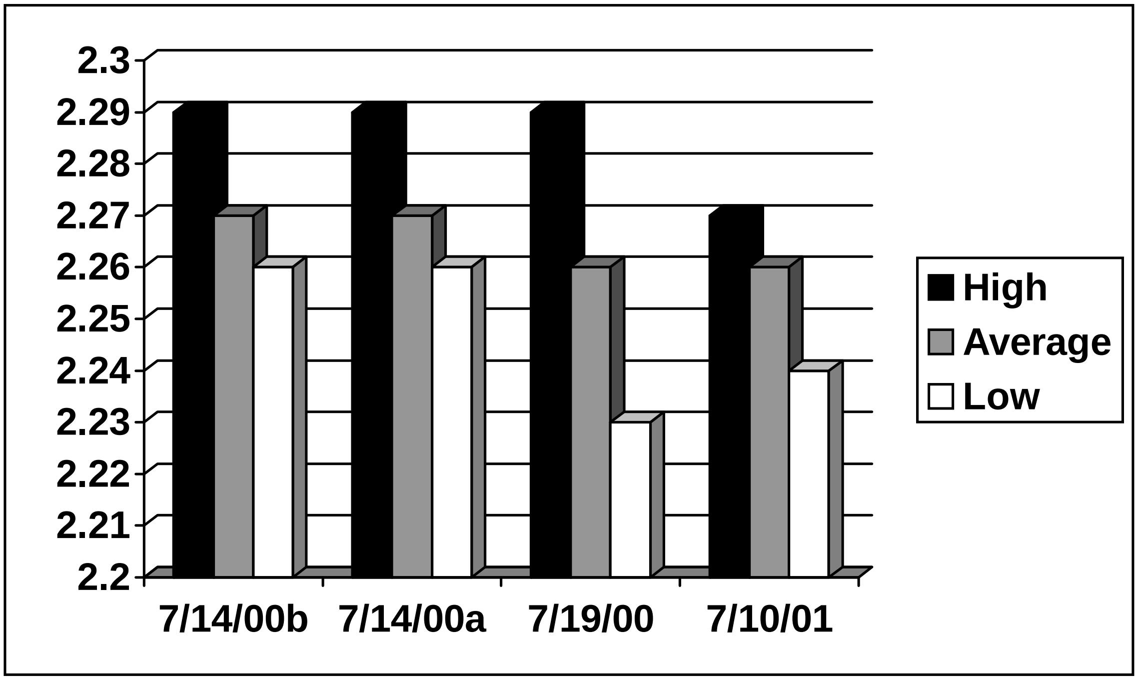

Impact of Catalyst & Re-Hydration
P Site GNB 100A-21 (1993)
Conductance
Cell Number
Inital Conductance
After 365 Days


Capacity Test Results Before & After Catalyst / Re-Hydration
P Site GNB 100A-21 (1993)
% Capacity
C
Cell Number
% Before
% After 4 Days
% After 365 Days

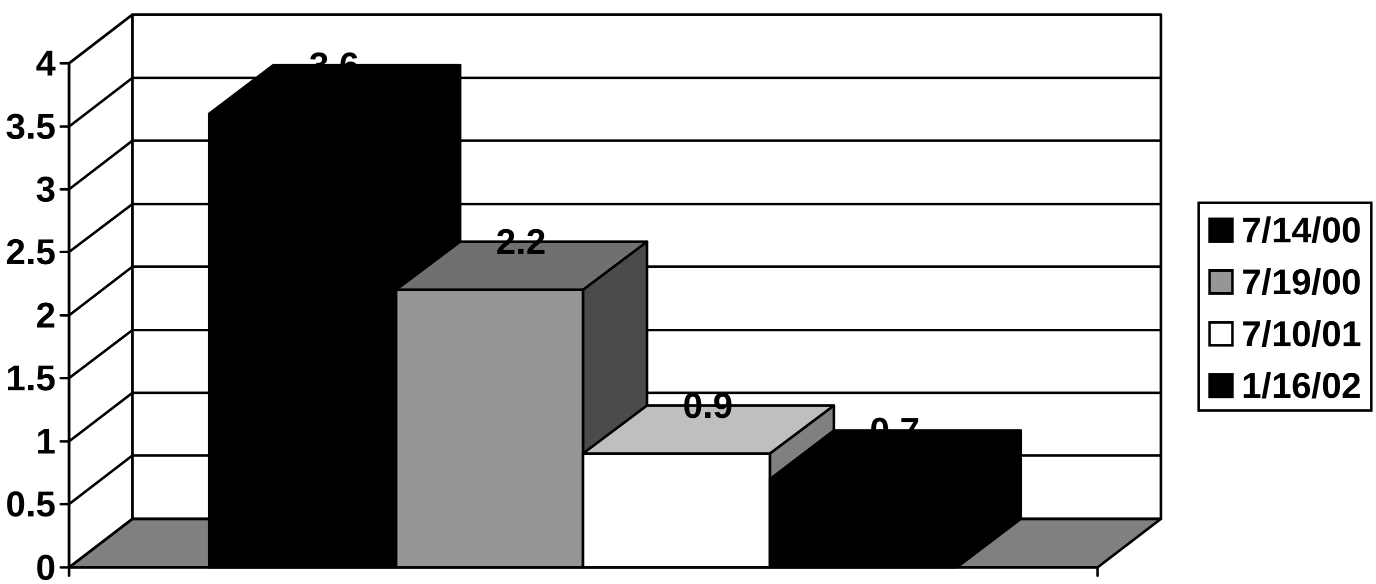

Impact of Catalyst & Re-Hydration
W Site GNB 100A-19 (1993)
Conductance
4000
3500
3000
2500
2000
1500
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
Cell Number
Inital Conductance
After 365 Days


Capacity Test Results Before & After Catalyst / Re-Hydration
W Site GNB 100A-19 (1993)
% Capacity
70
60
50
40
30
20
10
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
Cell Number
% Before
% After 4 Days
% After 365 Days

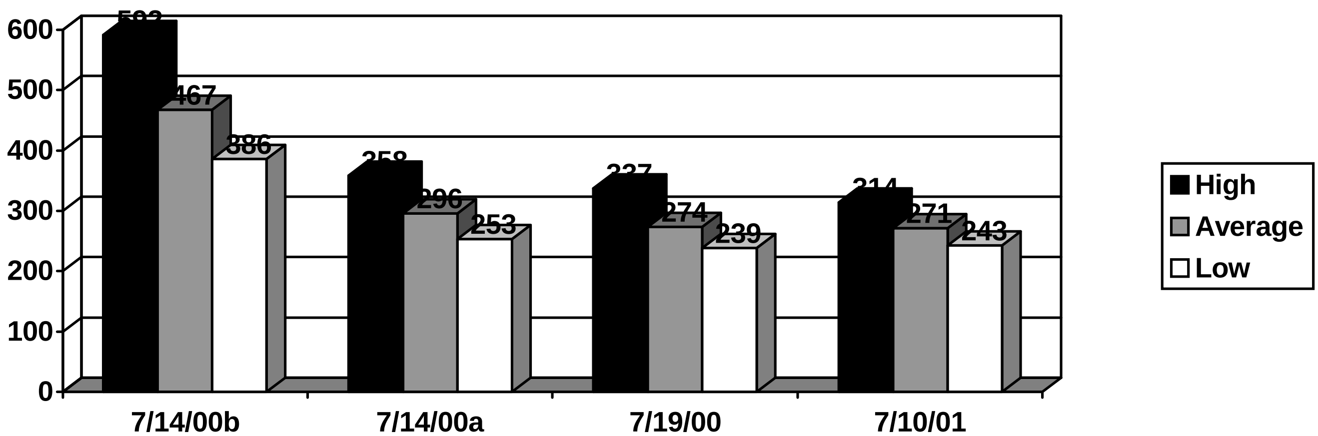
Float Voltages 75A-23



Float Charge Current 75A-23



Cell Impedance 75A-23



String Capacity 75A-23

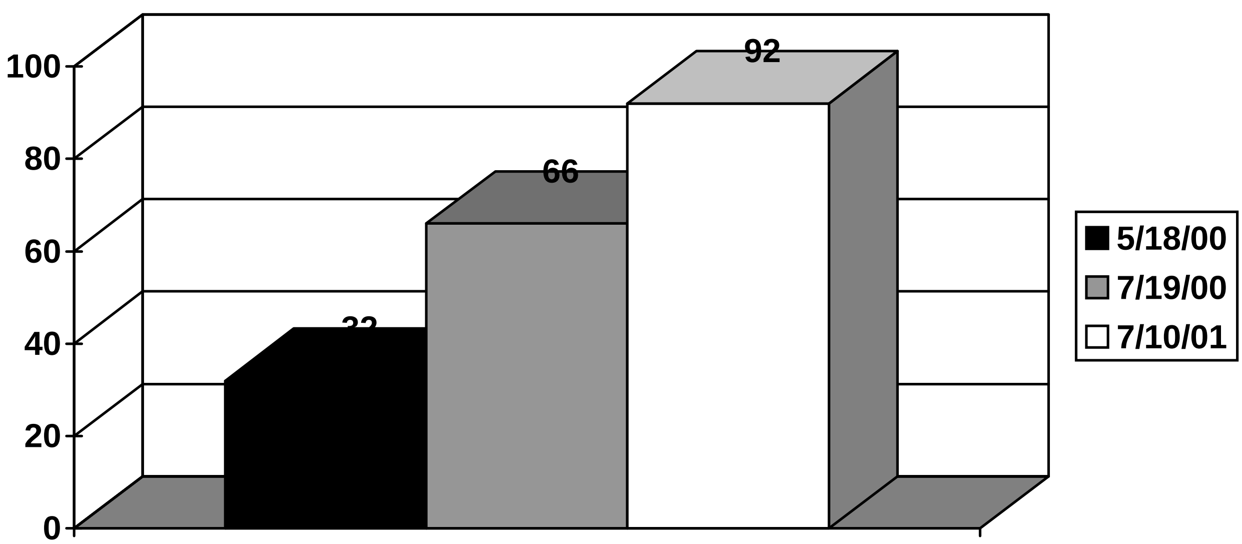
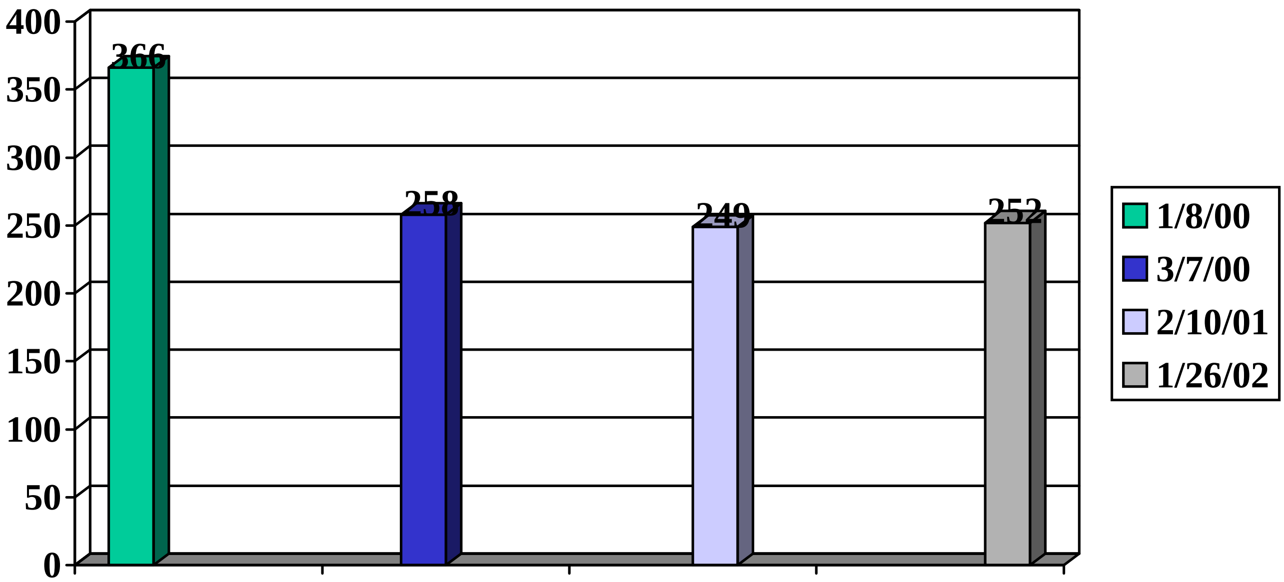


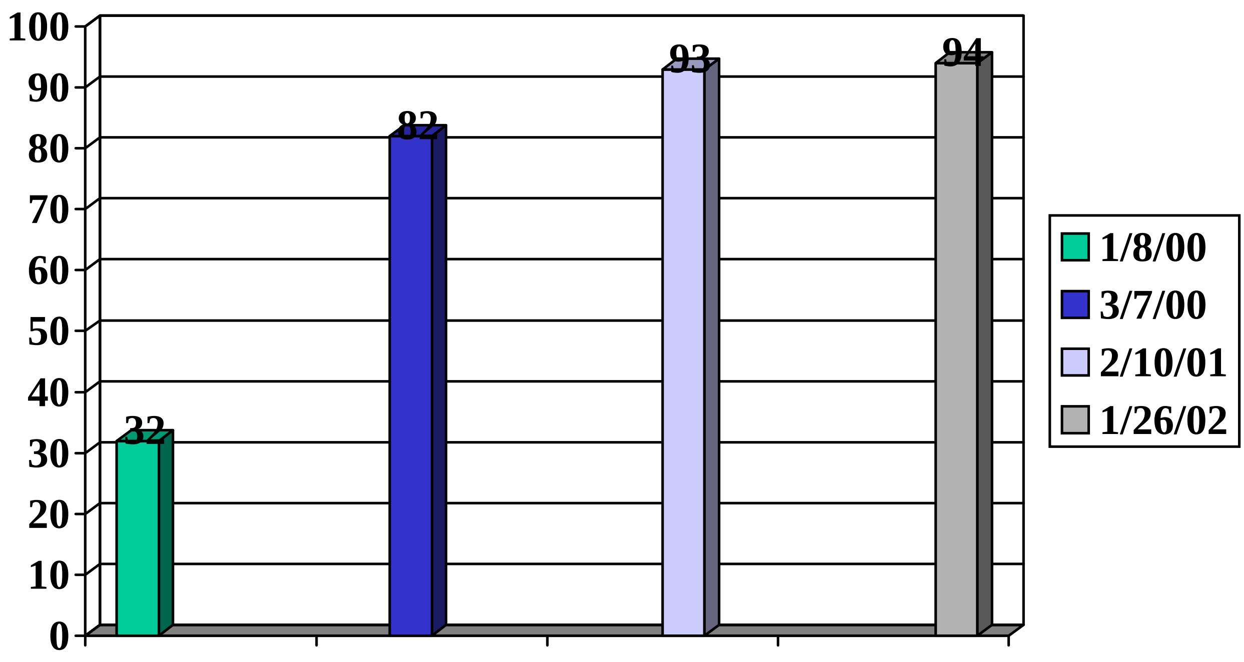
Plate Potentials changes before and after Cat-Vent installation 75A-23

	July 14, 2000		January 16, 2002	
	Positive	Negative	Positive	Negative
High	+1.3122	-0.9758	+1.284	-0.981
Low	+1.2869	-0.9600	+1.274	-0.971
Average	+1.295	-0.965	+1.278	-0.978

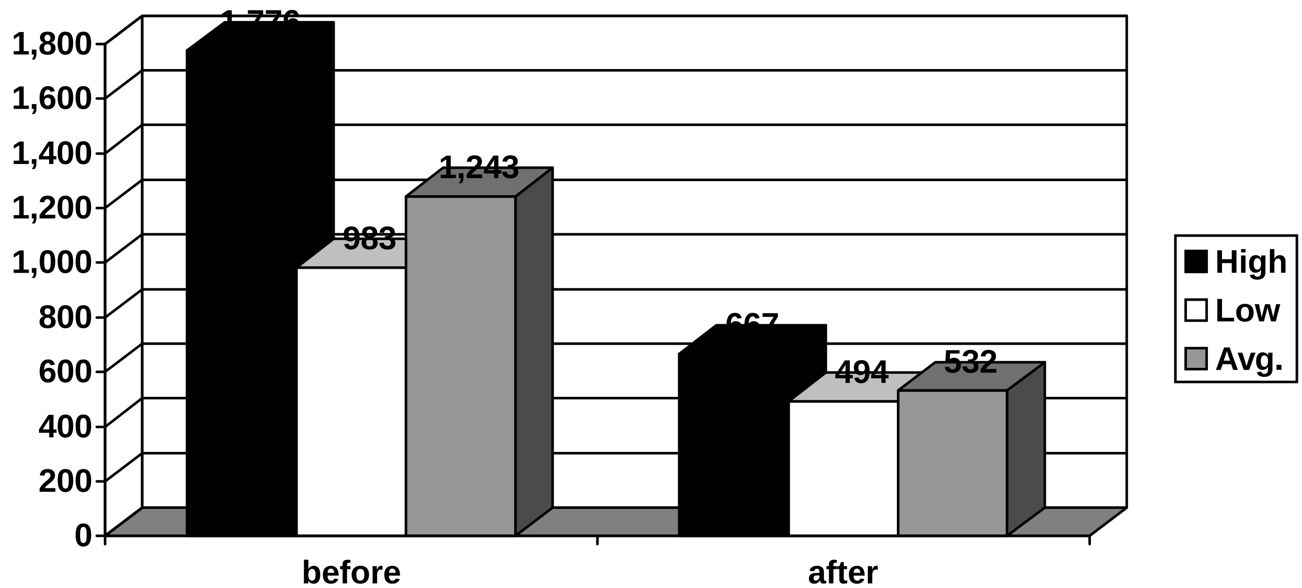
Avg. impedance values 48 Volt 1994 C&D HD-700



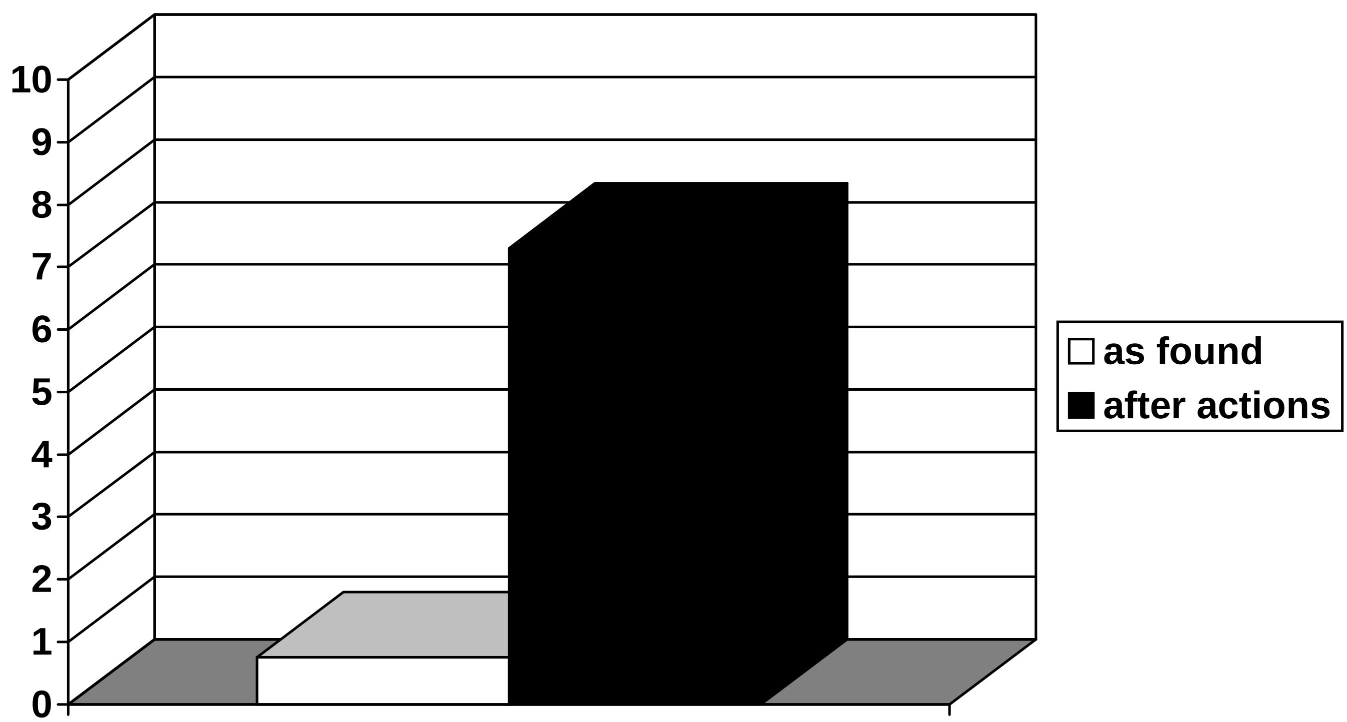
String Capacity results 1994 HD-700's



HD-300 Impedance values, before and after Restoration process.



HD-300 Run time before and after Restoration process.



Summary

- Internal Ohmic Measurements will detect an increase in dry-out or lack of compression, plus they will detect a decrease in capacity or capability of a cell.
- Charge current will provide an indicator of the need for corrective actions.
- Individual cell float voltages can remain the same no matter what the capacity or capability of the battery is.
- AGM VRLA cells can have lost capacity or capability restored through the process of water additions and Catalyst installation.
- Improper plate potentials can be corrected through the use of Catalysts.
- This process will work with a battery in either a low draw application such as telecom, a high draw short duration application such as a UPS, or a general duty application such as a power plant application.
- The failure mechanism of AGM VRLA cells can be substantially different than the failure mechanism of vented lead acid cells, and must be addressed as such. Just because an AGM VRLA battery has failed to perform as required, it does not mean that it must be replaced. It may be able to be saved.
- If you are not using internal ohmic values as your primary check during maintenance inspections, you are wasting your time.
- Also if you do not have a program that includes some load testing to build a correlation between your ohmic values and actual capacity or capability, you do not have any idea of the condition of your system/s.

Conclusion

- The general condition of a AGM VRLA battery string can be determined from a thorough inspection, which includes charge current, and internal ohmic values, as long as the correct ohmic values have been calculated, or are known as compared to a load test.
- Individual cell float voltages are meaningless in predicting cell capability.
- Adding water and a Catalyst to VRLA AGM cells will restore capacity that is lost, due to either dry out or lack of compression, and will maintain that restored capacity.
- Installation of Catalysts will help to restore the proper charging potential to plates that require it, or will maintain the proper potentials if installed before the damage has been done.
- Companies that use this process in the maintenance of their AGM VRLA cells will reduce their capital outlay for battery replacements substantially, and can extend their run time with their present systems. The inverse is also true. Those that do not will be spending substantial amounts of money needlessly.

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Now that we understand this failure mode with these batteries, here is a question. Should this be a reactive process, or should it be a proactive process?

I want to give a special thanks to Rob and Les Anderson of Andersons Electronics of London, Ontario, Canada, whom have supplied me with extensive data from their findings up there. Their efforts helped substantially in allowing us to come to our conclusions.