

ALPA WHITE PAPER



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Safely Transporting Lithium Batteries by Air

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Introduction

Lithium batteries represent a significant technological improvement over older battery types, such as lead acid, alkaline, nickel cadmium, and nickel metal hydride. They are smaller and lighter than previous chemistries, with a higher energy density, have no memory effect, and produce a slow loss of charge when not in use. However, due to their high energy density and flammable electrolyte, these batteries can initiate a fire and burn very violently when short-circuited or exposed to high temperatures. A short circuit may occur following a manufacturing defect, damage, or by bringing the external battery terminals into contact with other batteries or conducting material. The current provisions for the carriage of these batteries onboard commercial aircraft do not adequately address the risk presented in transport.

Lithium batteries can be categorized into two major types:

Lithium ion (including lithium polymer)

- 1 → These are generally rechargeable batteries used in laptops, cell phones, MP3 players, and many other personal electronic devices.
- They contain a flammable, liquid electrolyte and are capable of self-ignition if damaged, exposed to high temperature, or subjected to a short circuit.
- If a fire occurs, it may involve multiple eruptions of flame and sparks as the heat propagates between the cells in a battery. A lithium ion battery fire may be suppressed using Halon, and can also be controlled with the application of water or other nonflammable liquids. The use of water cools the cells and can prevent fire propagation within the battery.
- As lithium ion cells are heated in a fire, flammable vapors are vented from the cases. These vapors can accumulate in an enclosed space and cause an explosion if subjected to an additional spark or fire, such as would be created by another cell igniting.

- Can be carried as cargo on passenger and all-cargo flights without quantity restrictions. Further testing is needed to determine the maximum number of lithium ion batteries that can be carried on an aircraft given the amount of onboard, fire-extinguishing capability. Quantity limits of batteries carried as cargo should be established to ensure safety commensurate with that capability.

Lithium metal

- 2 → These are generally nonrechargeable and are used in cameras, watches, smoke detectors, and other devices.
- The cell or battery contains metallic lithium.
- If a fire occurs, the burning metallic lithium is difficult to extinguish. Halon is not effective at suppressing a lithium metal battery fire.
- Lithium metal fires burn at very high temperatures and produce large quantities of smoke. The smoke is produced at a pressure that may overcome aircraft airflow.

configurations meant to exclude smoke from the flight deck.

- ✈ The pressure pulse from a lithium metal battery fire may be sufficient to damage cargo compartment liners.
- ✈ Cannot be carried as cargo on passenger flights
- ✈ Can be transported on all-cargo flights with minimal restrictions

ICAO Rules

The International Civil Aviation Organization (ICAO) is the aviation arm of the United Nations, and is responsible for the development of standards and recommended practices for international aviation, including the international transport of dangerous goods. The provisions are published in the “Technical Instructions for the Safe Transport of Dangerous Goods by Air” (ICAO TIs), after consideration by member states and international organizations. ICAO developed new provisions for the transport of lithium batteries in 2012 that became effective on January 1, 2013. ALPA participated in the development of these provisions through its membership in the International Federation of Air Line Pilots’ Associations. Improvements to these provisions include the following:

- ✈ Packages of two or fewer batteries or eight or fewer cells of consumer-sized lithium batteries are excepted from regulations applicable to other dangerous goods, including requirements for the training of shippers, dangerous goods labels on packages, acceptance checks, inspection prior to loading and after unloading, and inclusion on the pilot-notification form.
- ✈ Packages containing three or more batteries or nine or more cells of consumer-sized lithium batteries are treated as fully regulated dangerous goods, including training for shippers, dangerous goods labels on packages, acceptance checks, inspection prior

What is Thermal Runaway?

Thermal runaway in a lithium battery is a situation where an internal temperature rise prompts a further rise in temperature that cannot be controlled. When this occurs, it can lead to an explosion and/or fire that results in the loss of the device and can create conditions for thermal runaway in other nearby lithium ion cells.



to loading and after unloading, and inclusion on the pilot notification form.

- ✈ Electronic equipment containing consumer-sized lithium batteries are excepted from the majority of dangerous goods regulations.

The TIs have certain shortcomings, including the following:

- ✈ There is no requirement to stow batteries in a compartment equipped with adequate fire suppression.
- ✈ There are no quantity limits per compartment or per aircraft, nor any standards for cargo-compartment suppression that address lithium battery fires. The aircraft may contain an unlimited number of lithium battery shipments regardless of cargo compartment location or suppression capability.
- ✈ Individual packages of two or fewer batteries or eight or fewer cells may be combined in an overpack, creating shipments of large quantities of lithium batteries that are still excepted from the majority of the dangerous goods provisions.

- The risk of explosion due to vented flammable vapors in enclosed spaces is not addressed.

The U.S. Pipeline and Hazardous Materials Safety Administration (PHMSA) issued a final rule in August 2014 to harmonize with ICAO TIs in several ways, which includes revising provisions for transport of small and medium lithium cells and batteries including those packed with or in equipment, amending shipping descriptions for lithium batteries, and adopting new provisions for the transport of damaged, defective, and recalled lithium batteries.

That same month, PHMSA issued a notice of proposed rulemaking to, among other things, propose harmonization with ICAO TIs concerning lithium battery–related shipping documentation and labeling of packages of lithium metal batteries not packed in or with equipment.

Recommendations that Should be Adopted to Further Increase the Safe Transport of Lithium Batteries

To ICAO:

- Implement packaging restrictions and quantity limits for lithium batteries based upon the cargo compartment location and capabilities. This can be achieved by conducting testing on these batteries, fully charged and packaged for transport, to determine the safe quantity of batteries that may be carried in Class C and E cargo compartments. Until testing is complete, adopt a conservative limit for the number of lithium batteries permitted in a single cargo compartment.
- Eliminate exceptions from the full provisions of the technical instructions for all lithium batteries shipped as cargo, regardless of watt-hour size and whether the batteries are installed in or shipped with equipment.
- Extend the prohibition of lithium metal batteries aboard passenger aircraft

to cargo-only aircraft until adequate packaging can be developed to protect the batteries from damage, external fire, or high heat source, and to prevent a fire involving a single lithium metal battery from spreading.

- Address the explosion risk created by venting lithium ion batteries in enclosed spaces.
- Provide transport provisions that allow the continued safe flight of the aircraft should a fire occur in a shipment of lithium batteries.
- Continue work toward developing packaging that will prevent and/or contain a lithium battery fire.

To PHMSA:

- Recognize the United Arab Emirates General Civil Aviation Authority’s report on the UPS accident at Dubai, September 3, 2010, as meeting the threshold established by Congress in Section 828 of P.L. 112-95, the “FAA Modernization and Reform Act of 2012,” which states in part, that the Secretary of Transportation may exceed ICAO requirements regarding transportation of lithium batteries when,

“a credible report with respect to a safety incident from a national or international governmental regulatory or investigating body . . . demonstrates that the presence of lithium metal cells or batteries or lithium ion cells or batteries on an aircraft, whether transported separately or packed with or contained in equipment, in accordance with the requirements of the ICAO Technical Instructions, has substantially contributed to the initiation or propagation of an onboard fire . . .”

- Develop regulations that produce the additional, specified safeguards per ALPA’s recommendations to PHMSA and ICAO.

DC-8 Onboard Fire, Philadelphia International Airport

On February 7, 2006, United Parcel Service Company Flight 1307, a McDonnell Douglas DC-8-71F, landed at Philadelphia International Airport after a cargo smoke indication in the cockpit during the landing approach. The captain, first officer, and flight engineer evacuated the airplane after landing. The flightcrew members sustained minor injuries, and the airplane and most of the cargo were destroyed by fire after landing. Although the source of the fire was never conclusively determined, extensive fire damage was found in cargo compartments known to have held equipment containing lithium batteries. The National Transportation Safety Board subsequently issued six safety recommendations addressing the transportation of lithium batteries by air.





B-747 Onboard Fire, Dubai, United Arab Emirates

On September 3, 2010, a Boeing 747-400F departed Dubai International Airport on a scheduled cargo flight to Cologne, Germany. Although the aircraft was carrying over 80,000 lithium batteries, none of the shipments were included on the pilot notification form. Twenty two minutes into the flight, the flight crew advised ATC that the fire warning systems for the cargo compartments indicated an onboard main-deck fire. The crew declared an emergency and requested an immediate return to Dubai, but ultimately crashed several miles from the airport, with the loss of both pilots, the aircraft, and its cargo. The UAE General Civil Aviation Authority's accident investigation report "concludes with reasonable certainty that the location of the fire was in an element of the cargo that contained, among other things, lithium batteries. It is possible that a lithium-type battery or batteries, for reasons which cannot be established, went into an energetic failure characterized by thermal runaway and auto ignited, starting a chain reaction which spread to the available combustible material."