Log 2572

National Transportation Safety Board

Washington, D.C. 20594

Safety Recommendation

Date: October 27, 1995

In reply to refer to: A-95-101 through -102

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

On September 16, 1995, the right main landing gear (RMLG) of a Boeing 767-332ER (B-767), operated as Delta Air Lines flight 69, collapsed while the airplane was making a right turn during its taxi to runway 23 for takeoff at Hamburg Airport, Hamburg, Germany. The airplane was 5 years and 3 months old and had 3,807 cycles and 25,196 hours.

Postaccident examination of the RMLG revealed multiple fractures on the outer cylinder aft trunnion, which had broken into three large sections. One section was retained by the German Flugunfalluntersuchungsstelle (FUS), Germany's aircraft accident investigation bureau, and the remaining two sections were sent to the Safety Board for metallurgical examination. The FUS's and Delta's preliminary examinations of the fractured trunnion revealed multiple stress corrosion cracks emanating from the outer cylinder aft trunnion bore.

The B-767 MLG is a conventional, four-wheel, dual tandem gear that has a metering pin orifice shock strut (see Figure 1). The gear has four support points: the forward trunnion, which attaches to a fitting on the wing rear spar; the aft trunnion, which attaches to the landing gear beam; the drag brace, which attaches to a fitting on the rear spar; and the side strut, which ties to a fitting at the outboard end of the landing gear beam. The outer cylinder of the MLG assembly transfers operational loads from the truck assembly (the wheels and tires) to the four support points. The aft trunnion support point is a pin-in-socket design in which the pin is held inside the trunnion by a crossbolt. The trunnion pin connects the outer cylinder to the MLG beam. The trunnion pin is housed inside the upper aft end of the outer cylinder and bears against a flanged bushing that is installed in the outer cylinder using temperature differential shrink fit. The outer edges of the bushing flange and the cylinder are covered by a putty-like flexible fillet seal, which prevents moisture from entering under the bushing flange and cylinder chamfer area. The trunnion cylinder bore has a 5-inch-wide increased diameter section along the inner circumference of the cylinder that serves as a lubrication reservoir.

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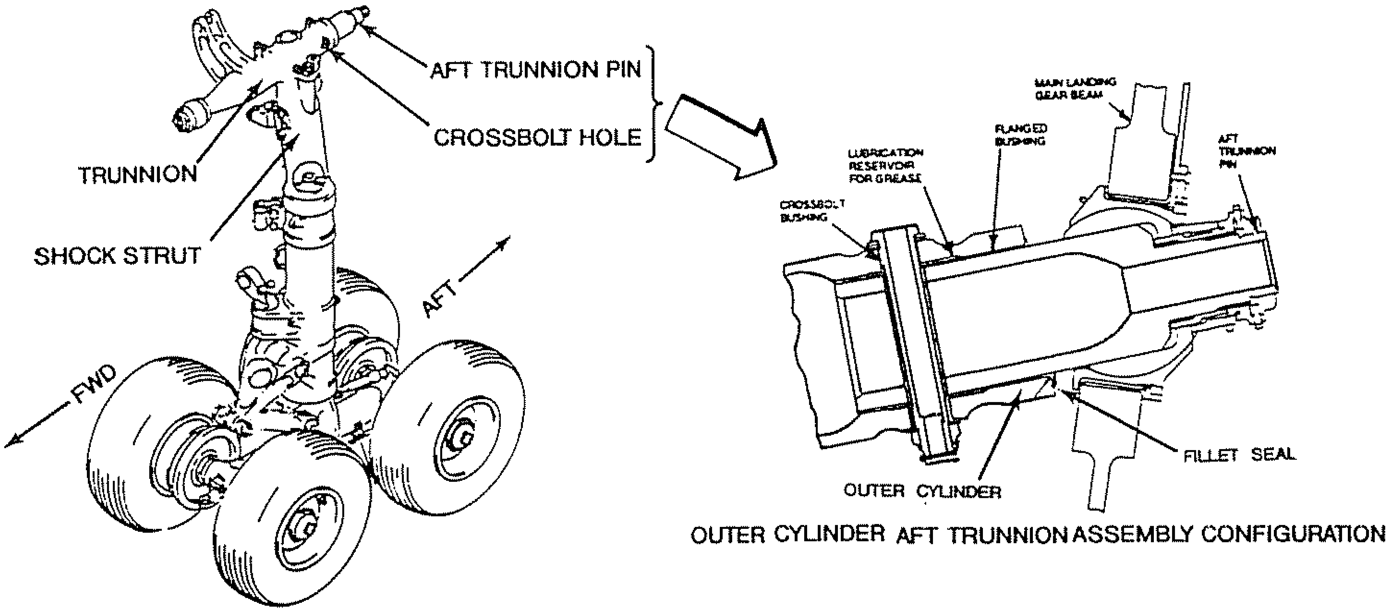

(Figure 1.) BOEING 767 MAIN LANDING GEAR ASSEMBLY

According to the Boeing Commercial Airplane Group, a lack of lubrication and/or insufficient interference between the trunnion cylinder and the trunnion pin may cause the bushing to move under loading. This results in the cracking of the fillet seal, allowing moisture to seep into and become trapped under the bushing flange and cause subsequent corrosion.

The Safety Board's materials laboratory examined two fragments of the outer cylinder aft trunnion, which represented about 75 percent of the aft trunnion. The examination revealed that the aft trunnion had multiple fractures and contained six areas of stress corrosion cracking (SCC), five primary and one secondary. The largest area of SCC originated at a corrosion-pitted area on the inside corner of the crossbolt hole extending through to the outside diameter wall approximately 5 inches in the aft and up direction. It contained a secondary SCC, which originated about 3 inches aft of the primary origin. The other four areas of SCC were as small as .04 inch deep by .1 inch wide. Of the four smaller SCC areas, one originated in the bore of the crossbolt hole and the other three emanated from the interior surface of the trunnion.

The inside surface of the outer cylinder aft trunnion was heavily corroded in two distinct circumferential bands. The corrosion bands were located at the forward and aft edges of the lubrication reservoir. The forward corrosion band was about 8 inches from the aft end of the trunnion. The reservoir contained a layer of dried grease that covered the lower half of the reservoir. Examination of the reservoir surface after it was cleaned revealed severe corrosion damage under the dried grease. Three of the SCC areas emanated from corrosion-damaged surfaces.

This failure differs from three previous B-767 landing gear trunnion fractures reported by Boeing, which had originated from corrosion damage at the aft end of the aft trunnion near the chamfer area under the trunnion pin bushing outer flange, whereas this failure was induced by corrosion on the trunnion bore.

Boeing records indicate that before the Hamburg accident, a total of three B-767 series accidents/incidents had occurred since 1992 involving MLG trunnion cylinder corrosion and subsequent failure. The first MLG trunnion fracture occurred in October 1992 and involved a B-767-200 owned by TACA airlines. This airplane had been in service for 6 years and 5 months and had accumulated 25,841 flight hours and 14,046 cycles. The fracture occurred in the outer cylinder aft trunnion from stress corrosion that had initiated from two corrosion pits on the chamfer at the aft end of the trunnion under the bushing flange. A third stress corrosion crack was discovered on the inner diameter surface in the trunnion undercut area. The second MLG outer cylinder aft trunnion failure occurred in April 1995 and involved a B-767-300 owned by Delta Air Lines. This airplane had been in service for 8 years and 4 months and had accumulated 27,177 flight hours and 13,745 cycles. Delta reported SCC initiating from severe corrosion in the chamfer under the sealed bushing flange. The third MLG trunnion failure occurred in July 1995 and involved a B-767-300 owned by Martinair. This airplane had been in service for 5 years and 10 months and had accumulated 28,887 flight hours and 6,640 cycles. Examination of the two recovered pieces also revealed SCC from severe corrosion in the chamfer under the sealed flange. All three incidents occurred while the aircraft were parked at the gate. All three MLG had been installed during the airplanes' production and had not been overhauled.

Following the third incident of MLG outer cylinder aft trunnion failure because of SCC, Boeing issued Service Letter (SL) 767-SL-32-067 on August 4, 1995, to provide interim visual inspection procedures and repair instructions for the aft trunnion joint on B-767 MLG. On September 14, 1995, the Federal Aviation Administration (FAA) issued Airworthiness Directive (AD) 95-19-10, effective on September 29, 1995, which incorporated procedures from the SL. The AD, applicable to all B-767 airplanes, requires operators to conduct visual inspections to ensure that corrosion is not present in the outer cylinder aft trunnion. The AD applies to MLG older than 5 1/2 years or that have been in service more than 5 1/2 years since the last overhaul of the MLG, and requires visual inspection within 60 days after the effective date of the AD.

The AD requires operators to perform a visual inspection of the outer cylinder aft trunnion on the MLG to determine if the fillet seal is cracked or missing, in accordance with SL 767-SL-32-067. If the fillet seal is found cracked or missing, the operator must remove the fillet seal, clean the adjacent area with solvent, apply corrosion-inhibiting compound (CIC), and perform a visual inspection to detect corrosion. If any corrosion is detected, operators must remove and repair the aft trunnion before further flight.

The AD and SL do not specify how to detect corrosion after applying CIC fluid to the fillet seal area or whether the CIC is to be used in detecting the corrosion. The Safety Board believes that the AD and SL should have clarified the application and use of the CIC.

On September 25, 1995 (9 days after the accident at Hamburg), the FAA issued Telegraphic AD T95-20-51, which requires, within 48 hours, that operators perform an external general visual inspection of the lower half of the aft trunnion of B-767 MLG to detect discrepancies. This inspection is to be performed repetitively, every 48 hours, on airplanes having MLG older than 4 years. Although the telegraphic AD specifically addresses detection of corrosion and cracks, it does not require a visual inspection of the entire outer surface of the MLG aft trunnion. The Safety Board believes that a detailed visual inspection for cracks and corrosion should be performed on the entire outer surface of the MLG outer cylinder aft trunnion for a lateral distance of at least 12 inches from the aft trunnion end to include the vicinity of the crossbolt holes. Although the telegraphic AD does not require a complete visual inspection, reportedly because of difficulty in inspecting the upper trunnion surface, the Safety Board found that Delta Air Lines has been inspecting the entire circumferential surface of the aft trunnion with the help of a mirror and without a requirement to remove the wing upper panel. Although the external visual inspection specified in the ADs will not detect internal corrosion, inspections may detect large stress corrosion cracks that penetrate the outer surface of the trunnion, such as cracks emanating from the crossbolt hole in the Delta/Hamburg accident.

Also, because the Delta/Hamburg accident revealed stress corrosion cracks in the bore of the aft trunnion near the crossbolt area and no corrosion under the bushing flange, chamfer, or fillet seal, the Safety Board believes that the moisture could have entered into the bore through areas such as the crossbolt area or the grease fitting hole or because of unknown reasons. The Safety Board believes that although the inspection of the fillet seal for cracks as specified in the AD is important to detect the possibility of corrosion near the chamfer area, it will not help in detecting corrosion in the trunnion bore as was found in the Delta/Hamburg accident. Because no methods currently exist to detect corrosion and cracks in the trunnion bore, the Safety Board believes that a reliable inspection technique should be developed immediately to detect corrosion and cracks in this area.

The Safety Board is aware that Boeing and other operators are developing non-destructive inspection (NDI) techniques to detect internal corrosion and cracks in the trunnion bore area and that the development of criteria for such inspections may require a significant amount of time. The Safety Board believes that until a definitive NDI technique is established, the entire MLG outer cylinder aft trunnion surfaces should be inspected frequently, and in detail, for cracks and corrosion.

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

> In conjunction with the Boeing Commercial Airplane Group and U.S. operators of the Boeing 767, establish a non-destructive inspection technique and criteria to inspect and detect corrosion and cracks on the internal surface of the main landing gear outer cylinder aft trunnion and, as soon as it is determined to be effective, issue an airworthiness directive to require operators to use the technique. (Class I, Urgent Action)(A-95-101)
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> Until a definitive non-destructive inspection technique is established, require Boeing 767 operators to visually inspect the entire main landing gear outer cylinder aft trunnion surfaces frequently, and in detail, for cracks and corrosion. (Class I, Urgent Action)(A-95-102)

Chairman HALL, Vice Chairman FRANCIS, Member HAMMERSCHMIDT, and Member GOGLIA concurred in these recommendations.

By: Jim Hall
Chairman