# Boeing 757-2T7, G-MONE

AAIB Bulletin No: 6/2000 Ref:EW/C2000/01/04 Category:1.1

INCIDENT

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| Aircraft Type and Registration: | Boeing 757-2T7, G-MONE |
| No & Type of Engines: | 2 Rolls-Royce RB211-535E4 turbofan engines |
| Year of Manufacture: | 1985 |
| Date & Time (UTC): | 22 January 2000 at 1200 hrs |
| Location: | London Gatwick Airport |
| Type of Flight: | Public Transport |
| Persons on Board: | Crew 10 - Passengers - 74 |
| Injuries: | Crew None - Passengers - None |
| Nature of Damage: | Failed nose landing gear retract actuator and failed lock actuator. Bent lock links and other components in nose landing gear area. Damaged landing gear position sensors |
| Commander's Licence: | Airline Transport Pilots Licence |
| Commander's Age: | 59 years |
| Commander's Flying Experience: | 16,358 hours (of which 9,942 were on type)<br>Last 90 days - 118 hours<br>Last 28 days - 25 hours |
| Information Source: | Aircraft Accident Report Form submitted by the pilot, metallurgical examination of failed component |

Background

TheCaptain reported the following events. On take off from Salzburg (SZG) a loud bang was heard from the area justbelow the front of the aircraft. As noother indications were present it was presumed to be the result of a birdstrike. On approach to Gatwick,however, on selecting landing gear down, a very loud bang was heard and theaircraft shook. The nose landing gearindicated unlocked amber. A go-aroundwas therefore carried out.

Duringthis manoeuvre, tower observers noted that the landing gear appeared to be downwhilst the crew of a taxiing aircraft considered that it was down but notlocked. A PAN call was transmittedand the QRH drill carried out. The noselanding gear amber warning remained.

Thesenior cabin crew member was given a Nature Intention Time Security (NITS)brief and the passengers were briefed by the cabin crew and kept informed ofthe situation by the Captain. Aprecautionary landing was then carried out with emergency services inattendance. The nose landing gearremained in the down and locked position. The aircraft was taxied clear of the runway and an inspection wasrequested. Ground-locks were put in andthe aircraft was taxied onto the stand without further incident.

Closerexamination of the aircraft revealed that the nose landing gear retractactuator eye-end had failed at the junction of the eye and its threaded section*(see Fig 1)*. The nose landing gear lock actuator had alsofailed and various mechanical components of the nose landing gear were bent.

Thefailed items were supplied to the AAIB who arranged a metallurgical examinationof the fracture surfaces. This showedthat the lock actuator had failed as a result of ductile overload, whilst thenose landing gear retract actuator had suffered a fatigue failure.

**Component description**

Theretract actuator eye-end is screwed into the end of the actuator piston rod. It is locked in position by a cupped collarpositioned between the eye-end and the rod. The collar is clamped against the end of therod by means of a shoulder on the body of the eye end, positioned where theeye-end profile merges into the plain cylindrical portion on which theattachment thread is formed. (seeFig 1).

Thelocking collar is positioned with the cup facing the eye bolt and locatedrotationally relative to the piston rod by means of a locating tag engaging ina slot machined into the rod. Thecupped sides of the collar are then peened into two recesses in the body of theeye-end after component assembly, thus locking the eye-end relative to thepiston rod. The failure was orientatedin the plane of the collar and the shoulder.

**Detailed examination**

Thefatigue failure exhibited a large number of closely spaced striations wherethey could be distinguished, although, over much of the section, individualstriations were not clearly identifiable. The machined face of the shoulder beneath the lock collar had beenalmost entirely obliterated by a series of deep marks created by either a sawor a file. The fatigue crack clearlyhad origins associated with some of the above pre-existing damage and hadextended to a point approximately one third of the way across the cylindricalsection. Examination of the face of thecollar in contact with the shoulder, revealed a pattern of witness marksmatching in mirror image the saw or file marks on the latter. (SeeFigs 2&3).

**Component history**

Theaircraft operator reported that there was no record of the actuator having beenremoved from the aircraft or worked upon since the work associated with aService Bulletin (SB) had been carried out on the corresponding retractactuators of 3 Boeing 757 aircraft on the fleet, including G-MONE, in1988. This had required the units to beremoved from the aircraft and routed to the operating companys hydraulic bayfor dismantling. Examination of theother two affected actuators has revealed that one had similar mechanicaldamage to the shoulder of the eye-end under the locking collar. On both actuators the eye ends were nottorque tightened to the correct value.

Afurther examination of the records indicated that the two personnel employed inthe hydraulic bay at the time the SB was carried out, one of whom certified thework, left the company soon after, in 1989. The bay supervisor at the time left the Company in 1990. It is not thought that these individuals arestill employed in aviation.

**Discussion**

Theevidence makes it clear that the fatigue cracking originated from thestress-raisers created by the mechanical damage seen adjacent to theshoulder. Although the number ofstriations on the fracture faces could not be counted, there was clearly a verylarge number, representing a large number of load cycles having taken placebetween crack initiation and failure. (It is thought that one cycle of high loading occurs during landing gearretraction and lesser loading during extension).

Themechanical damage was clearly present when the actuator was last reassembled,the eye-end having been screwed into position onto a new locking collarcreating the mirror image tool marks visible thereon. (A new collar must have been used, since the old collar could nothave been removed to unlock the two components without inflicting damage whichwould have remained evident on the collar. No such damage was present.) Themechanical damage is presumed to have been inflicted whilst the eye-end wasdisassembled from the piston rod or during the previous disassembly process.

Thesimilarity between the mechanical damage to the shoulder and that observed onone of the other retract actuators changed on the fleet at the same time leaveslittle doubt that all the corresponding damage was inflicted at that sametime. It seems likely that this wasdone in an attempt to free the locking collars previously installed. It is understood that the collar area isnormally coated in sealant so the means by which it is secured ( ie the peeningand the locking tag ) are not visible.

Disassemblyof the eye-end from the piston rod requires the sealant to be removed first inorder for the peened area and/or the tang to be located. Should the operative not have establishedthe details of the locking method, and not removed the sealant, it would nothave been possible to remove the lock collar and free the eye-end from the rodwithout destroying the collar. In sodoing, it is very probable that damage would be inflicted to the machined faceof the shoulder and the adjacent cylindrical section of the eye-end.

Thelock actuator failure was a ductile fracture typical of overload. Since a bang was heard during retraction,and the highest loading on the retract actuator appears to occur at or near theend of the retract cycle, it can reasonably be assumed that its failureoccurred after take off from SZG. It isdifficult, however, to visualise a mechanism by which the lock actuator couldhave been damaged during retraction as a result of the retract actuatorfailure.  As no landing gear indicationswere present in the cruise, it is probable that the up-lock was engaged and itsactuator still intact during this period.

Tolower the landing gear would normally require the up-lock to release.  The doors would also need to open and theretract actuator to extend.  With afailed retract actuator, however, once the up-lock actuator had released thegeometric up-lock, the normal damping would have been absent leaving nothingother than the doors to prevent the leg from descending under its ownweight.

Oncethe doors were open, the leg would have been free to fall unrestrained to thefully down position.  It is likely that therapid, unrestrained descent of the leg, coupled with the effect of the two locksprings, caused much more rapid extension of the lock actuator ram than couldbe achieved by normal hydraulic action. Alternatively elastic and plastic deformation of the structure andcomponents of the leg mechanism may have resulted in over-travel of the lockactuator ram.  Either way, a mechanismappears to exist for applying tensile overload to the small diameter ramrod ofthe lock actuator, which would account for its tensile failure.  This undamped descent of the leg probablyalso accounts for the bend damage to various other components of the landinggear mechanism.

Althoughthe lock actuator was thereafter not capable of ensuring that the down-lockremained made, the two locksprings performed that function.

**Conclusions**

Theincident was caused by failure of the eye-end of the nose landing gear retractactuator.  This failure resulted from along-term fatigue crack, which had propagated from an area of mechanical damageinflicted by means of a saw or file. The damage had occurred when the actuator was last dismantled, 11 yearsbefore the incident, as a result of the use of inappropriate workshop practiseduring dismantling of the component. The actuator was then re-assembled with the damage still present.  The operators quality system in place atthat time failed to detect the use of unsatisfactory workshop
procedures.