Fire Hazards from 18650 Li-ion Cells Used in Electronic Items for Aviation

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UL is involved with the aviation industry to better understand the hazards from rechargeable batteries and identify potential mitigation solutions. Data from FAA shows an increasing number of smoke and fire incidents from lithium-ion batteries in electronic items. The items involved in these incidents included individual cells as well as electronic items such as laptops, e-cigarettes, power banks, cell phones, and battery powered luggage.

There is interest with the cargo carriers to develop fire suppression/containment features for cargo containers to protect the plane and crew in an event of a fire involving electronic items or bulk transportation of li-ion cells.

A standardized test method to evaluate the fire performance of the cargo containers will require development of an ignition source that is representative of the hazard in the cargo. Research is required to identify a battery pack representative of a shipped item as it is the primary fire hazard that may initiate a fire event.

The review of literature identified three areas for further investigation:

(i) Influence of state of charge with a range representing limiting values considered by regulatory groups;
(ii) Influence of electrical configuration and capacity of battery packs representing personal electronic devices, and appliances likely to be shipped as cargo; and
(iii) Influence of how cells are electrically configured in a battery pack.

Baseline thermal runaway data were developed for 1, 4, 8, and 24 18650 li-ion cells that were not configured electrically and charged to 30, 50, 75 or 100% prior to testing. Then a series of tests were conducted to quantify the fire hazards from battery packs with the states of charge and cell configurations shown in Table 1.

Table 1 – Battery Pack Configurations

Battery Pack Configuration	Example of Electronic Item	State of Charge (%)
1s x 4p	Power bank	30, 50, 75, 100
4s x 2p	Laptop	30, 50, 75, 100
12s x 2p	Power tool, Hoverboard	30, 50, 75, 100
6s x 4p	Power tool, Hoverboard	100

The tests were conducted under a smoke collection hood to measure the following fire hazard metrics: heat release rate; hydrogen, total hydrocarbon, CO, and CO_2 gases, duration of thermal runaway event, and weight loss.

The results showed that the thermal runaway event (e.g., peak and total heat release rates) were influenced by the state of charge, irrespective of the battery size or electrical configuration tested in this investigation. While there is decrease in peak heat release rates with decrease in SOC, the drop is higher between 75% and 50% SOC values. There was difference in fire performance between 24 cell battery pack configured 12s x 2p versus 6s x 4p. However, additional testing is required to determine if this is related to electrical connection or cell packing configuration. Data relative to gas composition (e.g., CO and THC) is currently under review and shall be discussed in the presentation.