# Battery Technology for Data Centers and Network Rooms: Safety Codes

## White Paper # 31

Legendary Reliability™

Revision 5

## Executive Summary

**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.**

# Introduction

There are a wide number of standards and codes that apply to battery systems and battery rooms. At the local level, the ones that matter most are the Fire Codes. Initially, fire codes for stationary lead acid batteries were written for large systems utilizing vented (also called "flooded" or "wet cell") lead acid batteries that supported data centers and network rooms. These systems are typically located in rooms separate from the equipment they support. These batteries continuously vent hydrogen gas and contain electrolyte in liquid form. Consequently, special ventilation and spill containment systems must be employed.

Smaller and distributed back-up power systems are typically located much closer to the equipment they protect. They generally use Valve Regulated Lead Acid (VRLA) batteries. VRLA batteries are designed to recombine hydrogen and oxygen and emit only extremely small amounts of hydrogen under normal operating conditions. Normal room ventilation is sufficient to remove any hydrogen, so special ventilation is not required.

The electrolyte in a VRLA battery is not in liquid form but is immobilized. The most common technology, termed "Absorbed Glass Mat (AGM) uses a highly porous, absorbent micro fiberglass mats that immobilize the electrolyte and prevent it from spilling. A crack or hole in the casing of a VRLA battery using AGM technology will not result in a measurable electrolyte spill. Spill containment with VRLA batteries is therefore not meaningful or appropriate.

# Code of Federal Regulations

Flooded batteries are required to comply with the Occupational Safety and Health Administration (OSHA) Regulation 29 CFR 1926.441, Battery Rooms and Battery Charging. This regulation applies to batteries of the **unsealed** type installed in new construction. "Unsealed" in this case means flooded batteries. Under this regulation ventilation, worker protection, acid flushing and neutralization are required. If using flooded batteries please see the OSHA web site www.osha.gov or specific details on how to comply

VRLA batteries are of the "sealed" type so OSHA regulation 29 CFR does not apply.

The Environmental Protection Agency (EPA) Emergency Planning and Community Right-to-know Act (EPCRA) requires owners to inform local authorities when their facilities have large volumes (actually reported in weight) of hazardous materials such as sulfuric acid (present in lead-acid battery electrolyte). These laws are spelled out in 42 U.S.C. 9601, also known as Title III of SARA, and 42 U.S.C. 1101. These requirements will be discussed later in this paper, and are explained in detail in White Paper #32.

# Fire Codes

The two main codes in the United States relating to battery systems are the Uniform Fire Code (UFC)[1] and the International Fire Code (IFC)[2].

Originally published by the Western Fire Chiefs Association, the UFC is now published by the National Fire Protection Association (NFPA - 1)[3] as of 2003.

The International Code Council (ICC) writes the IFC. The ICC was created in 1994 when the Southern Building Code Congress International (SBCCI), the International Conference of Building Officials (ICBO), and the Building Officials and Code Administrators International (BOCA) united to create a set of harmonized standards.

Model codes are written by organizations and published every few years. A locality, town, county, or state, can choose which code (and which version of the code) to adopt and enforce. For example, the entire State of Alaska adopted the IFC, while only certain towns in Arizona have adopted it. Many jurisdictions still use the 1994 or 1997 UFC. Checking with the local safety inspector is the best method to determine which one applies to a specific installation. Local authorities can also modify the codes. Under the codes, battery systems are subject to special installation requirements, depending upon amount of electrolyte and battery technology.

Codes change with each rewrite and jurisdictions use differing versions of codes. This paper can only generalize about codes. Checking with a local authority is essential in order to determine what code they enforce.

# Application of the Codes to Different Battery Technologies

Before applying the codes, one must understand how the codes set criteria for when they are to be enforced. There are four questions that must be answered:

1. What is a Battery System?
2. How many gallons of electrolyte are in this Battery System?
3. Is the electrolyte free-flowing liquid or is it immobilized?
4. What is electrolyte volume at which the code applies?

### What is a Battery System?

Under the UFC definition,[4] a "battery system" consists of three interconnected subsystems:

- A lead-acid battery
- A battery charger

- A collection of rectifiers, inverters, converters and associated electrical equipment as required for a particular application.

From this definition each individual UPS or DC Plant constitutes one (1) battery system. Smaller, separately installed UPS are independent and do not have an additive effect on the electrolyte capacity. A fault in one system will not propagate to the others, as they are independent of each other. The threshold triggers are defined per battery system and not by facility. The code specifically does not instruct the summation of independent battery systems.

**How many gallons of electrolyte are in a battery system?**

Gallons are a liquid measure and the fire codes seek to determine the amount of liquid electrolyte in the battery system. In a flooded battery system 100% of the electrolyte is in liquid form. The amount of liquid electrolyte in a VRLA battery solution is very small, about 3% of the electrolyte used in production of the battery. These values are provided by the battery manufacturer. The liquid electrolyte value in each battery within the battery system would be added together to arrive at the total for a “system.”

**Is the electrolyte free-flowing liquid or is it immobilized?**

The International Fire Code was modified in 2001 to create different rules for VRLA batteries. It recognized that VRLA batteries have different properties versus flooded batteries. IFC (Section 609) applies to VRLA battery systems having an electrolyte capacity of more than 50 gallons. The IFC specifically states for VRLA batteries, “The battery systems are permitted to be in the same room with the equipment they support.” [5] The IFC also has requirements for thermal runaway, neutralization, and ventilation.

The 2003 Uniform Fire Code has also changed. Certain requirements, such as spill containment, applies only to battery systems having *free-flowing* electrolyte in excess of 1000 gallons. The intent was to exempt batteries with *immobilized* electrolyte (e.g., VRLA batteries) from such rules.

**What is the electrolyte volume at which the code applies?**

For a flooded battery system the IFC (Section 608 and 609) and UFC (Article 64 in the old code and Article 52 in the updated code) use 50 gallons of electrolyte capacity criteria for when compliance is required. Below 50 gallons the code is not applied. For a room with sprinklers the UFC threshold increases to 100 gallons. In data centers or network rooms using an alternative method of fire protection (for example, Halon or FM200), the 50-gallon level applies.

One should assume in any UPS application using a flooded battery that it must comply with the fire codes. Both codes specify requirements for occupancy separation, spill control, neutralization, and ventilation.

In the 2000 and earlier editions of the UFC, Article 64 required VRLA battery systems exceeding the liquid electrolyte volume threshold values listed above to meet special protection requirements. Compliance required occupancy separation, spill control, neutralization, and ventilation. In 2003 the code was revised to apply spill containment requirement only to flooded battery systems (ie., batteries with free-flowing electrolyte) with a minimum of 1,000 gallons. The purpose of the change was to hold batteries to no higher standard than applies for hazardous material covered elsewhere in the code. Requirements other than spill control still apply at the 50 and 100 gallon limits.

Both the UFC and the IFC require an approved method to prevent thermal runaway in VRLA battery systems.

# Interpretation

Codes are supposed to provide clear direction of when and how they should be enforced. However, interpretation is often up to the local inspector. This can present substantial variance in application of a code. A common misinterpretation of the older UFC has sometimes been to sum the quantity of electrolyte in different battery systems. Such an interpretation, if enforced, could lead to the absurd situation where there is a need to identify every item in a facility that contains a VRLA battery and to provide for separate spill containment and occupancy separation for each device. The UFC provides clear guidance in this area by providing a definition of a "battery system." [Exception: This distinction should not be confused with EPCRA reporting requirements. EPCRA requires a building owner to declare when the aggregate amount of sulfuric acid in batteries throughout the facility exceeds 500 pounds. Because electrolyte is approximately 2/3 water and 1/3 acid, some inspectors have recently taken a broader (and incorrect) interpretation by requiring owners to report when the total amount of *electrolyte* exceeds 500 pounds.] For full details on reporting requirements, see White Paper #32: "Battery Technology in Data Centers and Network Rooms: Environmental Issues."

# Conclusions

Flooded batteries require special containment and ventilation due to the risks posed by their liquid electrolyte and their continual hydrogen generation. VRLA batteries have miniscule amounts of liquid electrolyte and generate much lower amounts of hydrogen. The latest codes specifically recognize the technology differences between flooded and VRLA batteries and exempt VRLA batteries from spill containment and occupational separation. However, older codes might still be in use in many jurisdictions. They were not as clear in making the distinction, and an inspector might take a very narrow interpretation. Most practical installations of VRLA batteries do not trigger the spill containment and occupancy separation requirements due to their low liquid electrolyte volume. Battery systems based on VRLA batteries can be deployed, and are routinely deployed, within data centers, network rooms and work environments in compliance with fire codes.

# References

[1] Western Fire Chiefs Association , *Uniform Fire Code [UFC],* 2000

[2] International Code Congress – *International Fire Code [IFC ]*,  2003

[3] National Fire Protection Agency, *NFPA-1: Uniform Fire Code [UFC],* ] 2003

[4] UFC: Section 203 – B, “Battery System, Stationary Lead-Acid”

[5] IFC: Section 609.4,  “Room design and construction”