



Lithium Battery Cargo Awareness

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Lithium Battery Introduction

- The term “lithium battery” refers to a family of batteries having cathodes or electrolytes that contain either metallic lithium or a lithium compound
- Lithium batteries are generally divided into two categories:

Lithium Metal Batteries

- Lithium metal (primary) batteries are non-rechargeable.
- They feature higher energy density than other older non-rechargeable battery chemistries
- They are frequently used to power cameras, watches, medical devices (including implantable devices), etc.



Lithium-Ion Batteries

- Lithium ion (secondary) batteries are rechargeable.
- They feature a relatively high energy density, and a relatively slow loss of charge when not in use.
- Lithium ion batteries are frequently used in consumer electronics (mobile telephones, laptop computers, etc)
- Included within the lithium ion battery category are lithium polymer batteries (sometimes referred to as “pouch cells”)

Notebook
Battery that
Uses 18650
Cells



Pouch Cell



Causes of Energetic Lithium Battery Failures

Energetic failures (fire and/or explosion) of lithium type cells can occur for a number of reasons including:

- Poor cell design (electrochemical or mechanical)
- Cell manufacturing flaws
- External abuse of cells (thermal, mechanical, or electrical)
- Poor battery pack design or application
- Poor protection electronics design or manufacture
- Poor charger/system design or manufacture resulting in Overcharging of battery

Another failure is Cell thermal runaway, which is a rapid self-heating of a cell due to the exothermic chemical reaction of the highly oxidizing positive electrode and the highly reducing negative electrode.



Lithium Battery Cargo Shipment



Typical Li-Ion Battery Cells Packed for Shipment

- Size and frequency of lithium battery air cargo shipments continues to increase driven by growth in demand for consumer and industrial goods powered by lithium batteries.
- Concern about lithium battery cargo fires has led FAA William A. Hughes Technical Center to conduct battery fire tests with the following key findings:
 - A relatively small fire source can ignite lithium ion or lithium metal cells
 - Fire from one cell will ignite adjacent cells in a bulk shipment of batteries
 - Energetic failure of lithium cells often creates a pressure pulse which may damage fire-resistant cargo compartment liners and/or compromise their decompression features
 - Halon fire suppressant is effective on lithium ion electrolyte fires, but will not prevent the propagation of thermal runaway through bulk shipments of batteries
 - Halon does not suppress lithium metal battery fires
 - Failed lithium metal batteries can eject molten lithium which may damage cargo compartment liners
 - Metal pails and drums recommended by the ICAO are not effective in controlling lithium metal cell fires, but are effective in containing lithium-ion cell fires
 - Containers designed to ship oxygen generators can contain a 100-cell lithium-ion cell fire

Lithium Battery Transport Regulations

- Air transport of lithium batteries is controlled by international and local regulations governing the transport of dangerous goods (also referred to as hazardous material regulations)
- Most countries follow the ICAO Technical Instructions for the Safe Transport of Dangerous Goods by Air but many also have local variations contained in their own regulations
- An example of local variations are United States 49 CFR Parts 171-180 administered by the Department of Transportation Pipeline and Hazardous Materials Safety Administration (PHMSA)
 - A significant US local variation is that lithium metal batteries packed alone are prohibited from being transported on passenger airplanes
- Some airlines also have their own policies for transporting specific types of dangerous goods (known as airline variations)
- Many airlines, freight forwarders, and shippers use the IATA Dangerous Goods Regulations as the working reference for dangerous goods transport requirements because it includes the ICAO Technical Instructions, local variations, airline variations, and additional requirements agreed to by IATA-member airlines to reflect operational considerations

Lithium Battery Transport Regulations – Recent Developments

- ICAO regulation changes
 - New ICAO lithium battery air cargo transport regulations become effective January 1, 2013
 - New intermediate category introduced which increases control over battery/cell shipments; however, relief still provided from fully regulated Class 9 shipment requirements
- DOT Pipeline and Hazardous Materials Safety Administration (PHMSA) harmonizing US rules with ICAO standards as required by FAA reauthorization act (HR 658) signed into law on February 14, 2011
 - DOT not allowed to implement further lithium battery shipping regulations without credible evidence that lithium batteries transported in accordance with the requirements of the ICAO Technical Instructions, have substantially contributed to the initiation or propagation of an onboard fire
 - HR 658 further requires that US regulations conform only to ICAO standards with the exception that the DOT may enforce the existing prohibition on transporting lithium metal batteries aboard passenger aircraft

Aviation-Related Lithium Battery Incidents

Recent cargo and baggage incidents that the FAA is aware of from

BATTERIES & BATTERY-POWERED DEVICES

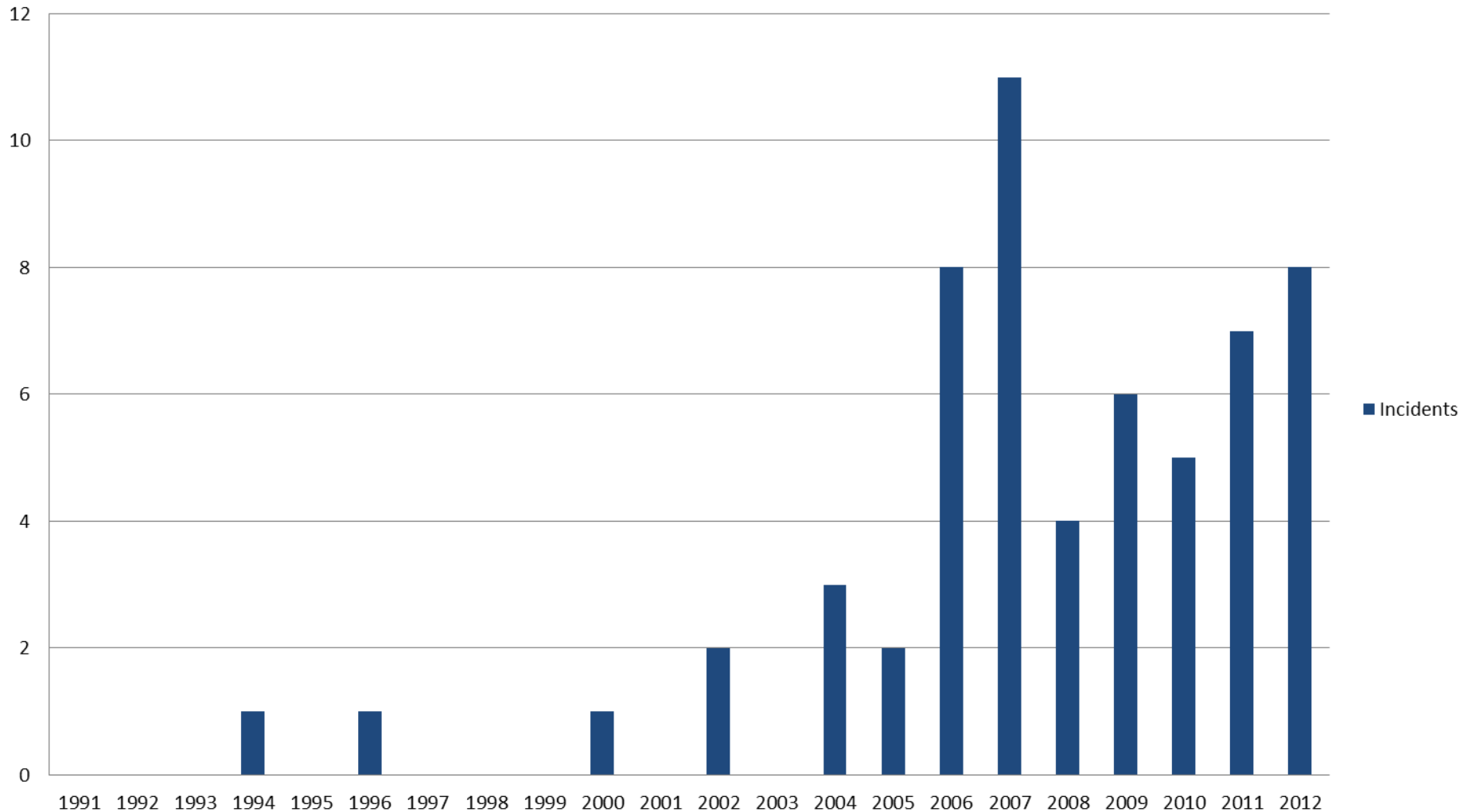
Aviation Incidents Involving Smoke, Fire, Extreme Heat or Explosion

As of October 9, 2012, 132 air incidents involving batteries have been recorded since March 20, 1991

- 61 total incidents are listed where Lithium Batteries were directly involved, resulting in heat, smoke, fire or explosion
- 2 of the 61 incidents were direct result of mishandling of the package containing the Lithium Batteries, and were not used for evaluation
- Remaining 59 incidents were sorted by year of occurrence and categorized for:
 - **Airplane Type** – Cargo or Passenger
 - **When** incident occurred – boarding, in-flight, before loading or after transport
 - **Battery Location** – equipment, ULD, package, carry-on or checked bag
 - **Where** incident occurred – vehicle, onboard, ramp, facility or terminal

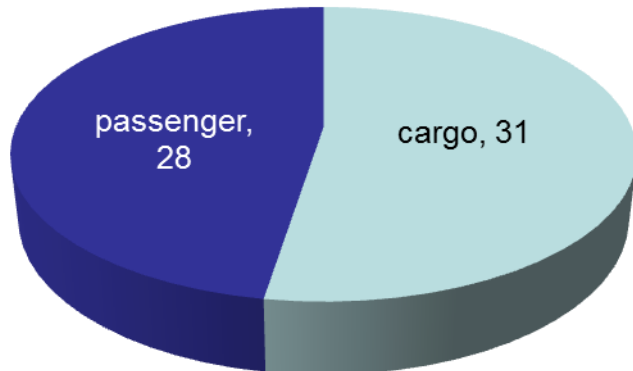
Aviation-Related Lithium Battery Incidents

March 20, 1991 to October 9, 2012
59 Lithium Battery Events

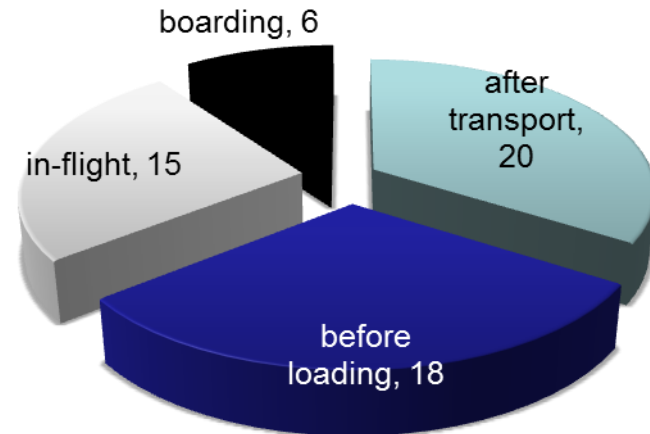


Aviation-Related Lithium Battery Incidents

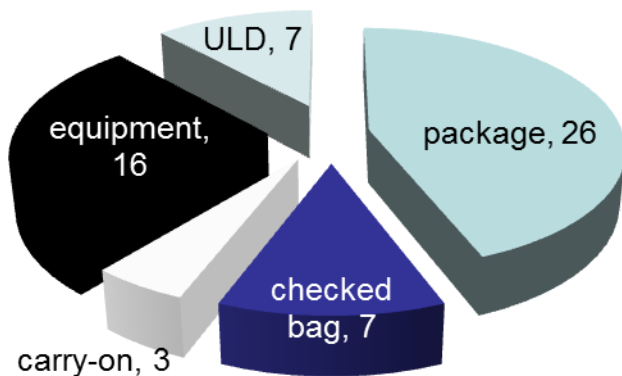
Airplane Type



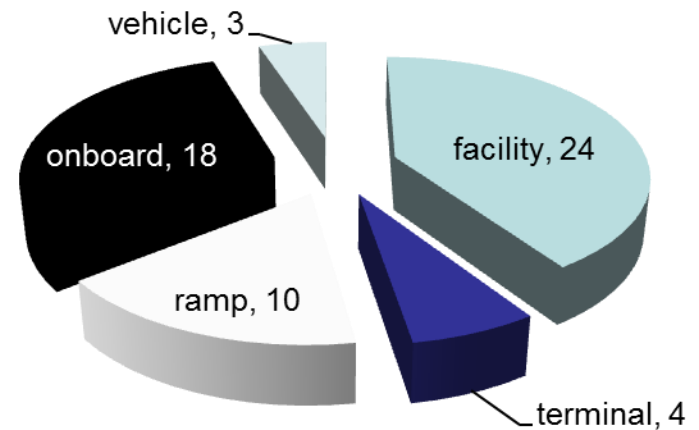
When



Battery Location



Where



Boeing Multi-Operator Message

Boeing released MOM-MOM-12-0356-01B (dated 22 May 2012) to share regulatory and guidance information for lithium battery cargo transport

- Boeing supports recommendations made by the FAA in the Safety Alert for Operators (SAFO) 10017, dated 10/8/10, for transport of lithium batteries:
 - 1) Request customers identify bulk shipments of currently excepted lithium batteries by information on air waybills and other documents provided by shippers offering shipments of lithium batteries
 - 2) Where feasible and appropriate, stow bulk shipments of lithium batteries in Class C cargo compartments or in locations where alternative fire suppression is available
 - 3) Evaluate the training, stowage, and communication protocols in your operation with respect to the transportation of lithium batteries in the event of an unrelated fire
 - 4) Pay special attention to ensuring careful handling and compliance with existing regulations covering the air transportation of Class 9 hazardous materials, including lithium batteries

- Additional Guidance can be found in:
 - EASA Safety Information Bulletin (SIB) No. 2010-30R1, dated 31 March 2011
 - ICAO Electronic Bulletin (EB) No. 2011/7, dated 15 February 2011
 - IATA Website: www.iata.org/whatwedo/cargo/dangerous_goods/Pages/lithium_batteries.aspx

Boeing Message to Operators

Boeing also provides the following non-mandatory suggestions to help minimize the hazards associated with transporting lithium batteries as cargo:

- 1) Only accept lithium battery shipments that comply with applicable regulations (ICAO and/or local regulations)
- 2) When possible, separate lithium battery shipments into smaller and separated groupings to minimize the size of a potential battery fire
- 3) When possible, segregate lithium battery shipments from other dangerous goods that present a fire hazard (e.g. Class 3 flammable liquid shipments) to minimize the effects of a lithium battery fire and the potential for involving lithium batteries in adjacent cargo fire events
- 4) Consider establishing a policy to notify the flight crew of all lithium battery shipments (including exempted shipments) so the flight crew is aware of the potential hazard
- 5) Implement methods or programs to increase your customer's awareness of issues surrounding the transport of lithium batteries. Items to consider might include:
 - Identifying customers who ship large volumes of lithium batteries
 - Creation of customer education materials to increase awareness around safely shipping lithium batteries and to minimize undeclared battery shipments
 - Conducting compliance audits of high-risk shippers, high-volume shippers, high-risk product locations
 - Employee education regarding regulations, handling procedures, the dangers of mishandling, and methods to identify lithium battery shipments

Boeing Message to Operators

- 6) Take precautions to avoid unrestrained or shifting cargo events that might cause damage to shipments of lithium batteries by establishing and following procedures to ensure cargo is properly secured within containerized/palletized cargo compartments, cargo unit load devices, and bulk cargo compartments
 - When possible, avoid loading lithium batteries in loosely-packed bulk cargo compartments to minimize the potential for damage to the lithium batteries from shifting, or by the shifting of other cargo within the bulk compartment, unless the cargo in the compartment is restrained against movement
- 7) Transporting bulk shipments of lithium metal batteries to, from, or through the US on passenger airplanes is forbidden by US Department of Transportation (DOT) regulations. In accordance with these regulations, consider eliminating bulk shipments of lithium metal batteries on passenger airplanes
- 8) The fire resistant cargo lining systems of airplane cargo compartments are an integral part of the overall cargo compartment fire protection system. Operators are reminded that airplane Master Minimum Equipment Lists (MMEL) and Dispatch Deviations Guides (DDG) do not allow cargo (except for ballast) to be transported in cargo compartments that have missing or damaged cargo compartment liners

Boeing Supports Industry Initiatives

- Boeing is supportive of lithium battery fire testing, including testing by the NTSB and the FAA Tech Center
- Boeing is aware of ongoing development of shipping containers and fire containment covers to facilitate the safe shipment of lithium batteries as cargo
- Boeing will continue working with ICAO, government agencies and operators to develop and share information and guidance to promote safe air transport of lithium batteries

Recommendations Going Forward

- An overall solution which reduces the risks associated with transport of lithium batteries will likely require concerted efforts by an industry forum consisting of airlines, airplane manufacturers, regulatory agencies, battery producers, package manufacturers, shippers, freight forwarders, ULD and equipment manufacturers, and other involved parties
- Suggest industry forum be led by DOT (FAA), since FAA Tech Center testing on FCCs, FRCs, and 727 vehicle will be focus of industry attention

Questions

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