



**NTSB** National Transportation Safety Board

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## **NTSB Concerns for Aircraft Fire Safety**

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# Overview

- NTSB
- Fuel Tank Explosions
- Fire Suppression and Detection Systems in Cargo Compartments
- Crew Response to Hidden Fires
- High Energy Density Batteries in Portable Electronic Equipment



# National Transportation Safety Board

- Accident Investigation Responsibilities
  - Conduct a credible and thorough investigation
  - Determine Probable Cause
  - “Reactive”
- Provide the basis for “proactive” recommendations and solutions
  - Speak through our Safety Recommendations

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# Recent Fuel Tank Explosions

- Philippine Airlines 737-300  
Manila Philippines, 1990
- Trans World Airlines 747-131  
East Moriches, NY 1996
- Thai Airways 737-400  
Bangkok Thailand, 2001
- Transmile Airlines 727-200  
Bangalore India, 2006





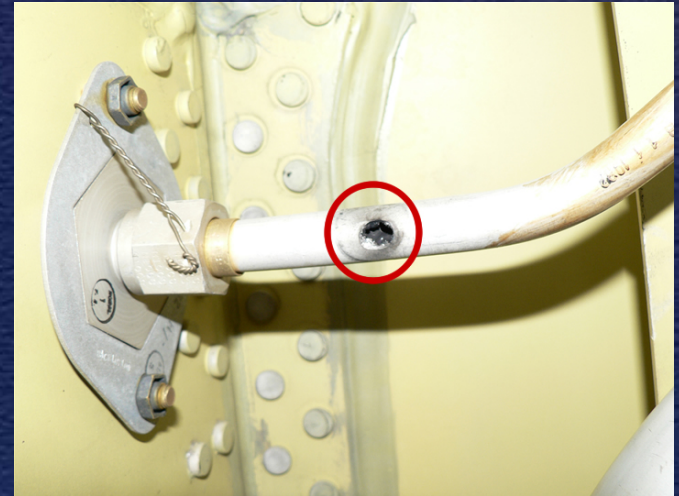
# Thai Airways 737-400



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# Transmile Airlines 727-200



- AD 99-12-51 – inspect and sleeve with Teflon



# Fuel Tank Explosions

Fuel tank safety requires a two sided approach:

1. Eliminate ignition sources
  - SFAR88
2. Reduce flammability

# Fuel Tank Explosion Prevention

## Recommendation A-96-174

FAA: Require the development of and implementation of design or operational changes that will preclude the operation of transport-category airplanes with explosive fuel-air mixtures in the fuel tank:  
(A) Significant consideration should be given to the development of airplane design modifications, such as nitrogen inerting systems & the addition of insulation between heat generating equipment & fuel tanks.

Status: Open-Acceptable Response



# Fuel Tank Explosion Prevention

## Recommendation A-96-175

FAA: Require the development of and implementation of design or operational changes that will preclude the operation of transport-category airplanes with explosive fuel-air mixtures in the fuel tank:

(B) Pending implementation of design modifications, require modifications in operational procedures to reduce the potential for explosive fuel-air mixtures in the fuel tanks of transport-category aircraft. In the B-747, consideration should be given to refueling the center wing fuel tank (CWT) before flight whenever possible from cooler ground fuel tanks, proper monitoring and management of the CWT fuel temperature and maintaining an appropriate minimum fuel quantity in the CWT.

Status: Closed-Unacceptable Action

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# Fuel Tank Inerting

The FAA Tech Center has conducted extensive research and testing to determine the feasibility of OBIGGS (separator membrane)

- Feasible & Effective

Boeing has developed inerting systems for new and retrofit applications

Awaiting final rulemaking



# Crew Response to Hidden Fires

- AirTran Flight 913

August 8, 2000 Greensboro, NC

- Delta Flight 2030

September 17, 1999 Covington, KY

- American Airlines Flight 1683

November 29, 2000 Washington, DC

# AirTran Flight 913

- DC-9 with 57 passengers and 5 crew
- Shortly after takeoff lead flight attendant smelled smoke and the flight crew had donned their oxygen masks.



# AirTran Flight 913

- Neither flight attendant made an effort to locate the source of the smoke or to use any fire-fighting equipment.
- One flight attendant considered using a Halon extinguisher, but was unsure where to aim it since there were no visible flames.
- Off-duty pilot in first class decided against using Halon, as it might “take away more oxygen.”



# AirTran Flight 913



fire was extinguished by airport rescue  
and firefighting personnel.

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# Delta Flight 2030

- MD-88 with 113 passengers and 5 crew and 3 off-duty flight attendants onboard
- Shortly after takeoff, flight attendants noticed a “lit match” smell and smoke in the forward cabin.
- Carry-on bag next to right sidewall vent was scorched. Flight attendant saw a flickering orange glow beneath the vent.

# Delta Flight 2030

- Lead flight attendant went to cockpit to inform the flightcrew.
- Captain told lead flight attendant *not* to use Halon in the cabin.
- Meanwhile, another flight attendant discharged Halon extinguisher into the vent, and the orange glow disappeared.
- No injuries to passengers or crew.



# Delta Flight 2030





# Delta Flight 2030



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**November 29, 2000**

## **MD-82 Washington National Airport**

- MD-82 with 61 passengers and 5 crew
- After takeoff, flight attendants saw a flash of light and heard a “boom.”
- Lead flight attendant saw smoke coming from ceiling panels, which began to blister and turn yellow.

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**November 29, 2000**

## **MD-82 Washington National Airport**

- Flight attendant began spraying Halon at the affected panels.
- Passenger cut circular hole in ceiling, and the flight attendant fully discharged extinguisher into hole.

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**November 29, 2000**

**MD-82 Washington National Airport**

- Flight diverted to IAD.
- Flight attendant gave another extinguisher to passenger for landing, told him to “use it if needed.”
- No injuries to passengers or crew.

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**Deactivated GPS Antenna Cable**

# Crew Response to Hidden Fire

- Crewmembers should take immediate and aggressive action
- Training should include firefighting drills with actual & simulated fires
- Training should include methods of gaining access to areas behind interior panels to apply extinguishing agent
- Some crewmembers are not aware of the properties of Halon and its negligible health effects compared to its safety benefits.



# Crew Response to Hidden Fire

## Recommendation A-01-83

FAA to issue an AC that describes the need for crewmembers to take immediate and aggressive action in response to signs of an in-flight fire. The AC should stress that fires often are hidden behind interior panels and therefore may require a crewmember to remove or otherwise gain access to the area behind interior panels in order to effectively apply extinguishing agents to the source of the fire.

## Status: Closed-Acceptable Action

FAA issued AC 120-80, "In-Flight Fires" on 1/8/2004

# Crew Response to Hidden Fire

## Recommendation A-01-84

FAA: Require principal operations inspectors to ensure that the contents of the advisory circular are incorporated into crewmember training programs.

## Status: Closed-Acceptable Action

FAA issued Notice 8400.70 directing POIs and or cabin safety inspectors to convey the availability of the AC to their respective air carriers and urge that the AC's contents be incorporated into carrier's approved training programs.



# Crew Response to Hidden Fire

## Recommendation A-01-85

FAA: Amend 14 Code of Federal Regulations 121.417 to require participation in firefighting drills that involve actual or simulated fires during crewmember recurrent training and to require that those drills include realistic scenarios on recognizing potential signs of, locating, and fighting hidden fires.

## Status: Open-Unacceptable Response

The Safety Board does not believe that the AC will adequately address the intent of this safety recommendation. Currently, crewmembers are not required to perform a firefighting drill during recurrent training. The intent of this recommendation is to require all crewmembers to fight an actual or simulated fire during recurrent training using handheld fire extinguishers.

# Crew Response to Hidden Fire

## Recommendation A-01-86

FAA: Develop and require implementation of procedures or airplane modifications that will provide the most effective means for crewmembers to gain access to areas behind interior panels for the purpose of applying extinguishing agent to hidden fires. As part of this effort, the FAA should evaluate the feasibility of equipping interior panels of new and existing airplanes with ports, access panels, or some other means to apply extinguishing agent behind interior panels.

Status: Open-Acceptable Response



# Crew Response to Hidden Fire

## Recommendation A-01-87

FAA: Issue a flight standards handbook bulletin to principal operations inspectors to ensure that air carrier training programs explain the properties of Halon and emphasize that the potential harmful effects on passengers and crew are negligible compared to the safety benefits achieved by fighting in-flight fires aggressively.

## Status: Closed-Acceptable Action

The Safety Board reviewed AC 120-80, “In-flight Fires”, issued on 1/8/2004 and found that issuance of this AC meets the intent of Safety Recommendations A-01-83 and –87.

# Crew Response to Hidden Fire

The Safety Board is generally pleased with the progress made in this area, although there still is a need for improvement with respect to recurrent crew training



# Fire Detection and Suppression

- ValuJet, Everglades, 5/11/1996
- FedEx, Newburg, 9/5/1996
- UPS, Philadelphia 7/2/2006

# ValuJet, Everglades, 5/11/1996





# FedEx, Newburg, 9/5/1996



# Fire Detection and Suppression

## Recommendation A-97-056

FAA : Expedite final rulemaking to require smoke detection and fire suppression systems for all class D cargo compartments.

## Status: Closed-Acceptable Action

FAA issued its final rule to upgrade the safety standards for cargo or baggage compartments in certain transport category airplanes by eliminating class D compartments as an option for future type certification. Compartments that can no longer be designated as class D must meet the standards for class C or class E compartments as applicable.



# Fire Detection and Suppression

## Recommendation A-98-078

FAA : Reexamine the feasibility of on-board airplane cabin interior fire extinguishing systems for airplanes operating under 14 code of Federal regulations part 121 and, if found feasible, require the use of such systems.

## Status: Closed-Acceptable Action

- FAA requires class E compartments to be provided with a means to shut off the flow of ventilating air.
- Smoke detection systems are required in class E compartments
- FAA has supported a program to develop water mist system for main deck compartment in passenger aircraft

# Cargo Container Fire Suppression

FedEx has developed a fire detection and suppression system for main deck cargo compartments.

- Cargo container temperature monitoring
- Foam injection into containers
- Fire barrier for open pallets



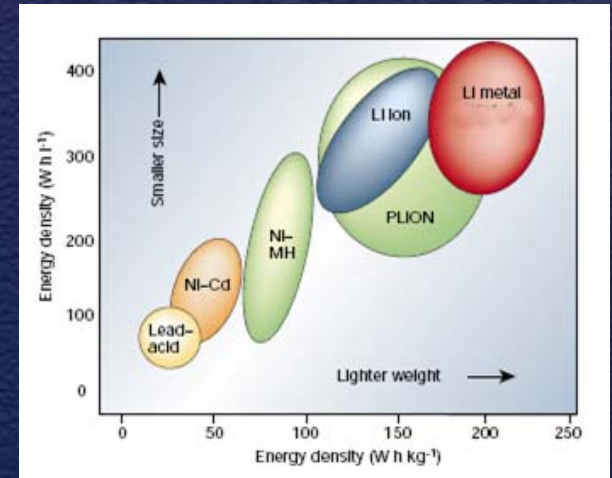
# Fire Detection and Suppression

- The Safety Board encourages further development of suppression systems for cabin areas and unprotected cargo compartments.

# High Energy Density Batteries

The trend in battery technology is...

- Smaller
- Lighter
- More Powerful



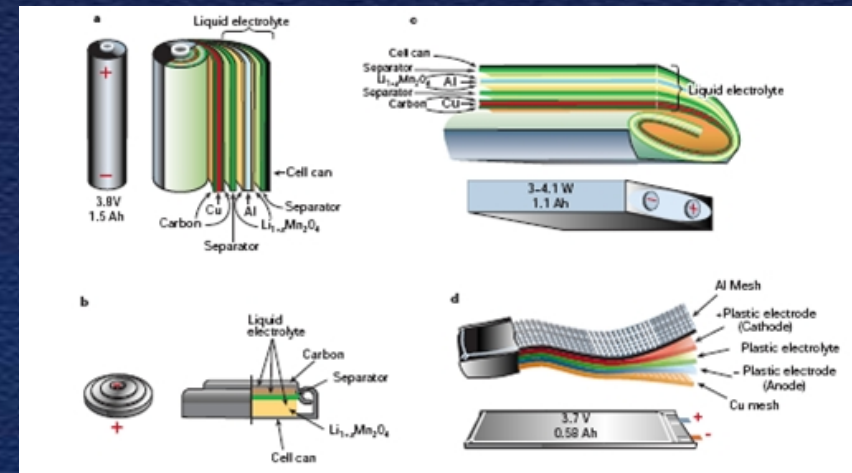
These advancements have made batteries become...

- Present in almost all portable electronic devices
- Capable of delivering sufficient energy to start a fire
- Unable to contain their own energy in a catastrophic failure



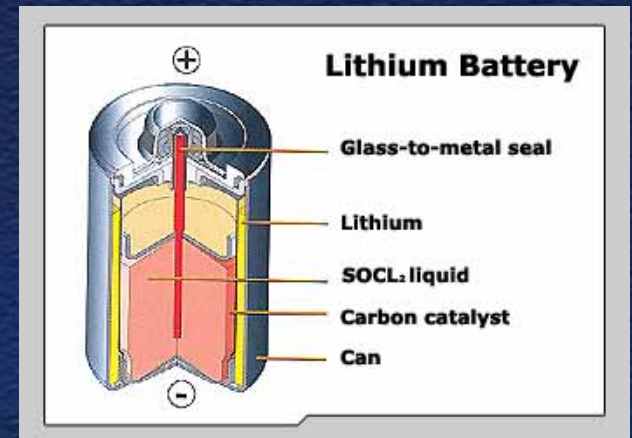
# Li-ion (Secondary) Batteries

- Rechargeable
- Flammable liquid fire behavior
- Testing at the FAA Tech center has shown that halon is an effective means of suppression for Li-ion battery fires



# Lithium (Primary) Batteries

- Non-Rechargeable (but similar in shape cr123)
- Combustible metal fire behavior
- Testing at the FAA Tech center has shown that halon is not effective against a lithium battery fire (smother)





# Recent Battery Fire Incidents

Since 1991, at least 75 reports of on transportation incidents

- Lufthansa overhead compartment fire (May 2006) – mishandling/storage a spare secondary battery, short circuit
- Ecoquest Airbuddy personal air purifiers (Dec. 2006 and June 2007) – recharging primary batteries
- JetBlue overhead compartment fire (Feb. 2007) - likely mishandling/storage a primary 9V battery, short circuit

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# Recommendations and actions

- LAX Northwest primary lithium batteries (2 pallets) fire after offloading, damaged during handling
- FedEx Memphis Cargo Facility fire – secondary car battery units, poor packaging loose part
- To FAA and PHMSA
  - A-99-80/85 (evaluate risk of transport, now looking at secondary), **open acceptable**
  - A-99-82 (labeling), NPRM out, **open acceptable**



# Recommendations and actions

- NTSB Public Hearing 2006
- ALPA advisory to pilots – 2007
  - Education and advice
- PHMSA safety advisory – March 2007
  - Handling, transport, storage
- PHMSA final rulemaking on transportation of lithium batteries on passenger a/c 2007
  - Limitations on board passenger aircraft

# High Energy Density Batteries

- Batteries will continue the trend of increasing energy density
- The proliferation of portable electronic devices will increase the number of battery failure incidents
- Consumer education is a necessary first step to mediate this threat.



# UPS DC-8 Cargo Fire



- AARF tactics and familiarity with cargo aircraft
- Hazardous materials identification (NOTOC)
- Smoke and Fumes checklists
- Smoke detection systems
- Fire suppression systems

# Closing Remarks

The Safety Board will continue to investigate fire related accidents and incidents as well as monitor emerging fire safety issues in order to make recommendations for fire safety improvements in aviation.

In our pursuits we have been fortunate to have the cooperation of government and industry groups. We wish to fortify these endeavors by reaching further into the safety community to establish new relationships to further investigate and promote fire safety.

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