RAISING THE BAR

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ABSTRACT

For years, the standby power industry has adopted and promoted standards through a number of organizations such as IEEE, Telcordia, NEC, NFPA, UBC, BOCA, City and County ordinances. These "standards" organizations are in place to ensure safety, compliance and uniformity. In addition, guidelines have been developed to provide quality assurance inspectors with the necessary knowledge to conduct field inspections. Spill containment products have been in existence for the past 20 years for a wide variety of containment applications, but only introduced into the standby power industry in 1993. To date, these organizations have only now begun to address the need for containment products and the need to conform with existing standards. The question is, which standard should be applied for spill containment products for standby power system applications, also known as, stationary lead acid batteries ?

INTRODUCTION

In 1994, epoxy liquid-based systems were developed to create a spill containment system that assisted end users of stationary lead-acid battery systems in complying with Article 64. This required a four-inch high, liquid tight containment system with the ability to neutralize sulfuric acid spill from the largest container in a string of batteries. In 1995, one company introduced an epoxy liquid-based system that was uniquely different. It fabricated a modular system that was removable for battery maintenance. Rails were coated in safety yellow and its neutralizing material performed as an absorbent, as well as a neutralizer, to reduce the volume of free acid in the event of a spill.

In 1999, patented liner technology became available along with new and improved neutralizing methods and has recently been approved by *Underwriters Laboratory*. Two companies invested an enormous amount of time, money and resources in quality testing of their products utilizing independent certified laboratories in the <u>absence of any standards</u> set forth for a containment product in the standby power industry. As a result, they began testing their products for flammability, as well as the ability to absorb and neutralize materials to safeguard against any harmful off gassing that may result from the neutralizing process during a spill.

Upon completion of testing by independent certified laboratories, each company began testing in accordance to separate standards set forth by existing testing organizations such as the American Society of Testing Materials (ASTM) ,BOCA, OSHA, etc. The end result was two companies promoting separate standards within the standby power industry using different testing protocols. Each company maintained independent testing standards for spill containment and marketed their products to mutual customers and specifying engineers. It became apparent that the engineering community would not adopt either company's testing criteria. This lack of acceptance was due to the fact that the testing criteria and selection of those tests were chosen by the spill containment companies themselves, rather than nationally and/or internationally recognized standards testing organizations such as *Underwriter Laboratories.*

In 1999, these two leading companies soon became conflicted in the marketplace over fire standards testing criteria. This became the topic of litigation that took over two years and hundreds of thousands of dollars to resolve. In the litigation, each company was represented by fire testing experts and independent testing laboratories, which conducted tests on each company's products. An agreement was reached between the two companies and their independent fire testing standards experts, which resulted in the finding that ASTM E -648 was the proper fire testing standard to apply to both company's products. Both company's products passed the selected ASTM E-648 test and the first standard had been set through expensive litigation.

Only one company has met the *Underwriters Laboratory* testing criteria which is requested by the majority of specifying engineers, quality assurance, fire inspectors and end users. This expensive and prolonged *UL* testing process is a necessity for the future.

Underwriters Laboratory had to establish a category for spill containment and debated for over nine months to determine if this category should be created. After investigating industry standards, *Underwriters Laboratory* decided on the ASTM E-648 testing criteria for spill containment systems for stationary lead-acid battery systems and extensive testing was then conducted. We anticipate the LOI of 30 will be expected to follow.

Underwriters Laboratory has completed testing of one company's spill containment systems based on the fundamental requirements of Article 64. These tests took over 18 months to perform and were based on overall system performance, as well as individual components, such as liner materials, sealants, absorbents, neutralizers, and fabric/pillow materials. It was then decided that epoxy liquid-based systems would not pass the stringent criteria set forth by *Underwriters Laboratory* and was a poor candidate for testing.

UNDERWRITERS LABORATORY - SCOPE OF TESTING

This category covers spill containment for stationary lead -acid battery systems and was evaluated for (liquid tightness) in accordance with Article 64 - Uniform Fire Code, Paragraph 6404.4; (acid resistance) in accordance with OSHA 1926-441 (a)(4); and (electrolyte pH neutralization capability) in accordance with Article 64 - Uniform Fire Code, Paragraph 6404.5.

These systems are intended to provide a reliable means of containment for hazardous material liquids in the event of electrolyte leakage from stationary lead-acid battery systems. Requirements for spill detection, spill clean-up, containment dimensions, containment capacity, neutralizer capacity and ventilation are included in the applicable federal or local governing codes, such as the Uniform Fire Code, Articles 64 and 80 and OSHA 1926-441

UL (6WA0) - SPILL CONTAINMENT FOR STATIONARY LEAD-ACID BATTERY SYSTEMS

These spill containment systems consist of a 4-inch deep container, lined with a water-tight, acid resistant polymeric sheet 80 millimeters thick. The liner is mounted on the floor beneath a rack assembly of sealed or flooded type lead acid batteries. The liner is a two-layer filled PVC composite.

The liner sidewalls are factory fabricated by slitting the corners, folding the material 90 degrees upward (forming the sides), and dielectrically welding the corners where the sides meet.

Mechanical support walls abut the liner sidewalls to provide mechanical support. Models Eagle and Condor Plus employ PVC coated steel barrier walls, while model Hawk employs a 1/2 inch thick polypropylene barrier wall. All mechanical support walls are 4 inches in height. Once the containment system is in place, an acid resistant sealant is beaded over the bolt heads and alongside the footprint of the battery rack, stack, or cabinet as a supplemental seal.

The containment system is lined with absorbent/neutralizing material, supplied in a fabric envelope consisting of a spun bound polypropylene material sewn together with Nomex thread. These components are identified as NABPIL, SOC or VRLA PAD and tagged with a unique serial number for traceability. NABPIL, SOC and VRLA PAD are similar, except for a variance in dimension and weight for different applications.

UL TESTING CRITERIA

Liquid Tightness

The containment system must have the ability to be liquid tight. This presents a challenge due to the fact that a containment system may be assembled by persons who are untrained or unfamiliar in installing liquid tight containment systems. This would ensure that after following the set-up instructions, the products would hold corrosive liquid. *Underwriters Laboratory* specifically indicated the need for certified or trained personnel to ensure a quality installation. Epoxy based systems were not considered and are discouraged from testing by *Underwriters Laboratory* due to the numerous variables during the installation process and the possibility of cracking during seismic events.

Liner Quality and Construction

It became apparent to *Underwriters Laboratory* that the liner material, with a Class A fire rating selected by Enviroguard, was the appropriate thickness of 80 mm for this application. Previous attempts were made to utilize thinner liner materials, but were ineffective. Other types of liners such as flat sheets or liners that did not extend upward inside the containment walls were eliminated for consideration. Too many variables for failure were present, which in turn, eliminated flat liners or liners constructed on site as good candidates for *UL* testing .

Materials were then tested for their ability to withstand puncturing or tearing during installation. The seams of any liner are the potential points of failure within any liquid tight system. The four corners that must extend upward inside the containment system must be prefabricated and are integrated into the liner itself. The liner by itself does not make a system *UL* Listed. All components working in conjunction with each other, such as liquid tightness, neutralization, absorption, material thickness, acid resistance, flammability ratings, etc., is what meets *UL* criteria.

Fire Testing of Fabric Material

As previously stated, tests conducted on the materials use an ASTM E-648 criteria for apparent reasons. Existing Lower Oxygen Index (LOI) thresholds were evaluated based on current standards allowed in battery rooms. A Styrene Acrylic Nitrile "battery container" used for most flooded batteries, have a LOI of 18. This will sustain a flame when lit with an open flame such as a cigarette lighter. New materials are now available to increase the LOI to 30 or greater. Unfortunately, the industry has demonstrated an unwillingness to pay for the additional expense of flame proofing during the manufacturing process, allowing other companies to offer non-UL Listed products at reduced prices.

Liner Material/Penetration Resistance/Exposure to Sulfuric Acid and Heat

The liner material submitted for testing was selected based on its ability to be acid resistant, and most important, its Class A fire rating. The material is 80 mm thick and was exposed to open flame testing as well. Material was tested for penetration, tear strength and seam construction durability. Acid immersion tests were conducted to define liner performance in 39.5% sulfuric acid. No testing has been conducted that supports the spring factor theory on liners. In fact, no battery or rack manufacturers have indicated their seismic racks are affected due to liners, shims, insulation materials, floor tiles, etc.

Chemicals to Neutralize and Absorb

The chemicals used to neutralize and absorb vary from manufacturer to manufacturer, but the common denominator is that they all utilize caustic based solutions or compounds for lead-acid batteries and acidic solutions for Nickel Cadmium batteries. The amount of base neutralizing compound needed to neutralize a spill is directly related to the amount of spilled battery acid. Most containment systems are designed to contain a spill from the largest battery container in a string of batteries. If a customer chooses to increase his ability to neutralize more acid, they simply add more absorbent and neutralizing pillows within the containment area. Not all manufactures add absorbent compounds to the neutralizing material due to additional costs. Adding absorbent compound to a pillow will enhance its ability to absorb spilled material and will lower clean up costs in the event of a spill.

Certification of Installers

In 2001, a national training program was set forth to ensure that multiple site installations were being performed per its detailed set-up instructions. An independent company was contracted to implement training, which was requested by end user customers and local fire inspectors. The training consists of new installation and retrofitting techniques to ensure the liquid tightness of installations. A number of major customers now require that certified installers perform installations within their critical sites. The program is now offered online at a greatly reduce price for any installation company. This is not a mandatory certification, but we believe it is necessary for quality assurance..

Overall System Evaluation and Quality and Standards

The new *UL* criteria for spill containment systems establishes an independent standard for the standby power industry for the first time, which is based on the entire system's ability to comply with today's industry standards. Individual components within the system must also meet the standards set forth by *Underwriters Laboratory*. Other independent testing laboratories should not be considered as an acceptable replacement for *Underwriters Laboratory*. To do so would create additional standards and testing criteria that may confuse customers and/or allow for a wide variety of testing protocols to vary from manufacture to manufacturer and ultimately lead to inaccurate data.

Underwriters Laboratory's independent testing should be the recognized testing organization adopted by all regulatory and enforcement agencies for compliance, and for customers who maintain a high level of internal quality assurance standards. The engineering and enforcement agencies are requesting *UL's* listing of spill containment systems.

CONCLUSION

The following conclusions represent the judgment of *Underwriters Laboratories Inc.* based upon the results of the examination and tests presented in the Report as they relate to established principles and previously recorded data.

Risk of Fire

It is judged that the risk of fire has been reduced to an acceptable level. This is based on the following:

Liner material and absorbent pillow fabric material demonstrated NFPA 101 Classification of Class 1 (Critical Flux of 0.45 watts/cm2) upon critical radiant panel testing in accordance with ASTM E648.

The pillow fabric was tested alone, due to the fact that its contents, as well as sulfuric acid, are not flammable. Furthermore, the salts which form from the reaction of sodium carbonate with sulfuric acid are likewise not flammable.

UL Conformity Testing

The liner material conformed to the requirements in the Outline of Investigation For Excavation Liners For Secondary Containment of Flammable and Combustible Liquids, UL 1854 for the following tests:

- Volume Change and Extraction of Soluble Material
- Air Oven Aging
- Immersion in Type A Liquid
- Penetration Resistance
- Leakage Test
- Tensile Strength
- Tear Strength
- Seam Strength
- Tensile Impact

The above testing demonstrated that the liner has good physical property retention after prolonged immersion to concentrated sulfuric acid at elevated temperatures. UL 1854 is available upon request.

The liner and sealant repair material conformed to the requirements of the Uniform Fire Code (1991), ICBO, Article 64, Par. 6404.4 for liquid tightness.

The Leakage Test was conducted with concentrated sulfuric acid instead of water, which is considered a more stringent test.

The sealant repair material was found to have adequate adhesion after 24 hour immersion in concentrated sulfuric acid. The sealant is to be used to seal bolt heads and footprints of the rack during installation and shall be replaced annually or after being subjected to a spill, which ever occurs first.

Absorbent pillow models NABPIL, SOC and VRLA PAD have been investigated using requirements contained in the Uniform Fire Code (1991), ICBO, Article 64, Par. 6404.5 for pH neutralization capability and have been confirmed to contain minimum 63% sodium carbonate by weight.

In addition to neutralizing capability, pillow models NABPIL, SOC, and VRLA PAD have also been investigated for maximum absorption capability.

System sizing is to be based on maximum absorption and neutralization capacity of 0.625 quarts 34% sulfuric acid, or 0.544 quarts 39.5% sulfuric acid per pound of absorbent material, based on ideal mixing conditions.

A complete *Underwriters Laboratory* report is available for viewing at the Enviroguard facility.

REFERENCES

Article 64 Uniform Fire Code 6401 through 6404.9 1999
National Building Code Assoc. Hazardous Materials 307.8,807.8.13, Hazardous Materials 417.0,
Hazardous Material Storage Systems 417.4 and Spill Control 417.5.5 Rooms and Structures 2315.1,
Floors and structure 2315.2, Chapter 28 Liquid and Solid Corrosive Materials 2802.2.1 in accordance with 2315.1/1996
Standard Fire Code Storage 407.1.1.1 , Storage and dispensing 407.2, Spill Control 407.2.3 /1996
International Fire Code Section 608 Stationary Lead Acid Batteries, 608.1 through 608.8
OSHA 1928.441 Batteries and Charging Systems
Code of Federal Regulations CFR Part 264.175
IEEE currently in subcommittee under revision
Environmental Compliance and Safety of Stationary lead Acid Batteries as printed in Power Quality