



National Transportation Safety Board

Washington, D. C. 20594

Safety Recommendation

Log # 2101B

Date: October 24, 1988

In reply refer to: A-88-121 through -128

Honorable T. Allan McArtor
Administrator
Federal Aviation Administration
Washington, D.C. 20591

On February 3, 1988, American Airlines flight 132, a McDonnell Douglas DC-9-83, departed Dallas/Fort Worth International Airport, Texas, for Nashville Metropolitan Airport, Tennessee. In addition to the passenger luggage in the midcargo compartment, flight 132 was loaded with a 104-pound fiber drum of textile treatment chemicals. Undeclared and improperly packaged hazardous materials inside the fiber drum included 5 gallons of hydrogen peroxide solution and 25 pounds of a sodium orthosilicate-based mixture. While in flight, a flight attendant and a deadheading first officer notified the cockpit crew of smoke in the passenger cabin. The passenger cabin floor above the cargo compartment was hot and soft, and the flight attendants had to move passengers from the affected area. The captain, who was aware of a mechanical discrepancy with the auxiliary power unit (APU) on an earlier flight which resulted in in-flight fumes, was skeptical about the flight attendant's report of smoke. No in-flight emergency was declared. After landing, the captain notified Nashville Ground Control about the possibility of fire in the cargo compartment, and he requested fire equipment. The flight attendants then initiated procedures to evacuate the airplane on the taxiway. About 2 minutes 8 seconds after the plane landed, the 120 passengers and 6 crewmembers began evacuating the airplane. After the plane was evacuated, crash/fire/rescue personnel extinguished the fire in the cargo compartment.¹

Following the accident, laboratory tests were conducted to determine the capability of materials shipped in the fiber drum and the consequences. The Safety Board concluded that the 5-gallon polyethylene drum packaged inside the fiber drum contained 50 percent strength hydrogen solution; that hydrogen peroxide solution leaked from the polyethylene drum before being loaded aboard flight 132 and again in flight while aboard flight 132; that a combination of the hydrogen peroxide solution, sodium orthosilicate-based mixture, and the previously wet fiber drum caused the in-flight fire in the midcargo compartment. Another incident that was strikingly similar to the incident that occurred in Nashville involved an undeclared

¹For more detailed information, read Hazardous Materials Incident Report--*In-Flight Fire, McDonnell Douglas DC-9-83, N569AA, Nashville Metropolitan Airport, Nashville, Tennessee, February 3, 1988* (NTSB/HZM-88/02).

shipment of hazardous materials for transportation through an air freight forwarder. The shipment involved 12 1-gallon containers of 35 percent hydrogen peroxide solution packaged in overpack containers. The hydrogen peroxide solution was also shipped for use in a demonstration, and no hazardous materials were declared on the shipping papers. Instead, the shipping papers described the contents of the packages as "ceiling cleaning solution and equipment." Furthermore, no hazardous materials markings or labels were affixed to the outside of overpacks to warn cargo handlers about the hazardous contents. The shipment originated in Pompano Beach, Florida, on October 31, 1986, and the destination was the Philippines. On November 6, 1986, in Seattle, Washington, cargo handlers found several packages in the shipment soaked with liquid and subsequently determined that 1 to 2 gallons of hydrogen peroxide had leaked from inner containers. Shipper representatives later said that they were unaware of hazardous materials transportation safety requirements when they offered the cargo to an air freight forwarder for transportation.

Industry also has recognized that undeclared hazardous materials present a problem. The International Air Transport Association dangerous goods regulations (Section 1.6.3) address precautionary measures against hidden hazards in cargo and baggage. It notes that experience has shown that shippers using some descriptions to declare the contents of their packages must be asked to check their consignments against the class definitions in the regulations and to confirm that the contents are not restricted.

Following a series of misdeclarations of freight, Swissair imposed new requirements on shippers who describe consignments in generic terms--shipping descriptions must include the phrase "not restricted." Unless the additional description is included with the shipping name, the cargo is assumed to contain hazardous materials.

While U.S. Department of Transportation (DOT) regulations require air passenger carriers to inform passengers about hazardous materials restrictions by posting a notice at locations where tickets are issued, baggage checked, and aircraft boarded, there are no requirements that notices be posted at freight counters where air cargo is offered to air carriers or to air freight forwarders. While American Airlines also posts this notice at freight counter locations, other passenger carriers and cargo-only carriers do not. However, even when the notices are posted, the National Transportation Safety Board has found the warnings to be inadequate. DOT regulations require the notices to be "prominently displayed"² and the lettering to be printed on a background of contrasting color. Instead, notices are often posted at the sides of passenger ticket counters or at other locations that do not readily attract the attention of the public, and they are usually printed in black and white. The notices do not use bright, multiple colors or illustrations to attract the public's attention. In a safety study on passenger safety education,³ the Safety Board noted that the visual attractiveness of information materials is important if the message is to be noticed and then read. Therefore, the Safety Board believes that in order to increase the effectiveness of the warning notices, air carriers should improve the

²"Prominently display" is not defined in the regulations and no written guidelines are available for use by Federal inspectors when determining compliance with this regulation.

³Safety Study--*Airline Passenger Safety Education: A Review of Methods Used to Present Safety Information (NTSB/SS-85/09)*.

design, content, and posted location of hazardous materials restriction notices. Additionally, the Federal Aviation Administration (FAA) should develop guidelines for use by persons inspecting air carrier facilities to determine if notices are "prominently displayed," and when found not properly displayed, require corrective action.

The airworthiness of the airplane was threatened by fire in the midcargo compartment. Temperatures in the compartment, although localized, were hot enough to melt a section of the ceiling liner aluminum support strap and to cause ceiling liner phenolic resin to cook off. As a result, heat penetrated a breach in the ceiling of the cargo compartment and threatened the safety of the airplane. Although the Safety Board was not able to determine when excessive heat first penetrated the cargo compartment, crewmembers knew the passenger cabin floor above the breached area was hot and soft several minutes before landing. Excessive temperatures reached critical flight, engine, and hydraulic system control cables, floor beams, and the passenger cabin floor. Therefore, the Safety Board concludes that the cargo compartment failed to meet the intent of Title 14 Code of Federal Regulations 25.857(d) and that the potential for a catastrophic in-flight fire existed.

Because the cargo compartment was not equipped with fire or smoke detection systems, the cockpit crew had no way of detecting the threat to the safety of the airplane until smoke and fumes reached the passenger cabin. After smoke was detected in the passenger cabin, the cockpit crew had no means to identify the location of the fire. Furthermore, because the cargo compartment was not equipped with a fire extinguishment system, the cockpit crew had no means available to extinguish or suppress the fire in the cargo compartment. Without fire detection or suppression systems, the cockpit crew must rely on the adequacy of cargo compartment designs and construction to control a fire in the cargo compartment.

The Safety Board participated in the investigation of the accident involving a Saudia Lockheed L-1011 at Riyadh, Saudi Arabia, on August 19, 1980, in which an in-flight fire resulted in the deaths of all 301 passengers and crew aboard the airplane after it landed safely. The probable cause of the accident was determined to be an in-flight fire in a class D cargo compartment. Although the cargo compartment was equipped with an operative smoke detector device, the cargo compartment was not equipped with a fire extinguishment system. As a result of its participation in the investigation, the Safety Board issued Safety Recommendations A-81-12 and -13 to the FAA on February 10, 1981:

A-81-12

Reevaluate the "Class D" certification of the L-1011 C-3 cargo compartment with a view toward either changing the classification to "C," requiring detection and extinguishing equipment, or changing the compartment liner material to ensure containment of a fire of the types likely in the compartment while in-flight.

A-81-13

Review the certification of all baggage/cargo compartments (over 500 cu. ft.) in the "D" classification to ensure that the intent of Title 14 Code of Federal Regulations 25.857(d) is met.

In its recommendations to the FAA, the Safety Board noted several instances of fire in checked baggage from the ignition of matches and other items. In most cases, the fires ignited while the aircraft were on the ground and the aircraft were not damaged. However, the Safety Board raised the possibility of such a fire while in flight and questioned the capability of class D compartments to contain a fire by "snuffing" it to keep it from spreading.

In June 1983, the FAA Technical Center completed a project to study experimentally the effectiveness of transport aircraft class D cargo compartments in containing fires through oxygen starvation. The study concluded that the Federal regulations did not ensure adequate burn-through resistance of class D cargo liners subjected to realistic fires. It noted that the cargo compartment liner is the initial fire barrier for the protection of aircraft components, structure, passenger, and crew from a fire inside the cargo compartment, and it noted that because of cabin exhaust ventilation airflow around the cargo compartment, an opening, rupture, or burn-through of any portion of the cargo liner could feed a cargo fire with large quantities of air. The report warned that some cargo compartments, although primarily lined with fiberglass, have aluminum components and that the use of aluminum may nullify the fire containment capability of burn-through resistant cargo compartment liners.

Subsequently, on August 8, 1984, the FAA issued a notice of proposed rulemaking, Notice 84-11, that addressed the problem of fire containment in cargo compartments by specifying a new test method for determining the flame penetration resistance of compartment liners. When the Safety Board provided comments on the rulemaking on October 9, 1984, it advised the FAA that while proposed flame penetration test methods are more stringent than previous ones, a fire should not be allowed to persist in any state of intensity in an airplane without the knowledge of the flightcrew and that a fire detection system should be required for class D cargo compartments.

On May 16, 1986, the FAA issued a final rule to amend fire safety standards for cargo or baggage compartments to become effective June 16, 1986. The final rule adopted more stringent cargo liner burn-through tests and smaller class D cargo compartments, but it rejected a requirement for fire detection systems in class D cargo compartments.

Furthermore, cargo compartment fire protection research and testing did not consider what effect hazardous materials involvement in a cargo fire could have on the capability of a cargo compartment to contain an in-flight fire. The FAA concluded in its final rule that the effects of hazardous materials were beyond the scope of its rulemaking notice. However, the Safety Board believes that the incident aboard flight 132 clearly demonstrates that hazardous materials involvement in a cargo compartment fire must be considered in all cargo compartment fire penetration safety standards; hazardous materials determined to present unacceptable threats should be prohibited.

Safety Recommendation A-81-12 was classified "Closed--Acceptable Action" on November 2, 1982, following a commitment by U.S. air carriers to improve the fire containment capability of the cargo compartment by replacing Nomex fabric cargo compartment ceiling liners with fiberglass. Because of the improved cargo liner flame penetration test requirements and the new restrictions limiting the size of class D compartments, Safety Recommendation A-81-13 was classified "Closed--Acceptable Action" on August 11, 1986.

The Safety Board urges the FAA to require fire detection and extinguishment systems in all class D cargo compartments; to review the certification of all types of cargo compartments to identify any aluminum or other components that fail to meet thermal protection requirements at least equal to cargo compartment liner thermal protection requirements; to consider the effects of hazardous cargo involvement in fires in all types of cargo compartments; to require that safety deficiencies identified be corrected; and to immediately evaluate prohibiting the transportation of oxidizers in present class D cargo compartments, and determine if other classes of hazardous materials should also be excluded from present class D cargo compartments. Adding these safety systems to class D cargo compartments will provide even greater protection than is presently provided by class C cargo compartments.

The review of the cockpit voice recorder and crew interviews indicates that a deficiency in communication occurred between the cockpit and cabin crews during the in-flight fire and the descent into Nashville. An examination of the dialogue among crewmembers suggests that the captain was skeptical about the flight attendant's initial report of smoke. The first officer also appears to have been reluctant initially to accept that smoke, rather than fumes, was in the airplane.

Given the acknowledged seriousness of in-flight fire and the obvious association of a report of smoke in the cabin with a strong possibility of a fire, the Safety Board is deeply concerned by the captain's apparent reluctance to accept either the flight attendant's or deadheading crewmember's report as valid or to seek additional information to resolve his uncertainty.

In order to understand the captain's reaction, the Safety Board examined other circumstances that might have predisposed his behavior. Because the captain was aware of a mechanical discrepancy with the APU on an earlier flight which resulted in in-flight fumes, it would have been natural for this information to influence his perception of the initial report of smoke. However, the APU was not operating; therefore, the captain should have dismissed it as being the source of any fumes.

Further, with the flight only a few minutes away from landing, the captain was entering into a high activity level, and he had limited options available to deviate from the succession of events and activities already set in motion. That is, his current flight path, speed, and traffic sequence already was directed toward getting the airplane on the ground expeditiously, and he considered an expeditious landing the only immediate option available to alleviate this abnormal and ill-defined situation.

The Safety Board believes that these circumstances may have operated in concert to predispose the captain to disbelieve the reports of smoke, and to establish a mind set that the cabin crew was instead experiencing the less serious fumes.

The captain's skepticism about the report of smoke was also reflected in the first officer's dialogue with the cabin crew. His comments appear to be more of a challenge of the accuracy of the reports than an effort to get additional details. Even after he determined the problem in the cabin to be serious and after he recognized the need for timely firefighting assistance on landing, the first officer failed to aggressively recommend that crash/fire/rescue equipment meet the airplane.

On identifying smoke in the passenger cabin, a flight attendant recognized the potential seriousness of the problem and without hesitation, even under "sterile cockpit" conditions, immediately informed the first officer about the condition.

Subsequent actions by the cabin crew, including efforts to locate the source of the fire, maintaining open communications with the cockpit, using a deadheading crewmember to evaluate and communicate information about the problem, and moving passengers from the affected area, also demonstrated that they considered the problem to be serious.

In conclusion, the Safety Board believes that while it is unlikely that the captain could have taken any action to land the plane more quickly, the cockpit crew failed to use the cabin crew effectively to obtain an accurate understanding of the developing problem. Had communications between the cockpit crew and the cabin crew been more effective, the Safety Board believes that the captain would have called for fire/rescue equipment to meet the airplane and ordered an emergency evacuation on the runway.

The Safety Board previously addressed the issue of cockpit and cabin crew coordination training as a result of its investigation of the in-flight fire aboard a DC-9 at Cincinnati, Ohio, on June 2, 1983.³ As a result of its investigation, the Safety Board issued Safety Recommendation A-84-76 which called for the FAA to require its principal operations inspectors to review air carrier training and, if necessary, require amendments concerning actions flight crews should take for immediately and aggressively determining the source and severity of any reported cabin fire. In responses to this recommendation, on November 2, 1984, and March 7, 1986, the FAA advised that it believed that current rules and guidance did not warrant further action. As a result, on May 12, 1986, the Safety Board classified Safety Recommendation A-84-76 "Closed--Unacceptable Action."

Subsequent to the Safety Board closing the recommendation, the FAA developed two proposed advisory circulars that addressed cabin safety training for crewmembers and improved coordination and communications among and between cockpit and cabin crews. The Safety Board commented in support of the FAA's proposals. The lack of close coordination and timely exchange of accurate information among crewmembers were clearly problems during preparations for a possible emergency landing of a DC-8 at Portland, Oregon, in 1978; during an in-flight fire aboard an L-1011 at Riyadh, Saudi Arabia, in 1980; during preparations for a possible ditching of an L-1011 near Miami, Florida, in 1985; and during an in-flight fire aboard a DC-9 at Cincinnati, Ohio, in 1985. These instances, as well as this in-flight fire, vividly support improved coordination and communications and joint cockpit and cabin crew training with respect to conducting emergency procedures and periodic emergency drills in which cockpit/cabin crew coordination and communication are practiced.

The lethal threat of smoke and fire in aircraft to passenger safety and the need to remove passengers from that environment quickly is well acknowledged. Because the captain failed to order an emergency evacuation of the airplane until 2 minutes 8 seconds after touchdown, the passengers were unnecessarily exposed to these threats for about 1 1/2 minutes longer than necessary.

The captain's delayed decision also increased the time necessary to evacuate the airplane; therefore, flight attendants did not have time to use the public address system to prepare passengers for a quick exit or to provide clear, oral instructions to

³Aircraft Accident Report--Air Canada Flight 797 McDonnell Douglas DC-9-32, C-FTLU, Greater Cincinnati International Airport, June 2, 1983 (NTSB/AAR-84/09).

passengers on evacuation procedures. Consequently, while most passengers considered the evacuation orderly, some complained that they could not hear commands shouted by the flight attendants until they were near the exits. As a result, the evacuation was delayed when passengers were stopped at exits to remove their shoes and to discard their carry-on luggage. The delayed decision to evacuate also prevented crash/fire/rescue personnel from being in place to assist in the evacuation and to protect passengers should the fire have broken through to the cabin.

The Safety Board concluded that the actions of the flight attendants were performed in accordance with American Airlines training and procedures. The Safety Board noted that American Airlines emergency procedures require flight attendants to instruct passengers to remove shoes, while passenger safety information cards provide no similar instructions. The Safety Board believes that the communication of emergency evacuation procedures to passengers could be improved if American Airlines operational procedures, manuals, training, the flight attendants' oral instructions, and passenger safety information cards provide consistent instructions to passengers regarding the removal of shoes. The Safety Board also urges the FAA to instruct principal operations inspectors to determine if passenger safety cards and flight attendant instructions to passengers for emergency evacuations are consistent with each air carrier's evacuation procedures.

Although some air carriers instruct passengers to remove shoes during unplanned emergency evacuations to prevent damage to slides, other air carriers do not. The Safety Board is aware that slide manufacturers have not recommended that shoes be removed. Certification demonstrations by air carriers and airplane manufacturers of evacuation systems have been routinely conducted with persons wearing tennis-type shoes and other low-heeled shoes. Although there have been instances when passengers' shoes, particularly women's high-heeled shoes, have damaged slides or have caught on the slide fabric and injured persons; these instances are infrequent. On the other hand, there have been instances when passengers and crewmembers have removed shoes and successfully evacuated a crashed airplane only to sustain frostbite and injuries when they walked on wreckage and through fire.

The Safety Board is also aware of recent actions by the FAA to require the sliding surface of evacuation slides to be more puncture resistant. It appears that in view of the FAA's recent actions and the need for the crew and passengers to have foot protection following an evacuation, the FAA should research the safety aspects of removing shoes during an evacuation.

Therefore, the National Transportation Safety Board recommends that the Federal Aviation Administration:

Develop written guidelines for use by persons responsible for inspecting air carrier facilities, require those persons to determine if hazardous materials warning notices are "prominently displayed" in all required locations, and require corrective actions as necessary. (Class II, Priority Action) (A-88-121)

Require fire/smoke detection systems for all class D cargo compartments. (Class II, Priority Action) (A-88-122)

Require a fire extinguishment system for all class D cargo compartments. (Class II, Priority Action) (A-88-123)

Evaluate prohibiting the transportation of oxidizers in cargo compartments that do not have fire/smoke detection and fire extinguishment systems, and determine if other classes of hazardous materials also should be excluded from cargo compartments without these safety systems. (Class II, Priority Action) (A-88-124)

Review the certification of all types of cargo compartments to identify any aluminum or other components that fail to meet thermal protection requirements at least equal to cargo compartment liner thermal protection requirements. Require that all safety deficiencies be corrected. (Class II, Priority Action) (A-88-125)

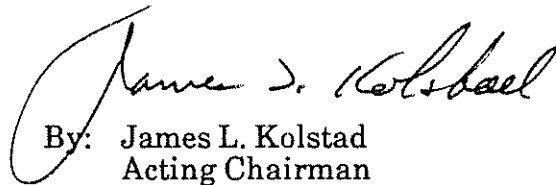
Require passenger carriers operating under Title 14 Code of Federal Regulations Parts 121 and 135 to include in training programs joint cockpit and cabin crew training on emergency procedures and to conduct periodic emergency drills in which cockpit/cabin crew coordination and communication are practiced. (Class II, Priority Action) (A-88-126)

Consider the effects of authorized hazardous materials cargo in fires for all types of cargo compartments, and require appropriate safety systems to protect the aircraft and occupants. (Class II, Priority Action) (A-88-127)

Instruct principal operations inspectors to determine if passenger safety cards and flight attendant instructions to passengers for emergency evacuations are consistent with each air carrier's evacuation procedures. (Class II, Priority Action) (A-88-128)

Also, as a result of its investigation, the Safety Board issued Safety Recommendations A-88-115 through -119 to American Airlines, Inc.; A-88-120 to the Research and Special Programs Administration; A-88-129 to the Air Transport Association of America; and I-88-7 to Textile Treatments International, Inc.

KOLSTAD, Acting Chairman, and BURNETT, LAUBER, NALL, and DICKINSON, Members, concurred in these recommendations.


By: James L. Kolstad
Acting Chairman