EAGLE EYE TECHNICAL NOTE

Title	**Battery Spill Containment is NOT required for VRLA Batteries**
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Revision History

Date	Revision	Change Description	Author(s)
2/1/12	0	Original document	JAB
2/11/17	1	Updated codes	JAB
5/18/20	2	Updated references	JAB

Battery Spill Containment is NOT required for VRLA Batteries

Overview.

Almost all non-Institute of Electrical and Electronics Engineers (IEEE) battery related codes were written with the Vented Lead-Acid (VLA) in mind. VLA is the correct IEEE term for a battery that has free-flowing, liquid, dilute sulfuric acid electrolyte that allows gases generated during charging to be vented out of the battery. Because of this design, precautions were put in place to both protect against electrolyte spills and the effects of gas evolution from the battery.

Spill containment is not required for Valve-Regulated Lead-Acid (VRLA) batteries. These batteries are sometimes referred to as "sealed" or "maintenance free" batteries. In short, there is nothing to spill as the electrolyte is completely absorbed in the micro-porous plate separators or is gelled. New VRLA cells sometimes have a very small amount of free electrolyte but this is usually less than a few drops. With battery aging, the cells lose electrolyte which is known as "dry-out." Indeed, dry-out is one of the main failure mechanisms of VRLA batteries.

The various relevant code setting bodies have recognized that spill containment should not be required for something that cannot spill and have amended or rewritten the relevant codes to reflect this fact.

What the codes say.

The 2003 edition of the International Fire Code saw the addition of Article 609 which supplements Article 608 that had addressed VLA (flooded) batteries but did not differentiate VRLA batteries. Article 609 specifically excludes VRLA batteries from spill containment. (See Below.)

In 2007 the IEEE Energy Storage and Stationary Battery Committee (ESSBC) produced a new standard which specifically addresses spill containment titled "IEEE - 2007 *Recommended Practice for Battery Electrolyte Spill Containment and Management*. This document recognizes that there is no spillable electrolyte in a VRLA battery as demonstrated in the following extracts:

> "5.1.2 Valve-regulated lead-acid
> The valve-regulated lead-acid (VRLA) battery has the electrolyte immobilized with either a gelling agent or within an absorbent glass mat (AGM) type of separator. These materials contain the electrolyte in a suspended state such that it would not flow like a liquid in the event of cell damage. Each cell or monobloc has a sealed container with a valve used to vent excess gas at a fixed internal pressure. Electrolyte mist or vapor may be expelled into the air if excess gas is vented."

"B.2 Applicability
This section shall apply to any battery room or area in which the aggregate amount of free-flowing liquid electrolyte contained in all battery containers in a battery system exceeds 3785 liters (1000 gallons).

Exception – Batteries in which electrolyte is immobilized, such as in Valve-Regulated Lead Acid (VRLA) batteries, are specifically exempted."

In conjunction with the Spill Containment document, other IEEE documents have been updated to recognize the fact that VRLA batteries do not require spill containment. Specific examples are given below.

IEEE Std. 1187-2013, *IEEE Recommended Practice for Installation Design and Installation of Valve-Regulated Lead-Acid Storage Batteries for Stationary Applications*.

"5.1.1 General criteria

d) The electrolyte in a VRLA cell is immobilized so that it is not a free liquid. Electrolyte immobilization provides a cell that will leak little or no electrolyte if damaged (refer to IEEE Std 1189-1996). Furthermore, there is no requirement or provision for the user to add water or perform electrolyte maintenance. For the above reasons, spill containment is not necessary for VRLA battery installations."

IEEE Std 1189-2007, *IEEE Guide for Selection of Valve-Regulated Lead-Acid (VRLA) Batteries for Stationary Applications*.

"5.6 Absence of free electrolyte

Designs of VRLA cells are such that the electrolyte should be fully immobilized and thus little, if any, liquid electrolyte should leak from the cell in the event of a jar and/or cover break or crack. The absence of free electrolyte simplifies the handling of VRLA cells. It also means that spill containment is unnecessary. See also 5.11."

"5.11 VRLA advantages and disadvantages

Much has been written about the drawbacks of VRLA batteries. However, they do have advantages over other battery types (most specifically, vented lead-acid cells). Some of the advantages are listed as follows:

- **"Non-spillable" (transport and placement)**—VRLA batteries that have passed the appropriate qualification tests set forth in the Code of Federal Regulation (CFR 49) can be classified by the U. S. Department of Transportation (DOT) as UN2800—Batteries, Non-Spillable for road shipments (CFR 49 [B25]). This classification allows these batteries to be transported with fewer restrictions than for vented batteries. VRLA batteries can also be air-shipped as "non-spillable, non-dangerous," as long as they meet the "non-spillable" requirements mentioned above, in addition to a

separate International Air Transport Association (IATA) requirement (A67) for a puncture test. Because they are essentially "non-spillable," most VRLA cells can be placed in more convenient space-saving configurations, such as front terminal, or "horizontal" (see 5.8). By most interpretations, VRLA batteries are exempt from costly spill containment mandated by Fire Codes."

The Alliance for Telecommunication Industry Solutions (ATIS), which writes many of the standards for telecommunications, specifically addresses battery installations in the following document:

ANSI/ATIS – 0600003-2007. *Battery Enclosures and Room/Areas.*

"7.1. Electrolyte containment and handling
Electrolyte containment may be required by Authorities Having Jurisdiction (AHJ) based upon the volume of electrolyte with flooded technology type modules. No containment shall be required when VRLA technology cells are used."

Verizon Wireless has addressed the fact that VRLA batteries do not require spill containment in the following standard:

Network Standard NTSD 30. *Batteries – MSC (Mobile Switching Centers), Microwave Radio, and Cell Sites - Installation and Maintenance.*

17.3 VRLA Batteries

" … The valve is why this genre of battery is called a Valve Regulated Lead Acid cell. Because all of the electrolyte in an AGM battery is absorbed in the mat, there is no extra fluid (called "Free Electrolyte") to leak even if the battery case breaks. For this reason, VRLA batteries can be placed in virtually any mounting position with no worries about leakage." … "Gell cells do not use a fiberglass mat to absorb electrolyte. Rather, the electrolyte is immobilized by adding a silica material to water/acid electrolyte so that it solidifies into a mass with the consistency of petroleum jelly. Cracks form in the gel and under pressure, water and hydrogen recombine into water in these cracks to rehydrate the electrolyte. Because the electrolyte is a gel, these batteries may be mounted in virtually any position as is the case with AGM cells."

The major UPS manufacturers, in particular APC, also recognized the need to educate and help users and code inspectors with the changed requirements with respect to the installation of VRLA batteries and to this end have published several White Papers addressing battery issues. Of particular interest are:

White Paper 31. *Battery Technology for Data Centers and Network Rooms: Safety Codes.*

White Paper 32. *Battery Technology for Data Centers and Network Rooms:*

Environmental Regulations.

> White Paper 34. *Battery Technology for Data Centers and Network Rooms: Ventilation.*

In White Paper 31. *Battery Technology for Data Centers and Network Rooms: Safety Codes,* the executive summary states:

> "Fire safety regulations and their application to UPS battery installations are reviewed. In some cases, fire codes do not clearly recognize improvements in battery safety resulting from changing battery technology. Valve Regulated Lead Acid (VRLA) batteries are frequently deployed within data centers and network rooms without the need for the elaborate safety systems that are required for Vented (Flooded) Lead Acid batteries. Proper interpretation of the fire codes is essential in the design and implementation of data centers and network rooms."

Code of Federal Regulations (CFR).

The Occupational Safety and Health Administration (OSHA) requires that flooded (VLA) batteries comply with Regulation 29 CFR 1926.441, *Battery Rooms and Battery Charging*. This regulation applies to "unsealed" batteries with free flowing, liquid electrolyte. It does not apply to VRLA (sealed) batteries.

Fire Codes

There are two main fire codes that address battery systems. They are the

International Fire Code (IFC) and Uniform Fire Code (UFC).

The International Code Council (ICC) writes the IFC. The IFC was modified in 2001 in order to apply different requirements for VRLA batteries. It recognized that VRLA batteries have different properties compared to VLA. A new Section 609 was written which applied to VRLA battery systems. The IFC states that for VRLA batteries, "The battery systems are permitted to be in the same room with the equipment they support."

The UFC was originally published by the Western Fire Chiefs Association but the UFC is now published by the National Fire Protection Association (NFPA - 1) The UFC also recognized that spill containment requirements applies only to battery systems having liquid electrolyte in excess of 1000 gallons. The intent was to exempt VRLA batteries that have no free-flowing electrolyte from such rules.

Code Requirements Regarding Electrolyte Weight and Volume.

For VLA batteries the IFC, in Section 608 and 609 and in the old UFC Article 64, and in Article 52 in an updated code, there was a compliance requirement for an electrolyte volume of over 50 gallons. Below 50 gallons the code is not applicable. For a battery location that has sprinklers, the UFC compliance requirement increases to 100 gallons.

Both codes required occupancy separation, spill control, neutralization, and ventilation. UFC, Article 64 required both VLA and VRLA battery systems exceeding the liquid electrolyte volumes referenced above to comply with certain protection requirements

including, occupancy separation, spill containment, electrolyte neutralization, and location ventilation. In 2003 the code was revised to apply spill containment requirement only to VLA battery systems with a minimum of 1,000 gallons. The reason for the change was to hold batteries to the same standard than applies for hazardous material covered elsewhere in the codes.

The Superfund Amendment and Reauthorization Act (SARA) which is the Emergency Planning and Community Right-To-Know Act (EPCRA), requires a building owner to declare when the total amount of sulfuric acid in batteries throughout the facility exceeds 500 pounds. Because battery electrolyte is only approximately 1/3 sulfuric acid, this essentially means that only an electrolyte volume of more than 1500 pounds is reportable.

Federal Government Requirements.

The Federal Government under the auspices of the Department of Defense (DOD) published a document titled, *DOD Unified Facilities Criteria (UFC) 3-520-05 – 2008*. In this document it states:

> "2-2.4 Provide spill control for battery installations as required by NFPA 1. An electrolyte spill is defined as an unintended release of liquid electrolyte that exceeds 1.0 liters. Battery enclosures that do not provide integral spill containment shall not be used. Permanently installed physical containment structures shall be capable of resisting continuous exposure to a 70 percent concentration of the electrolyte's acid or alkaline chemical. The containment area shall not encroach upon space designated for room egress.
>
> Note: Valve-regulated lead acid (VRLA) batteries have the electrolyte immobilized in a gel or absorbent glass mats. The immobilization limits the potential release of electrolyte to much less than the definition of a spill. For this reason, VRLA designs do not require permanently installed spill containment systems. Electrolyte releases from VRLA batteries, while small, can occur and the necessary supplies for manual cleanup should be available in the battery area."

Conclusion.

VLA batteries require spill containment and special forced air ventilation due to the fact that they have liquid electrolyte and hydrogen out-gassing. VRLA batteries have no liquid electrolyte and only out-gas a very small amount of hydrogen except in very abnormal (fault) conditions. Updated codes recognize the differences between VLA and VRLA batteries and exempt VRLA batteries from spill containment and occupational separation. Battery systems based on VRLA batteries can and are commonly deployed and used in accessible locations and occupied workspaces in compliance with current battery, building and fire codes.

References.

ATIS0600003-2007. *Battery Enclosures and Rooms/Areas*. Alliance for Telecommunications Industry Solutions, 1200 G St. NW. Suite 500, Washington DC 20005. Tel (202) 628 6380. www.atis.org

Code of Federal Regulations, Title 49 CFR Section 173.159. U.S. Department of Transportation (DOT). U.S. Department of Transportation. 1200 New Jersey Avenue SE, Washington DC 20590. Tel. (202)-366-4000. Web. www.dot.gov

International Code Council (ICC). IFC–2009. *International Fire Code* ICC. 500 New Jersey Avenue, NW, 6th Floor, Washington, DC 20001 Tel. 1-888-ICC-SAFE (422-7233). (202) 783-2348. Web. www.iccsafe.org

IEEE Std 1184-2006™. *IEEE Guide for Batteries for Uninterruptible Power Supply Systems*. Institute of Electrical and Electronics Engineers. 445 Hoes Lane Piscataway NJ 08854, Tel. (732) 981 0060. Web. www.ieee.org

IEEE Std 1187-2013™. *IEEE Recommended Practice for Installation Design and Installation of Valve-Regulated Lead-Acid Storage Batteries for Stationary Applications*.

IEEE Std 1189-2007™. *IEEE Guide for Selection of Valve-Regulated Lead-Acid (VRLA) Batteries for Stationary Applications*.

IEEE Std 1578-2007™. *IEEE Recommended Practice for Stationary Battery Electrolyte Spill Containment and Management*.

NFPA 1. *Fire Code*. National Fire Protection Association/ (NFPA). 1 Batterymarch Park, Quincy, Massachusetts USA. 02169-7471. www.nfpa.com

Telcordia. GR 63. *NEBS Requirements: Physical Protection*. Telcordia. One Telcordia Drive (formerly 444 Hoes Lane) Piscataway, NJ 08854-4151 General Information and Inquiries: 732-699-2000. Sales and Product Inquiries: 1-800-521-2673.

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