Log 2309

National Transportation Safety Board

Washington, D.C. 20594

Safety Recommendation

Date: August 28, 1991

In reply refer to: A-91-83 and -84

Honorable James B. Busey
Administrator
Federal Aviation Administration
Washington, D.C. 20591

On June 13, 1991, United Airlines (UAL) maintenance personnel were unable to electrically open the aft cargo door on a Boeing 747-222B, N152UA, at John F. Kennedy Airport (JFK), Jamaica, New York. The airplane was one of two used exclusively on nonstop flights between Narita, Japan, and JFK. This particular airplane had accumulated 19,053 hours and 1,547 cycles at the time of the occurrence.

The airplane was being prepared for flight at the UAL maintenance hanger. An inspection of the circuit breaker panel revealed that the C-288 (aft cargo door) circuit breaker had popped. The circuit breaker, located in the electrical equipment bay just forward of the forward cargo compartment, was reset, and it popped again a few seconds later. A decision was made to defer further work until the airplane was repositioned at the gate for the flight. The airplane was then taxied to the gate under its own power and work on the door resumed.

The aft cargo door was cranked open manually, the circuit breaker was reset, and it stayed in. The door was then closed electrically and cycled a couple of times without incident. With the door closed, one of the two "cannon plug" (multiple pin) connectors was removed from the J-4 junction box located on the upper portion of the interior of the door. The wiring bundle from the junction box to the fuselage was then manipulated while readings were taken on the cannon plug pins using a volt/ohm meter. Fluctuations in electrical resistance were noted. When the plug was reattached to the J-4 junction box, the door began to open with no activation of the electrical door open switches. The circuit breaker (C-288) was pulled and the door operation ceased. When the circuit breaker was reset, the door continued to the full open position, and the lift actuator motor continued to run for several seconds until circuit breaker C-288 was again pulled. At this time, a flexible copper conduit which covered a portion of the wiring bundle was slid along the bundle toward the J-4 junction box, revealing several wires with insulation breaches and damage.

UAL personnel notified the National Transportation Safety Board of the occurrence, and the airplane was examined at JFK by representatives of the Safety Board, United Airlines, and Boeing. After the wires in the damaged area were electrically isolated, electrical operation of the door was normal when the door was unlocked. When the door was locked (master latch lock handle closed), activation of the door control switches had no effect on the door. This indicated that the S2 master latch lock switch was operating as expected (removing power from the door when it was locked). The S2 switch is located on the lower end of the cargo door, and first movement of the lock sectors toward the locked position opens the switch and interrupts the 28 volt control power to the interior and exterior cargo door control switches. After the on-site examinations, the wiring bundle was cut from the airplane and taken to the Safety Board's materials laboratory for further examination.

The wiring bundle with the damaged wires contains all electric control wires (28 volt DC) and power wires (115 volt AC) that pass between the fuselage and the aft cargo door. From the forward side of the J-4 junction box, the bundle progresses in the forward direction, just above the forward pressure relief door, then upward, following the forward lift actuator arms. The bundle then enters an empty space between two floor beams, where the bundle has an approximate 180-degree bend when the door is closed. From this location, the wiring bundle progresses inboard, through a fore-to-aft intercostal between two floor beams. The wiring bundle then splits, with wires going in several directions. The bundle is covered by the flexible conduit approximately from the lower end of the lift actuator arms to the fore-to-aft intercostal between the floor beams.

The conduit covering the wiring bundle is a sealed flexible interconnector consisting of a convoluted helical brass innercore covered by a bronze braid. The innercore is soldered at every other convolute, and should be capable of withstanding pressures exceeding 1000 psi. Boeing has indicated that the conduit is an evolutionary improvement and has been installed on all 747 airplanes produced since 1981 (line number 489 and on). Airplane N152UA was delivered in April 1987.

Examination of the wires in the damaged area on the wiring bundle revealed that four of the wires were similar in appearance, with insulation breaches that progressed through to the underlying conductor. Adjacent to the breach on these four wires, the insulation was blackened, as if it had been burned. Another wire contained an extensive breach but no evidence of burned insulation. The damaged area was located on the bundle at a position approximately corresponding to a conduit support bracket and attached standoff pin on the upper arm of the forward lift actuator mechanism. This support bracket was bent in the forward direction. In addition, mechanical damage was noted on adjacent components in this area.

A second damaged area was noted on the wiring bundle at a position approximately corresponding to the conduit swivel clamp at the elbow between the two arms of the forward lift actuator mechanism. Wires in this area were missing portions of their exterior coating, but no breaches to the underlying conductors were noted.

The exterior braid on the conduit contained minor rub marks and was slightly kinked at a position corresponding to the area on the wires with breached insulation. Additional examinations revealed that the innercore of the conduit contained multiple circumferential cracks in the areas corresponding to the damage areas on the wires. The cracks were in the convoluted innercore directly adjacent to the inside diameter of the conduit.

The lock sectors, latch cams, and latch pins from the aft cargo door were examined on the incident airplane and were generally in excellent condition. There was no evidence to suggest that the cams had ever been electrically (or manually) driven into or through the lock sectors.

The Boeing Company has also informed the Safety Board that, in May of 1991, a 747 operated by Quantas was found to have chafing of the wires in the wiring bundle to the aft cargo door. This airplane also had a flexible conduit protecting the wires, and the chafing was located approximately at the standoff pin on the bracket at the upper arm of the forward lift actuator. Boeing is gathering additional facts on that incident.

The Safety Board believes that the chafing of the wires on the 747 airplane involved in the JFK occurrence is caused, or is greatly accelerated by, the circumferential cracks in the conduit and that the cracks in the conduit are caused either by repeated flexing of the conduit as the cargo door opens and shuts or by unusual stresses on the conduit generated concurrently with damage to the conduit guide bracket and attached standoff pin on the upper end of the forward lift actuator upper arm. Also, the Safety Board is concerned that there may be additional 747 airplanes with chafed wires within the flexible conduit for the aft cargo door, and that there is a possibility that these chafed wires may send an unintended signal to the actuator motors to open the door. Although the improved steel lock sectors should be capable of preventing a properly locked door from opening, the Safety Board believes that all reasonable precautions should be taken to ensure that chafed wires in the aft cargo door wiring bundle do not produce unintended electrical signals to the door operating mechanism.

A portion of the wiring bundle for the forward cargo door on many 747 airplanes is also covered by a flexible conduit that is very similar to the conduit for the aft cargo door. However, there are substantial differences between the orientation of the flexible conduits for the two doors, and the Safety Board is not aware of problems associated with the flexible conduit for the forward door. Nevertheless, the conduit for the wiring bundle for the forward cargo door is also subjected to repeated flexing and the Safety Board is concerned that it may also develop damage similar to that found on the airplane involved in the JFK occurrence.

Because of the concerns expressed in this letter, the National Transportation Safety Board recommends that the Federal Aviation Administration:

Issue an Airworthiness Directive applicable to all Boeing 747 airplanes with a flexible conduit protecting the wiring bundle between the fuselage and aft cargo door to require an expedited inspection of:

(1) the wiring bundle in the area normally covered by the conduit for the presence of damaged insulation (using either an electrical test method or visual examination);

(2) the conduit support bracket and attached standoff pin on the upper arm of the forward lift actuator mechanism;

(3) the flexible conduit for the presence of cracking in the convoluted innercore.

Wires with damaged insulation should be repaired before further service. Damage to the flexible conduit, conduit support bracket and standoff pin should result in an immediate replacement of the conduit as well as the damaged parts. The inspection should be repeated at an appropriate cyclic interval. (Class II, Priority Action)(A-91-83)

Evaluate the design, installation, and operation of the forward cargo door flexible conduits on Boeing 747 airplanes so equipped and issue, if warranted, an Airworthiness Directive for inspection and repair of the flexible conduit and underlying wiring bundle, similar to the provisions recommended in A-91-83. (Class II, Priority Action)(A-91-84)

Chairman KOLSTAD, Vice Chairman COUGHLIN, and Members LAUBER, HART, and HAMMERSCHMIDT concurred in these recommendations.

Sincerely,

James L. Kolstad
Chairman