

# Lithium Battery Shipping

- **ICAO Dangerous Goods Panel Update**
- **Packaging Standard**

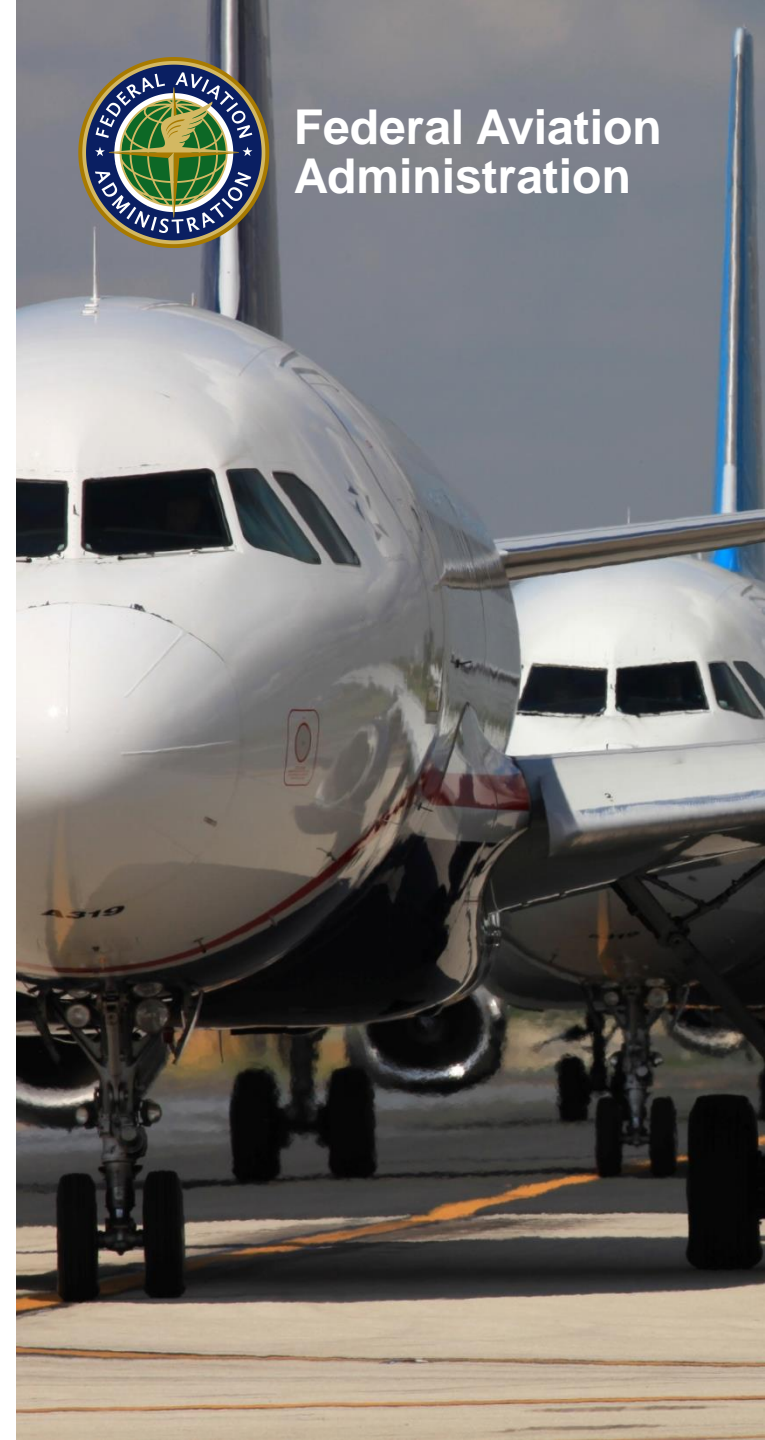
Presented to: Systems Meeting

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Federal Aviation  
Administration



# ICAO Dangerous Goods Panel

- **The DGP met in Montreal April 27-May 1**
- **Presentations were made to the panel**
  - UPS presented the results of their Fire Resistant Container tests
  - FAA presented an update on current testing
    - Methods to induce thermal runaway
    - Fire Containment Cover Test
    - Cells shipped as class 2 in plastic storage boxes
    - Halon 1301 concentration required to suppress a lithium-ion vent gas explosions



# ICAO Dangerous Goods Panel

- **ICCAIA AND IFALPA**

- Presented an information paper stating that current aircraft are not capable of withstanding a fire involving high density shipments of lithium batteries
- Recommendations:
  - That appropriate packaging and shipping requirements are established to more safely ship lithium ion batteries as cargo on passenger aircraft;



# ICAO Dangerous Goods Panel

- ICCAIA and IFALPA recommendations:
  - that high density packages of lithium ion batteries and cells (UN 3480) not be transported as cargo on passenger aircraft until such time as safer methods of transport are established and followed; and
  - that appropriate packaging and shipping requirements are established to more safely ship lithium metal and lithium ion batteries as cargo on freighter aircraft.



# ICAO Dangerous Goods Panel

- Discussion ensued...
- The panel decided to form a subgroup to develop a *Performance Packaging Standard* to insure the safe shipment of lithium batteries.
- A Terms of Reference was written and approved by the panel
  - Details, organization and membership of the subgroup have not yet been established
  - Goal is to develop the standard before the October meeting.



# ICAO Dangerous Goods Panel

- **No action was taken on the recommendation to stop shipment of high density cells at this time.**
- **IFALPA has indicated it will submit a formal paper to ban such shipments at the October meeting.**



# Packaging Standard Considerations

**The following are some of the concerns that would need to be addressed by a lithium cell packaging standard:**

- **Hazards**

- Thermal runaway

- Propagation from cell to cell, battery to battery, box to box
- Heat produced can ignite normal combustibles

- Flammable electrolyte

- Contributes to the fire and speeds propagation of thermal runaway



# Packaging Standard Considerations

- Flammable gases and explosion
  - A cell in thermal runaway produces a mix of gases, many of which are flammable, including hydrocarbons and hydrogen.
  - When contained, an explosive mixture can occur
- Explosive cells
  - Certain cell chemistries and cell construction combinations can result in explosions when heated.
  - These include, but are not limited to thionyl chloride, manganese dioxide and iron phosphate





# Packaging Standard Considerations

- Pressure pulse
  - All cells in thermal runaway produce a pressure pulse, some much more forceful than others.
  - The larger the cell size, generally, the larger the pulse.
- Large format cells and batteries
  - Automotive, stationary power storage
  - Similar behavior to smaller consumer cells, only on a much larger scale.
  - Single cell failure is a significant event
  - Propagation of thermal runaway escalates the hazard dramatically.
  - A single cell may constitute a “high density shipment”



# Packaging Standard Considerations

- External fires
  - When a shipment size exceeds a certain number of cells, the effect of external fire exposure needs to be examined.
  - The external fire hazard is somewhat mitigated by shipping in Class C compartment but not eliminated
- Halon 1301 consumption and leakage
  - Cells in thermal runaway produce pressure and gases that are released into the cargo compartment. This pressure and volume of gases will cause increased leakage of Halon 1301 from the compartment reducing the effectiveness of the agent and length of time that the compartment is protected.



# Packaging Standard Considerations

- **Mitigations**

- Aircraft cargo compartment based mitigations

- Smoke detectors
- Fire suppressant
- Ventilation control
- Operator installed suppression systems
- Fire hardened cargo containers
- Fire containment covers

- Operations based mitigations

- Reduce number of cells shipped per compartment
- Reduce cell density per shipment



# Packaging Standard Considerations

- Packaging based mitigations
  - Prevent propagation of thermal runaway
    - Prior to the gas data recently developed, it was thought acceptable to simply contain the fire to within a package.
    - This, however, can result in the buildup of explosive gases, which may be difficult if not impossible to contain.
    - Preventing propagation solves the explosive gas problem as well as mitigating the other fire hazards presented by a cell in thermal runaway.
    - This becomes critical as the number of cells shipped in the package increases.



# Packaging Standard Considerations

- Contain the cell fire to within the package
  - For shipments of small numbers and sizes of cells this may be sufficient.
- Prevent or contain the release of gases from the package
  - May be possible for small packages



# Packaging Standard Considerations

- Protect from external fire.
  - For shipments exceeding a certain number of cells or large format cells, protecting the shipment from external fires and heat becomes important. The number of cells is dependent on the size of shipping container or compartment. In a large cargo container can be as few as 200-300 cells.
  - May need two criteria dependent on the availability of a Class C compartment
  - Class C compartment suppressed with Halon 1301 will not have open flames. However the temperatures can exceed that required to drive a cell into thermal runaway, resulting in release of electrolyte and flammable gases. An oven type test may be sufficient to address this concern.



# Packaging Standard Considerations

- Class E compartments, with no active fire suppression system, relies on decompression to suppress the fire. Temperatures of fires in Class E compartments can be much higher than Class C compartments, and the fire can intensify as the aircraft reduces altitude.
- Combination Based Mitigations
  - Fire resistant packaging and fire resistant cargo container / covers may be viable if utilized in conjunction with each other.
  - Aircraft compartment, fire resistant cargo containers, fire containment covers, and performance packaging can all work together to achieve a desired level of risk.



# Packaging Standard Considerations

- ICAO DGP based mitigations
  - Restrict the number of cells shipped per package
    - Restrict over packs
    - Reduce cell density
  - Restrict cell size
    - Generally, the hazard increases with the size of the cell
    - There are cell sizes and types where a single cell presents a significant hazard
  - Identify all lithium cells
    - Eliminate Section II packaging instructions for cells and batteries in UN3480 and UN3090





# FAA Packaging Testing

- **The FAA has invited companies that have prototype or commercially available products or packaging for evaluation.**
- **This is not official “testing” since a test standard has not yet been established or approved by ICAO**
  - State of the industry survey
- **We have been in contact or received products from AKRO Fireguard, Americase, Pyrophobics and NoChar.**
  - We welcome products from any other companies



# Questions?

## Contact Information

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