

## Lithium Battery Hazard Detection, Mitigation, and Safety Certification in the Navy

D. Fuentevilla; C. Winchester; J. Simmons; J. Ko; C. Hendricks; K. Ivory; J. Schwartz  
NAVAL SURFACE WARFARE CENTER CARDEROCK DIVISION

The U.S. Navy has utilized the higher energy density of lithium batteries since the early 1970s and was an early adaptor of lithium ion batteries when they emerged. However, the use of these power systems came with risks, and in the late 70s the Navy had tallied several personnel injuries, loss of facilities, and equipment as a result of lithium battery safety incidents. As a result, the Navy initiated a Lithium Battery Safety Program. This program requires any battery, utilized by Navy or Marine Corps personnel, facilities, or platforms to be safety certified. This talk describes the Navy's technical approach for incorporating lithium batteries into the fleet safely, and the increasing challenges involved as the size and complexity of the electrochemical systems increases. Specifically, we will discuss the components of the Navy's safety assessment, sometimes known as the "safety onion"<sup>1</sup>, including:

- Right battery for the application;
- Right design for the battery/application/usage;
- System hazard analysis;
- Appropriate detection;
- Appropriate casualty management and mitigation; and
- Appropriate trigger.

A comparison will be made to the commercial transportation industry, and the tools and limitations available for ensuring safety.

Finally, the talk will include examples of system-specific approaches to hazard mitigation utilized by Navy programs as well as a discussion of developmental diagnostic technologies for pre-event detection and post-casualty quick response.

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<sup>1</sup> F. Larsson, P. Andersson, B-E. Mellander, "Lithium-Ion Battery Aspects on Fires in Electrified Vehicles on the Basis of Experimental Abuse Test," *Batteries*, 2, 9, 2016.