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National Transportation Safety Board

Washington, D.C. 20594

Safety Recommendation

Date: July 31, 1998

In reply refer to: A-98-62 through 64

Honorable Jane F. Garvey
Administrator
Federal Aviation Administration
Washington, D.C. 20591

On February 17, 1998, the right main landing gear (MLG) of a Boeing 757-200 (757) airplane, operated by Canada 3000 on an intended passenger charter flight from Brussels, Belgium, to Montreal, Canada, collapsed while the airplane was taxiing for takeoff at Brussels International Airport. None of the occupants were injured and the airplane sustained minor damage. The airplane had accumulated 11,450 cycles and 42,196 hours in 8 years and 9 months of service.

The National Transportation Safety Board is participating in the Belgian Civil Aviation Administration's investigation of the incident, in accordance with the provisions of Annex 13 to the Convention on International Civil Aviation. Postincident examination of the right MLG revealed a circumferential fracture on its truck beam, which had broken into two large sections. The examination of the fracture surfaces revealed intergranular stress corrosion cracking (SCC) emanating from corrosion pits on the lower inside diameter of the truck beam. Examination of the inside surface of the truck beam revealed multiple localized areas where the primer painted on the inside surface had deteriorated, bubbled-up, or was missing.

The 757 MLG is a conventional, four-wheel, dual-tandem landing gear that has a metering pin orifice shock strut (see figure 1). The gear has four support points: the forward trunnion, the aft trunnion, the drag brace, and the side strut. The shock strut outer cylinder of the MLG assembly transfers operational loads from the truck assembly to the four support points. The assembly consists of a truck beam, axles, wheels and tires, brake rods, and a protective shield. The truck beam is the primary supporting member of the truck assembly. It pivots on the lower end of the shock strut outer cylinder.

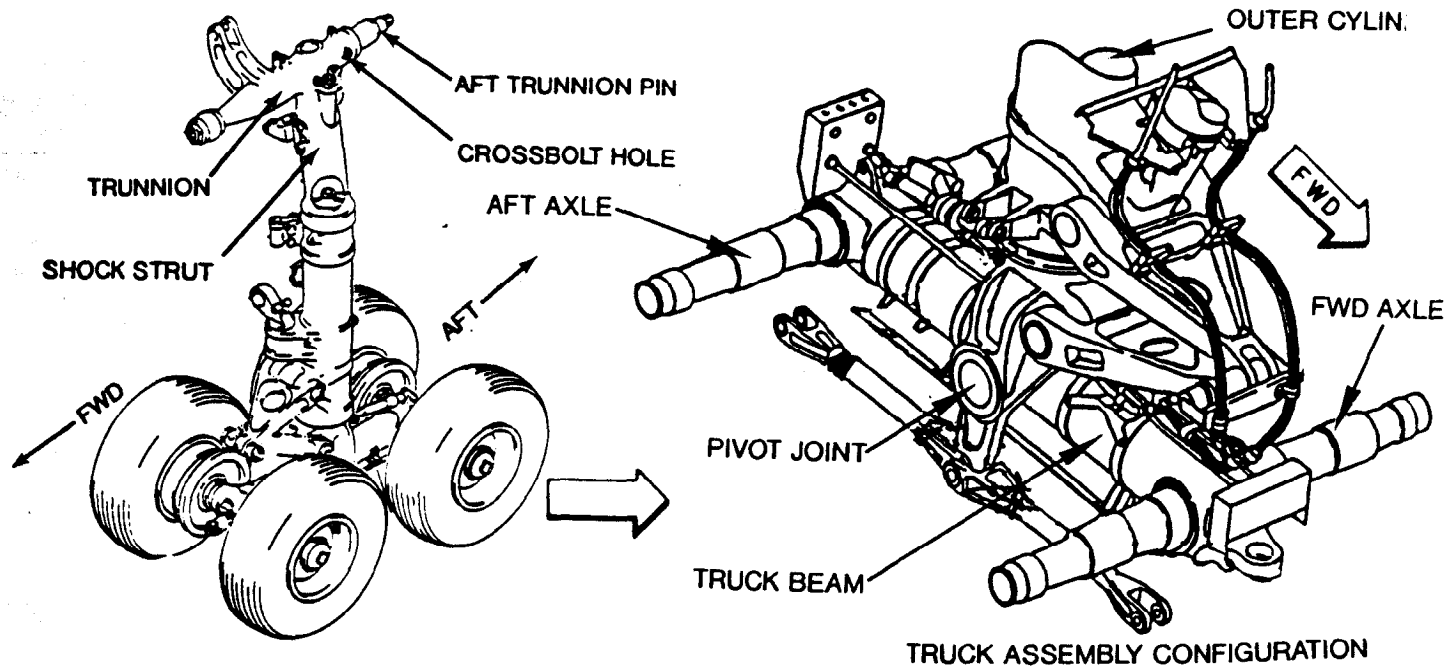

Figure 1. Boeing 757 Main Landing Gear Assembly

The truck beam is a hollow cylinder made from 4340M steel. The inner surface has three primary means of corrosion protection: cadmium-titanium electroplating; Boeing Material Specification BMS10-11 type 1 primer; and MIL-C-11796 Class 1 corrosion-inhibiting compound (CIC), also called Cosmoline. This CIC is applied in a hot liquid form and coats the inner surface of the truck beam with a uniform layer. Any moisture in the truck beam is drained through an opening at the aft end of the cylindrical truck beam section by gravity during truck tilt during takeoff.

The Safety Board's materials laboratory examined the right MLG truck beam and found three anomalies: missing primer, missing CIC, and a plugged drainage opening. About 75 percent of the inner surface of the truck beam was missing CIC, exposing the primer. There were localized spots of corrosion and exposed bare metal where the primer was missing. The primer was missing primarily on the bottom inner surface of the truck beam. In this area, some remaining primer had bubbled up and could easily be scraped off. Both ends of the truck beam contained approximately 2-inch diameter globules of CIC and grease. These globules and a dirt/grease mixture had clogged the truck beam's drainage opening.

The examination of the fracture surfaces disclosed a 0.9-inch wide region that showed characteristics of SCC. The primer was missing on the inner surface of the truck beam in the SCC area. Scanning electron microscope examination of the 0.9-inch wide SCC fracture region disclosed intergranular features, typical of SCC in 4340M steel, that emanated from three corrosion pits on the inner diameter surface. These corrosion pits measured no more than 0.01 inch deep by 0.01 inch diameter. The rest of the fracture area exhibited river pattern features characteristic of overstress.

Examination of the left MLG of the incident airplane at the overhaul facility revealed large globules of grease and CIC clogging the truck beam drainage opening similar to that found in the right MLG. The CIC had separated from the inner surface and there were patches of corrosion and areas where the primer was missing. The surface corrosion on the inner surface of the left MLG truck beam was more extensive than that found on the right MLG.

Boeing records indicate no other 757 MLG truck beam failures from SCC. Following this incident, the Safety Board contacted various 757 MLG overhaul facilities and was informed that typically 757 MLGs are inspected and overhauled after 8 to 10 years of service. Boeing's Maintenance Planning Document[1] for the 757 recommends the disassembly/restoration of the MLG between 12,000 and 18,000 cycles, or 10 years, whichever occurs first. The overhaul facilities informed the Safety Board that at overhaul, almost all 757 MLG truck beam inner surfaces exhibit patches of corrosion, but the primer and CIC are normally present. The overhaul facilities reported that globules of grease and CIC had not been found in any MLG truck beam that they had overhauled. The overhaul facilities reported that the truck beam drainage opening was found clogged in some MLGs that had been brought in for overhaul, but Boeing has informed the Safety Board that there have been a few isolated cases in which the CIC has separated from the truck beam inner surface and the primer has remained intact.

According to Boeing, if the CIC or primer separates from the inner surface, the corrosion protection capability is reduced. Also, if the gravity drain opening is clogged, the truck beam will retain ingested moisture creating an environment conducive to corrosion and SCC. The 757 maintenance manual does not specify a way to determine the condition of the corrosion protection layers (i.e., CIC and primer) or the gravity drainage opening of the MLG truck beam before overhaul. Because moisture is one of the primary causes of corrosion and can easily be ingested into the truck beam, it is important to eliminate it by preventing the drain opening from becoming blocked. Therefore, the Safety Board believes that the Federal Aviation Administration (FAA) should require operators of 757s to conduct periodic inspections of the MLG truck beam to ensure that the drainage opening at the aft end of the beam is unobstructed.

The balling up of the CIC and the loss of the primer from the interior surface of the truck beam resulted in the corrosion protection deteriorating over much of the surface of the beam, including the area where the stress corrosion cracking initiated. The presence of moisture and aggressive contaminants trapped within the beam by blockage of the drainage opening probably accelerated the deterioration of the corrosion protection and created an environment that led to the initiation of the stress corrosion cracking. A periodic visual inspection of the truck beam inner surface is important to detect the condition of the CIC and primer to minimize the possibility of corrosion or SCC in the beam. Also, to ensure detection of corrosion and cracking on the inner surface of the 757 truck beam, a nondestructive

[1] The Boeing Maintenance Planning Document provides general guidance to airlines in the formulation and establishment of individual maintenance programs.

inspection (NDI) technique should be developed and implemented. The Safety Board is aware that Boeing and other operators have developed NDI techniques to detect corrosion and cracks in the trunnion bore of the 767 MLG, and the FAA has mandated the inspection.[2] A similar technique could be developed to detect corrosion and cracks on the inner surface of 757 truck beams. Because no inspection methods currently exist to detect the condition of the CIC and primer or corrosion and cracks in the truck beam, the Safety Board believes that the FAA should develop and require the periodic use of visual and NDI techniques to evaluate the condition of CIC and primer and to detect corrosion and cracks on the inner surface of the 757 MLG truck beam.

Boeing has not yet completed its analysis of samples of the CIC and primer from the Canada 3000 incident airplane MLG truck beam to determine the reasons for reduction in its corrosion protection capabilities. It is important that the FAA monitor the progress of that analysis and take appropriate actions accordingly. Therefore, the Safety Board believes that the FAA should monitor Boeing's testing and analysis of the Canada 3000 MLG truck beam CIC and primer and, after the reasons for the reduction in its corrosion protection capabilities are determined, take corrective action to ensure that 757 MLG truck beams have adequate corrosion protection.

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

> Require operators of Boeing 757s to conduct periodic inspections of the main landing gear truck beam to ensure that the drainage opening at the aft end of the beam is unobstructed. (A-98-62)
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> Develop and require the periodic use of visual and nondestructive inspection techniques to evaluate the condition of corrosion inhibiting compound and primer and to detect corrosion and cracks on the inner surface of the Boeing 757 main landing gear truck beam. (A-98-63)
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> Monitor the Boeing Commercial Airplane Group's testing and analysis of the Canada 3000 main landing gear truck beam corrosion inhibiting compound and primer and, after the reasons for the reduction in its corrosion protection capabilities are determined, take corrective action to ensure that Boeing 757 main landing gear truck beams have adequate corrosion protection. (A-98-64)

[2] See Safety Board recommendations A-95-101 and -102, issued on October 27, 1995, which addressed a Boeing 767 right MLG trunnion failure in Hamburg, Germany.

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

By: Jim Hall
Chairman