National Transportation Safety Board

Washington, D.C. 20594

Safety Recommendation

DEC 17 2007

Date:

In reply refer to: A-07-104 through -109

The Honorable Krista L. Edwards
Acting Administrator
Pipeline and Hazardous Materials Safety Administration
U.S. Department of Transportation
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On February 7, 2006, about 2359 eastern standard time,[1] United Parcel Service Company (UPS) flight 1307, a McDonnell Douglas DC-8-71F,[2] N748UP, landed at its destination airport, Philadelphia International Airport (PHL), Philadelphia, Pennsylvania, after a cargo smoke indication in the cockpit. The captain, first officer, and flight engineer evacuated the airplane after landing. The flight crewmembers sustained minor injuries, and the airplane and most of the cargo were destroyed by fire after landing. The scheduled cargo flight was operating under the provisions of 14 *Code of Federal Regulations* (CFR) Part 121 on an instrument flight rules flight plan. Night visual conditions prevailed at the time of the accident.[3]

The National Transportation Safety Board determined that the probable cause of this accident was an in-flight cargo fire that initiated from an unknown source, which was most likely located within cargo container 12, 13, or 14. Contributing to the loss of the aircraft were the inadequate certification test requirements for smoke and fire detection systems and the lack of an on board fire suppression system.

Suppression of Secondary and Primary Lithium Battery-Related Fires

A number of secondary lithium batteries, which are described in more detail below, were found loose and in laptop computers and cell phones in the accident debris. No primary batteries were found in the accident debris.

There are basically two types of lithium batteries: secondary (rechargeable) and primary (nonrechargeable). Secondary lithium batteries, which are commonly used in items such as

[1] Unless otherwise indicated, all times are eastern standard time based on a 24-hour clock.

[2] McDonnell Douglas is now owned by the Boeing Commercial Airplane Group.

[3] For more information, see *In-Flight Cargo Fire, United Parcel Service Company Flight 1307, McDonnell Douglas DC-8-71F, N748UP, Philadelphia, Pennsylvania, February 7, 2007*, Aircraft Accident Report NTSB/AAR-07/07 (Washington, DC: NTSB, 2007).

cameras, cell phones, and laptop computers, contain lithium ions (charged molecules) in a flammable liquid electrolyte. Halon suppression systems (the only fire suppression systems certified for aviation) are effective in extinguishing fires involving secondary lithium batteries.

Primary batteries, which are commonly used in items such as watches and pocket calculators, contain metallic lithium that is sealed in a metal casing. The metallic lithium will burn when exposed to air if the metal casing is damaged, compromised, or exposed to sustained heating. Primary lithium battery flammability tests conducted by the Federal Aviation Administration (FAA) have shown that Halon suppression systems are not effective in extinguishing fires involving primary lithium batteries. Both primary and secondary lithium batteries are regulated as hazardous materials for the purposes of transportation.

Currently, the Safety Board is unaware of any fire suppression system that is effective on primary lithium battery fires. Therefore, although the installation of fire suppression systems in all cargo compartments on cargo-only aircraft, as recommended by the Board,[4] would reduce the risks from a fire involving most cargo items, including secondary lithium batteries, this action would essentially have no effect on a primary lithium battery fire. Further, until such time that fire suppression systems are installed on cargo-only aircraft, secondary lithium batteries will continue to typically be transported in compartments without fire suppression systems.

Therefore, the Safety Board concludes that flight crews on cargo-only aircraft remain at risk from in-flight fires involving both primary and secondary lithium batteries. The Safety Board believes that the Pipeline and Hazardous Materials Safety Administration (PHMSA) should require aircraft operators to implement measures to reduce the risk of primary lithium batteries becoming involved in fires on cargo-only aircraft, such as transporting such batteries in fire resistant containers and/or in restricted quantities at any single location on the aircraft. The Safety Board further believes that, until fire suppression systems are required on cargo-only aircraft, as asked for in Safety Recommendation A-07-99, PHMSA should require that cargo shipments of secondary lithium batteries, including those contained in or packed with equipment, be transported in crew-accessible locations where portable fire suppression systems can be used.

Retrieval and Dissemination of Hazardous Materials Information

The captain and first officer were not able to find the notice to captain (NOTOC), which contained information on the hazardous materials on board the airplane, during the evacuation because of the smoke in the cockpit and because they did not know that the flight engineer had moved it. Aircraft rescue and firefighting (ARFF) personnel who entered the cockpit after the evacuation were also unable to locate the NOTOC. When asked for the hazardous materials information, the UPS ramp supervisor stated that he could only provide the locations of the hazardous materials, not their identity, and that the NOTOC on board the airplane was the only source he was aware of that contained this information. About 40 minutes after the airplane landed, ARFF personnel reentered the airplane without knowing whether any potential safety hazards existed, found the NOTOC, and provided it to the incident commander.

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[4] As a result of this accident, the Safety Board also issued Safety Recommendation A-07-99, which asked the FAA to require that fire suppression systems be installed in the cargo compartments of all cargo airplanes operating under 14 CFR Part 121.

According to UPS management, in the event of an emergency, airport ground personnel were supposed to contact the UPS Flight Control Group in Louisville, Kentucky, to obtain specific information related to hazardous materials on board UPS flights from the Hazardous Materials Information System (HMIS). However, UPS ground personnel at PHL did not contact the UPS Flight Control Group on the day of the accident. Although UPS' HMIS was on line at PHL, UPS ground personnel were only authorized to access information about the quantity and locations of hazardous materials, not their identity. According to Flight Control personnel, once they heard about the accident, they retrieved the hazardous materials information for the flight from the HMIS; however, Flight Control did not provide this information to PHL Airport Operations or UPS ground or ARFF personnel. Additionally, both Airport Operations and ARFF personnel requested the hazardous information from UPS ground personnel at PHL; however, UPS ground personnel did not have access to the electronic system containing the desired information and did not contact UPS Flight Control in Louisville to obtain a copy of it.

Although emergency responders eventually located the NOTOC on the airplane and ARFF efforts were not significantly delayed, UPS personnel's failure to quickly access specific hazardous materials information and provide it to ARFF personnel could have potentially created a safety hazard. The Safety Board concludes that UPS guidance on hazardous materials information retrieval and dissemination was inadequate, which resulted in UPS personnel not providing emergency responders with detailed information about the hazardous materials on board the airplane in a timely manner.

Since the accident, UPS has revised its operations manuals to clarify personnel reporting responsibilities and the role and capabilities of Flight Control, promoting a more proactive approach to emergency response and hazardous materials communication. However, although these changes are an improvement and should result in hazardous materials information being provided in a timelier manner, the Safety Board is concerned that other operators might not have adequate guidance on hazardous materials information dissemination. The Board has previously addressed the importance of providing detailed hazardous materials information to emergency responders in a timely manner in its investigation of the in-flight fire and emergency landing in Newburgh, New York.[5] The investigation revealed that emergency responders did not receive specific information concerning the identity of hazardous materials, their quantities, or the number of packages on the airplane during the firefighting phase of the emergency. Although the unavailability of such information did not affect firefighting efforts, the overall importance of the timeliness in which emergency responders receive specific information about hazardous materials and the potential implications of unawareness were emphasized in the Board's report.

In the Newburgh report, the Safety Board noted that shipping documents are inherently at risk of destruction by fire and that flight crewmembers would most likely be unable to retrieve such paperwork because of the dangers of on-board fire, leaving it to the operator to provide the information to emergency responders. At the time of the Newburgh accident, Federal regulations did not adequately address the need for hazardous materials information on file with an air carrier to be quickly retrievable in a format useful to emergency responders. As a result, the

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[5] National Transportation Safety Board, *In-Flight Fire/Emergency Landing, Newburgh, New York, Federal Express Flight 1406, Douglas DC-10-10, N68055, September 5, 1996,* Aircraft Accident Report NTSB/AAR-98/03 (Washington, DC: NTSB, 1998).

Board issued Safety Recommendation A-98-80 to the Research and Special Programs Administration (RSPA),[6] proposing that it require air carriers to have a means to quickly retrieve and provide consolidated, specific hazardous materials information to emergency responders, 24 hours per day.

In response, on March 25, 2003, RSPA published a final rule, which revised 49 CFR 175.33 to mandate that air carriers have a copy of the NOTOC at the departure and intended arrival airports and, upon request, make the information available to emergency responders. In an August 18, 2003, letter, the Safety Board stated that it was pleased that RSPA had made it a requirement that hazardous materials information be made available immediately upon request but that it was disappointed that the revision did not address the need for providing such information in a consolidated format. Consequently, the Board classified Safety Recommendation A-98-80 "Closed—Unacceptable Action."

Because 49 CFR 175.33(d) requires air carriers to make a copy of the NOTOC information available to emergency responders "upon request," the regulatory requirement suggests that the voluntary transfer of hazardous materials information, without a formal request, is optional for the carrier. In contrast, the International Civil Aviation Organization (ICAO) document, "Technical Instructions for the Safe Transport of Dangerous Goods by Air," provides the following guidance on the transfer of hazardous materials information between aircraft operators and emergency personnel:

> In the event of an aircraft accident or serious incident, the operator of an aircraft carrying dangerous goods as cargo must provide information, without delay, to emergency services responding to the accident or serious incident about the dangerous goods on board, as shown on the copy of the information to the pilot-in-command.

The ICAO document promotes a proactive approach to the transfer of hazardous materials information during an emergency, which improves the likelihood that this information will get to emergency responders in a timely manner. In the case of this accident, UPS Flight Control personnel's actions satisfied the intent of the requirements as they are written. Flight Control had the on-board hazardous materials information readily available; however, they stated that they did not volunteer the information because they did not receive a request for it, therefore, they were not obligated to volunteer it, as stipulated by the regulations.

The Safety Board concludes that the requirements of 49 CFR 175.33(d) are not adequate because they do not require operators to provide hazardous materials information to emergency responders immediately upon notification of an accident. Therefore, the Safety Board believes that PHMSA should require aircraft operators that transport hazardous materials to immediately provide consolidated and specific information about hazardous materials on board an aircraft, including proper shipping name, hazard class, quantity, number of packages, and location, to on-scene emergency responders upon notification of an accident or incident.

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[6] RSPA no longer exists, and PHMSA has assumed its responsibilities.

Air Transport of Lithium Batteries

As noted, although it could not be determined whether lithium batteries played a role in the UPS cargo fire, public hearing testimony and the continued occurrence of incidents involving these batteries on board airplanes suggest the need for greater attention to the risks posed by transporting these batteries on commercial aircraft. A review of FAA and Consumer Product Safety Commission (CPSC) records shows that the number of both secondary and primary lithium battery-related incidents, many of which involved laptop computer fires that resulted from either internal or external short-circuiting of the secondary lithium batteries, has increased consistently over the years.[7] Since February 2006, the CPSC has recalled more than 9 million laptops containing secondary lithium batteries and has issued additional recalls for other products containing secondary lithium batteries. During the Safety Board's public hearing, the CPSC predicted that more incidents and recalls would occur if the deficiencies were not addressed. Further, the increasing popularity of portable electronic devices suggests that lithium battery-related incidents, particularly those involving secondary lithium batteries, will continue to increase. The Safety Board concludes that testing and incident data indicate that lithium batteries can pose a fire hazard.

In response to recent secondary lithium battery-related incidents and issues addressed during the Safety Board's public hearing, the FAA, Air Line Pilots Administration, and PHMSA all issued safety alerts or advisories in 2007, which addressed smoke and fire hazards, recommended crew actions in the event of a battery fire, the availability of guidance for the safe transport of batteries and battery-powered devices on board aircraft, and proper packing and handling procedures for these batteries.

On August 9, 2007, PHMSA issued new requirements that tightened the safety standards governing the air transportation of both primary and secondary lithium batteries. The final rule prohibits the transport of primary lithium batteries and cells as cargo on passenger-carrying aircraft. Additionally, spare lithium batteries can only be transported as carry-on items. Further, the exemptions for medium primary and secondary lithium batteries were eliminated, and new marking paperwork requirements were added for those batteries transported as cargo by air or vessel. Under this rule, on the basis of the FAA's initial testing of the fire risks posed by secondary lithium batteries and PHMSA's elimination of many of the exemptions for primary and secondary lithium batteries, greater shipments of lithium batteries will be transported by air as declared hazardous materials that will be required to comply with enhanced packaging and identification standards.

The issuance of the safety alerts and advisories and the new, more stringent requirements demonstrate the growing awareness and concern within the Department of Transportation and the airline industry over the air transportation of primary and secondary lithium batteries and electronic equipment containing such batteries. These initiatives will also heighten awareness about the common risks associated with both primary and secondary lithium batteries. Although the Safety Board is encouraged by these efforts, other concerns still remain.

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[7] Incidents involving small secondary battery-related incidents are not required to be reported, and the reporting level might have increased, in part, as a result of greater awareness of the hazards associated with these batteries.

The FAA currently maintains records of aviation incidents involving batteries and battery-powered devices, including those involving primary and secondary lithium batteries. The records likely do not provide a complete listing because many of the incidents involved lithium batteries that were exempted from incident reporting requirements. As a result, many operators have most likely not reported similar incidents. In addition, although the PHMSA's August 2007 final rule includes a marking and paperwork requirement for small secondary and primary cells and batteries, the new requirement only applies to packages containing 24 or more cells or 12 or more batteries and does not include batteries packed with or contained in equipment. As a result, shipments of batteries and electronic equipment with fewer than 24 cells or 12 batteries, such as laptop computers, are still exempt from reporting requirements, and, therefore, incidents involving such shipments are likely to remain largely unreported.

Consequently, the Safety Board concludes that, because many incidents involving lithium batteries are exempt from reporting requirements, the data regarding such incidents are incomplete, which has prevented a thorough assessment of the causes of these failures and the risks associated with transporting lithium batteries. Therefore, the Safety Board believes that the PHMSA should require commercial cargo and passenger operators to report to the PHMSA all incidents involving primary and secondary lithium batteries, including those contained in or packed with equipment, that occur either on board or during loading or unloading operations and retain the failed items for evaluation purposes. The Safety Board also remains concerned that the causes of secondary lithium battery failures are not well understood or documented. This may be due, in part, to the fact that proper evaluation of failed lithium batteries is not always performed and that, in many cases, these batteries are disposed of before the incident is reported, precluding an accurate analysis of the failures. Regarding primary lithium batteries, although it is understood that physical damage and exposure to heat and fire are major concerns, the impact of clustering several thousand primary batteries on a single pallet or in a single cargo container has not been considered or evaluated. Given that Halon is not an effective suppressant for a primary lithium battery fire, the risk of battery involvement in any type of fire needs to be determined.

Analyzing future secondary and primary lithium battery-related incidents should help determine the causes of the failures and, in turn, allow the most appropriate transportation requirements to be established. Therefore, the Safety Board concludes that an in-depth analysis of the causes of secondary and primary lithium battery failures would improve the safe transportation of these batteries. Therefore, the Safety Board believes that PHMSA should analyze the causes of all thermal failures and fires involving secondary and primary lithium batteries and, based on this analysis, take appropriate action to mitigate any risks determined to be posed by transporting secondary and primary lithium batteries, including those contained in or packed with equipment, on board cargo and passenger aircraft as cargo; checked baggage; or carry-on items.

The Safety Board is also concerned about the remaining exemptions for small secondary lithium batteries, such as those used to power laptop computers, cameras, cell phones, and other personal electronic devices, which are allowed to be shipped on passenger and cargo aircraft even though these types of batteries have been involved in at least nine aviation incidents. Cargo shipments of small secondary lithium batteries should be subject to the same packaging and identification requirements that apply to medium and large secondary lithium batteries to

increase general awareness of the risks of these batteries and to alert package handlers to exercise greater care when loading and unloading packages containing lithium batteries.

Until the causes of the failures of secondary lithium batteries are understood and effectively addressed, the prudent course of action is to eliminate these exceptions, particularly with respect to packaging and identification. Therefore, the Safety Board concludes that PHMSA's August 2007 final rule regarding the transportation of lithium batteries did not establish sufficient levels of safety for air transportation of small secondary lithium batteries (no more than 8 grams (g) equivalent lithium content). Therefore, the Safety Board believes that PHMSA should eliminate regulatory exemptions for the packaging, marking, and labeling of cargo shipments of small secondary lithium batteries (no more than 8 g equivalent lithium content) until the analysis of the failures and the implementation of risk-based requirements asked for in Safety Recommendation A-07-108 are completed.

Therefore, the National Transportation Safety Board makes the following recommendations to the Pipeline and Hazardous Materials Safety Administration:

> Require aircraft operators to implement measures to reduce the risk of primary lithium batteries becoming involved in fires on cargo-only aircraft, such as transporting such batteries in fire resistant containers and/or in restricted quantities at any single location on the aircraft. (A-07-104)
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> Until fire suppression systems are required on cargo-only aircraft, as asked for in Safety Recommendation A-07-99, require that cargo shipments of secondary lithium batteries, including those contained in or packed with equipment, be transported in crew-accessible locations where portable fire suppression systems can be used. (A-07-105)
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> Require aircraft operators that transport hazardous materials to immediately provide consolidated and specific information about hazardous materials on board an aircraft, including proper shipping name, hazard class, quantity, number of packages, and location, to on-scene emergency responders upon notification of an accident or incident. (A-07-106)
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> Require commercial cargo and passenger operators to report to the Pipeline and Hazardous Materials Safety Administration all incidents involving primary and secondary lithium batteries, including those contained in or packed with equipment, that occur either on board or during loading or unloading operations and retain the failed items for evaluation purposes. (A-07-107)
>
> Analyze the causes of all thermal failures and fires involving secondary and primary lithium batteries and, based on this analysis, take appropriate action to mitigate any risks determined to be posed by transporting secondary and primary lithium batteries, including those contained in or packed with equipment, on board cargo and passenger aircraft as cargo; checked baggage; or carry-on items. (A-07-108)

Eliminate regulatory exemptions for the packaging, marking, and labeling of cargo shipments of small secondary lithium batteries (no more than 8 grams equivalent lithium content) until the analysis of the failures and the implementation of risk-based requirements asked for in Safety Recommendation A-07-108 are completed. (A-07-109)

The Safety Board also issued recommendations to the Federal Aviation Administration and the Cargo Airline Association.

In your response to the recommendations in this letter, please refer to Safety Recommendations A-07-104 through -109. If you need additional information, you may call (202) 314-6649.

Chairman ROSENKER, Vice Chairman SUMWALT, and Members HERSMAN, HIGGINS, and CHEALANDER concurred with these recommendations.

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Chairman