Lithium Battery Testing Update

Federal Aviation Administration

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Lithium Battery Test Program

- **Evaluate the feasibility of using water mist to extinguish both primary and rechargeable lithium battery fires.**
- **Evaluate the ability of currently available shipping containers to withstand an internal lithium-ion or lithium primary battery fire.**
  - Fire containment
  - Molten lithium
  - Pressure containment
- **Evaluate the ability of currently available shipping containers to protect a shipment of lithium batteries from an external fire.**

Lithium Battery Test Program

- **Bulk shipment packaging upgrades**
  - Evaluate the effectiveness of improved separation materials in preventing fire propagation between cells
- **Large scale lithium-ion fire tests**
  - Small scale tests have shown the effectiveness of Halon 1301 in controlling lithium-ion fires
  - The effectiveness of Halon 1301 in large scale cargo compartment tests with mixed fire loading and up to 1000 18650 cells will be evaluated

Water Mist Results

- **Initial tests with relatively high volume water spray appears to be effective on both primary and ion batteries**
  - Lithium-ion cells
    - Extinguishes electrolyte fire
    - Cools cells
    - Stops propagation between cells
  - Lithium primary cells
    - Water reacts with molten lithium
    - Cools cells
    - Stops propagation between cells

Shipping Container Tests

- **Two types of robust shipping containers have been procured.**
  - 5 gallon sized steel pail, with sealed crimped lid
  - 30 gallon sized steel drum with removable lid and locking ring
- **Preliminary containment tests**
  - Small number of cells (2-5)
  - Thermal runaway induced by 100 watt cartridge heater

Shipping Container Tests- Preliminary Results

- **Five gallon pail**
  - Two lithium-ion 18650 cells
    - Cells overheated and vented electrolyte
    - Electrolyte ignited
    - Pail contained the fire
    - Pail seal did not contain the pressure, released smoke around the perimeter of the lid
  - Five CR2 lithium primary cells
    - Ignition of 1-2 cells blew lid 10-12 feet in the air
    - Remaining cells ejected from the container and continued to burn

Near Term Test Schedule

- **Five gallon pail tests**
  - Increase number of 18650 cells
- **Thirty gallon drum tests**
  - Lithium-ion cells (pending results of pail tests)
  - Lithium-primary test
    - Begin with 5 CR2 cells
- **Packaging material tests**
  - Replace cardboard dividers with thermal resistant materials (thin cargo liner, insulation blocking layer)
  - Use 100 watt cartridge heater to initiate fire

Near Term Test Schedule

- **Full scale cargo tests**
  - Determine effectiveness of Halon 1301 in controlling a cargo fire with mixed fire loading and lithium-ion cells
    - 100 cells
    - 500 cells
    - 1000 cells
  - Container tests
    - Measure temperature rise inside container when exposed to a suppressed cargo fire
    - Evaluate effectiveness of intumescent paint coatings

Long Term Test Schedule

- **Water Mist Tests**
  - Evaluate spray volume
  - Droplet size
  - Effectiveness of water spray in mixed fire loading
- **Develop specifications for lithium battery shipping container**
  - Internal fire containment
  - Pressure containment / release
  - External fire