

# A PRIMER ON THE

# Safety of Transporting Lithium Batteries by Air



*Damage to an aircraft unit load device from an e-cigarette shipment fire*



## Introduction

Since their first commercial introduction in the early 1990s, lithium batteries have been used to power a variety of consumer, aerospace, automotive, and military applications. Their advantages include light weight, high energy density, favorable charging and discharging characteristics, and the ability to mold into different shapes and sizes. However, when lithium batteries are mishandled, damaged, misused, improperly packaged, overcharged, defective, or of an inferior design, they may overheat and ignite. Additionally, when lithium batteries are exposed to heat or an external fire source, they may also ignite, significantly contributing to the severity of the fire. Lithium battery fires have been shown to be difficult to extinguish, and their carriage as cargo aboard aircraft represents a risk in transportation.

## Types of Lithium Batteries

### Lithium ion

- Lithium ion batteries are generally rechargeable, and may be constructed using a single cell for small consumer applications (e.g., cell phones, MP3 players), or multiple cells electrically connected for larger applications (e.g., laptop computers, hybrid vehicles, or aerospace applications).
- Lithium ion batteries contain a flammable liquid electrolyte and are capable of self-ignition if damaged, exposed to high temperatures, or after an external or internal short circuit.
- In batteries with multiple cells, a fire will spread between the



cells with increasing intensity and involve multiple eruptions of flame and sparks.

- Testing has shown Halon, the extinguishing agent used in cargo compartments on passenger aircraft, to be effective in suppressing a fire involving small lithium ion batteries.

### Lithium metal

- Lithium metal batteries are generally non-rechargeable and normally consist of a single cell. Their applications include cameras, watches, smoke detectors, and other small devices.
- Testing has shown that fires involving lithium metal batteries do not respond to Halon.



- When shipped as cargo and not installed in equipment, lithium metal batteries are prohibited on U.S. passenger aircraft.

## Incidents Involving Lithium Batteries

According to the U.S. Federal Aviation Administration, there have been over 40 documented lithium battery incidents involving smoke, fire, extreme heat, or explosion in air transportation since the early 1990s. The incidents have occurred both in the passenger cabin and in cargo compartments when batteries have been shipped as cargo on passenger and cargo-only aircraft. Additionally, there have been two major cargo accidents involving U.S. carriers where lithium batteries are suspected of playing a role.

## 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 the crew received 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 United Parcel Service 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. While the investigation is ongoing and no source of fire has been determined, the presence of large quantities of lithium batteries likely contributed greatly to the severity of the fire and the loss of the aircraft.



### ICAO Rules and PHMSA Regulations

The International Civil Aviation Organization (ICAO), of which the United States is a member state, develops standards and related rules, called “technical instructions,” for the transport of lithium batteries as air cargo. The Pipeline and Hazardous Materials Safety Administration (PHMSA) is the U.S. agency responsible for regulating the carriage of these batteries as air freight.

ICAO developed new rules in 2012, with PHMSA’s full participation, which became effective January 1, 2013. ALPA participated in the development of the rules via its membership in the International Federation of Air Line Pilots’ Associations (IFALPA). Following are highlights of the rules, along with the positions of PHMSA and ALPA regarding each:

- Packages of one to two batteries or eight or fewer cells of consumer-sized lithium batteries are excepted from regulations applicable to other dangerous goods that require training for shippers, dangerous goods labels on packages, acceptance checks, inspection prior to loading and after unloading, and inclusion on the pilot notification form
  - PHMSA’s dangerous goods regulations are far less stringent than ICAO rules and allow exceptions for large numbers of consumer batteries in a single package, and any number of packages on the airplane
  - ALPA opposes excepting any packages containing lithium batteries from the regulations
- 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 to loading and after unloading, and inclusion on the pilot notification form

- *PHMSA regulations do not harmonize with these new ICAO rules, despite the agency's involvement in developing them*
- *ALPA supports this rule and strongly urges PHMSA to harmonize with it*
- Electronic equipment containing consumer-sized lithium batteries are excepted from the majority of dangerous goods regulations
  - *PHMSA regulations contain this exception*
  - *ALPA strongly opposes this exception and recommends its elimination*
- Despite recommendations by FAA and industry, there is no requirement to stow batteries in a compartment equipped with fire suppression
  - *If PHMSA regulations are not harmonized with the new ICAO rules, airlines will not be made aware of large lithium battery shipments and, as a result, will not be able to follow FAA and industry guidance to stow them in cargo compartments equipped with fire suppression*
  - *ALPA recommends that, at a minimum, PHMSA harmonize with the ICAO rules and subsequently require stowage in a cargo compartment having 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.
  - *PHMSA regulations conform with ICAO rules and contain no quantity limit per compartment or aircraft, nor any standards for cargo compartment suppression that address lithium battery fires*
  - *ALPA recommends that FAA team with government and industry airworthiness and airline operations experts to develop standards for the safe transport of lithium batteries, including quantity limits per compartment and aircraft, as well as cargo suppression standards to ensure that a lithium battery fire does not threaten the safety of the aircraft*

## Chronology of Actions by PHMSA

- January 2010—Issued a notice of proposed rule-making (NPRM) to address lithium battery air cargo. ALPA strongly endorsed the NPRM
- February 2012—Participated in ICAO Dangerous Goods Panel (DGP) meeting in Montreal and helped develop new technical instructions
- April 2012—Issued additional NPRM soliciting comments on consequences of harmonizing with ICAO DGP rules
- January 2013—Issued a further NPRM soliciting comments on permitting shippers and carriers to choose between compliance with the existing U.S. hazardous materials regulations or ICAO standards

## Recommendations

The Pipeline and Hazardous Materials Safety Administration should:

- 1 Immediately withdraw its January 7, 2013, notice of proposed rulemaking and issue an immediate final rule to harmonize with ICAO.
- 2 Urge ICAO to further improve its technical instructions to correct the deficiencies identified in this document.
- 3 Finalize and publish the additional safeguards that it proposed in January 2010 which would correct the deficiencies highlighted in this document.

Founded in 1931, the Air Line Pilots Association, International (ALPA), is the largest airline pilot union in the world, representing nearly 51,000 pilots at 35 U.S. and Canadian airlines.