

Lithium Battery Update

Lithium Metal Cell Container Vent Tests

Presented to: Systems Working Group

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Lithium Metal Cell Container Tests

- **Background**

- Lithium metal cells are banned from cargo shipment on U.S. passenger aircraft, but are allowed to be shipped on cargo aircraft
- The International Civil Aviation Organization (ICAO) allows small quantities of lithium metal cells to be shipped on passenger aircraft when packed in metal containers
- There are currently no approved and tested containers that can sufficiently contain the known effects of accidental lithium metal battery ignition.



Lithium Metal Cell Container Tests

- **Previous testing results / Conclusions :**
 - As few as 6 CR2 lithium metal cells, induced into thermal runaway, were sufficient to cause failure.
 - Common metal shipping containers, pails and drums, are not designed to withstand the pressures from a lithium metal cell fire.
 - Flame arrestor vent screens attached to an over pack container failed to contain a lithium metal cell fire



Lithium Metal Cell Container Tests Over Pack Screen Failure



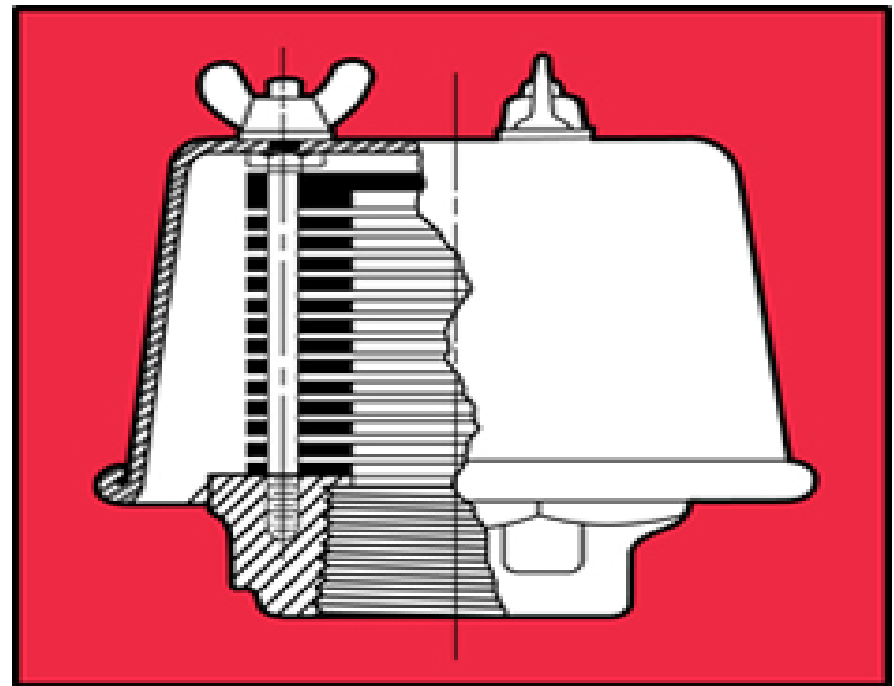
Lithium Metal Cell Container Tests

- **Tests were designed to evaluate the effectiveness of an end-of-line deflagration flame arrestor as a container vent**
 - the selected 1” vent was installed onto drum lid
 - in each test one cell was replaced with a 100 watt cartridge heater to simulate one cell in thermal runaway
 - pressure transducer installed on side of drum
 - Cell, drum internal and vent temperatures were recorded



Lithium Metal Cell Container Tests

Vent



Lithium Metal Cell Container Test (30 Gallon steel) Configuration



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Lithium Metal Cell Container Tests

- **Three tests were conducted**
 - The first and second tests were wired in a group around the cartridge heater
 - 6 cells
 - 18 cells
 - The third test was $\frac{1}{4}$ of standard packaging 123's
 - 99 cells, 1 replaced by heater

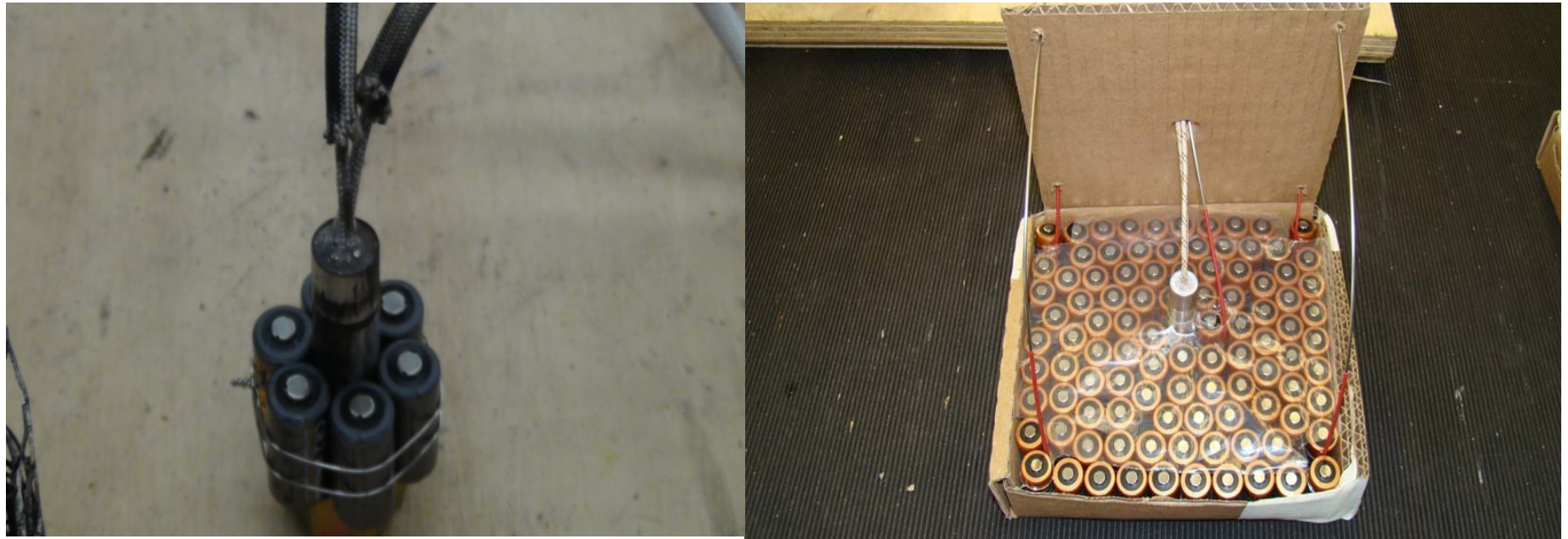


Lithium Metal Cell Container Tests

- Evaluation of effectiveness
 - Internal fire containment
 - Pressure release
 - Container and vent integrity

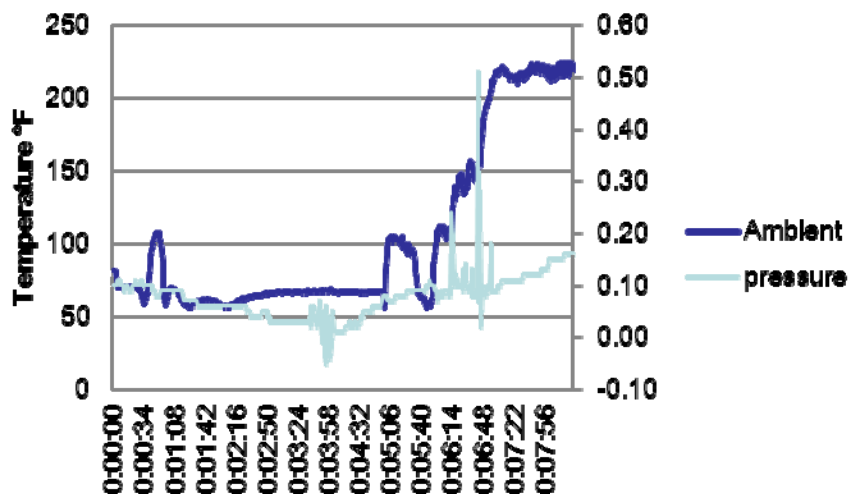


Lithium Metal Cell Container Tests

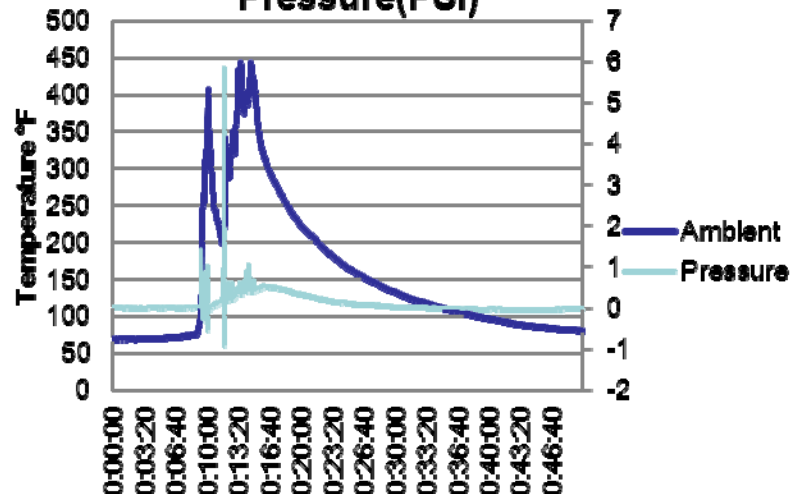


Lithium Metal Cell Container Tests Data

18 Cells: Temperature (°F) / Pressure(PSI)



99 Cells: Temperature (°F) / Pressure(PSI)



Lithium Metal Cell Container Tests

- **Results**

- 6 Cell test

- Internal fire containment, smoke release, no pressure rise or pressure pulse, bulging of the lid,

- 18 Cell test

- Internal fire containment, smoke release, pressure rose with a few pressure pulses of .40 increase psi along with bulging of the lid,

- 99 Cell test

- Internal fire containment, pressure increased to .50 psi, pressure pulses up to 5.85 psi, large amount of smoke released, lid bulged and was permanently deformed



Lithium Metal Cell Container Tests

- **Conclusions**

- Deflagration flame of arrestors of this type can safely release the pressure generated by a lithium metal battery fire without allowing flaming gases to escape
- The pressure and temperatures generated by a lithium metal battery fire is a function of the number of cells involved

