



National Transportation Safety Board

Washington, D.C. 20594

Safety Recommendation

Date: April 9, 1992

In reply refer to: A-92-21

Honorable Barry L. Harris
Acting Administrator
Federal Aviation Administration
Washington, D.C. 20591

On February 24, 1989, United Airlines flight 811, a Boeing 747-122 (B-747), N4713U, was operating as a regularly scheduled flight from Los Angeles, California, to Sydney, Australia, with intermediate stops in Honolulu, Hawaii, and Auckland, New Zealand. There were 3 flight crewmembers, 15 flight attendants, and 337 passengers aboard the airplane.¹

The flightcrew's first indication of a problem was while the airplane was climbing between 22,000 and 23,000 feet at an indicated airspeed of 300 knots. They heard a sound, described as a "thump," which shook the airplane. This sound was followed immediately by a "tremendous explosion." The airplane had experienced an explosive decompression. Power was lost from the Nos. 3 and 4 engines because of damage from foreign object ingestion.

The airplane made a successful emergency landing in Honolulu, and the occupants evacuated the airplane. An examination of the evidence at the time revealed that the forward lower lobe cargo door had separated in flight, causing

¹For more detailed information, read Aviation Accident Report--"Explosive Decompression--Loss of Cargo Door in Flight," United Airlines, Flight 811, Boeing 747-122, N4713U, Honolulu, Hawaii, February 24, 1989, (NTSB/AAR-92/02; supersedes NTSB/AAR-90/01)

extensive damage to the fuselage and cabin structure adjacent to the door. As a result, nine of the passengers were ejected from the airplane and lost at sea.

A year after the accident, the Safety Board was uncertain whether the cargo door would be located and recovered from the Pacific Ocean. Therefore, the Board decided to proceed with a final report based on the available evidence without the benefit of an actual examination of the door mechanism. The original report was adopted by the Board on April 16, 1990, as NTSB/AAR-90/01.

Subsequently, on July 22, 1990, a search and recovery operation was begun by the U. S. Navy with the cost shared by the Safety Board, the FAA, Boeing Aircraft Company, and UAL. The operation was supported by U.S. Navy radar data that had tracked the separated cargo door, underwater sonar equipment, and a manned submersible vehicle. The effort was successful, and, on September 26 and October 1, 1990, the cargo door was recovered in two pieces from the ocean floor at a depth of 14,200 feet.

Before the recovery of the cargo door, the Safety Board believed that the door locking mechanisms had sustained damage in service prior to the accident flight to the extent that the door could have been closed and appeared to have been locked, when in fact the door was not fully latched. This belief was expressed in the original report and was supported by the evidence available at the time. However, upon examination of the door, the damage to the locking mechanism did not support this hypothesis. Rather, the evidence indicated that the latch cams had been back-driven from the closed position into a nearly open position after the door had been closed and locked. The latch cams had been driven into the lock sectors that deformed so that they failed to prevent the back-driving.

There are only two possible means for the latch cams to have been back-driven: electrically or mechanically. Examination of the cargo door manual latch cam drive port revealed that the decal installed over the drive port had been damaged by the forces of the door separation and the fall into the ocean. Close examination of the decal revealed that it had not been compromised by the insertion of a manual drive tool. Consequently, the only other possibility for the condition of the latch cams and lock sectors was that the latch actuator had been electrically activated after the door had been properly closed and locked.

The Safety Board attempted to determine if an electrical short circuit in the cargo door circuitry had caused the latch actuator to operate and drive the latch cams open. Analysis of the door wiring circuits and routing revealed certain wire pairs

that could power the latch actuator if the wires shorted to each other. There were more possibilities for short circuits if the master latch lock handle S2 switch had failed in the "not locked" position. Moreover, if the S2 switch had failed, momentary actuation of the door switch to the open position by ramp personnel could have driven the latch cams open,

Examination of the electrical wires recovered with the cargo door revealed no evidence of arcing; however, tests indicated that even if arcing had occurred, such evidence might not be readily apparent. Unfortunately, not all of the electrical wires for the door were recovered from the ocean floor. As a result, the precise manner of electrical back-driving of the latch cams could not be determined.

Further evidence that electrical short circuits could have been the reason for this accident resulted from the June 13, 1991, incident at JFK Airport in which another UAL B-747's cargo door opened without actuation of the "door open" switch. Examination of that airplane revealed breaches in the door wiring insulation and a short circuit that caused the door latch cams to move uncommanded after the lock handle was pulled and the S2 switch closed.

The Safety Board remains convinced that the modifications per AD-88-12-04 to the B-747 cargo door lock sectors to prevent the latch cams from opening are valid and provide protection to preclude the inadvertent opening of a cargo door. However, the unacceptable and catastrophic nature of the loss of a cargo door in flight from a transport-category airplane requires redundant protection against a failure of the mechanical protection. Therefore, the Safety Board believes that switches or relays should be included in door power and control circuits to deactivate the electrical power to such cargo doors after they are properly closed, latched, and locked. Of course, the indicating systems to alert flight and groundcrews to the condition of the doors should remain active.

As a result of the recovery and examination of the cargo door, the Safety Board's original analysis and probable cause were modified. The Safety Board's report adopted on March 18, 1992, (NTSB/AAR-92/02) incorporates these changes and supersedes AAR-90/01.

Therefore, the National Transportation Safety Board determines that the probable cause of this accident was the sudden opening of the forward lower lobe cargo door in flight and the subsequent explosive decompression. The door opening was attributed to a faulty switch or wiring in the door control system which permitted electrical actuation of the door latches toward the unlatched position after

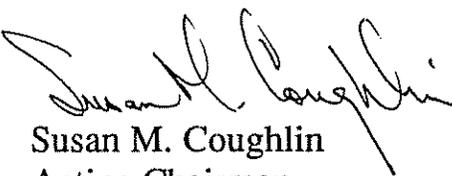
initial door closure and before takeoff. Contributing to the cause of the accident was a deficiency in the design of the cargo door locking mechanisms, which made them susceptible to deformation, allowing the door to become unlatched after being properly latched and locked. Also contributing to the accident was a lack of timely corrective actions by Boeing and the FAA following a 1987 cargo door opening incident on a Pan Am B-747.

As a result of its investigation of this accident, the Safety Board issued Safety Recommendations A-89-92 through -94 and A-90-54 through -64 addressing measures to improve the airworthiness of the B-747 cargo doors and other nonplug doors on pressurized transport-category airplanes, as well as recommendations affecting cabin safety.

As a result of its subsequent findings following the recovery and examination of the cargo door, the National Transportation Safety Board recommends that the Federal Aviation Administration:

Require that the electrical actuating systems for nonplug cargo doors on transport-category aircraft provide for the removal of all electrical power from circuits on the door after closure (except for any indicating circuit power necessary to provide positive indication that the door is properly latched and locked) to eliminate the possibility of uncommanded actuator movements caused by wiring short circuits. (Class II, Priority Action) (A-92-21)

Acting Chairman COUGHLIN and Members LAUBER, HART, HAMMERSCHMIDT, and KOLSTAD concurred in this recommendation.


By: Susan M. Coughlin
Acting Chairman