The Dutch Safety Board

Occurrence #: 2004106 **Classification: Serious incident**

FACTUAL INFORMATION

Date:	06-07-2004	Cockpit crew:	3
Place:	Amsterdam Airport Schiphol	Cabin crew:	12
Aircraft registration:	CS-TMR	Passengers:	314
Aircraft model:	Lockheed L-1011-385-3 Tristar 500	Injuries:	None
Type of aircraft:	Passenger aircraft		
Type of flight:	Commercial air transport, passenger	Lighting conditions:	Daylight
Phase of operation:	Take-off roll		
Damage to aircraft:	Serious		

The flight and the occurrence

At 09.17 UTC[1] flight DCA2000, with destination Willemstad in Curacao, received clearance for take-off from runway 24 at Amsterdam Airport Schiphol. The flight of Dutch Caribbean Airlines (DCA), an airline from the Antilles, was executed by a three engined Lockheed L-1011-385-3 Tristar 500, owned by the Portuguese airline Luzair and operated by a flight crew of the Portuguese airline Air Luxor. The take-off was rejected by the crew. The captain stated that he rejected the take-off at a speed of approximately 140 knots due to a blast noise coming from the left hand side of the aircraft, followed by a sudden and momentarily yaw to the left. The yaw movement was stopped by the captain by applying rudder. The calculated V_1 was 152 knots. The captain stated that during the take-off no abnormal engine instrument indications had been observed by the flight crew.

One witness stated that during the acceleration phase of the take-off he had noticed a blowpipe flame from the exhaust cone of engine #1 twice, followed by a bang. Another witness noticed one blowpipe flame during the acceleration phase and two white plumes of smoke originating from the tires after the take-off had been rejected. When the aircraft taxied from the runway air traffic control instructed the flight crew to hold the aircraft because of smoke development and some flames near the right main landing gear (MLG). The crew stopped the aircraft and the engines were shut down. The airport fire fighting services were on standby to keep the situation under control. No crew members or passengers got injured.

The broken lug (bottom left) of the right MLG

The crack in the right MLG bogie beam

[1] All times in this report are universal time co-ordinated (UTC) unless otherwise specified. At the time of the occurrence, local time (LT) at Amsterdam Airport Schiphol was UTC + 2 hours.

It was found that the right MLG had sustained serious damage during the rejected take-off. The brake link connection lug on its right front brake unit (see left picture) and a number of electronic and hydraulic lines of the brake- and anti-skid system of the right MLG were found broken. No other evidence of cracking was observed at that time. The four tires of the left MLG had deflated of which two tires showed large scouring spots. Three tires (two aft and one left front) of the right MLG had deflated partially. Several small parts of the right MLG were found on the runway. Subsequent to being towed from the runway, a very large crack was observed in the front part of the right MLG bogie beam (see right picture).

Investigation & Analysis

The investigation by the Board was focussed on engine #1 and the fracture of the bogie beam. Underlying causes were not investigated.

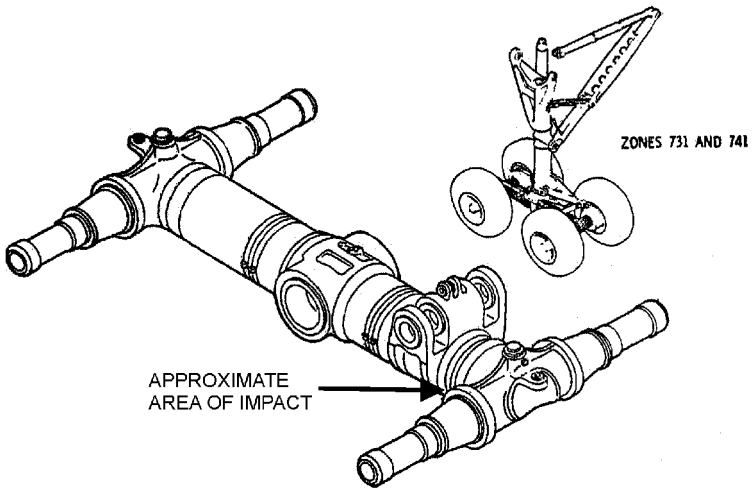
The flight data recorder (FDR) and cockpit voice recorder (CVR) were removed from the aircraft and taken to the Bureau d'Enquêtes et d'Analyses (BEA) in Paris, where they were read out. The event was recorded by the FDR. The sound quality as recorded on the CVR was good but the event was overwritten by other data, because the circuit breakers had not been pulled by the flight crew.

Under the authority of Air Luxor, Air Portugal performed a borescope inspection on engine #1. The findings report concluded that the damage of three rotor blades of the sixth stage of the intermediate pressure compressor (IPC) was within limits. Some rotor blade damage of the second stage of the high pressure compressor (HPC) was out of limits. There was also some abradable coating missing on the internal area of the stator case of the second stage of the HPC. It was not determined if these damages were already present before the occurrence took place.

The borescope inspection report and the FDR data were sent to the engine manufacturer Rolls-Royce. They reviewed the relevant FDR data and concluded that a surge had taken place on engine #1, which was most likely the result of the HPC damage. From the available FDR data, the engine start up and temperature stabilisation running periods were analysed. According to Rolls-Royce it is unlikely that the surge was the result of incorrect engine handling. Previous experiences suggest that the loss of the abradable stator coating and the observed blade damage of the second stage could have caused the engine surge.

The fractured bogie beam was submitted to the Boeing Metallurgy Laboratory in California, USA, for fractographic evaluation. The objective of this investigation was to determine the cause of fracture of the bogie beam and to determine if any material or processing discrepancies contributed to the fracture. The following conclusions were drawn:

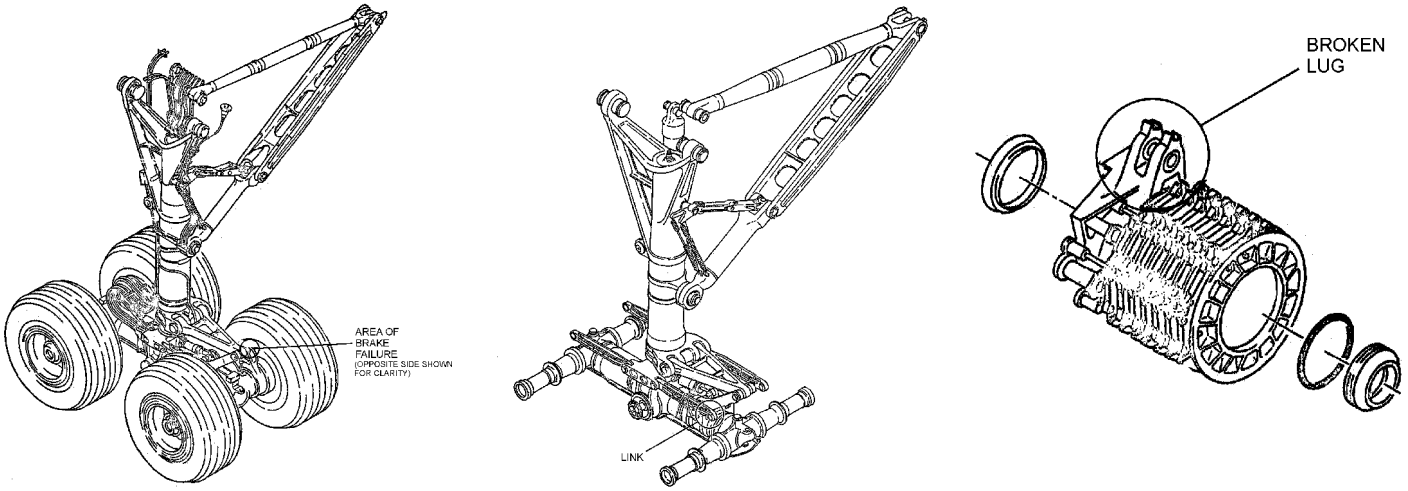
- Fracture of the right main landing gear bogie beam occurred due to stress corrosion cracking, which emanated from an area of mechanical damage on the right (outboard) side of the part, approximately seven inches aft of the centreline of the forward axle lug hole.
- Evidence of bubbling in the paint along the inner surface and softening of the base material along the outer surface in the area of mechanical damage, indicated that this region reached an elevated temperature.
- No material or processing defects were observed.



Bogie beam

The two detached parts of the brake link connection lug were submitted to KLM Engineering Support & Development for examination of the fractured areas. The department performed a microscopic investigation. The following conclusions were drawn by the Board:

- Investigation of fractures surfaces of the broken brake unit lug showed signs of overloading.
- At the edges some mechanical damage was present. Its cause could not be determined.



Brake link connection lug

Summarizing:
The observed bang during the take-off roll was probably caused by a single self-recovering compressor surge of engine #1. Because of the fast recovery the flight crew did not observe abnormal engine indications.

For the damage to the right MLG no unambiguous cause could be found.

The two most likely scenarios are discussed:

1. The area with mechanical damage on the bogy beam already existed before the occurrence. This damage had caused internal residual stresses in this area. The material of the bogie beam is susceptible for stress corrosion cracking. The loads on the bogie beam applied during the rejected take-off were above the stress corrosion cracking limit, causing the beam to crack.
Deformations of the cracked beam caused bending at the lugs on the brake unit, resulting in fracture of them. The brake link with the free end cut the electronic and hydraulic lines of the brake and anti-skid system.

2. The lugs on the brake unit broke first. This could be a result of some pre existing deficiency in it. Too much play in the bearing, existing damage, material or processing discrepancies.
As a result, the brake unit could rotate around the wheel axle. The brake link with the free end cut the electronic and hydraulic lines of the brake and anti-skid system.
A small aluminium part bolted to it scrapped along the beam, smearing the soft metal on it. This process caused the damage and the heating of the damaged area. The heating reduced locally the strength of the material. Under the loads on the beam during the rejected take-off it fractured.

Because no material or processing defects were observed during the investigation of the bogie beam no action was taken by the Board to inform the operators who are flying with the Lockheed L-1011 Tristar, regarding the fracture of the bogie beam.

Note: This report has been published in English and Dutch language. If there are differences in interpretation the Dutch text prevails.