

Log 2519



National Transportation Safety Board

Washington, D.C. 20594

Safety Recommendation

Date: November 21, 1994

In reply refer to: A-94-190

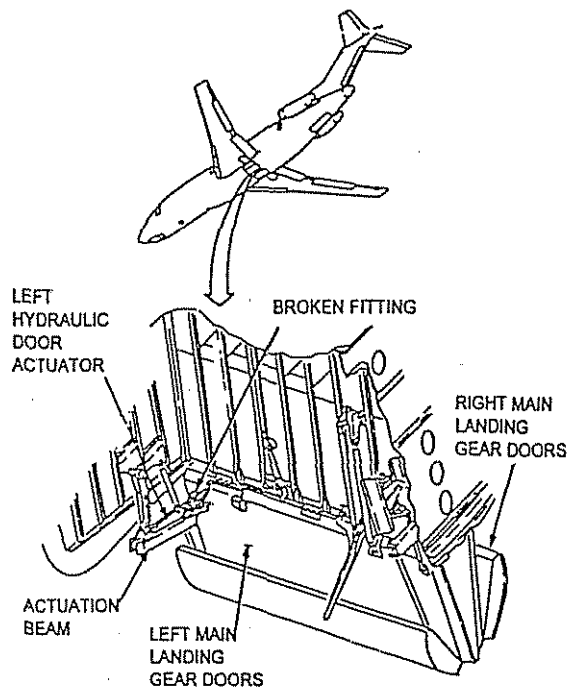
Honorable David R. Hinson
Administrator
Federal Aviation Administration
Washington, D.C. 20591

On April 2, 1994, about 1439 eastern standard time, a Boeing 727-243, N59412, operating as Continental Airlines flight 1447, landed at Orlando International Airport with the left main landing gear partially extended. The airplane came to rest on the left wing leading edge slats, trailing edge flaps, wing tip, nose tires, and right main landing gear. None of the nine crewmembers or 141 passengers were injured. Examination of the airplane revealed that the left main landing gear was in the wheel well, resting on the main landing gear door. A broken door fitting was found lodged in the door hinge area.

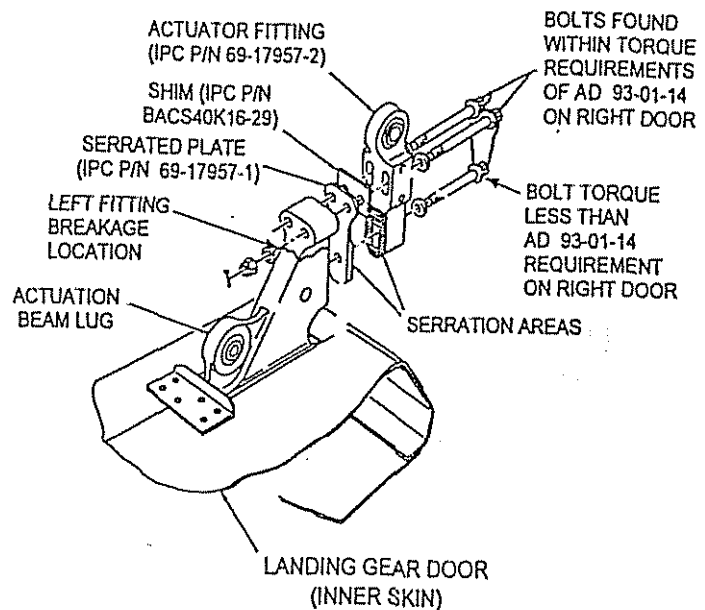
According to the B-727 maintenance manual description of main landing gear door operation, the main landing gear doors cover the wheel well openings when the landing gear is retracted or extended. A lock-operated door sequence valve is provided to ensure that the gear is locked in the up or down position before the wheel well doors close. A hydraulic actuator operates in conjunction with the actuator beam to open and close the wheel well doors. The actuator and the beam are attached to the door fitting assembly, located on the forward end of the inner wheel well doors. The fitting assembly consists of an aluminum fitting that attaches to the actuator beam and is part of the door, a serrated steel fitting that is bolted to the aluminum fitting and attaches to the hydraulic door actuator, and a serrated plate to maintain alignment of the fittings. Laminated shim material fills a pocket between the serrated plate and steel fitting.

The left main landing gear door fitting assembly laminated shims were removed and found degraded. The rectangular shims were distorted in shape, the individual plies were shifted, and the bolt holes were elongated. Degradation of the shims prevented a determination of their thickness prior to the incident.

At the Safety Board's laboratory, investigators found that loosening the single outboard bolt and not filling the shim pocket caused the left steel fitting and serrated plate on the damaged serrations at the base of the fitting pocket to pivot. Pushing the walls of the pocket toward each other caused separation of the serrated surfaces near the single outboard bolt.



DOOR COMPONENTS



FITTING ASSEMBLY

Because of the damage to the left door fitting assembly, the serviceable right door actuator fitting assembly was also examined. The right fitting single outboard bolt was found to have slightly less than the required torque. Evidence of fretting was seen at the edges of the fitting teeth and light could be seen between the aluminum fitting and the serrated plate. Shims removed from the right door fitting assembly were found to be distorted, with bolt hole elongation and shifting of the laminated plies. The shims in the right door fitting had degraded to the point of extruding from the assembly.

Serration damage seen in the left fitting, fretting residue found in the right fitting, extrusion of shim material, and shifting of plies indicated that the fitting assemblies had not been stable before the incident. Insufficient torque of the fitting bolts and loss of shim material may have loosened the actuator fitting bolts.

The Safety Board's materials laboratory examined the broken aluminum left actuator attachment fitting and found a low cycle-high stress fatigue failure. Fatigue striations indicated that at least 13,000 progression cycles¹ preceded the failure of the door fitting after the crack had

¹The Marks Standard Handbook for Mechanical Engineer's, Eighth Edition, provided a description of fatigue failure. A fatigue-originated crack will normally initiate at a surface, then progress during a number of strain (load/unload) cycles until becoming large enough for a rapid terminal mode, such as a ductile rupture or brittle fracture. Progression cycles are denoted by a series of concentric marks such as rings that originate at the crack initiation point and extend to the point of terminal failure.

initiated. Continental Airlines' maintenance records indicated that the landing gear had been maintained and inspected in accordance with current regulations and procedures. Airworthiness directives (ADs) applicable to the failed fitting, including those that directed repetitive inspections, had been accomplished. The records indicated that the main landing gear doors had not been replaced since the airplane was acquired in February 1987. The airplane had flown 34,039 hours and completed 22,777 flight cycles (approximately 45,554 door operations).

The landing gear door actuator fitting assembly had been the subject of, or associated with, four previous Safety Board safety recommendations, a Boeing service letter (SL), three Boeing service bulletins (SBs), an FAA Maintenance Bulletin, and four ADs. The three Boeing SBs have been revised seven times since 1967.

Following the investigation of a February 15, 1983, Eastern Airlines B-727-225 incident, the Safety Board found that the door actuator fitting was loose enough to move laterally and that the attachment bolts could be turned by hand. Safety Recommendation A-83-2 was issued on March 4, 1983, asking the FAA to require daily inspections of the attachment fittings for proper torque and security. The safety recommendation also asked that if evidence of looseness or relative motion of the fitting was found, the landing gear doors be rerigged.

The Safety Board also found a loose actuator fitting after a similar landing gear/wheel well door jam incident on a United Airlines B-727 on October 28, 1983. Safety Recommendation A-84-65, dated July 9, 1984, asked the FAA to consider mandating an option contained in AD 79-04-01, effective March 12, 1979, for a redesigned safety bar as an added measure to preclude main landing gear/wheel well door jams. The AD had required installation of improved main landing gear lock components, but left optional the installation of the redesigned safety bar.

The Safety Board classified Safety Recommendation A-83-2 "Closed--Acceptable Alternate Action" and A-84-65 "Closed--Acceptable Action" after the FAA issued Maintenance Bulletin 32-28 (FAA Order 8340.1A, Change 71), dated April 27, 1983, to alert operators and FAA inspectors to the problems and Boeing issuance of SL 727-SL-32-47. The FAA assured the Safety Board that its review with Boeing found the emergency extension system "adequate" and that the installation of the redesigned safety bar should not be mandated. However, in its letter to the Safety Board, dated October 3, 1984, the FAA acknowledged that the reasons for the Eastern and United Airlines incidents were unknown.

The Safety Board later investigated another Eastern Airlines B-727 main landing gear/wheel well door jam incident that occurred November 29, 1989. As in the previous incidents, the door actuator fitting bolts were found loose. Safety Recommendations were issued on September 24, 1990, asking the FAA to:

Issue an airworthiness directive applicable to Boeing 727 airplanes without new improved landing gear safety bars, installed during production or per Boeing SB 727-32-275, requiring immediate and recurring inspections of the landing gear

door actuator fittings for security and bolt torque in accordance with Boeing Service Letter 727-SL-32-47. (A-90-117)

Issue an airworthiness directive applicable to Boeing 727 airplanes without new improved landing gear safety bars, installed during production or per Boeing SB 727-32-275, requiring modification of the landing gear door actuator fittings to ensure that they remain correctly and securely fastened. The Boeing Company anticipates the issuance of a service bulletin in the near future regarding this subject. (A-90-118)

The FAA agreed with the Safety Board and issued AD 91-15-14 on July 8, 1991, to require inspection of the main landing gear door actuator attachment fitting bolts and replacement, if necessary. The AD referred to Boeing SB 727-32-388, which addressed positive retention of two of the actuator fitting bolts. AD 93-01-14 called for incorporation of SB 727-32-0383 (original issuance and Revision 1) and superseded AD 91-15-14 to require repetitive inspections for looseness in all three assembly bolts and for full mating of the serrated surfaces that align the fitting pieces.

The broken aluminum fitting within the assembly had been the subject of AD 90-02-19, which required inspections for cracking, as described within Boeing SB 727-32-0364. Revision 2 to the SB, dated April 14, 1991, stated that five operators had reported 10 cracked fittings, one of which resulted in a gear-up landing. The cracked fittings had been found on airplanes with 20,000 to 50,000 flight cycles.

Accomplishing the terminating actions described by ADs 90-02-19 and 93-01-14 allows operators to end the periodic inspections for cracks and loose bolts otherwise required by the ADs. The terminating action for AD 90-02-19 called for rework, repair, or replacement of the aluminum fitting. Continental Airlines maintenance records indicate that the broken fitting from N59412 had been reworked on October 9, 1991, and at least two subsequent inspections had been performed. Boeing reported to the Safety Board that other airlines had also found cracked fittings during inspections that followed incorporating the terminating actions specified by the AD.

Terminating action for AD 93-01-14 required replacement of the main landing gear door fitting attachment bolts with new bolts, castellated nuts, and cotter pins. Although the required inspection had been accomplished, the terminating action had not been accomplished in N59412. Since bolt torques are addressed by AD 93-01-14, the Safety Board is concerned that the finding of an inadequately torqued bolt in the right door actuator fitting assembly in N59412 suggests that the interval between bolt torque inspections may not have been adequate to ensure that the fitting bolts remained adequately torqued. The Safety Board believes that the aluminum fitting should continue to be inspected for fatigue-induced cracks since other cracks have been found following incorporation of the AD terminating actions. Additionally, the previous ADs and SBs do not address inspection for shim degradation or thickness of the laminated shim material.

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

Revise Airworthiness Directives 90-02-19 and 93-01-14, applicable to Boeing 727 main landing gear door actuator fitting assemblies, to reduce the current inspection intervals, thereby improving the potential for identifying loose bolts and cracks in the aluminum fittings. The revision should also require inspection of the laminated shims within the assembly for reduction of thickness and degradation and require continued periodic inspections until an alternative design is available. (Class II, Priority Action) (A-94-190)

Chairman HALL, and Members HAMMERSCHMIDT and VOGT concurred in this recommendation. Member LAUBER did not participate.

By: 
Jim Hall
Chairman