

Investigation Report

The Investigation Report was written in accordance with para 18 Law Relating to the Investigation into Accidents and Incidents Associated with the Operation of Civil Aircraft stating facts only.

Identification

Type of Occurrence:	Accident
Date:	26 November 2010
Location:	Frankfurt/Main Airport
Aircraft:	Transport aircraft
Manufacturer / Model:	The Boeing Company / B747-400
Injuries to Persons:	None
Damage:	Aircraft severely damaged
Other Damage:	None
State File Number:	BFU 1X005-10

Factual Information

During line-up, the right Wing Landing Gear (WLG) fractured in the area of the aft mounting of the landing gear.

History of the Flight

After 257 passengers and 17 crew members had boarded for a flight from Frankfurt/Main Airport to Buenos Aires, Argentina, the airplane was pushed back from terminal 1 at 2255 hrs¹. It taxied along taxiways N5 and N towards runway 18.

The crew stated that about 300 m before they reached runway 18 the clearance to roll on to runway 18, after an Airbus A319 taking off, was issued. After the A319 had begun to roll they slowly began to roll on to runway 18. The A319 stopped again and at 2310 hrs the B747-400 was decelerated abreast of the taxi-holding position N in order to delay entering the runway.

The crew stated that simultaneously with the deceleration a hard and loud blow could be felt: "Ähnlich wie wenn man mit einem Auto durch ein tiefes Schlagloch fährt (similar to driving through a deep pot-hole with your car)."

After the A319 had taken off, the crew decided to roll on to runway 18 and leave it again via taxiway L in order to not block the runway and check out the incident.

After the airplane had been parked outside of the runway safety area the passengers disembarked via mobile stairs from the fire brigade and were taken to the terminal by buses.

Personnel Information

The 57-year-old Pilot in Command (PIC) held an Airline Transport Pilot's License (ATPL(A)) issued in accordance with JAR-FCL, German. The license was initially issued on 14 March 1985 by the Luftfahrt-Bundesamt (German Civil Aviation Authority, LBA) and valid until 28 February 2015. His Class 1 Medical Certificate was valid until 30 August 2011. He had a total flying experience of 19,595 hours; of which 7,987 hrs were flown on type. The type rating was valid until 28 February 2011.

The 48-year-old first co-pilot held an Airline Transport Pilot's License (ATPL(A)) issued in accordance with JAR-FCL, German. The license was initially issued on 4 May 1992 by the LBA and valid until 28 April 2015. His Class 1 Medical Certificate was valid until 3 September 2011. He had a total flying experience of 8,434 hours; of which 5,310 hours were flown on type. His type rating was valid until 28 February 2011.

¹All times local, unless otherwise stated.

The 56-year-old second co-pilot held an Airline Transport Pilot's License (ATPL(A)) issued in accordance with JAR-FCL, German. The license was initially issued on 4 November 1994 by the LBA and valid until 10 June 2015. He had a total flying experience of 13,707 hours; of which 7,549 hours were flown on type. The type rating was valid until 22 June 2011. His Class 1 Medical Certificate was valid until 20 December 2011.

Aircraft Information

The aircraft type B747-430 of The Boeing Company is an all-metal low wing airplane with nose wheel configuration. It was equipped with four General Electric CF 6-80C2B1F jet-engines. The aircraft with the Manufacturer's Serial Number 29101 was built in 1998. Maximum take-off mass was 394,625 kg.

At the time of the accident it had a take-off mass of 393.7 t.

The aircraft had a German certificate of registration and was operated by a German operator.

Meteorological Information

According to the statement of the BFU representative at the airport wind velocity was 2 kt/150°. Temperature was 1°C and ground visibility 7,000 m.

Aerodrome Information

Frankfurt/Main Airport (EDDF) had three runways with concrete surfaces. Two runways are oriented 069° and 249° and have the designations 07L/25R and 07R/25L, respectively. Both are 4,000 m long and 45 m wide. A third runway with the designation 18 is oriented 179° and also 4,000 m long and 45 m wide.

Flight Recorders

The airplane was equipped with a Fairchild FA2100 p/n 2100-4043-00 Flight Data Recorder (FDR) with the serial number 00475, and a Fairchild A100S p/n S100-0080-00, serial number 03007, Cockpit Voice Recorder (CVR).

The recordings were available for evaluation purposes.

Wreckage and Impact Information

The occurrence took place at the area of taxi-holding position N of runway 18. In order to not block the runway, the airplane had left via taxiway L and parked outside of the runway safety areas.

Personnel of the operator and the responsible maintenance organisation, respectively, appraised the damage at the site on taxiway L and determined that the right wing landing gear had fractured in the area of the trunnion, the aft bearing of the landing gear cylinder (Appendices, Fig. 1). The wheel well and the wheel well door were also damaged. It leaked hydraulic fluid.

The wing in the area of the landing gear was punctured (Appendices, Fig 2). The outer skin of the fuselage above the right wing between Station STA 1335 and STA 1350 abreast of Stringer STR 21 was punctured inward (Appendices, Fig 3). These damages were due to the fill plug of the former load evener system, which had been pressed out of the fill plug bore.

During an extended search in the area of the taxi-holding position N an approximately 30 cm long fracture piece of the aft landing gear pivot pin lug was found, but not the fill plug or the respective safety bolt.

The defective landing gear was removed and together with the other seized items transported to Hamburg to the operator's maintenance organisation. There the technical equipment was available to examine a landing gear of this size.

The BFU led the examination and representatives of the National Transportation Safety Board (NTSB) and the aircraft manufacturer facilitated. Maintenance and laboratory employees of the operator assisted in the examination.

The examination of the fractured outer cylinder showed that the base material was AISI 4340M (300M) with a general hardness of 52HRC. This met the manufacturer's requirements.

The fracture origin was located in the area of the fill plug bore of the former load evener system. Further inspection showed that the fracture origin had occurred at the inner diameter below the nickel coating. The fracture surface of the fracture origin was surrounded by brown areas.

The examination with the scanning electron microscope confirmed the fracture origin at the inner diameter (Appendices Fig. 4 - 6). The fracture origin showed minor corrosion. The fracture origin proceeded transcrystalline followed by forced rupture

which showed a ductile structure. The fracture was caused by stress corrosion cracking.

Additional Information

The fractured outer cylinder was an older version which originally had been used in the B747-200/300. For these airplanes, there was a 'load evener' system which would apply an even pressure to all four main landing gear struts in order to keep the airplane level anytime the airplane weight was being carried by the landing gear. Based on service experience, the 'load evener' system was omitted for the B747-400 model. In order for an 'older style' (with the load evener system) outer cylinder to be used in aircraft types such as the B747-400 the manufacturer modified it by filling the fill plug hole (for the evener system) with a plug. It was secured with a bolt (Appendices Fig. 7). The plug was subject to the pressure of the nitrogen fill of the landing gear. The surface of the fill plug bore was coated with nickel.

The fractured outer cylinder on the accident aircraft was manufactured in 1976 for an older model of the B747 which had the load evener system installed. For use on the B747-400, the fill port on the strut for the evener system was plugged. The landing gears of the B747 do not have a life span limitation due to the redundancy of having 4 main landing gears to support the weight of the airplane. If a main landing gear fails, the other three are certified to carry the weight of the airplane during taxi, take-off and landing. Therefore no detailed information as to the number of cycles on the fractured gear was available. Maintaining cycle/hour counts are therefore not required for components which are not subject to life span limitations. Estimates show that the outer cylinder had completed about 27,750 cycles. During its life span the outer cylinder was subject to maintenance actions in 1996 and 2003. Among other things, the area of the fill connection was overhauled so that it could be fitted to a B747-400 model. Since the last overhaul it had completed about 4,500 cycles.

The fractured outer cylinder was the last of this kind which the operator had still used. During maintenance work it was replaced by the newer version which was manufactured without the evener system fill plug.

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Appendices



Fig. 1: Fractured outer cylinder

Source: BFU



Fig. 2: Punctured R/H wing, viewed from the window

Source: BFU

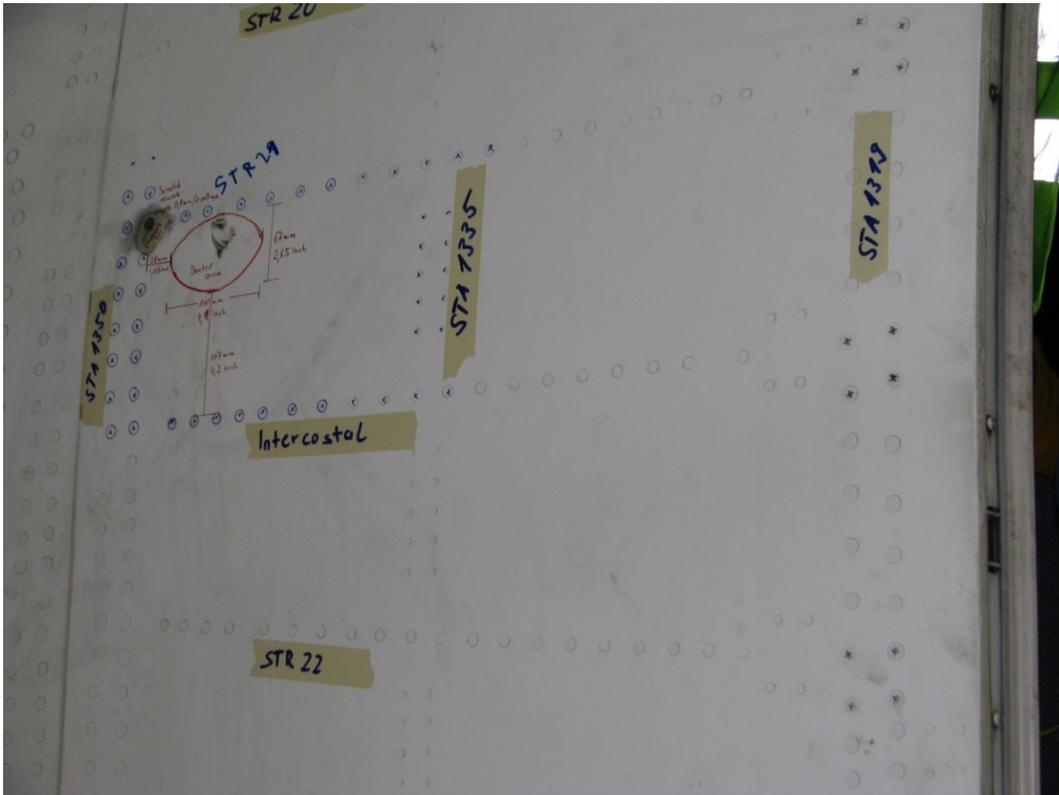


Fig. 3: Damaged outer skin

Source: BFU



Fig. 4: Fracture piece including fracture origin

Source: BFU

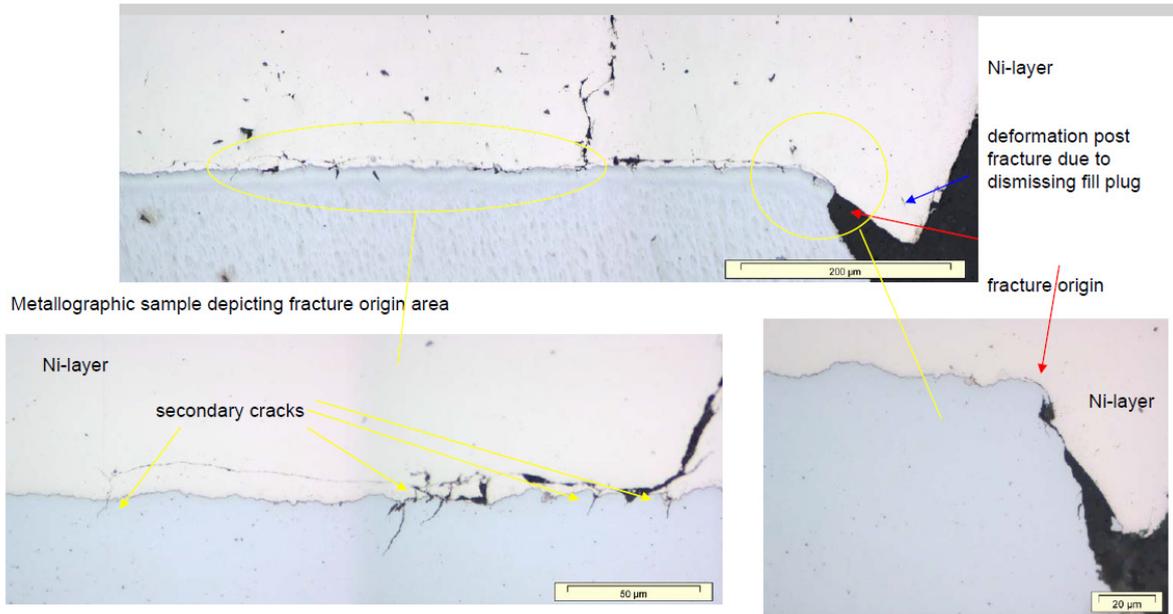


Fig. 5: Metallographic images of the fracture origin

Source: LHT Laboratory

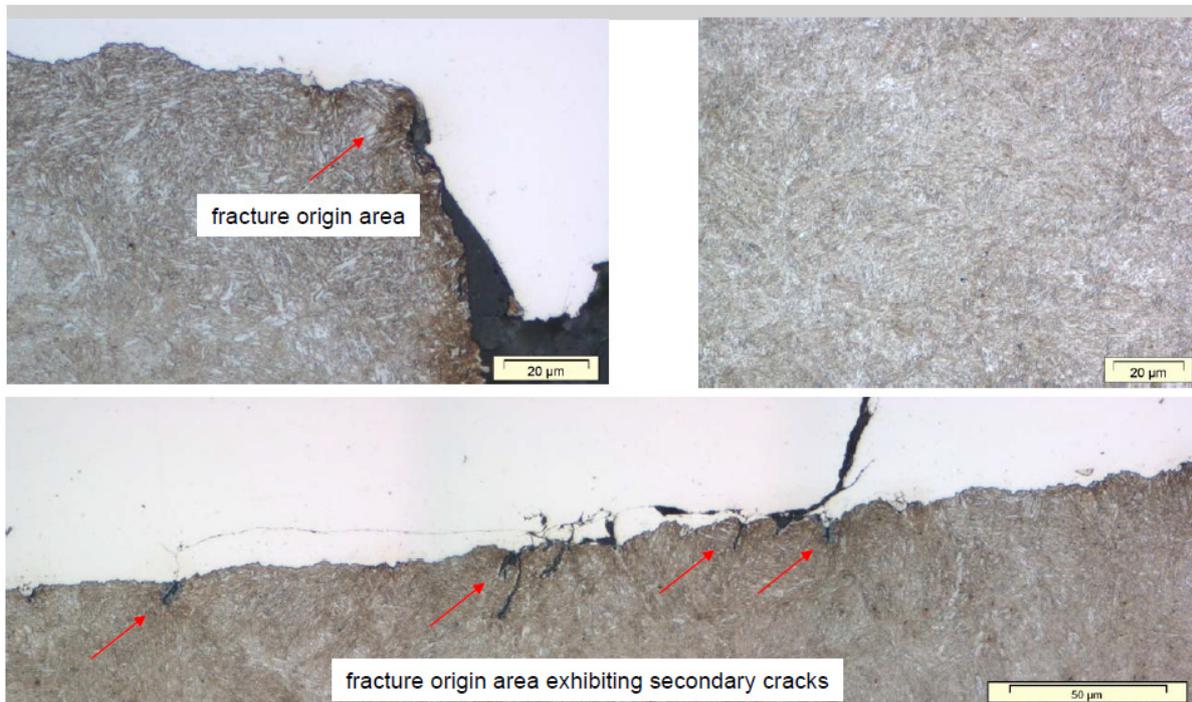
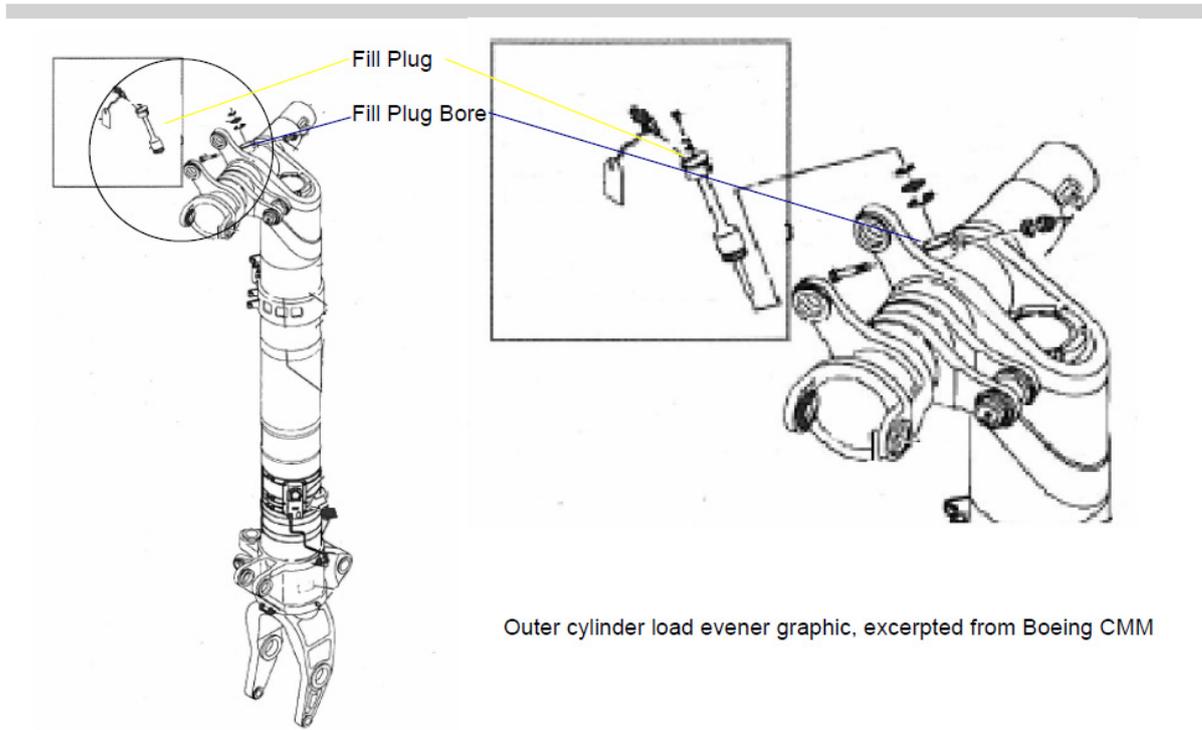


Fig. 6: Scanning electron microscope image of the fracture origin

Source: LHT Laboratory



Outer cylinder load evener graphic, excerpted from Boeing CMM

Fig. 7: Fill plug bore including fill plug

Source: Manufacturer

This investigation was conducted in accordance with the 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 the Federal German Law relating to the investigation of accidents and incidents associated with the operation of civil aircraft (*Flugunfall-Untersuchungs-Gesetz - FIUUG*) of 26 August 1998.

The sole objective of the investigation is to prevent future accidents and incidents. The investigation does not seek to ascertain blame or apportion legal liability for any claims that may arise.

This document is a translation of the German Investigation Report. Although every effort was made for the translation to be accurate, in the event of any discrepancies the original German document is the authentic version.

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