



National Transportation Safety Board

Washington, D.C. 20594

Safety Recommendation

LOG 2117

Date: January 26, 1989

In reply refer to: A-89-1 and -2

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

On January 20, 1989, the right engine separated from the wing of a Boeing 737-201, N242US, operated as Piedmont Airlines flight 1480, as the airplane lifted off runway 27L at the Chicago O'Hare International Airport, Chicago, Illinois. The flightcrew continued the takeoff and returned the airplane to the airport where an emergency single-engine landing was accomplished without further incident. The airplane was stopped on the runway and the remaining engine was shut down. There were no injuries to any of the 6 crewmembers or 27 passengers aboard the airplane. The separated engine fell on airport property approximately 800 feet past the departure end of runway 27L.

The separation of the engine resulted from fractures in all three of the engine attachment bolts. The leading edge control surfaces were damaged during the engine separation. Cockpit displays indicated that both the A and B hydraulic systems were also affected. The National Transportation Safety Board's investigation of this accident is continuing.

A preliminary visual examination of the cone bolts which attach the engine to the wing of the airplane disclosed that the aft attachment was weakened by fatigue cracking before separation and that the two forward cone bolts broke in ductile overstress. The metallurgical examination of the aft bolt revealed that fatigue had progressed from two diametrically opposed areas in the thread relief radius; the larger fatigue zone had propagated inboard through approximately half the cross section of the bolt and a smaller fatigue zone had propagated outboard. The fatigue had initiated at multiple sites within each fatigue zone.

Examination of the mating cone bearing surfaces of the aft bolt and the mating isolator mount disclosed mechanical deformities to the surfaces indicative of damage produced prior to or during assembly of the cone bolt in the isolator mount. The damage was a roughly cut gouge with raised material. Such damage could have caused a slight mismatch of the mating surfaces during assembly resulting in a nonuniform fit between the bearing surfaces. Consequently, even though the attachment bolt initially may have been properly

torqued, the torque may have loosened during cyclic loading of the attachment bolt as the anomalies on the bearing surfaces readjusted toward the conical shape. It is believed that fatigue cracking in the cone bolts would occur only if the prestressed condition intended by the designed torque preload is relaxed. The Safety Board is concerned that other 737-100/200 series airplanes also may lose the prestressed condition in the engine aft attachment mount due to bearing surface anomalies or other undetermined factors.

Two similar occurrences involving fractures of the aft cone bolts have been investigated by the Safety Board. Examinations of the separated cone bolts in both cases showed the failure mode to have been fatigue through the thread relief radii of the bolts. On December 21, 1987, the Safety Board issued Safety Recommendations A-87-125 and -126 recommending that an inspection of the aft attachment bolt for each engine be performed before each flight of those Boeing 737 airplanes containing secondary support cables and that recurrent inspections be performed to detect cracking in the thread relief radius of the aft cone bolts. The Federal Aviation Administration (FAA) issued airworthiness directive (AD) 88-01-07 effective January 25, 1988, requiring an ultrasonic inspection of the aft cone bolts within 300 cycles of the effective date of the AD and thereafter at an interval not to exceed 600 cycles. The AD incorporates Boeing alert service bulletin (ASB) 737-71-A1212, dated December 22, 1987, which provides for on-wing ultrasonic inspections. Records show that an ultrasonic inspection (as specified in AD 88-01-07) had been accomplished on the Piedmont airplane approximately 330 cycles before separation of the engine.

AD 88-01-07 and ASB 737-71-A1212 were further amended effective December 17, 1988, to require the installation of a new crushable secondary support structure for the engine. The new structure is designed to preclude the complete separation of the engine in the event of a bolt failure. This amendment is to be accomplished within 4,000 cycles of the effective date. The airplane involved in this accident had the secondary cable support installed as recommended by the original issue of SB 737-71-1069, dated December 13, 1982. The installation of the new secondary support structure had not been accomplished at the time of the accident.

The Safety Board believes that the Piedmont accident indicates that the recurrent inspection interval of 600 cycles specified in AD 88-01-07 may be too great since the cone bolt failure occurred only 330 cycles after an ultrasonic inspection of the bolt had been accomplished. Further, the Safety Board believes that a check of the preload torque at the time of the last inspection may have disclosed a loss of torque which subsequently resulted in an accelerated fatigue failure. In addition, the Board believes that the installation of the new secondary support structure should be required as early as the availability of parts permits.

The Safety Board is concerned also that the engine aft cone bolt may have been broken before the Piedmont airplane was taxied from the gate and that the secondary support cable could have been supporting the engine until it separated during takeoff. Consequently, the Safety Board believes that a simple precautionary inspection should be performed before each flight of those airplanes containing secondary support cables.

The Safety Board notes that while no loss of life or property has occurred as a result of the cone bolt failure to date, the possibility of a catastrophic accident resulting from the separation of an engine from a Boeing 737-100 or -200 model airplane exists.

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

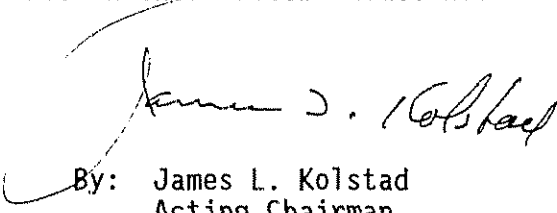
Amend airworthiness directive 88-01-07:

- (1) to decrease the number of cycles between ultrasonic inspection of the aft attachment cone bolts for the engine;
- (2) to require a check of the preload torque of the aft cone bolt concurrently with these ultrasonic inspections, and until repetitive inspection indicates that the torque preload has stabilized, to require more frequent inspection and torque check intervals for bolts that have been in service with less than specified torque; and
- (3) to accelerate the required installation of the new secondary support structure at the engine aft attachment.

(Class I, Urgent Action) (A-89-1)

Issue an airworthiness directive for Boeing 737-100 and -200 series airplanes to require that the operators of these airplanes inspect the engine nacelle fairings before each flight to verify that the aft cone bolt is intact on each engine until the aft engine mounts have been modified to include the new secondary support structure. (Class I, Urgent action) (A-89-2)

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


By: James L. Kolstad
Acting Chairman