SP-20
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NATIONAL TRANSPORTATION SAFETY BOARD
WASHINGTON, D.C.

ISSUED: November 27, 1985

Forwarded to:

Honorable Donald D. Engen
Administrator
Federal Aviation Administration
Washington, D.C. 20591

SAFETY RECOMMENDATION(S)

A-85-129 through -132

The National Transportation Safety Board is continuing to participate in the investigation of the circumstances of the in-flight fire which was detected onboard a Royal Jordanian Airlines Lockheed L-1011 airplane while the airplane was descending to land at Singapore on October 18, 1985. The examination of the airplane was conducted in Singapore by an investigation team that included representatives of the Safety Board. The preliminary investigation disclosed that the fire originated in the left aft underfloor area of the airplane's fuselage, aft of the C-3 cargo compartment and forward of the rear pressure bulkhead. The Safety Board's concern that the fire ignited as a result of electrical arcing between a frayed generator feeder cable and a thin wall titanium duct containing high-pressure bleed air and the fire's subsequent propagation to other fuel sources was described in a letter to the Federal Aviation Administration (FAA) dated October 25, 1985. The safety recommendations contained in that letter, A-85-91 and -92, address actions needed to prevent future occurrences of a similar nature. The investigation of the accident disclosed other discrepancies in the L-1011 airplane which were not causal to the emergency but which could adversely affect the safety of passengers during an emergency situation.

During the airplane's descent following the first indications of an overheat condition or fire in the aft part of the airplane, the flightcrew became aware of a loss of cabin pressure. The loss of pressure was subsequently attributed to a hole approximately 8 inches in diameter that had been burned through the aft pressure bulkhead. The loss of pressure did not cause an automatic deployment of the passenger oxygen system. Normally, the passenger oxygen system will activate automatically, i.e., the oxygen mask compartment doors will open and a chemical oxygen generator in each compartment will be activated if the pressure in the cabin decreases to a cabin altitude equivalent to 13,300 + 600 feet. The Safety Board did not determine the cabin altitude reached as a result of the pressure loss through the aft pressure bulkhead. However, noting that the passenger oxygen system had not been activated automatically, the flightcrew attempted to activate the system by alternate means from the flight engineer's station. In this alternate mode of actuation a switch on the panel must be depressed for a minimum of 6 seconds; this action provides an electrical signal to the system in the same manner that an electrical signal is applied in the automatic mode by aneroid switches sensitive to cabin pressure. The passenger oxygen system failed to operate in the manual mode as well. After attempting to activate the oxygen system, the crew noted that the system circuit breakers had tripped.

Subsequent investigation by the manufacturer disclosed that a sequence timer, a component in the passenger oxygen system's electrical activation circuit, was faulty. Preliminary findings indicate that two capacitors in the sequence timer were shorted to ground thus causing excessive current which tripped the circuit breakers for both the normal and alternate power input sources for the oxygen compartment door latch circuits. The tripped circuit breakers interrupted the latch circuit power for both sequence timers and prohibited both the automatic and manual opening of the oxygen compartment doors and subsequent deployment of the oxygen masks.

The Safety Board is concerned that these preliminary findings suggest a potential fault in the L-1011 passenger oxygen system that may not have been considered during the system's design and certification and was not evident until this emergency activation was attempted. The Safety Board is aware that periodic inspections of the system are designed to verify the integrity of the system. However, the fault that caused this failure in the passenger oxygen system would not be detectable during currently required functional system checks. Current test procedures use a separate power source in the test mode and therefore do not evaluate the condition of the capacitors in the sequence timers which receive 28VDC power input for the activation of the compartment door latches and the oxygen generators. Consequently, current test procedures do not fully evaluate the condition of all components in the L-1011 passenger oxygen system. This explains how the oxygen system of the Royal Jordanian Airlines airplane was inspected without observed deficiencies about 650 flight hours before the October 18, 1985, accident. Therefore, the Safety Board believes that the FAA should review both the design and the maintenance program of the L-1011 passenger oxygen system and require changes as needed so that there is no potential for faults which can disable the system and remain undetected.

The second problem identified in the investigation of this accident involved the operation of the airplane's cabin doors. After landing, the flight and cabin crews initiated an emergency evacuation, and the L-1 door was opened and the slide deployed. Immediately thereafter, however, the crew realized that the initial fire problem had been controlled and they decided to hold passengers on the airplane until stairs could be installed so that the passengers could be deplaned normally. The crew also decided to ventilate the cabin by opening all of the cabin doors. The manual mode was used to open the remaining doors, i.e., the girt bar was disarmed to prevent slide deployment. The passenger doors on the L-1011 airplane are designed to open in the manual mode using energy stored in a counterbalance mechanism when a T-handle is pulled down to activate the opening mechanism. The door is supposed to open in about 3 to 6 seconds without assistance.

Two of the cabin doors, L-2 and R-3, failed to open normally. The R-3 door at the aft section of the airplane, near the area affected by the in-flight fire, failed to operate. In fact, the T-handle that activates the opening mechanism could not be moved. The manufacturer's representative examined the door-opening mechanism and found that the fire had melted the sleeve around a cable operated by the T-handle. Although the problem may have been unique to the circumstances of the accident, the Safety Board is concerned that the cable mechanism of the L-1011 cabin doors may be susceptible to binding when exposed to heat and that such binding could preclude proper emergency operation in the event of an in-flight fire emergency or postcrash fire. Consequently, the Safety Board urges the FAA to review the design and construction of the cabin door opening mechanism to minimize the probability of the cable binding when overheated.

When the cabin crew attempted to open the L-2 door in the manual mode, the door moved through about one-half of its full travel. A considerable manual effort was required to open the door fully. The examination of the L-2 door following this incident disclosed a problem with the counterbalance mechanism. The Safety Board is concerned that this problem may not be unique to the accident airplane and that other L-1011 airplanes may be in service with passenger doors that have defective counterbalance mechanisms which have not been and will not be routinely detected through the normal maintenance inspection program. The normal inspection program requires a random inspection of one door on each airplane at 3,000 flight-hour intervals. Therefore, less than 17 percent of the doors are inspected annually.

Preliminary information indicates that a malfunction of the counterbalance mechanism similar to the one that occurred on the Royal Jordanian Airlines airplane could significantly affect the operation of the cabin doors during an emergency evacuation in which the slides are deployed. The Safety Board believes that the FAA should require a one-time inspection of all cabin doors on L-1011 airplanes to ensure that they open fully using counterbalance energy within allowable time limits. Further, the Board believes that the FAA should determine the extent to which these malfunctions can affect adversely the emergency evacuation from the airplane and should require appropriate corrective action based upon these determinations.

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

> Require that a revised functional test be prepared and issue an Airworthiness Directive to immediately evaluate the condition of all components of the passenger oxygen system on Lockheed L-1011 aircraft to ensure operation both during automatic activation and when activated from the flight engineer's station. (Class I, Urgent Action) (A-85-129)
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> Review the design of the Lockheed L-1011 passenger oxygen system, and require changes as needed so that there is no potential for faults which can disable the system and remain undetected. (Class II, Priority Action) (A-85-130)
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> Review the design of the Lockheed L-1011 cabin door opening mechanism to ensure that the mechanism will operate properly when exposed to overheat conditions which could occur during survivable in-flight and postcrash fire emergencies, and require modification to preclude cabin door opening problems. (Class II, Priority Action) (A-85-131)
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> Issue a telegraphic Airworthiness Directive to require an immediate one-time inspection of all cabin doors on Lockheed L-1011 airplanes to determine whether they will open in the manual mode within prescribed time limits using energy stored in the counterbalance mechanism. Require that actions are taken before further flight to correct defects which can affect adversely the operation of a door during an emergency evacuation. (Class I, Urgent Action) (A-85-132)

BURNETT, Chairman, GOLDMAN, Vice Chairman, and LAUBER, Member, concurred in these recommendations.

By: Jim Burnett
Chairman