PARTING SHOT

Abusing LiFePO4 Batteries in ABYC's Test Kitchen

by John Adey

To learn more about the associated causes and risks of lithium-ion-battery fires, last year the U.S. Coast Guard tasked ABYC with simulating some of the issues the industry had been reporting. Delighted by this challenge, the ABYC Technical department set to work. The council and I are no strangers to innovative approaches to destroying things to prove a point. From running over ballistic-gel samples with guarded and unguarded propellers, to running various experimental fuels through perfectly good engines, we have a history of breaking things in the pursuit of boating safety. As usual, I've watched and participated as the battery project progressed, and recently I included my casual observations in a president's letter to the ABYC membership. Here, I'll report further on what I have seen and document my surprise at the outcomes so far.

The first steps in our testing program were to choose battery chemistry and then specific subject products. Because the dominant lithium-ion battery chemistry in the marine industry is lithium iron phosphate (LiFePO4), that was an obvious selection. The next step was obtaining a variety of LiFePO4 batteries to subject to testing. Without naming specific brands and models at this point in our ongoing research, our choices included products ranging from high-end marine-specific batteries to less expensive varieties for unspecified applications. All these units are readily available to the public and easy to obtain, including some reconditioned after powering industrial floor cleaners.

Armed with anecdotal observations and lots of sea stories, we began testing. The tech team started with a standard ABYC-compliant electrical system. Chargers, inverters, and various loads were assembled, and, as expected, all products performed with no "out-of-parameter" issues. Apart from the office staff wondering where their load-inducing space heaters went, no one here at headquarters was even aware of the groundbreaking testing under way in our parking garage.

Then the fun started. The team introduced abnormal uses and applications—overcharging, undercharging, high temperatures, deep draw-down, high- and abrupt-load scenarios, etc. The marine-specific batteries that included elements required under ABYC's E-13 Standard, such as a battery management system (BMS), took in stride all the abusive test scenarios we threw at them. In short, the BMS successfully protected the battery, the attached wires, and components.

With anxious anticipation, we set to testing the noncompliant products. As these batteries were being subjected to the same challenging test parameters as the others, I made a point to observe from a safe distance at our undisclosed location. I waited for the conflagration, and I waited, and I waited. With my attention span exhausted and other duties calling, I asked for regular updates, then occasional updates, and finally the standing request, "If something happens, let me know."

The day finally came when I received a quick video of smoke pouring out of a battery. At last, I thought, we had re-created a lithium-battery incident that could help us suggest an addition to our standard that would prevent some of the failures that we had been hearing about, and the technology would be safer for boat owners and builders. Turns out, where there's smoke there isn't always fire. Also, it turns out that the out-of-parameter test that precipitated the event was driving not one but two 10-penny framing nails into the battery cases—not a documented accident that we've seen reported but nonetheless fairly dramatic.

Next, we jumped at an opportunity to have our batteries included in a boat burn through the International Association of Arson Investigators (IAAI). The batteries were placed very close to the epicenter of the choreographed incident. When asked what observations he had, our project manager merely said, "Uh, hmm." When pressed to confirm that the batteries contributed to the fire, he continued to disappoint, concluding that the LiFePO4 batteries did not add to the conflagration.

Now we're purchasing Instant Ocean, the aquarium hobbyists' method of creating pure salt water. With this brew we'll be able to see the effect of submersion on energized and nonenergized batteries, which I look forward to observing.

The full report of what we attempted in these tests will be available in due time. Also, we will likely take our inquiry to the next level in a laboratory environment.

This is not a yarn about the safety of lithium batteries but rather a testimony to the alarmists who prompted our inquiry. To date, our work suggests that, when treated and installed correctly, LiFePO4 deserves a chance, and that the boat-owning end users will benefit from these products. Also, we need to consider them not just as batteries, like an 8D or a group 31, but as a complete system with associated technology that has the potential to vastly improve the safety of a DC power plant. However, a "drop-in" lithium battery that matches the case size of traditional lead-acid or other batteries can really cause more harm than good, especially if it comes without a BMS.

I am reminded of the early days of galvanic isolators, when they became the catchall for a series of fires in the early 2000s. We at ABYC strive to develop and disseminate engineering standards that result in the consistent construction of a "reasonably safe product." ABYC undertakes projects such as this to keep boating one of the safest recreation choices out there. Experts from multiple fields created the ABYC Standard E-13, *Lithium Ion Batteries*, published in 2022; and a three-year revision cycle gives us the opportunity to add, delete, or modify requirements when necessary. As part of this cycle, we will continue to abuse the batteries in question. Next up: submersion, both hot and no load. And there's talk of using one for target practice. Stand by for the next chapter. PBB

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