U.S. Department
of Transportation
**Federal Aviation
Administration**

SAFO

Safety Alert for Operators

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Flight Standards Service
Washington, DC

http://www.faa.gov/other_visit/aviation_industry/airline_operators/airline_safety/safo

A SAFO contains important safety information and may include recommended action. SAFO content should be especially valuable to air carriers in meeting their statutory duty to provide service with the highest possible degree of safety in the public interest. Besides the specific action recommended in a SAFO, an alternative action may be as effective in addressing the safety issue named in the SAFO.

Subject: Risks in Transporting Lithium Batteries in Cargo by Aircraft

Purpose: To alert operators to the recent findings from the Federal Aviation Administration (FAA) William Hughes Technical Center testing results from April 2010 to September 2010. The Pipeline and Hazardous Materials Safety Administration (PHMSA), in coordination with the FAA, is considering the best course of action to address the risk posed by lithium batteries. In the interim, carriers should consider adopting the actions recommended at the end of this document.

Background: Lithium batteries are currently classified as Class 9 materials under the Hazardous Materials Regulations (HMR) (49 CFR 180 185). Nonetheless, most lithium batteries and devices are currently classified as excepted from the Class 9 provisions of the HMR. Because of this exception, they do not require a Notice to the Pilot in Command (NOTOC) to alert the crew of their presence on-board an aircraft.

Testing conducted by the FAA William J. Hughes Technical Center (FAA Tech Center) indicates that particular propagation characteristics are associated with lithium batteries. Overheating has the potential to create thermal runaway, a chain reaction leading to self-heating and release of a battery's stored energy. In a fire situation, the air temperature in a cargo compartment fire may be above the auto-ignition temperature of lithium. For this reason, batteries that are not involved in an initial fire may ignite and propagate, thus creating a risk of a catastrophic event. The existence and magnitude of the risk will depend on such factors as the total number and type of batteries on board an aircraft, the batteries' proximity to one another, and existing risk mitigation measures in place (including the type of fire suppression system on an aircraft, appropriate packaging and stowage of batteries, and compliance with existing requirements contained within both FAA and PHMSA regulations).

We note as well that United Parcel Service Flight 006 crashed in the United Arab Emirates on September 3, 2010. Investigation of the crash is still underway, and the cause of the crash has not been determined. We are aware, however, that the plane's cargo did include large quantities of lithium batteries and believe it prudent to advise operators of that fact.

Discussion of Continued Research: The FAA Tech Center has continued its research into lithium battery fires and the packaging, processes, and systems that can mitigate lithium battery fires aboard aircraft.[1]

[1] Past findings related to lithium battery research have been published in the following FAA Technical Center Reports:

Lithium metal batteries are highly flammable and capable of ignition. Ignition of lithium metal batteries can be caused when a battery short circuits, is overcharged, is heated to extreme temperatures, is mishandled, or is otherwise defective. Once a cell is induced into thermal runaway, either by internal failure or by external means such as heating or physical damage, it generates sufficient heat to cause adjacent cells to go into thermal runaway. The result of thermal runaway in a lithium metal cell is a more severe event as compared to a lithium-ion cell in thermal runaway. The lithium metal cell releases a flammable electrolyte mixed with molten lithium metal, accompanied by a large pressure pulse. The combination of flammable electrolyte and the molten lithium metal can result in an explosive mixture. Halon 1301, the suppression agent found in Class C cargo compartments, is ineffective in controlling a lithium metal cell fire.

The explosive potential of lithium metal cells can easily damage (and potentially perforate) cargo liners, or activate the pressure relief panels in a cargo compartment. Either of these circumstances can potentially lead to a loss of Halon 1301, allowing rapid fire spread within a cargo compartment to other flammable materials. For this reason, lithium metal cells are currently prohibited as bulk cargo shipments on passenger carrying aircraft.

FAA testing has shown that encased or enclosed lithium metal batteries may pose a safety risk. Two types of robust, readily available containers were tested at the FAA Tech Center: five gallon steel pails with crimp on gasketed lids, and 30 gallon steel drums with bolt closed ring seals and gasketed metal lids. For both types of container, as few as six loose CR2 lithium metal cells were sufficient to cause failure when induced into thermal runaway by an electric cartridge heater. The confined electrolyte and the molten lithium ignition source formed an explosive condition, forcefully separating the lid from the container. The explosive force in this test was likely high enough to cause physical damage to an aircraft's Class C cargo compartment.

A container specially designed to ship lithium metal batteries would need to demonstrate that it can withstand this explosive condition. There are currently no approved and tested containers that can sufficiently contain the known effects of accidental lithium metal battery ignition. Common metal shipping containers, pails and drums, are not designed to withstand a lithium metal cell fire.

Our test results have also demonstrated that lithium-ion cells are flammable and capable of self-ignition. Self-ignition of lithium-ion batteries can occur when a battery short circuits, is overcharged, is heated to extreme temperatures, is mishandled, or is otherwise defective. Like lithium metal batteries, lithium-ion batteries can be subject to thermal runaway. A battery in thermal runaway can reach temperatures above 1,100 degrees F, which exceeds the ignition temperature of most Class A materials, including paper and cardboard. These temperatures are also very close to the melting point of aluminum (1,220 degrees F). The fire suppression system in Class C compartments, Halon 1301, has been shown to be effective in suppressing fires generated by lithium-ion batteries, but does not eliminate the risk of transporting such batteries.

DOT/FAA/AR-06/38 – Flammability Assessment of Bulk-Packed, Rechargeable Lithium-Ion Cells in Transport Category Aircraft
http://www.fire.tc.faa.gov/pdf/06-38.pdf

DOT/FAA/AR-04/26—Flammability Assessment of Bulk-Packed, Nonrechargeable Lithium Primary Batteries in Transport Category Aircraft
http://www.fire.tc.faa.gov/pdf/04-26.pdf

DOT/FAA/AR-09/55 –Flammability Assessment of Lithium-Ion and Lithium-Ion Polymer Battery Cells Designed for Aircraft Power Usage
http://www.fire.tc.faa.gov/pdf/09-55.pdf

The complete results of the FAA Tech Center's study, reported in summary form here, will be made available to the public and for peer review in the near future. The study has not yet been peer-reviewed.

Additional Research: The FAA Tech Center will continue research on improved cell separator materials to stop or slow down thermal runaway propagation. In addition, the Tech Center will research packaging materials to adequately control the properties lithium batteries exhibit in a fire condition. These methods, results, and findings will be subject to peer review.

Rulemaking: PHMSA issued a Notice of Proposed Rulemaking (NPRM) (75 FR 1302, January 11, 2010) with proposals to reduce the risks associated with the air transport of lithium batteries, and has submitted a final rule based on the NPRM to OMB for review. The Department of Transportation is concerned about the risk that lithium batteries pose to aviation safety in the event of an onboard fire. As a result of this concern, PHMSA and FAA are considering additional appropriate actions to address these safety risks.

The FAA and PHMSA have determined that carriers can now take prudent steps to reduce the risk that lithium batteries pose, which is why the FAA is issuing this safety alert.

Recommended Action: It is recommended that all air carriers institute additional procedures for safely transporting lithium batteries by aircraft:

1) Request customers to identify bulk shipments of currently excepted lithium batteries by information on airway bills 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.

These recommendations are limited to lithium batteries transported in the cargo hold of an aircraft (including cargo holds that are not distinct from the flight deck), and do not apply to lithium batteries carried onboard by passengers and crewmembers, or otherwise stowed in the passenger cabin of the aircraft. These recommendations are not exclusive; we hope that carriers will use the information provided here and in our Tech Center study, together with any other available information, to consider other reasonable measures they believe appropriate to mitigate the risk of transporting lithium batteries by air.

Contact: Questions or comments concerning this SAFO should be directed to the FAA Office of Hazardous Materials, ADG-200 at 202-385-4897.