

**No: 11/88**

**Ref: EW/C1085**

**Category: 1a**

**Aircraft Type and Registration:** Boeing 747-136, G-AWNM

**No & Type of Engines:** 4 Pratt and Whitney JT9D turbofan engines

**Year of Manufacture:** 1973

**Date and Time (UTC):** 11 September 1988 at 0525 hrs

**Location:** 27L approach, Heathrow Airport, London

**Type of Flight:** Public Transport

**Persons on Board:** Crew - 18                      Passengers - 360

**Injuries:** Crew - None                      Passengers - None

**Nature of Damage:** Fracture of No 6 flap track and extensive damage to wing and flap structure in area of starboard inner flap assembly

**Commander's Licence:** Airline Transport Pilot's Licence

**Commander's Age:** 50 years

**Commander's Total Flying Experience:** Company flying 9505 hours (of which 6403 hours were in command of Boeing 747 aircraft)

**Information Source:** AAIB Field Investigation

The aircraft was on a scheduled public transport passenger flight from Abu Dhabi to London Heathrow.

The flight from Abu Dhabi to LHR was uneventful, and a radar vectored approach was flown to intercept runway 27L ILS. Intercept took place at 3000 feet, with 20° of flap set. The landing gear was selected down at 2400 feet, and the aircraft was in a stable approach, with flap 30, by 800 feet. Vref was 137 kt, however, anticipating the possibility of slight low level wind shear, the commander used a target Vref of 145 kt.

At 600 feet the commander felt a 'thump' and the aircraft yawed and rolled to the right. Suspecting a bird strike and engine failure, the commander levelled the aircraft and asked the flight engineer if they had lost an engine. The answer was negative. The commander had some difficulty in regaining the centre line, and the first officer later confirmed that almost full aileron deflection was necessary to turn the aircraft back onto the extended centre line. The aircraft was landed without further incident.

An inspection after landing revealed damage to the flaps, which were left extended as the aircraft was taxied to the stand.

Examination of the aircraft revealed extensive damage to the right inboard flap assembly. This had resulted from fracture of the No.6 flap track, (ie the outboard of the two tracks supporting the inboard right hand flap assembly).

The fracture had occurred through the "number 1" bolt hole, approximately 6 inches aft of the forward attachment. This had permitted the rear section of the track to pivot upwards about the rear spar, inflicting major damage to the spoiler support beam and impacting the spoiler above it. Substantial damage to both wing and flap structure, together with the flap mechanism, occurred either during the initial failure or during the final short period of flight.

Initial metallurgical examination indicated that failure was the result of stress corrosion cracking, which had originated from a corrosion pit in the number 1 bolt hole. The approximate depth of the pit was .015 inches, whilst the initial crack had a depth of 0.175 inches. These beams are manufactured from steel in the form of a modified inverted channel, with a rectangular section aluminium alloy member positioned within the channel, to form the fourth side of a box. The alloy member is secured to the steel member by means of bolts screwed into holes threaded in the aluminium alloy, except that at the number 1 bolt position the alloy member is modified to a forked shape, permitting the two bolts to be secured by nuts.

This is the fourth documented in-flight fracture of a flap track on Boeig 747 aircraft. The previous such failure occurred to aircraft G-AWND at Chicago on 9 May 1988 and is the subject of an investigation by the National Transportation Safety Board of the USA (NTSB), which is still in progress.

A different failure, but with similar direct consequences, has also occurred in which all eight bolts of the attachment fitting between the forward end of the track and the wing structure failed, allowing the flap track to pivot about the rear spar. This occurred to aircraft G-AWNE at Boston, Mass., in December 1985 and was the subject of an NTSB investigation, with AAIB participation.

All of these failures have occurred during the approach phase, and have caused varying amounts of damage. In the latter 3 cases, although some control difficulty was experienced, no attempt was made to perform a "go-around" manoeuvre.

Both the flap track and the bolts supporting the forward attachment bracket are manufactured from high tensile strength steel alloys. In the case of the bolts, the material is H11, whilst the tracks are of 4340M steel. Both materials have high notch-sensitivity and low fracture toughness. Hence the presence of very small cracks will critically weaken the components and lead to rapid failure.

The Boeing Commercial Airplane Company issued an Alert Service Bulletin (ASB) No. 747-57A2229 in 1984 after the first in-flight track failure. This called for certain inspections to be carried out on the flap tracks. This ASB then underwent a series of revisions, and had reached revision 4 by the time aircraft G-AWND suffered a track failure during the approach to Chicago on 9 May 1988.

At that time revision 4 called for visual inspection of tracks 3, 4, 5 and 6, and ultrasonic inspection of certain parts of tracks 1, 2, 7 and 8. As a result of the Chicago incident, revision 4 was further amended by Alert Telegraphic Revision 5, which was formalised as Revision 6 on 25 August 1988. This amendment replaced the visual inspections of tracks 3, 4, 5 and 6 by an ultrasonic technique, and required its implementation within 100 flight cycles (ie landings) of receipt of revision 5, followed by repeat inspections at 300 flight cycle intervals.

Notwithstanding this change, the incident to G-AWNM occurred at only 152 flight cycles after its last inspection to the requirements of revision 6.

On the day following this accident, the operator issued a Special Check calling for a repeat of the ultrasonic inspection at the forward ends of all tracks. In addition it called for a further ultrasonic inspection to be carried out specifically looking for cracks developing upwards from the forward bolt holes, and also required visual examination of the forward bolts (in-situ) for "signs of distress". This inspection was required to be carried out on the affected aircraft within 15 flight cycles.

On the 14 September 1988 the AAIB notified the CAA (with a copy to the NTSB) stating that the No 6 flap assembly outboard track on G-AWNM had failed in a similar manner to that which had occurred on G-AWND at Chicago in May 1988 and also referring to the flap failure experienced on G-AWNE at Boston in December 1985. It noted that the inspections implemented after the Chicago accident had failed to prevent a recurrence of this type of flap track fracture. Concern was expressed regarding the potential consequences of another such failure, particularly if it occurred in weather conditions which caused the crew to attempt a go-around manoeuvre.

On the 16 September 1988, the CAA issued Emergency Airworthiness Directive No. 011-09-88 which confirmed the initial requirements for the ultrasonic testing within the next 15 cycles, and subsequently at 35 cycle intervals. It modified the requirement, however, to include an inspection of all bolt holes for corrosion (with bolts removed) within the period up to 31 October 1988, and introduced the further requirement that all operations be planned and conducted on the basis of using the "Flaps 25" configuration for landing. The Flaps 30 configuration is no longer permitted, unless an emergency should arise that necessitates its use.

The Chief Inspector of Accidents has ordered an Inspectors Investigation into this accident. The failed flap track is the subject of continuing metallurgical examination by the Materials Department of the Royal Aerospace Establishment as part of this investigation. The investigation has been assisted by the appointment of an Accredited Representative from the NTSB in accordance with the procedures laid down in Annex 13 of the Convention of the International Civil Aviation Organisation.