Getting Long Float Life from VRLA Batteries - The Pure Lead-Tin Option

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ABSTRACT

As absorbed glass mat (AGM) valve regulated lead acid (VRLA) cells become accepted in more and more mission-critical applications, the ability of these cells to meet their design life specifications is coming under increased scrutiny. End users frequently claim that conventional lead calcium VRLA batteries they purchased and thought would last 8 to 10 years typically fail capacity tests after only 2 to 4 years in relatively benign applications. An unfortunate result of this negative experience with conventional lead calcium VRLA technology is the vilification of all VRLA cells and batteries as unreliable and not worthy of consideration in high-reliability applications.

This paper demonstrates the superior longevity, when compared with lead calcium VRLA, of thin plate pure lead (TPPL) VRLA batteries with a small amount of tin added to it. Using well-established accelerated float life (AFL) testing techniques, it will be shown that long-life TPPL VRLA batteries commercially available today will provide reliable service for anywhere from 8 years to over 15 years at 25°C (77°F), depending on the rate of discharge.

INTRODUCTION

Ever since the introduction of the VRLA AGM battery in the early 1970s, it has seen increasing use in emergency power applications such as uninterruptible power systems (UPS) and telecommunications applications. Its low maintenance and low-gassing features make the VRLA battery attractive for installation in offices and computer rooms.

Since its introduction, the average user has been dissatisfied with the typical life of a VRLA battery. Batteries thought to have a design float life of 10 years or more were lasting only a few years. This experience has left a bad taste in the mouths of many customers who bought into the VRLA AGM technology for their standby battery needs.

There is an abundance of literature[1, 2, 3, 4] that provide details on the premature failure of these batteries. However, most if not all of this body of literature looked at the behavior of lead-calcium VRLA batteries and an incorrect assumption was made that the highest quality VRLA batteries cannot last as long as their claimed design life, even under favorable conditions. This is unfortunate because it ignores the superior performance characteristics of VRLA batteries using TPPL technology. This paper presents AFL test data that will demonstrate the longevity of TPPL batteries in float (standby) applications.

The paper concludes with a few observations on the use of conductance as a diagnostic tool for VRLA battery maintenance and replacement decisions. A key finding is that the discharge rate should determine the conductance threshold selected.

EXPERIMENTAL SETUP

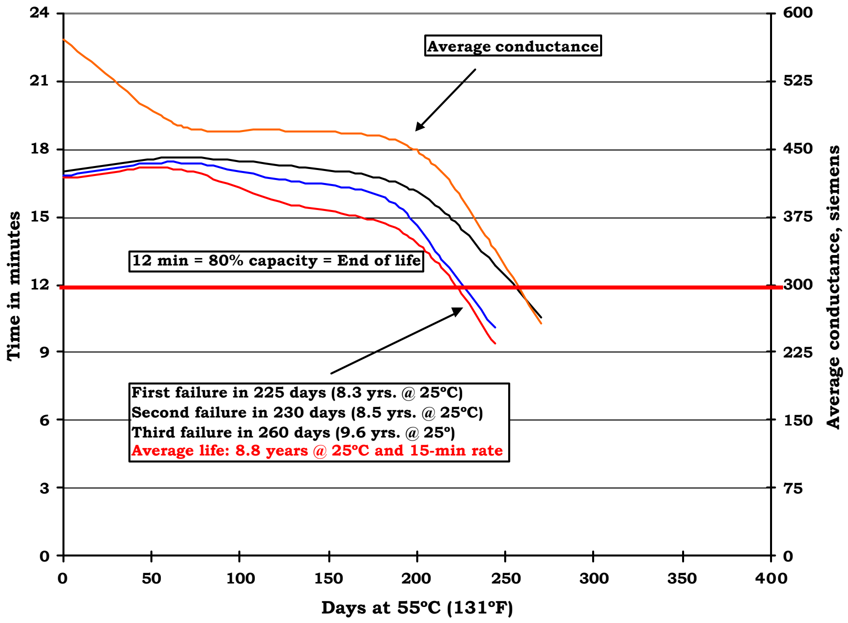
The Genesis EP and XE versions of our TPPL VRLA technology were tested. Both versions have a capacity of 16 amp-hours at the 10-hour rate of discharge at 25°C (77°F). The XE is a longer-life version of the TPPL technology, with a specified float life of 12+ years at 25°C (77°F) to 80% of its rated capacity.

Three samples of each type were tested at 55°C (131°F) using accepted AFL test procedures, discharging the batteries once a month at the 15-minute rate (representing a typical high-rate discharge) and at the 5-hour rate (representing a low-rate discharge). The end of discharge voltage in each case was 10.02V or 1.67 volts per cell (VPC). The conductance was measured and recorded after each discharge.

Based on a 50% reduction in float life for every 8°C increase in operating temperature above 25°C, the float life acceleration factor for an ambient temperature of 55°C is 13.454. In other words, each day the battery spends at 55°C is kinetically equivalent to spending 13.454 days at 25°C. The life calculations on the graphs shown below reflect this acceleration factor.

DISCUSSION OF THE EXPERIMENTAL RESULTS

Figures 1, 2 and 3 show data for the EP batteries, while Figures 4, 5 and 6 show similar data for the XE batteries. Also plotted on each discharge graph is the average conductance value, visually demonstrating how conductance tracks the capacity available from the batteries tested.

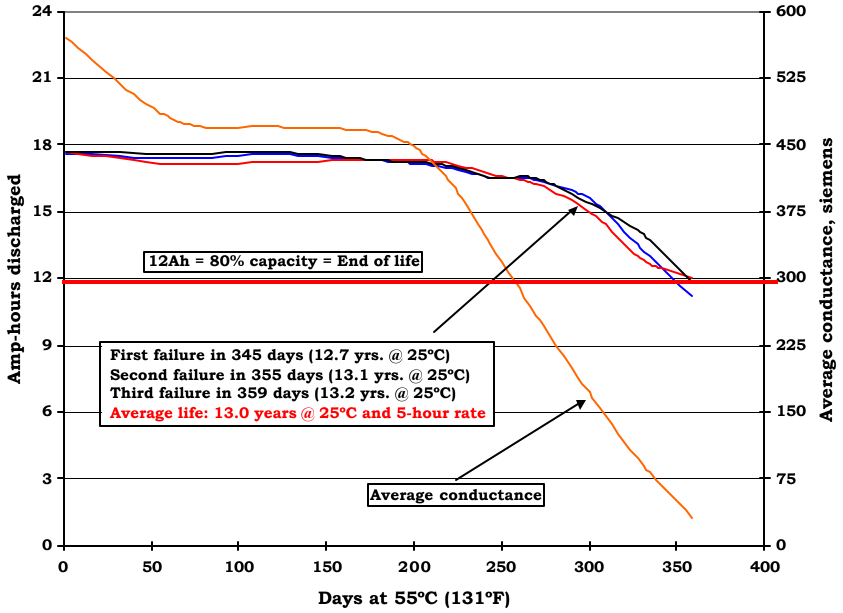


Average conductance

12 min = 80% capacity = End of life

First failure in 225 days (8.3 yrs. @ 25°C)
Second failure in 230 days (8.5 yrs. @ 25°C)
Third failure in 260 days (9.6 yrs. @ 25°)
Average life: 8.8 years @ 25°C and 15-min rate

Figure 1: Genesis 16EP AFL data at 15-minute rate



12Ah = 80% capacity = End of life

First failure in 345 days (12.7 yrs. @ 25°C)
Second failure in 355 days (13.1 yrs. @ 25°C)
Third failure in 359 days (13.2 yrs. @ 25°C)
Average life: 13.0 years @ 25°C and 5-hour rate

Average conductance

Figure 2: Genesis 16EP AFL data at 5-hour rate

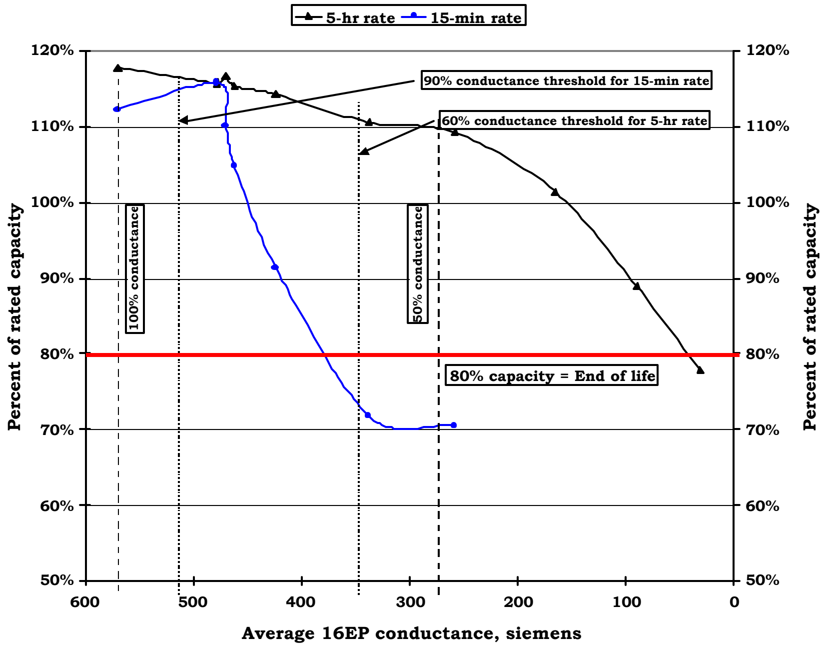


Figure 3: Average conductance for Genesis 16EP

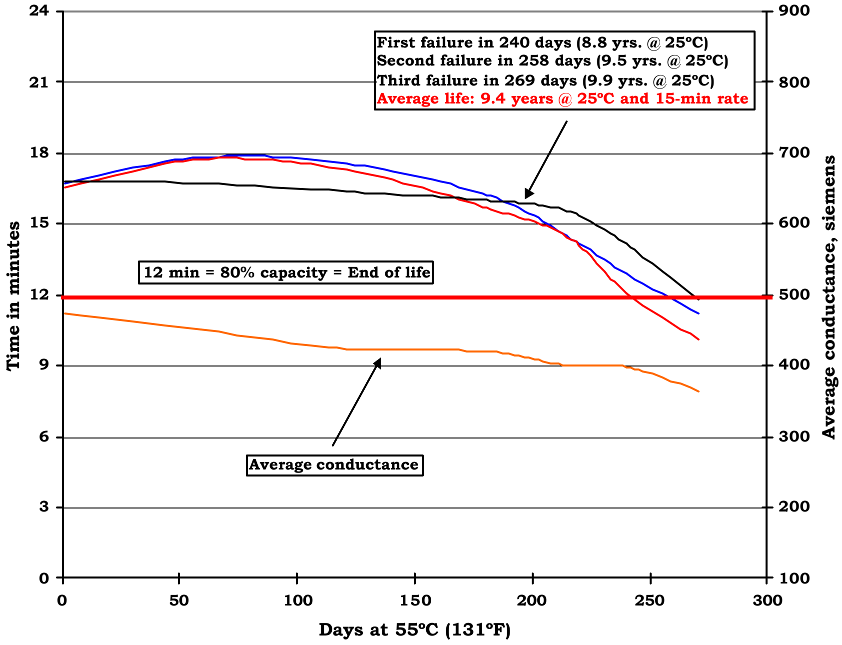


Figure 4: Genesis XE16 AFL data at 15-minute rate

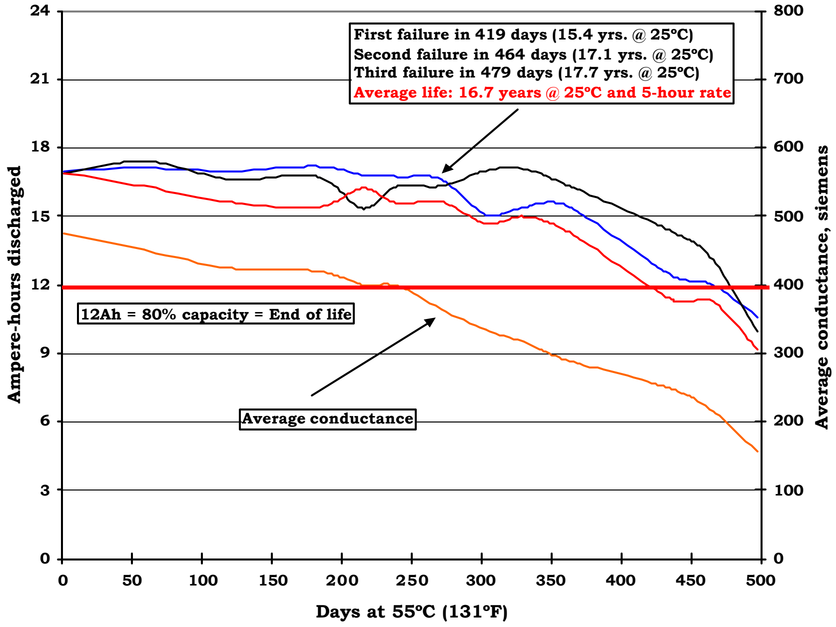


Figure 5: Genesis XE16 AFL data at 5-hour rate

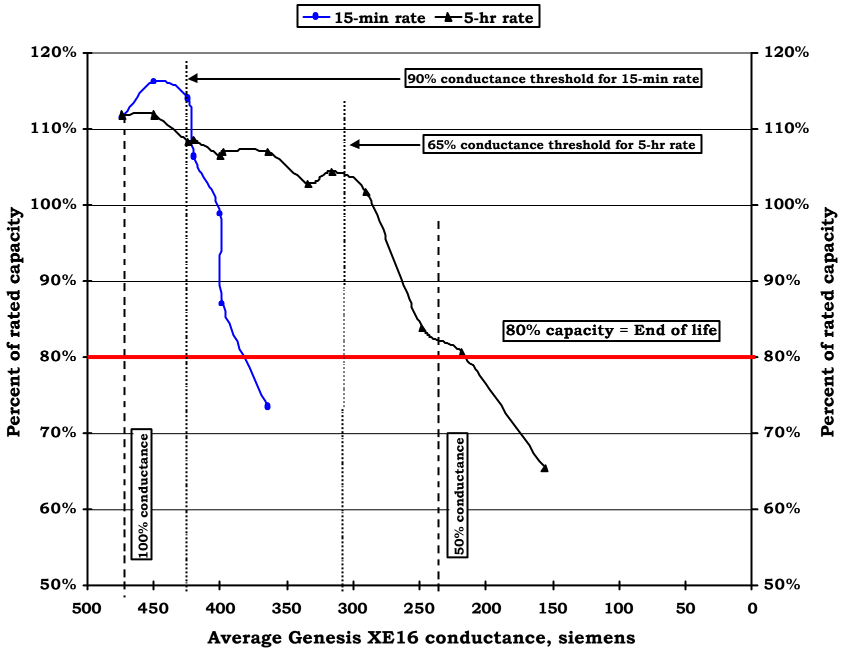


Figure 6: Average conductance for Genesis XE16

Figures 1, 2, 4 and 5 offer proof that life expectancy in a float application is dependent on the rate of discharge. For example, the average life expectancy of the XE battery is over 16 years at 25°C (77°F) and at the 5-hour rate of discharge. At the 15-minute rate of discharge, the average life expectancy drops to 9.4 years at 25°C (77°F). A similar reduction in life occurs with the EP battery.

Figures 3 and 6 provide some interesting results. Batteries discharged at a high rate (15-minute) had an average conductance graph with a steeper slope when compared with the average conductance graph of those discharged at a low rate (5-hour). This has major implications in terms of selecting appropriate conductance values as thresholds in a battery maintenance program. For example, these two figures show that choosing 50% of initial conductance value as a threshold is not a good idea when the battery is in a high-rate float application, typical of a UPS application. By the time the battery conductance drops to 50% of initial value its capacity is well below 80% of its rated capacity, which typically defines the battery's end of life.

Based on data shown in Figures 3 and 6 it is suggested that threshold conductance values be selected to be somewhere in the 85-90% of initial value when the battery is in a high-rate application; if the battery is in a low-rate application the conductance threshold may be lowered to be in the 60-65% range.

CONCLUSIONS

Experimental data presented in this paper proves that TPPL batteries are commercially available today for those float applications where reliable long life is a critical requirement. The key findings are summarized below:

1. *TPPL technology is well suited for float applications that require VRLA batteries to last 10 or more years at 25°C (77°F) before reaching end of life, traditionally defined as 80% of its rated capacity.*

2. *Ignoring the effect of ambient temperature, the life expectancy of a VRLA battery will depend on whether it is in a high-rate or a low-rate application, such as UPS or telecommunications, respectively.*

3. *If conductance is used as a diagnostic tool to determine when batteries are replaced, trending must be used with the initial installed and fully charged value taken as the reference value of 100%.*

4. *The discharge rate should determine the threshold value of the conductance selected. Experimental data presented in this paper suggest thresholds of 85-90% of initial conductance for high-rate applications and between 60-65% of initial value for low-rate applications.*

REFERENCES

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