



PRELIMINARY REPORT

Righthand Body Landing Gear separation during
landing of a Boeing B747-4R7F registered LX-OCV
and operated by Cargolux Airlines International
S.A. on runway 06 at Luxembourg Airport (ELLX)
on 14 May 2023

DATE OF ISSUE: 6 August 2024

The information in this preliminary safety investigation report is subject to change and may contain errors. It will be supplemented or corrected during the course of the investigation.

ADMINISTRATION OF TECHNICAL INVESTIGATIONS

CIVIL AVIATION – RAILWAYS – MARITIME – RIVER – ROAD



Ministry of Mobility and Public Works

Department of mobility and transports

Administration of Technical Investigations

Report N° AET/AC-2024/01

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Cargolux Airlines International S.A. on runway 06 at
Luxembourg Airport (ELLX) on 14 May 2023**

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FOREWORD

In accordance with Annex 13 - Aircraft Accident and Incident Investigation - to the Convention on International Civil Aviation, Regulation (EU) No 996/2010 of the European Parliament and of the Council of 20 October 2010 on the investigation and prevention of accidents and incidents in civil aviation and Luxembourg amended law dated 30 April 2008 on technical investigations in relation to accidents and serious incidents which occurred in the domains of civil aviation, maritime transport, railways and vehicle traffic on public roads, it is not the purpose of the safety investigation to apportion blame or liability.

The sole objective of the safety investigation and the related reports is the prevention of accidents and incidents.

Consequently, the use of this interim report for purposes other than accident prevention may lead to wrong interpretations.

Note: All times indicated in this report are in Universal Coordinated Time (UTC), unless stated otherwise.

On 14 May 2023, at 17:00:46 a Boeing B747-4R7F registered LX-OCV suffered a righthand Body Landing Gear (RH BLG) separation during landing on runway 06 (RWY 06) at Luxembourg Airport (ELLX).

History of flight

On 14 May 2023 at 16:08:43, the occurrence aircraft was cleared for takeoff on RWY 06 for a scheduled freight flight from Luxembourg Airport (ELLX) to Chicago O'Hare International Airport (KORD). Shortly after rotation, the PM was not able to select gear-up and a "GEAR TILT" EICAS¹ message was triggered, followed by a "GEAR DISAGREE" EICAS message. The aircraft proceeded to the DIK² holding with the gear extended, where the crew performed the related non-normal checklists, decided to dump fuel and return to ELLX with the gear extended. In order to be cleared to dump fuel over land, the crew declared an emergency, and the aircraft was vectored to an area over Belgium for fuel dumping. At 16:51:30, after dumping approximately 40 tons of fuel at FL100, the aircraft was vectored back to ELLX for an ILS³ approach to RWY 06. At 16:59:04 the aircraft was cleared to land on RWY 06. When the aircraft touched down at 17:00:46, the wheel truck of the RH BLG with part of the inner cylinder attached separated from the aircraft. In this process, the separated gear assembly impacted the lower part of the aft fuselage multiple times and struck the righthand horizontal stabilizer.

The crew was not aware of the RH BLG separation until they were informed by the tower that the aircraft had lost part of its landing gear on touchdown with four wheels attached. The crew then immobilized the aircraft on the runway.

Injuries to persons and damage

Nobody was injured during the occurrence. The aircraft sustained damage to the RH BLG, to parts of the lower aft fuselage and to the righthand horizontal stabilizer. The runway surface in the landing zone of RWY 06 was scratched by the separated gear parts and had to be repaired before reopening of the aerodrome on the same day.

After a damage assessment by the aircraft manufacturer, some damage could be categorized as substantial (i.e., punctured fuselage preventing the aircraft to pressurize) and the event was subsequently classified as an accident.

Investigation participants

After notification by the "Administration des enquêtes techniques" (AET, Luxembourg), the following Safety Investigation Authorities have appointed accredited representatives to the investigation:

¹ Engine Indication and Crew Alerting System.

² ID of the Radio Navigation Aid named Diekirch DVOR/DME located at the coordinates 495141N/0060747E.

³ Instrument Landing System.

- the National Transportation Safety Board (NTSB, USA), representing the States of design and manufacture;
- the “Bundesstelle für Flugunfalluntersuchung“ (BFU, Germany), representing the State of design of the engines;
- the Air Accidents Investigation Branch (AAIB, UK) representing the State of manufacture of the engines.

The following advisers have been designated to participate in the investigation:

- Designated by the AET:
 - the European Union Aviation Safety Agency (EASA);
 - the Directorate of Civil Aviation (DAC, Luxembourg);
 - Cargolux Airlines International S.A. (Luxembourg).
- Designated by the NTSB:
 - the Federal Aviation Administration (FAA, USA);
 - the Boeing Company (USA).

Factual information

Airport surveillance video footage showed that after becoming airborne, the RH BLG wheel truck initially rotated to a normal pitch-up position (Fig. 1-1) before an over-extension of the strut could be observed (Fig. 1-2). The over-extension was accompanied by a vapor release. During climb out, the RH BLG wheel truck could be observed in a pitch-down position (Fig. 1-3). The same pitch-down position could also be observed on a publicly available landing video⁴, up to the point of the RH BLG separation on touchdown.



Fig. 1-1



Fig. 1-2



Fig. 1-3

(Fig. 1-1, 1-2 & 1-3 - Source: lux-airport⁵)

⁴ [Link to the landing video.](#)

⁵ Société de l'Aéroport de Luxembourg S.A.

During normal operation of the BLG (Fig. 2), the Truck Positioning Actuator (TPA) tilts the wheel truck to a 7° pitch-up position to ensure the correct positioning for the gear retraction sequence. The piston rod of the TPA was found fractured near the actuator body after the occurrence. In case of failure of the TPA, the wheel truck would still pitch up due to the weight of the lower torsion link and the steering cylinders that attach aft of the gear truck pivot joint.

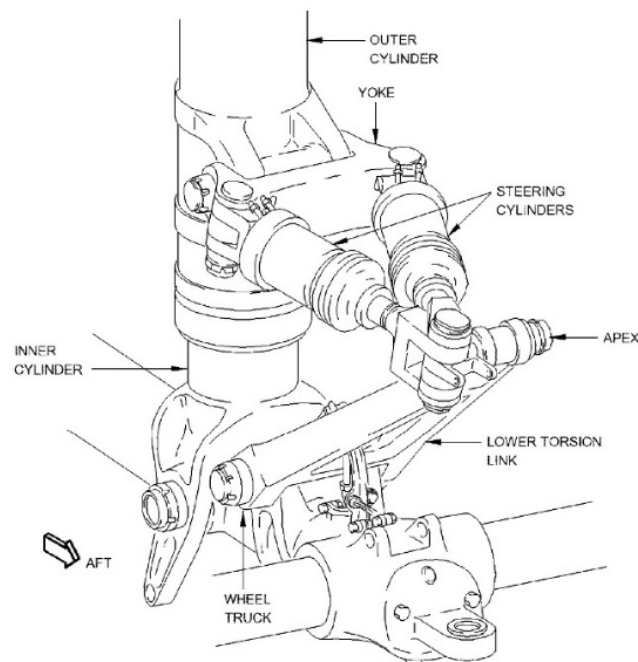


Fig. 2 (Source: The Boeing Company)

The pitch-down position of the wheel truck after takeoff indicates an over-extension of the shock strut. According to the Aircraft Maintenance Manual (AMM)⁶, in fully extended condition with the Upper Bearing and Snubber Valve stopping against the Follower Tube, the Inner Cylinder extends to 33.30 inches (Fig. 3-1⁷). A kinematic diagram provided by the manufacturer showed that in case of an over-extension of the shock strut beyond the fully extended condition, the steering yoke contacts the outer cylinder steering yoke attach lugs at an angle of approximately 32° (Fig. 3-2), with an over-extension of approximately 7 inches. Based on the truck pivot and torsion linkage attachment geometry, any further over-extension beyond that position will induce a pitch-down movement of the gear truck and the TPA must expand (or fail) against its commanded pitch-up position.

The over-extension of the shock strut is limited by the steering mechanism assembly to a value of approximately 12 inches beyond the fully extended condition, where the lower torsion link to truck attach lugs contact the inner cylinder and the gear truck reaches a pitch-down angle of approximately 31° (Fig. 3-3). The lack of contact witness marks on the attach lugs or the inner cylinder seems to indicate that this maximum over-extension condition was not reached during the investigated event.

⁶ TASK 12-15-04-603-055 Body Landing Gear Shock Strut Servicing.

⁷ Fig. 3-1, 3-2 & 3-3: The BLG is represented without the wheels and the TPA.

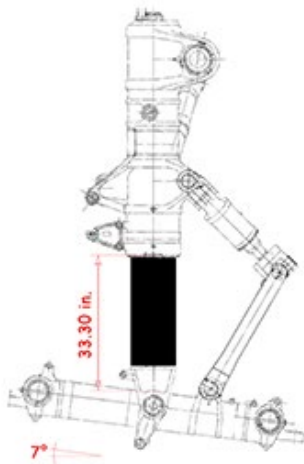


Fig. 3-1

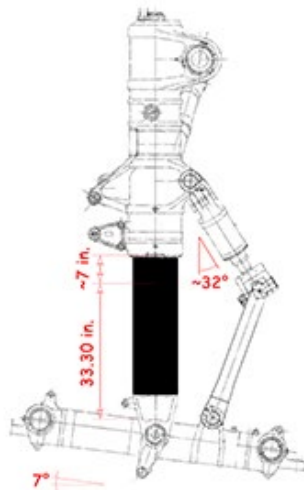


Fig. 3-2

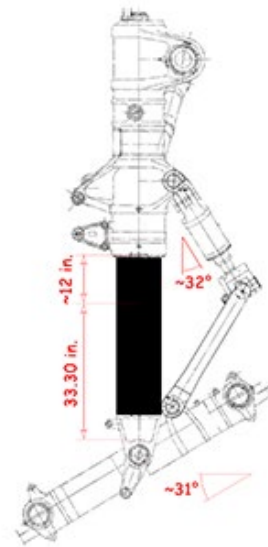


Fig. 3-3

(Fig. 3-1, 3-2 & 3-3 - Source: The Boeing Company, modified by AET)

The parts of the RH BLG were sent to Boeing’s Equipment Quality Analysis (EQA) and Research and Technology (BR&T) laboratories for examination under the oversight of the National Transportation Safety Board (NTSB). The Boeing laboratories found that the upper bearing carrier had failed, with the bearing and piston ring retention lands sheared off. Other key features of the examined parts were found to be within design, wear or repair limits. An additional examination of an inner cylinder segment was started at the Boeing laboratories in May 2024.

The occurrence aircraft had operated 4717 cycles from 10 June 2016, when the RH BLG was installed, until the gear separation event on 14 May 2023. The last BLG shock strut servicing, consisting of deflating the shock strut, filling it with hydraulic fluid and pressurizing it, was carried out on 24 January 2023 (deflating and filling up) and 1 February 2023 (pressurizing). In accordance with the AMM, subsequent services after 5 – 10 landings were performed between release to service on 6 February 2023 and 18 February 2023 to ensure that the strut extension value and the inflation pressure were within the band on the servicing chart.

Similar occurrences

On 14 September 2005, a similar event took place during takeoff of a Boeing 747-400F on a scheduled freight flight from Amsterdam Airport Schiphol (EHAM) to Milan Malpensa (LIMC).

The report published by the Dutch Safety Board⁸ stated that *“the damage was caused by over-extension of the left-hand body landing gear. During gear retraction, the tires of the over-extended left main body gear contacted and damaged the structure”*. The investigation further identified *“that failure of the upper bearing carrier initiated the failure sequence of the shock strut internal component damage and subsequent over-extension”*.

⁸ https://onderzoeksraad.nl/wp-content/uploads/2023/11/2006039e_2005135_ja_01_kz_short_report.pdf

The failed upper bearing carrier could be traced to a series of parts affected by a material defect reported via supplier notice of escapement (NOE), which *“had not been properly heat treated and were delivered in the annealed condition”*. The airplane was in service for about three months at the time of the occurrence.

The RH BLG upper bearing carrier of LX-OCV was confirmed by Boeing not to be in population of the parts identified via the NOE.

Investigation status

The examination of BLG components and the gathering of further information are still ongoing. The drafting of the final report has been initiated and will be finalized once all pertinent information is available and has been analyzed.

At the date of publication of this Preliminary Report, no recommendation had been issued.