

# Passive Fire Protection for Lithium Battery Shipments



Federal Aviation Administration



[1]



[2]

Presented to: Systems Meeting

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# 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.



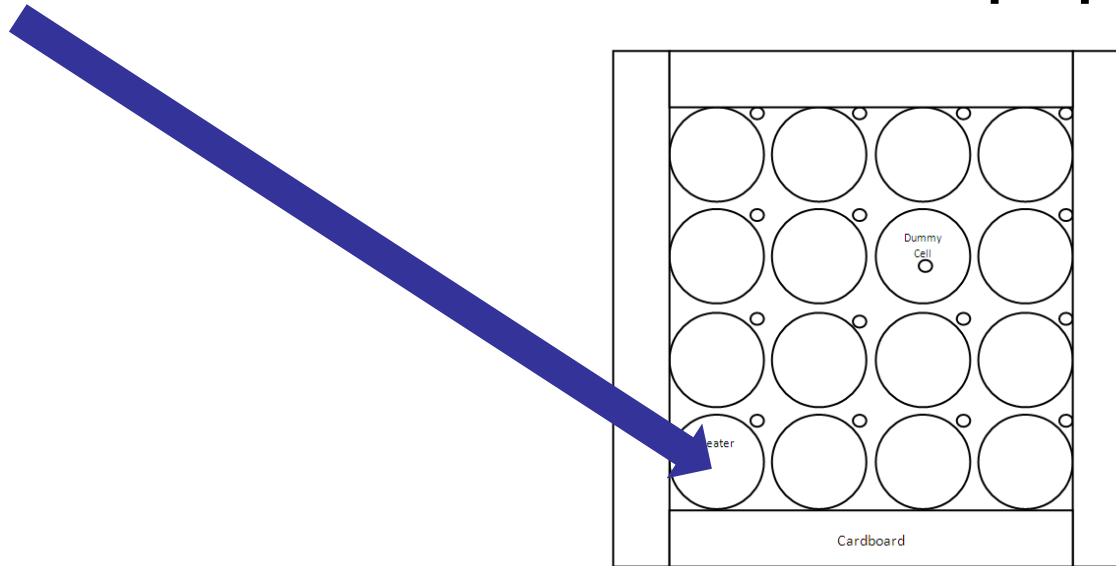
# Objective

- **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**

State of Charge	Cardboard separators (as shipped)	Aluminum separators	Fire Retardant Cardboard	Cardboard separators (as shipped) with another cell chemistry
30%				
40%				
50%	x2 (repeatability)			
60%				
80%				
90%				
100%				

- **Once conditions that prevent cell propagation are determined they are to be verified with a full box test.**



# Questions or Suggestions?

- **Contact**

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# Citations

- [1] Thurber, Matt. "Cargo Carriage of Lithium Batteries Suspected in Some Accidents." *AINonline*. Aviation International News, Feb. 2012. Web. 01 Nov. 2012. <<http://www.ainonline.com/aviation-news/aviation-international-news/2012-02-01/cargo-carriage-lithium-batteries-suspected-some-accidents>>.
- [2] Lowy, Joan. "Report: Lithium Batteries on Crashed UPS Plane." *Salt Lake City and Utah Breaking News, Sports, Entertainment and News Headlines*. Associated Press, 3 Apr. 2011. Web. 01 Nov. 2012. <<http://www.deseretnews.com/article/700124082/Report-Lithium-batteries-on-crashed-UPS-plane.html?pg=all>>.
- [3] "Air Accident Investigation Interim Report." General Civil Aviation Authority, n.d. Web. 1 Nov. 2012. <<http://www.gcaa.gov.ae/en/ePublication/admin/iradmin/Lists/Incidents%20Investigation%20Reports/Attachments/16/2010-Interim%20Report%20B747-400F%20-%20N571UP%20-%20Report%2013%202010%20-%20Rev%201.pdf>>.
- [4] "BATTERIES & BATTERY-POWERED DEVICES." FAA Office of Security and Hazardous Materials Safety, n.d. Web. 1 Nov. 2012. <[http://www.faa.gov/about/office\\_org/headquarters\\_offices/ash/ash\\_programs/hazmat/air\\_carrier\\_info/media/Battery\\_incident\\_chart.pdf](http://www.faa.gov/about/office_org/headquarters_offices/ash/ash_programs/hazmat/air_carrier_info/media/Battery_incident_chart.pdf)>.
- [5] Exponent Failure Analysis Associates. "Lithium-Ion Batteries Hazard and Use Assessment." N.p., July 2011. Web. 1 Nov. 2012. <<http://www.nfpa.org/assets/files/pdf/research/rflithiumionbatterieshazard.pdf>>.

