GOT WARRANTY?
Taking Another Look At the 20-Year Battery Warranty

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Introduction

One of the most confusing issues impacting the lead acid battery industry centers on the interpretation and implementation of the standard 20-year product warranties offered by battery manufacturers. There is a significant disconnect between the understanding and expectations of end users regarding these warranty programs and its correlation to the actual battery performance and life they are realizing on most real-world applications. The 20-year battery warranty has been a standard offering in the industry for decades, and one might wonder what is driving this negative response. Much of it is due to the huge growth over the past 20 years in the installed base of VRLA batteries, as well as the significant proliferation of new customers and applications using lead-acid batteries. This market growth has only increased the level of scrutiny on many of the inconsistencies and confusion surrounding battery warranties. The result has been a growing dissatisfaction by both end users and manufacturers alike in the current industry practice.

The objectives of this paper are the following:

1.) To briefly review the origins and history of the 20-year battery warranty, and better understand some of the original assumptions involved, particularly with the relationship and differences between battery design life, service life, and warranty.

2.) To provide an overview of the main issues and concerns with current warranty programs in relation to actual battery performance and life expectancy, and fairly represent the points of view of all parties involved (manufacturer, user, and reseller).

3.) To suggest a process for exploring alternatives to the current practice, aimed at developing warranties that more accurately reflect the actual performance and life expectancy parameters of the lead-acid battery.

History

The genesis of the 20-year standard pro-rated warranty was rooted in the effort (begun in the 1950's) to promote the emerging lead calcium flooded battery designs into a variety of industries that had long standardized on traditional Plante and antimony grid style batteries. These traditional designs, based on either Plante grid construction, or the Manchester & Manchex antimony grids with inserted lead 'rosettes' or grooved lead, offered generally high reliability and a life expectancy that was routinely in the range of 18-25 years for batteries.[1] At the same time, these traditional batteries were also expensive to manufacture, with a large footprint, high weight, and a fairly limited range of sizes that could be offered.[2]

Beginning in 1951, with the approval of the lead calcium grid style battery by Bell Labs, a few US battery manufacturers began promoting the pasted plate lead calcium grid design as an alternative to the traditional Plante and high antimony batteries.[3] Lead calcium advocates argued that their batteries offered better economics in terms of the production costs, size, and weight of comparably sized batteries. They also claimed that the lead calcium grid design had lower maintenance and watering requirements compared to high antimony lead batteries. The lead calcium manufacturers' believed this new grid design offered users a battery with better life expectancy compared to the high antimony types, and better economics and footprint compared to the Plante types.[4]

Despite the approval of lead calcium grid designs by Bell Labs, the adoption in the U.S. of the lead calcium battery was very slow, particularly in industries outside of telecommunications (Switchgear, Utility). Both the Plante and high antimony type batteries had generally performed well for decades, and many markets were resistant to such a significant change. The lead calcium manufacturers had only limited empiric field data to support their claims, and realized that more extensive accelerated life testing was needed in order to more confidently characterize the performance and life expectancy of the lead calcium battery.[5]

It was the work of Eugene Willihnganz (circa 1964-1966) that added to the original research done by Haring & Thomas at Bell Labs, and represented a major step forward in developing methods for comprehensive accelerated life testing of the lead calcium battery. His intent was to more accurately project the life expectancy of the lead calcium battery for typical industrial applications. Willihnganz developed testing procedures that more accurately accelerated battery aging, in a research project using over 500 batteries placed in specialized test ovens set at five different temperature levels between 100˚F and 160˚F, at float voltages between 2.10Vand 2.50V. After two years of testing, Willihnganz presented his paper at the C&D Chicago Meeting in October of 1967, and published his findings in 1968. In his final report, Willihnganz offered the strong conclusion that the lead calcium flooded battery would provide typical life expectancies of 20 years, based on the data he had collected during his extensive accelerated life test.[6]

This study by Willihnganz strongly influenced one lead calcium battery manufacturer to consider creating a new marketing weapon in the fight to promote its lead calcium batteries. They believed that the only way to combat the reluctance of many industries to add lead calcium batteries to their specifications was to provide a guarantee on their batteries. This performance warranty would offer users more of a comfort level with this 'new' battery technology, and to give their sales and marketing groups a strong tool to overcome customer reluctance. Thus the first 20-year battery warranty was introduced (circa 1968), offering a 1 year full/19 year pro-rated guarantee. This warranty made an attempt to provide valuation formulas which were based on the manufacturer's assumptions for life and replacement costs, along with caveats such as record-keeping, required environmental temperature conditions, etc. Though many of these valuation formulas and caveats were not fully understood by many users, the relative high life expectancy typical for most flooded lead-acid batteries prevented this from becoming a major issue in the early days of the 20-year warranty. Other lead calcium manufacturers soon matched this program with warranties of their own, leading to the rapid adoption of lead calcium batteries for use in most stationary battery applications in the U.S.[7]

The situation became a lot more complicated with the adoption of the Valve Regulated Lead Acid battery (VRLA) battery design for stationary applications, which began in earnest around 1977-78. The VRLA design, which was first commercialized by companies like Gates and Gould, was a revolutionary approach to the construction, packaging and design of lead acid batteries. Ironically, the Gould Industrial Battery Division initially developed the VRLA for cycling motive applications, like forklifts and electric guided vehicles. The original intent was to reduce the significant maintenance and watering requirements of flooded style batteries in typical motive applications.

Despite many early problems with the development of the VRLA, the early manufacturers believed they had a viable commercial product. But they were completely unprepared for the huge market response when they first approached users with stationary float applications. And why not? Battery users immediately saw the potential of the VRLA as an energy storage solution with significantly reduced size, footprint, and weight, along with higher power densities. More importantly, the internal recombination design of the VRLA was touted as eliminating the need for watering and maintenance, which was a huge potential benefit to users. The form factor of the VRLA dramatically increased the number of potential applications for lead acid batteries, many of which would be in uncontrolled environments previously not considered viable for battery use. A good example of this was the explosion of VRLA battery applications in telecommunications, as beginning in the mid 1980's we witnessed a shift in telephone systems from Central Office locations to outdoor distributed cabinets in support of subscriber line loop network architecture. Clearly the customer response to the VRLA design in stationary applications went beyond all expectations.[8]

While the early VRLA proponents saw a huge market opportunity, they also realized that solidifying market acceptance of the new technology would require a strong warranty statement backing up the product. Despite the original design assumptions of the VRLA as a 4-5 year cycling product for motive applications, the VRLA pioneers pointed to some preliminary test results on plate corrosion and water loss as suggestive that 20-year VRLA battery life was possible. They felt it was reasonable to assume that a VRLA battery design incorporating relatively thick plates, along with proper recombination and little or no water loss, would provide solid battery life and performance.[9] At the same time, a 20-year industry standard had already been established regarding general battery warranties. Customers who were eager to move to the VRLA technology pressed hard for a similar guarantee. In retrospect, it appears that the VRLA manufacturers faced strong pressure from both within their organizations (sales & marketing) and externally (customers) to offer a 20-year warranty on this exciting new product, especially for the larger stackable batteries that were being promoted as an alternative for the 20-year flooded product.

The Gap Between Expectation and Reality-Design Life vs. Service Life

As VRLA battery sales and shipments grew rapidly, manufacturers and users soon realized that they were facing problems and issues very different from the industry experience with flooded lead acid batteries. Contrary to the early high hopes and expectations, the early VRLA products began exhibiting widespread problems inside of five years of life, many of which were not fully understood at the time. Early VRLA batteries suffered from the chronic undercharging (depressing) of the negative plate, which was related to the VRLA gas recombination principle.[10] These resulting voltage imbalances over time resulted in a loss of battery capacity. VRLA batteries also suffered from problems with maintaining and equalizing internal pressure, as the nuances of good valve design were not fully understood. Other problems included battery dry-out due to gradual outgassing, plate growth and bulging, as well as plate compression. (You can have a fully saturated glass mat separator, but if it is not fully in contact with the active material, the result is a loss of capacity.) Achieving good jar cover and post seals was more difficult than originally thought, leading to problems with leaking batteries. It took time to understand these dynamics, and the knowledge came at a high price, as relatively high rates of VRLA field failures begin to take its toll on customers and manufacturers alike.[11]

Looking back, some long-time industry observers admit that one of the biggest problems was the lack of procedures and equipment at the time to conduct more accurate tests to characterize long-term VRLA performance. The accelerated life testing procedures developed by Willihnganz was the foundation for design life definition used by VRLA manufacturers. In many respects, applying the accelerated life testing procedures established for flooded lead calcium batteries had little correlation to the actual service life of the VRLA battery. Accelerated life tests were designed to test for positive grid corrosion and growth, which are traditional determinates of life for flooded batteries; these were often not the primary causes of premature VRLA failure. Unlike the comprehensive temperature tests that could be performed on flooded batteries, researchers were limited in the temperature ranges they could impose on VRLA batteries under test, which resulted in a broader range of assumptions that were made regarding VRLA life expectancy. These assumptions suffered from the relative scarcity of hard laboratory and field data, and as one observer noted, “We just didn’t know then what we didn’t know.” In many respects, the true characterization of the VRLA battery was done in the most difficult laboratory of all – the field.

Manufacturers were forced to respond with warranty valuation and replacement formulas that were increasingly filled with strong language on caveats, exceptions, and increased responsibilities placed on the users to document installation and maintenance procedures, as well as environmental conditions. This was particularly critical to the manufacturers prior to the widespread use of temperature compensated battery chargers. Many users were forced to alter their internal processes and planning assumptions regarding VRLA battery life, which often significantly impacted the economic basis and planning for system deployment. As users became more educated on battery warranty programs, many were unpleasantly surprised by the reality of battery warranties in terms of what was covered, even on the more traditional flooded batteries. For example, most manufacturers warranty only electrical capacity, and exclude the mechanical issues of jar cover and terminal post leaks on lead acid batteries. The resultant conversations between customers and manufacturers over these ‘fine points’ were understandably less than ideal from the point of good relationship building. This gap between design life and actual service life is an on-going issue for the US battery industry, impacting manufacturers and users alike.

Where Are We Today?

From our perspective, there are three main objectives behind most standard battery warranties. First, battery warranties attempt to define the primary responsibilities of both the manufacturer and the end user over the life of a battery. Secondly, it attempts to frame the life cycle economics of the battery from installation to end of life. Thirdly, the warranty establishes the actual value of the battery at any stage in its life, particularly in the event of battery failure and replacement. In other words, when a battery fails, the questions should be very simple: Who is responsible for what, and who pays how much? On the surface it would appear that this is a simple, clear compact between the manufacturer and the end user.

In reality, there are many inconsistencies and issues with the current practice. In one sense, the VRLA battery was the victim of the original high expectations and excitement surrounding its introduction. The proliferation of new applications, which began seriously around 1985, resulted in an explosion in the installed base of VRLA batteries by customers who did not fully understand the limitations of this technology and the critical need for proper operations and maintenance procedures. It is interesting to note that much of the criticism of our industry in the past decade has come from many of our newest customers, having the least experience and knowledge of the intricacies of lead acid batteries and their proper application.

Users are confused and frustrated by the complex valuation formulas used by manufacturers in determining replacement value for battery failures, due to the caveats surrounding warranty claims. Their original expectations for battery life, particularly for VRLA batteries, were in large part based on the 20-year warranties offered for these products. For many customers the result has been real disappointment and dissatisfaction in the face of their actual experience. There is significant empiric life data that clearly demonstrates average battery life that is lower than the 20 years suggested by industry standard warranties. Additionally, a 20-year warranty in and of itself is not a standardized measure of true product quality, as each warranty may be based on the different design/service life assumptions of each manufacturer. In the final analysis, a good argument can be made that it was not unreasonable for users to have a general expectation of long life for their VRLA batteries, especially when offered a 20-year battery warranty similar to flooded battery products.

Users are not alone in their dissatisfaction. Manufacturers are frustrated by what they feel is unfair blame for many battery failures which are due to variables beyond their control, such as installation, environmental and maintenance factors. They believe increased customer education and battery knowledge, along with improved operational practices, would solve many of the problems currently blamed on the manufacturers. Battery resellers, representatives, and distributors are also frustrated and stressed, as they often find themselves in the middle of these increasingly adversarial relationships, trying to broker solutions acceptable to both sides of the conflict.

Given the above, it would appear that that the industry standard battery warranties are not accomplishing the purpose for which they were originally created.

Is There A Solution?

Few people in our industry would seriously doubt the intentions and good faith of the American battery manufacturers when they offer a standard 20 year warranty on products they build and offer. We should understand that despite any private misgivings they may have about the practice, battery manufacturers would be understandably reluctant to challenge long-standing industry norms and convention. But from the perspective of our customers and other non-industry people, even the appearance of illogic or inconsistency in the battery warranty lifetimes ‘promised’ and the actual life expectancies being realized can cause increased levels of frustration, skepticism, and even cynicism. These impressions, however false, impact the credibility of our industry. If it is not addressed, we as an industry increasingly run the long-term risk of our customers migrating to alternative, competitive energy storage solutions.

The irony is that there are two trends already underway that are working to reduce this gap in expectations and actual product performance (design life vs. service life). First, most large users today have a better understanding of the actual performance and life expectancy characteristics of lead acid batteries (particularly VRLA) that they can expect. Much of this is the result of better education by the battery manufacturers, distributors, and resellers of the strengths and weaknesses of lead acid batteries, as well as over 20 years of empiric experience with VRLA batteries. This improved knowledge and education has helped customers understand the many environmental, maintenance, and application variables that impact battery performance and life. The global marketplace has also helped customers better understand the broad range of battery technologies available, and the trade off’s between the costs and life expectancies of various battery technologies (e.g. flooded vs. VRLA, tubular vs. flat plate, lead selenium vs. lead calcium vs. plante, etc.).

At the same time, the American battery industry has invested an enormous amount of capital and effort overt the past 25 years to significantly improve the lead acid battery, particularly VRLA. These product improvements have been substantial, and include the following:

- Better pressure-valve designs
- The development and adoption of the catalyst system to improve internal recombination
- Improved design and production techniques for better jar cover and terminal post seals to prevent leaking
- More robust grid designs and improved alloys to assure more corrosion resistance
- Better understanding of the dynamics of plate growth and bulging, as well as improve manufacturing processes to prevent plate separation

As customer expectations are dropping, the overall performance and reliability of VRLA technology is getting better. Recently, we have seen a few manufacturers offering Five and Seven-year full warranties on their VRLA products, based on the significant increases in MTBF and life testing data they are seeing with improved design and manufacturing efforts. Both trends represent a positive direction for the industry, and might present an opportunity to eliminate some of the confusion and inconsistencies of the current warranty standards. **Perhaps it is time for the battery industry to formally re-establish a new market equilibrium that matches up design life and service life to create a more realistic lead acid battery life expectancy specific for each major battery technology.**

The key to establishing a new industry standard for warranty programs, for both flooded lead acid and VRLA batteries, would require a body or group that has the authority, neutrality, and technical credibility to address this difficult issue, and that would be an authority recognized and accepted by both end users and manufacturers. For many, the ideal choice might be the IEEE Battery Standards Committee. Battery warranty is a complex problem with both technical and commercial considerations, and any committee established would need to represent both the manufacturers and users in any final recommendations.

The three primary objectives of such a committee might include:

- Determine the feasibility of establishing new warranty standards, and identify the benefits and drawbacks of such a standard for both manufacturers and users.
- Define a new industry standard for all major lead acid battery types (e.g. flooded, VRLA, flat plate, tubular, plante, lead selenium, lead calcium, etc.
- Proposing standards and procedures for an IEEE-approved testing and certification process, to be used by manufacturers to certify their products to any new IEEE warranty standard, and to be used by customers as a base standard for evaluating battery products.

The US Battery Industry could benefit greatly from this industry effort to redefine workable standards for both flooded and VRLA battery warranty programs. Bringing clarity to this complex problem, from both a technical and commercial perspective, can only benefit customers and manufacturers alike.

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