Passive Fire Protection for Lithium Battery Shipments

Presented to: Systems Meeting
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Date: 11-15-2012
Background

• **Dubai Accident (2010)**
  - The heat from an onboard fire created slack in the aircraft control cables. [3]
  - The fire created smoke which blocked the view of aircraft controls. [3]

• **UPS DC-8 (2006)**
  - Lithium batteries may not have been the initial source of fire but contributed upon ignition. [1]

• **Other incidents**
  - Approximately 63 other Lithium and Lithium-ion cell related aviation incidents from 1991 to 2012 [4]
Related Tests

- **Fire Protection Research Foundation**
  - Provided a detailed report of battery chemistry and technology \[^{[5]}\]

- **FAA**
  - Showed the usefulness of various materials to replace cardboard in cell packaging.
    - Cardboard with intumescent paint.
    - Aluminum foil instead of cardboard.
    - Composite sheets instead of cardboard.
  - Work was done that demonstrated the dependence of cell propagation on state of charge.

- **Other related tests**
  - Calorimeter tests have been done to determine the heat release of cells in thermal runaway.
Objective

- Perform experiments to better understand the effect of variation in cell packaging and cell state of charge.
  - Variation of cell “state-of-charge”.
  - Variation in shipment packaging
Planned Tests (Setup)

- 16 cell (4 cell x 4 cell) boxes are to be made from cardboard.
- One cell in the array is an aluminum cylinder to be used to approximate heat flow into a cell.
- Each cell location will have a thermocouple for data collection
- A 100 Watt heater will be used to initiate the propagation
Planned Tests

- Baseline repeatability tests are to be performed at 50% state-of-charge with typical cardboard cell separators.
- Substitute cell separators.
  - Aluminum sheet metal
  - Fire retardant cardboard
  - Thermoplastics?
- Perform cardboard (as shipped) tests another Lithium-ion chemistry

<table>
<thead>
<tr>
<th>State of Charge</th>
<th>Cardboard separators (as shipped)</th>
<th>Aluminum separators</th>
<th>Fire Retardant Cardboard</th>
<th>Cardboard separators (as shipped) with another cell chemistry</th>
</tr>
</thead>
<tbody>
<tr>
<td>30%</td>
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<tr>
<td>40%</td>
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<td>50%</td>
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<td>x2 (repeatability)</td>
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<td>60%</td>
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- Once conditions that prevent cell propagation are determined they are to be verified with a full box test.
Questions or Suggestions?

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Citations