BATTERY ACID SPILL CONTAINMENT - BIG ISSUE OR BIG YAWN?

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ABSTRACT

A four-inch tall barrier has separated two sides of a war for more than five years. Ever since acid spill containment showed up in the Uniform Fire Code this controversial requirement has generated thousands of hours of work, explanation, and anxiety for users, suppliers, and inspectors alike… plus it has cost millions of dollars in expense. The battle hit fever pitch when inspectors started red-tagging VRLA batteries. Is battery acid spillage and containment a real issue, or is somebody just trying to make a buck? Who is doing what about it? What can you do about it? This paper looks at the background of the issue and attempts to give a brief view of both sides of the argument. It will identify the regulatory agencies and standards organizations involved in the issue, and it will update the status of their activities. A table provides an overview and gives information about where to go to get more information or to get involved.

SOME HISTORY

There was a time when a stationary battery was a stack of lead plates immersed in a mixture of water and acid (electrolyte). Routine maintenance required regular replenishment of the liquid and periodic inspection for leaks and plate corrosion. Today there are many other types of batteries and energy reserve techniques, but the so-called "flooded" lead-acid battery continues to be widely used.

Over the years some accidents have occurred with flooded batteries. Most of the accidents involved moving and handling of the batteries. Batteries developed cracks from bumps and vibration during transportation (this is rare today). Batteries developed cracks or fell over and dumped their electrolyte on the floor after falling off a truck or forklift (this still happens).

Far less common were incidents involving installed batteries. As batteries age the plates can corrode and deform, putting pressure on the containers. Covers can separate. Posts can push through. Acid then slowly drips out. The design of flooded batteries is so mature that such failures are unusual today, but they do occur. Occasionally the human element still contributes to a spill. An operator spills electrolyte during maintenance, or he torques a connection too tightly. One source summarized the following root causes of battery acid loss (leaks, spills): [1]

Jar breakage	Physical abuse
Scores surface	Earthquake/Natural disaster
Old age	Positive plate growth
Manufacturing defect	Filling & draining accidents
Overcharging	Battery & battery room fires
Physical orientation	Work errors

Some of the more spectacular incidents have occurred because of unforeseeable events such as fires, tornadoes and earthquakes. An earthquake in Kobe, Japan a few years ago caused the authorities to totally rethink their energy reserve strategies so that today there are few flooded batteries in service there. In the USA a couple of fires in telephone company battery rooms attracted a lot of attention. The first, in 1988, heightened awareness levels about the presence of batteries in buildings and the possible need for special safety measures. At about this time entrepreneurs started emerging with commercial solutions. Also at this time began a confusing argument about what regulations covered batteries and who should have authority over them. Article 80 of the Uniform Fire Code required spill containment for battery systems with greater than 17 gallons of electrolyte, but batteries were frequently exempted from the classification of hazardous material. In the early 90's references to a document called "BRASSUPS" started appearing in UPS battery specifications. While seeming to be a credible document, it was actually created by a spill containment manufacturer to fill in the absence of any standard.

Another fire, in 1994, started in the over-head cabling of a battery room on an upper floor of a building. Of the 200+ batteries in the room, fewer than 50 were damaged to the point that some electrolyte spilled onto the floor, and two were completely destroyed. Several gallons of electrolyte were released. Fire fighting water further diluted and spread the electrolyte. Although there were no electrolyte-associated injuries, there were complaints about breathing the acid mist caused when the over-heated batteries vented into the air. The biggest problem was dealing with the electrolyte in the aftermath of the fire. [2] This prompted a number of people to push for stiffer regulations.

In 1994 the Uniform Fire Code, which is widely used in states west of the Mississippi, added article 64. This new code had multiple consequences. It:

1 - established Article 64 as a model around which other codes were created
2 - set a precedent that Fire Codes are the appropriate place to deal with battery acid spill regulations
3 - defined stationary batteries as belonging to a special category separate from the other requirements for storage of hazardous materials
4 - prescribed the solution for battery acid spill containment to be a 4" tall barrier around the perimeter of a battery rack
5 - applied the requirement to all lead-acid batteries over a certain limit, regardless of whether the electrolyte is liquid or immobilized (such as in a VRLA battery)

Around 1997-1998 things really began to heat up. For the first time communities across America began to adapt the code containing Article 64. Secondly, and more importantly, manufacturers of spill containment systems aggressively pushed for enforcement. Seeing that the code was being sporadically enforced, they waged campaigns to educate Authorities Having Jurisdiction (AHJs). While the latter were usually fire marshals, they also included other government and quasi-government officials from such groups as building code inspectors, environmental protection officials (EPA), and safety inspectors (OSHA). The latter group was paying attention and added batteries to the list of things to look for in site inspections. Businesses who exceed OSHA limits and who do not declare their stationary batteries as hazardous material to Local Emergency Planning Committees (LEPC) are subject to penalties. In at least one case a well-known telephone company faced fines of nearly 2.4 million dollars.

As the movement caught on, other people with different agendas joined in. Web sites and magazines began to feature stories about the dangers of batteries in buildings, especially when used in UPS applications for computer rooms and offices. Scare tactics were used and widely believed. One spread fear about massive battery explosions. Another alleged that a baby was critically mutilated by battery acid during a visit to open house day at Daddy's office. [These stories can still be read on the Web even today.]

In 1994 a new organization, the International Code Council, was formed. The ICC's intention was to bring together a number of conflicting and overlapping codes into one, unified set of rules. These include a building code, a fire code, a plumbing code, a gas code, and so forth. The Western Fire Chiefs, who publish the Uniform Fire Code, did not sign on but rather decided to continue the UFC on their own. One of the ICC's first documents, published in 1997, was the International Fire Code. Section 608 of the code required acid spill containment for any stationary battery system with a cumulative amount over 50 gallons. It did not mandate a solution such as a 4" barrier. Like the UFC, it did not distinguish between flooded lead-acid batteries and VRLA batteries. The result was, rather than bring harmony, the ambiguity in wording and the creation of competing fire codes just added to the confusion. [3]

SOME EDITORIALIZING

Do battery spills pose a clear and present danger? Are all these rules and regulations justified? A paper such as this should deal only in facts, not opinions. Unfortunately, the above are subjective questions for which there can be no cut-and-dry answers, only opinions. So let it be clearly stated here that the following conclusions are opinions based on several years of involvement and research on the subject.

1. Flooded batteries of any type (e.g., lead acid, NiCad, or any other) contain free-flowing liquid and therefore have an inherent potential for spills.
2. The majority of spills occur during handling of the batteries. In most documented cases the spill have occurred outside of an area that could have been contained by conventional containment systems.
3. The record indicates that spills occurring on installed batteries are quite rare. However, when they have occurred with flooded batteries, a containment system could have helped prevent the spread of the electrolyte.

4. Electrolyte is mostly water, so it is a mild agent. One can come in contact with electrolyte with few or no lasting effects if it is washed off within a few minutes. The most serious effects come from contact with the eyes or lungs. There is no evidence to date that shows that a containment system will prevent such an occurrence.
5. Electrolyte is easily neutralized, after which it is no longer corrosive or caustic.
6. Electrolyte contains minute traces of lead that, if allowed to escape into drinking water, could pose a risk to health. Therefore, even neutralized electrolyte should be treated as hazardous material.
7. An uncontained spill could allow some electrolyte to seep into cracks, porous concrete, and other hard-to-reach locations. If left un-neutralized, the electrolyte can cause long-term damage to metal and other materials.
8. Actual spills are rare; most release of electrolyte is in the form of slow leaks or drips

Conclusion #1: Battery acid spills occur but are not a big problem.
Conclusion #2: A containment system may be appropriate for flooded batteries, but it is not necessarily the only solution

9. Containment can take many forms (for example, barriers, whole-room containment, berms, shelf containment, individual cell containment, etc.)
10. Batteries come in many sizes and shapes, so a containment system that works for one battery system may be inappropriate for another
11. The record overwhelmingly shows that when spills have occurred, the spill was only a very small percentage of the total installed electrolyte.

Conclusion #3: Codes should set objectives. Codes should not prescribe a solution. That is best left to science. The authority having jurisdiction ultimately determines if the intent of the code has been met.

12. VRLA batteries do not have free electrolyte. Even if the container of a VRLA battery is damaged or nearly destroyed, only a very small amount of electrolyte can escape (e.g., not more than a few table spoons)
13. VRLA batteries can crack and ooze electrolyte. If left untreated, the electrolyte could eventually drip onto the rack or the floor below
14. The primary failure mode of VRLA batteries is dry-out.
15. The Federal Government has devised tests to determine if a battery poses a hazardous material risk. If it passes the test, it is safe to be transported on an aircraft. Most (but not all) VRLA batteries can pass the test
16. Many VRLA batteries are identified as "non-spillable battery" right on the box
17. VRLA batteries can experience a condition known as "thermal runaway" that is usually caused by a combination of excess temperature and excess current. If left untreated the battery can sometimes heat to a flammable condition. It will vent hydrogen gas that, if not allowed to escape, can accumulate into explosive concentrations. There is no evidence that any type of spill containment would be useful in this failure mode. There are many documented cases in which little or no electrolyte escaped and the battery continued to function even after the battery casing had been shattered. The commonly accepted method to stop thermal runaway is to reduce the float voltage and/or to remove the heat source.

Conclusion #4: VRLA batteries should be exempt from any regulations about spill containment
Conclusion #5: It may be appropriate for codes to address "oozing" and "drips" (as distinguished from "spills").
Conclusion #6: No amount of code legislation will ever substitute for shabby maintenance practices or lack of common sense.

WHO IS DOING WHAT TODAY?

The organizations regulating *something* about stationary batteries that could have *something* to do with spill containment can be lumped into four categories.

Code-writing agencies (see Table 1) are the most important. The organizations write model documents that are then adopted in whole or in part by local and/or regional governments.

ICC: As already mentioned, the International Code Council has combined BOCA, ICBO, and SBCCI. In March of 2001 the ICC agreed to create a new chapter (609) in the International Fire Code specifically for VRLA batteries. Under the new section, VRLA batteries do not require spill containment, but they do requires an approved method to prevent thermal runaway. The new code also adds new definitions to clear up ambiguities. The existing chapter 608 was modified slightly and will apply only to flooded batteries.

WFCA: Again as already mentioned, the Western Fire Chiefs did not accept the International Fire Code and continue to publish the Uniform Fire Code. However, they have joined with the NFPA to create a new fire code, at which time the UFC will be discontinued (see below).

NFPA: The National Fire Protection Agency was close to adding a section about spill containment into the National Electric Code (NEC), NFPA-70 in mid-2001. However, under review the committee was unable to reach consensus. It was decided that spill containment did not belong in the Electric Code. Instead it will be put into the National Fire Code, NFPA-1. As of this writing that decision is being challenged by an advocate of one of the spill containment manufacturers. NFPA-1, as drafted today, will only require spill containment if the cumulative amount of electrolyte in a facility exceeds 1000 gallons. However, even though draft NFPA-1 defines VRLA batteries as containing "immobilized" electrolyte, it does not yet acknowledge that VRLA batteries are non-spillable and should therefore be exempt from spill control. The period for public review and comment ended April 5, 2002. The Technical Committee will review comments in June. Several other NFPA documents have the potential to address spill containment. For example, NFPA-111, which covers standby power systems, nearly passed a ruling several years ago that would have mandated containment systems large enough to contain *twice* the amount of electrolyte in an entire battery system. That was killed, but its sponsor is still actively pushing to bring it to life again.

Standards writing organizations (see Table 2) such as the IEEE do not have the clout enjoyed by codes, but they can have significant influence on the code writing process and are frequently referenced in interpretations of codes. As of this writing the most significant is probably document P1578. This committee is drafting recommended language for use by code-making bodies that would be acceptable to the scientific community. It hopes to clarify spill containment code issues and methods by late 2002 or early 2003. As with all codes and standards, it is arrived at by consensus of the people who volunteer their time to serve on the committee, so it is here that companies seeking a commercial advantage will try to get their products specified.

Governmental Agencies (see Table 3) obviously have potential for a lot of muscle.

EPA is most interested in disposal of hazardous materials, and the lead in batteries has been high on their list. The amount of lead that could escape in an acid spill is extremely small, but any amount is large enough to get a regulator's attention.

OSHA is concerned about declaration of hazardous materials. OSHA requires that you declare stationary batteries over a specified volume. Once you have gone on public record declaring batteries under hazardous materials, it is a very small step to the next level of requiring plans and materials to deal with a spill. OSHA has not mandated details of a containment system, but they do require proof that you can neutralize and safely dispose of a spill. EPA and OSHA are competing government agencies that claim overlapping jurisdiction, so they do not always cooperate with each other.

DOT worries about batteries leaking and causing nasty experiences during transport by truck, train, airplane, boat or any other means. Their tests include dropping a battery, drilling a hole in it and squeezing it for a period of time to coax electrolyte from it. An IATA label indicates that the battery has been certified safe for air transport.

Battery Industry Trade Organizations (see Table 4) are somewhat self-regulating groups interested in lobbying for regulations that serve their best interests. Battery manufacturers theoretically should be little concerned about spill containment unless they build such systems. However, they are concerned about their customers' best interests. What hurts their customers hurts them, so they are motivated. These groups provide a forum for discussion. They will sometimes hire consultants to lobby code sessions on their behalf.

CONCLUSIONS

Battery acid spills occur but are not a big problem. While a containment system may be appropriate for flooded batteries, it is not necessarily the only solution. Codes should set objectives but the methods of compliance should be left to science. The authority having jurisdiction must determine if the intent of the code has been met. VRLA batteries should be exempt from any regulations about spill containment, but there is no assurance today that they will be. Code writers might wish to consider language about drips as well as spills. No amount of code legislation will ever substitute for shabby maintenance practices or lack of common sense.

There are many different ways to treat the release of electrolyte from a battery. Spill containment is only one. If the people who use batteries are unaware of what the rules are or who writes them, they will be at the mercy of other people who have a different agenda.

CODES, STANDARDS, AND REGULATORY ACTIVITIES TO WATCH

Code	Title	Parent Organization	Activity	Where to get information
BOCA	National Building Code	Building Officials and Code Administrators [BOCA]	Driving towards phase-out with the adoptions of the International Building Code [IBC] and IFC by jurisdictions	www.bocai.org
IFC	International Fire Code	International Code Council [ICC]	Next edition will have separate chapters (Articles 608 & 609) for flooded and VRLA lead acid batteries respectively	www.intlcode.org
NFPA 1	Uniform Fire Code [UFC]	National Fire Protection Agency [NFPA]	In committee. Chapter 52 Report On Proposals (ROP) open for public comment 1/28 - 4/5/02. Spill containment required if electrolyte >1000 gal. To be published 2003	www.nfpa.org
NFPA-70	National Electric Code [NEC]	National Fire Protection Agency [NFPA]	June 2001 proposal to add spill containment to NEC Article 480 failed to get the 2/3 vote needed; should be covered in NFPA 1 and NFPA 5000	www.nfpa.org
NFPA-75	Standard for the Protection of Electronic Computer/ Data Processing Equipment	National Fire Protection Agency [NFPA]	Needs to harmonize language with NFPA 1 and NFPA 5000; will probably do it by reference to those documents	www.nfpa.org
NFPA 76	Recommended Practice for the Fire Protection of Telecommunications Facilities	National Fire Protection Agency [NFPA]	Present draft standard has basic references, which are expounded upon by other codes referenced here. Needs to harmonize language with NFPA1 and NFPA 5000.	www.nfpa.org
NFPA 111	Emergency and Standby Power Systems	National Fire Protection Agency [NFPA]	Attempt to broaden spill containment in this standard a few years ago was defeated, so they're now looking for guidance from forthcoming NFPA1 and NFPA 5000 documents	www.nfpa.org
NFPA 5000	NFPA Building Code	National Fire Protection Agency [NFPA]	The present draft attempts to take the best from industry best practices, so its battery language could be similar to what is now in the IFC	www.nfpa.org
SBC	Standard Building Code	Southern Building Code Council International [SBCCI] [SBCCI]	Harmonized under ICC. Defers to the International Fire Code	www.sbcci.org
UBC	Uniform Building Code	International Council of Building Officials	Driving toward phase-out with the adoption of the IBC by jurisdictions	www.icbo.org
UFC	Uniform Fire Code	Western Fire Chiefs Association [WFCA]	Article 64 continues to be the main enforcement arena. 2003 edition will be joint effort with NFPA (see NFPA 1). Past interpretations have not recognized differences between VRLA and flooded batteries	www.wfca.com

Table 1
Code Writing Organizations

Code	Title	Parent Organization	Activity	Where to get information
IEEE 450 - 1995	Maintenance, Testing and Replacement of Vented Lead-Acid Batteries for Stationary Applications	Institute of Electrical and Electronics Engineers [IEEE] SCC 29	Revising the 1995 standard	Grouper.ieee.org/ groups/scc29
IEEE 484 - 1996	Design and Installation of Vented Stationary Lead Acid Batteries	Institute of Electrical and Electronics Engineers [IEEE] SCC 21	Recently balloted rewrite refers to applicable codes (shown in this table) as well as provides its own guidance	Grouper.ieee.org/ groups/scc29
IEEE 937	Installation and Maintenance of Lead-Acid Batteries for PV	Institute of Electrical and Electronics Engineers [IEEE] SCC 21	Presently in rewrite draft status	Grouper.ieee.org/ groups/scc21
IEEE 1106 -1995	Installation, Maintenance, Testing, and Replacement of Vented Ni-Cad Batteries	Institute of Electrical and Electronics Engineers [IEEE] Standards Coordinating Committee SCC 29	Revising the 1995 standard	Grouper.ieee.org/ groups/scc29
IEEE 1187 -1996	Recom. Practice, Design & Installation of Stationary Lead-Acid Batteries	Institute of Electrical and Electronics Engineers [IEEE] SCC 29	Revising the 1996 std. Adds wording about VRLA's and the inappropriateness of spill containment	Grouper.ieee.org/ groups/scc29
IEEE 1188 -1996	Recom Practice, Maintenance, Test & Replacement VRLA	Institute of Electrical and Electronics Engineers [IEEE] SCC 29		Grouper.ieee.org/ groups/scc29
IEEE P???	Guide for the Ventilation and Thermal Management of Stationary Battery Installations	Institute of Electrical and Electronics Engineers [IEEE] Standards Coordinating Committee SCC 29	Working jointly on a document with ASHRAE that will provide calculations and methods for maintaining Hydrogen concentrations in battery rooms or compartments below Code/Standard recommended levels	Grouper.ieee.org/ groups/scc29
IEEE P1578	Guide for Spill Containment of Stationary Lead Acid Batteries	Institute of Electrical and Electronics Engineers [IEEE] Standards Coordinating Committee SCC 29	Draft standard recommends language for use by code-making bodies that would be acceptable to the scientific community. Clarifies spill containment code issues and methods. Due late 2002 or early 2003	Grouper.ieee.org/ groups/scc29

Table 2-A
Standards Writing Organizations: IEEE, Installation & Maintenance

Code	Title	Parent Organization	Activity	Where to get information
IEEE 485-1997	Recom. Practice for Sizing Lead-Acid Batteries	Institute of Electrical and Electronics Engineers [IEEE] SCC 29		Grouper.ieee.org/ groups/scc29
IEEE 535 - 1986	Qualification of Class 1E Lead Acid Battery for Nuclear Power Generating Stations	Institute of Electrical and Electronics Engineers [IEEE] SCC 29		Grouper.ieee.org/ groups/scc29
IEEE 1115 - 1992	Recom Practice for Sizing NiCad Battery	Institute of Electrical and Electronics Engineers [IEEE] SCC 29		Grouper.ieee.org/ groups/scc29
IEEE 1184 - 1994	Guide for Selection and Sizing of Batteries for UPS	Institute of Electrical and Electronics Engineers [IEEE] SCC 29	Revising 1994 standard – proposed to add section on spill containment	Grouper.ieee.org/ groups/scc29
IEEE 1189 - 1996	Guide for Selection of VRLA Batteries	IEEE, SCC 29	Section 5 discusses immobilized electrolyte	Grouper.ieee.org/ groups/scc29

Table 2-B
Standards Writing Organizations: IEEE, Selection & Sizing

Code	Title	Parent Organization	Activity	Where to get information
ANSI T1 Y1 - 21	VRLA Batteries Used in the Telecommunications Environment	American National Standards Institute, Committee T1 E1.5	Defines tests for VRLA, sets criteria for battery environment, and sets installation guidelines	www.T1.org
ANSI T1 E1 - 40	Battery Rooms & Enclosures Standards	American National Standards Institute, Committee T1 E1	Defines requirements for electrolyte handling and containment in Chapter 8	www.T1.org

Table 2-C
Standards Writing Organizations: ANSI T1

Code	Title	Parent Organization	Activity	Where to get information
29 CFR 1910.120 -C 1910. 268(b)	Occupational Safety and Health Standards	U.S. Department of Labor OSHA	Reporting requirements Hazmat spill containment	www.osha.gov
29 CFR 1926.441	Battery Rooms and Battery Charging	U.S. Department of Labor OSHA	Floor coating Flushing & neutralizing spilled electrolyte	www.osha.gov
40 CFR Parts 260, 265, 300, 302, 311, 312, 350, 355, 370, & 372	Hazardous Waste Management System: General [SARA Title 3]	U.S. Environmental Protection Agency EPA	Requires filing with Local Emergency Planning Commissions (LEPC) and State Emergency Response Commission (SERC) when amount of battery acid exceeds 500 lbs (CAS: 7644-93-9) or when amount of lead exceeds 10,000 lbs (CAS: 7439-92-1), and mandates emergency response plans	www.epa.gov
49CFR Subtitle B Subchapter C 173.150(d)	Hazardous Materials Regulations	U.S. Department of Transportation DOT	Regulations for transport of batteries by truck, rail, ocean and air	www.dot.gov

Table 3
Federal Government Organizations

Organization	Description	Activity	Where to get information
Battery Congress International (BCI)	Interest group made up mostly of manufacturers of stationary batteries, battery manufacturing/ test equipment, and components	Has sent position papers to code writing organizations and has sent delegates to code-writing committees; favors removal of requirements for spill containment on VRLA batteries	

Table 4
Battery Industry Trade Organizations

REFERENCES

1. Calicorp, “Spill Containment Systems: Situation Overview,” pg. 1, 1998
2. Marts, Ronald, Testimony to IEEE Standards Committee Nov 1998
3. Reckner, Jack V., “Controversy and Change in the Fire Code Adoption Process, June 1999