RESEARCH BRIEF

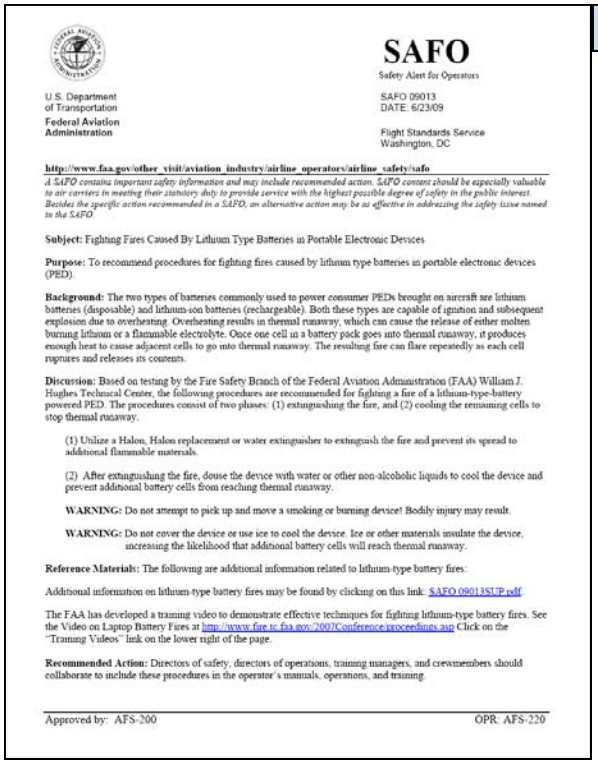
Research Request:

Lithium Battery Fires/Lithium Battery Containment Kits

Research Response:

Introduction

In June 2009, the FAA released a SAFO (Safety Alert for Operators) concerning the possibility of in-flight fires and explosions due to the lithium batteries found in common portable electronic devices. Lithium batteries when overheated and/or exposed to certain metals can go into what is referred to has thermal runaway. This is a chemical reaction which increases temperature and pressure until the battery ruptures and releases molten burning lithium.



SAFO
Safety Alert for Operators

U.S. Department of Transportation
Federal Aviation Administration

SAFO 09013
DATE: 6/23/09

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: Fighting Fires Caused By Lithium Type Batteries in Portable Electronic Devices

Purpose: To recommend procedures for fighting fires caused by lithium type batteries in portable electronic devices (PED).

Background: The two types of batteries commonly used to power consumer PEDs brought on aircraft are lithium batteries (disposable) and lithium-ion batteries (rechargeable). Both these types are capable of ignition and subsequent explosion due to overheating. Overheating results in thermal runaway, which can cause the release of either molten burning lithium or a flammable electrolyte. Once one cell in a battery pack goes into thermal runaway, it produces enough heat to cause adjacent cells to go into thermal runaway. The resulting fire can flare repeatedly as each cell ruptures and releases its contents.

Discussion: Based on testing by the Fire Safety Branch of the Federal Aviation Administration (FAA) William J. Hughes Technical Center, the following procedures are recommended for fighting a fire of a lithium-type-battery powered PED. The procedures consist of two phases: (1) extinguishing the fire, and (2) cooling the remaining cells to stop thermal runaway.

(1) Utilize a Halon, Halon replacement or water extinguisher to extinguish the fire and prevent its spread to additional flammable materials.

(2) After extinguishing the fire, douse the device with water or other non-alcoholic liquids to cool the device and prevent additional battery cells from reaching thermal runaway.

WARNING: Do not attempt to pick up and move a smoking or burning device! Bodily injury may result.

WARNING: Do not cover the device or use ice to cool the device. Ice or other materials insulate the device, increasing the likelihood that additional battery cells will reach thermal runaway.

Reference Materials: The following are additional information related to lithium-type battery fires:

Additional information on lithium-type battery fires may be found by clicking on this link: SAFO 09013SUP.pdf

The FAA has developed a training video to demonstrate effective techniques for fighting lithium-type battery fires. See the Video on Laptop Battery Fires at http://www.fire.tc.faa.gov/2007Conference/proceedings.asp Click on the "Training Videos" link on the lower right of the page.

Recommended Action: Directors of safety, directors of operations, training managers, and crewmembers should collaborate to include these procedures in the operator's manuals, operations, and training.

Approved by: AFS-200 OPR: AFS-220

To read the full SAFO visit: http://www.faa.gov/other_visit/aviation_industry/airline_operators/airline_safety/safo/all_safos/media/2009/SAFO09013.pdf

Recent Events

There have been 3 NTSB and FAA investigated events involving fires ignited by lithium batteries. In each, the crew declared an emergency and landed safely.

Aircraft: Airbus A320-230
Date: 2/10/2007
Airport: JFK
Event ID: 20080409X00446

During climb out from the departure airport, a flight attendant noticed smoke coming from a bag containing camera equipment in one of the overhead bins. She extinguished the smoke, and notified the captain of the situation. He declared an emergency, and the airplane landed uneventfully at the departure airport approximately 6 minutes later. Examination of the bag containing camera equipment

revealed that remnants of a 9-volt battery sustained damage consistent with a catastrophic battery failure. The main component of the 9-volt battery had a flashpoint of 21 degrees Fahrenheit, or room temperature. Other batteries, located in the same pocket of the equipment bag as the 9-volt battery, had unprotected contacts, including two fully charged 14-volt battery packs. One of the 14-volt battery packs displayed significant exterior thermal damage, consistent with damage from coming in contact with another battery. Battery industry research has revealed that a short circuit is the most common cause of battery fires, often initiated by contacts coming into contact with metal objects. Batteries are generally not designed to be able to contain catastrophic failures, and when they go into thermal runaway, they often explode and expel their contents into the environment, potentially causing ignition in areas well beyond the initiating battery cell.

Aircraft: Airbus 737-800
Date: 12/15/2006
Airport: IAH
Event ID: 20061219X01807

The passenger was wearing an Ecoquest Fresh Air Buddy Personal Air Purifier around his neck. According to the manufacturer, it "generates an intense electrostatic ion wind that charges floating particles in the 'breathing zone.' The particles are substantially repelled away from the wearer, creating an almost particle-free 'exclusion zone' for toxic allergens, smoke, dust, viruses, and bacteria. Perfumes and odors can also be minimized by the ion particle-charging-effect." The passenger was observed to be holding a Sprint Trio 700 camera phone up to the window, sometimes talking into it, but he claimed he was only taking photographs. As he held his telephone to the window, there was a noise that sounded "like a fuse." There was a flash and a loud bang, and smoke emanated from the device. The passenger yelled and flung the air purifier from around his neck because it had started to burn him. It exploded into a ball of flames "about the size of volleyball" and fell between the seat cushions, starting a fire. Passengers poured water and other liquids on the smoldering cushions, and a flight attendant used a Halon fire extinguisher to put the fire out. The battery was never recovered. NTSB's fire and explosion expert examined the device. Her report stated that the air purifier originally came with a 3.6V CR123A non-rechargeable lithium battery, but a kit containing a charger and a rechargeable lithium-ion battery was available for purchase. The battery compartment cover was melted and deformed, and had two areas of metal splatter. Analysis of this splatter revealed the presence of manganese. Manganese dioxide is a component in primary (non-rechargeable) lithium batteries. The report noted that a short circuit is the most common cause of battery fires, and that charging a non-rechargeable battery could cause an internal short that could lead to thermal runaway, battery failure, and possibly an explosion.

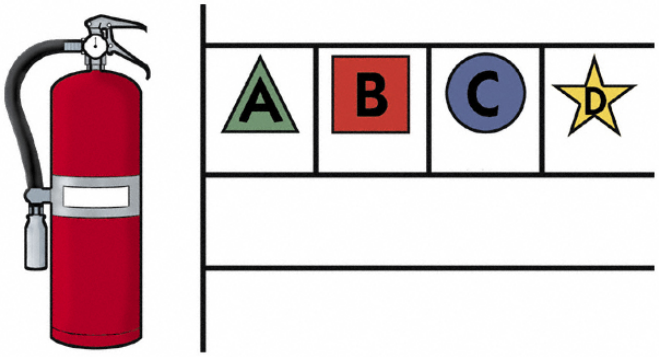
Aircraft: B727-225
Date: 29-oct-2004
Airport: RDL
Report number: 20041029028789c

On 10/29/04 at approximately 2221 local N679MG, a Boeing 727-225 aircraft was departing Raleigh-Durham airport (RDU) and was enroute to Parkersburg, WV (PKB) when a fire ignited in seat 14A of the passenger cabin. The source of the fire was determined to be caused by a 9 volt lithium camera battery, which according to witness exploded and the shrapnel ignited the seat on fire. The fire was extinguished by the flight attendants and on board personnel. The flight crew declared an emergency and returned to RDU airport where they landed without incident. N679MG is operated by champion air, a far 121 supplemental air carrier and was chartered to carry ^privacy data omitted^ no injuries were sustained by ^privacy data omitted^ after landing back at RDU the fire was evaluated by airport fire rescue, and was determined to be fully extinguished. The seat assembly was placed on the minimum equipment list (MEL) by on board maintenance personnel and the aircraft was returned to service.

Conclusion

The FAA advises not to treat a lithium battery fire as a Class D fire, even though batteries consist of metal. Using fire resistant burn bags to extinguish the fire is also not advised due to the hazard of moving a device while it ruptures molten burning lithium. The recommended firefighting technique is the same regardless of battery type:

1) Relocate passengers away from the device;
2) Use a Halon fire extinguisher to prevent the spread of the fire;
3) Pour water, or other non-alcoholic liquid, over the cells immediately after knockdown or extinguishment of fire; and
4) After thermal runaway is stopped place the device into a containment bag.



Fire Containment Kits/Lithium-Ion Battery Containment Kits

Fire Containment Kits usually consist of fireproof gloves and a specially designed fire-proof containment bag that can be used for the transport of appliances powered by Lithium batteries, or for preventative containment after a Lithium battery fire has occurred and the proper extinguishing procedures have been followed per the FAA's recommendation within SAFO 09013.

The following is a list of manufacturers, in no particular order, of Fire Containment Kits/ Lithium-Ion Battery Containment Kits designed to prevent and/or extinguish an on-board appliance fire.

**PRISM Solutions, LLC does not endorse any particular product.*

Manufacturers

Manufacturer	All Hands Fire Equipment
Product Name	HOT STOP "L" FIRE CONTAINMENT BAG KIT
Cost per unit	$1074.99
Website	http://www.allhandsfire.com/HOT-STOP-L-FIRE-CONTAINMENT-BAG

Included in Kit	• Aluminized Glastemp Shell Gloves (14")
	  * Aluminized Glastemp Shell
	  * Base Fabric has a 1000ºF melting point
	  * Suede reinforced palm for better grip
	  * Fleece lined hand area
	  * Cotton fabric lined gauntlet
	  * Kevlar stitching
	• Fire Containment Bag
	  * 20" x 20" x 3/4"
	  * 5lbs
	  * Proven performance
	  * Guess work eliminated
	  * Reduced smoke release
	  * Customizable on request

Product Images	 

Manufacturer	Aircare Access
Product Name	Aircare FireSock™ Battery Risk Management System
Cost per unit	$339.00
Website	http://www.aircareaccess.com/products.html
Included in Kit	• FireSock containment bag • Heat resistant gloves • Resealable storage container
Product Images	 

Manufacturer	ShipitAOG
Product Name	Fire-Fighter
Cost per unit	$1075.00
Website	http://www.shipitaogllc.com/firefighter

Included in Kit	• Containment bag
	  * 20” x 20” x 3/4”
	  * Customizable sizes available
	  * Proven Performance
	  * Guess Work eliminated
	  * Reduce Smoke release
	  * 5lbs empty
	• Heat resistant gloves

Product Images