Boeing 737 3Y0 Series, F-GLLD

AAIB Bulletin No: 5/97 Ref: EW/C96/12/4Category: 1.1

Aircraft Type and Registration:	Boeing 737 3Y0 Series, F-GLLD
No & Type of Engines:	2 CFM 56 3B1 turbofan engines
Year of Manufacture:	1988
Date & Time (UTC):	6 December 1996
Location:	London Heathrow Airport, Block 95
Type of Flight:	Public Transport
Persons on Board:	Crew - Not Known - Passengers - Not Known
Injuries:	Crew - Nil - Passengers - Nil
Nature of Damage:	Failure of No 1 mainwheel
Commander's Licence:	Not Known
Commander's Age:	Not Known
Commander's Flying Experience:	
	Last 90 days - Not Known
	Last 28 days - Not Known
Information Source:	Pilot Report submitted to operating company, AAIB
	examination of wheels and failed bolts, information supplied by UK overhaul subsidiary of wheel manufacturer

The aircraft was manoeuvring through Block 95 before take off. The path taken through that taxiway area requires aircraft tomake a right-hand followed by a left-hand turn. As speed wasreduced, the flight crew became aware of noise and vibration andnoted that the aircraft was listing to the left. The aircraftwas brought to a halt and the crew requested a check for the presenceof fire or smoke.

The APU was started, the engines were shut down and the towerwas informed of the situation. A passenger announcement was madeand the handling company were informed by radio. As the Captainleft the aircraft to examine the landing gear the emergency servicesarrived. The Captain and the fire service confirmed that no fireor smoke was present, so the passengers waited aboard the

aircraftuntil the passenger bus arrived. Original reports stated thatboth tyres on the left side were found to be deflated.

AAIB examined the Nos 1 and 2 mainwheels and tyres after theirremoval from the aircraft and confirmed that No 1 wheel had failedwhilst No 2 wheel and tyre were undamaged. The No 2 tyre was,however, found to be deflated. It was accordingly re-inflated(in an appropriate tyre-bay protected inflation enclosure) toa high pressure and checked in a water tank for leakage. Nonewas found. (It is the practice of the handling company to deflatetyres once removed from an aircraft, although they generally retaina low pressure of approximately 25 psi to ensure the beadof the tyre remains in contact with the wheel flange and re-inflationcan be carried out readily).

The main wheels are of conventional split hub design, the twowheel halves being held together by 16 bolts. On examinationof the number 1 wheel, it was noted that it had lost one completerim, together with sections of the spoke area through which 6of the split hub securing bolts pass. The 6 bolts in questionhad fractured; neither any of their nuts nor the detached threadedbolt ends were recovered. All heads and shanks of the failedbolts were, however, available for examination.

The bolt type is manufactured from an ultra-high tensile strengthsteel. It is understood that the correct torque tightening ofthese bolts results in a tensile loading of approximately 60%of the bolt material ultimate tensile strength being applied.

All six bolts had fractured by a very fast fatigue mechanism resultingin cup and cone type fractures in the main plane of separation. Event markers in the fast fatigue separation region were presentin each bolt. These were thought to each equate to one flightcycle. There were also separate regions of very much slower tensionfatigue initiation and progression, in some cases not in the primaryplane of separation but connected to it by plastically deformedshear-out.

The UK overhaul agents responsible for the wheel type subsequentlyvisited the company responsible for wheel maintenance on thisfleet after the remainder of the wheel (*ie* the other wheelhalf with the remaining portion of the failed half still boltedto it) had been returned to them. Their investigation revealedthat the surviving unbroken bolts had been correctly torque tightenedand the standard method of torque tightening, including the useof thread lubricant, was being carried out correctly by the overhauler. Records showed that all the bolts in the failed wheel had beenpreviously used, but the repair company routinely use a magneticparticle method to inspect such wheel bolts before re-use.

The operator reported that the wheel had completed 161 landingssince it was last assembled. The event markers visible in therapid fatigue areas indicated that as few as 15 events had occurredsince the initiation of the fast fatigue. There is reason tobelieve, however, that the slower tension mode fatigue crackingmay have been present before these wheels were last assembledbut remained undetected during pre-assembly inspection of thebolts. The consequent slight reduction in local cross-sectionalarea may have been sufficient to have caused the cyclic or intermittentloadings, such as those resulting from landing or ground manoeuvring,to raise the local stresses into the fatigue range. It shouldbe noted that magnetic particle inspection, in common with manyother NDT methods, presents difficulties of interpretation whenapplied to threaded regions of components.

The major UK operator of the heavier Boeing 737-400 series aircrafthas experienced a number of bolt failures on this type of wheelrecently and has responded by instituting a limited calendar lifeon its bolts together with a programme of progressive replacementof these bolts by similar items manufactured from Inconel. TheBoeing 737-300 series aircraft does not appear to have any

historyof failure of wheel bolts. It is understood that the operatorin this incident, in common with many others, operates its 300series aircraft at weights of up to 139,000 LB, whereas themain UK operator of the nominally heavier 400 series Boeing 737suses a reduced maximum weight for their 400 series machines notgreatly in excess of this figure. These two operators, however,use a different classification of tyre with a different tyre pressure,hence making reliable comparisons of wheel loadings difficultto make.

Since the incident, the affected operator has also elected tobegin replacing the steel bolts with Inconel components.