ACCIDENT

Aircraft Type and Registration:	DHC-6 Twin Otter Series 310, G-BZFP
No & Type of Engines:	2 Pratt & Whitney PT6A-27 turboprop engines
Year of Manufacture:	1980
Date & Time (UTC):	22 March 2007 at 1750 hrs
Location:	Glasgow Airport, Renfrewshire
Type of Flight:	Commercial Air Transport (Passenger)
Persons on Board:	Crew - 2 Passengers - 7
Injuries:	Crew - None Passengers - None
Nature of Damage:	Damage to nose leg and fuselage skin
Commander's Licence:	Air Transport Pilot's Licence
Commander's Age:	62 years
Commander's Flying Experience:	11,623 hours (of which 2,964 were on type) Last 90 days - 148 hours Last 28 days - 59 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot, defect investigation report from operator and follow up telephone inquiries by AAIB

Synopsis

Whilst taxiing after landing, the lower section of the nose landing gear, including the wheel, detached from the nose leg. This resulted from corrosion damage to the screw threads of a lock nut used to secure the wheel fork to the lower extremity of the sliding element of the oleo strut. As a result of this incident, the operator has reviewed and amended their maintenance practices for the nose landing gear on the DHC-6.

History of the flight

After landing on Runway 09, the aircraft was initially directed to Stand 17 but, after making a 110º turn from Runway 09 threshold on to Taxiway Alpha, the crew were re-directed to Stand 22. Whilst taxiing behind two other aircraft, having completed approximately 10º of a left turn into cul-de-sac Mike, the lower section of the nose landing gear, including the wheel, detached from the oleo strut. The aircraft rapidly came to a standstill, resting on the projecting remains of the nose leg, with the underside of the aircraft's nose having made grazing contact with the ground. The crew informed ATC of the situation and requested attendance of the Airport Fire Service (AFS). After shutting shut down both engines, they were informed by both the Tower Controller and the AFS that there was no visible fire. No injuries were reported from the cabin, and the passengers were instructed to remain on board whilst options for evacuating with the aircraft were assessed. Having confirmed that using the

rear airstairs was a viable option, despite the aircraft's nose-down attitude, the passengers left the aircraft via these stairs, assisted by a fireman and the co-pilot.

The crew reported that they had felt a slight thump during the latter stages of the landing roll, at about 10 kt, whilst in the vicinity of the intersection of Runways 09/27 and 05/23. The thump provoked comment on the flight deck, and was described as similar to that produced by a car tyre running over a cat's eye. The crew commented that there is a slight lip on the paved surface in the area of the intersection that usually produces a slight bump during takeoff from Runway 27, but they stated that no bump of any kind had been felt during their previous landing on Runway 09.

Nose landing gear description

The DHC-6 nose landing gear is of a conventional design, incorporating a telescopic oil/gas oleo shock strut. The upper (fixed) section, which forms the cylinder of the shock strut, is attached at its upper end to the fuselage by means of a pair of integral lugs. The rearwards facing half of the lower end of the cylindrical housing is supported by a pillow block attached to fuselage structure; a semi-circular cap passes around the forward half of the housing, and is clamped to the pillow block by two bolts. The cap fitting incorporates a central recess in its outer face, into which a peg on the underside of the upper torque arm engages as the nose oleo extends fully. This arrangement holds the nosewheel in the straight-ahead position during flight in the event of a hydraulic or nosewheel steering system failure.

The lower (sliding) portion of the shock strut comprises the piston tube, the bottom end of which engages a socket in the nosewheel fork. This is secured in place by what the maintenance manual describes as a locknut, but which in practice comprises a large diameter, externally threaded steel barrel, with a shoulder at its lower end. This nut, inserted into the fork fitting from below, engages a female thread cut into the inner surface of the piston tube.

Aircraft examination

An investigation of the incident by the operator's Quality & Safety Department established that, during the aircraft's left turn into Taxiway 'M', the fork section of the gear, complete with its wheel, axle and the lower torque link arm, had detached from the lower end of the oleo strut. In so doing, the separated part of the gear caused secondary damage to the lower fuselage. At some stage during this process, a failure of the lower torque link arm occurred, adjacent to its hinged connection to the upper torque link arm, as a result of overstress. The operator subsequently carried out a detailed technical investigation into the cause of the failure, including an assessment of all relevant maintenance activities.

Failure investigation

The detailed examination of the failed landing gear carried out by the operator found that the nosewheel fork fitting, complete with the nosewheel, had detached from the piston tube due to a breakdown of the thread profiles. This had been caused by corrosion, which allowed the threads progressively to disengage from one another and, ultimately, the fork fitting to wrench free of the strut. Disassembly of the landing gear revealed the following:

- Remnants of a circumferential bead of sealant were found around the periphery of the piston tube where it abutted the top face of the fork fitting. The location of these remains was consistent with the piston tube having been correctly installed in the fork, and the locknut tightened, when the sealant was applied.

- A large disc of sheet rubber, not referenced in any of the applicable technical publications, was bonded onto the underside of the fork fitting, covering the head portion of the locknut and overlapping onto the surrounding regions of the fork. This apparently stemmed from a perceived need to prevent salt-water spray from entering the cavity of the locknut, via a large square cut-out in the head of the nut used to apply torque. (The aircraft is exposed to regular operations from beach landing sites when operating to various Scottish Islands.)

- The semi-circular cap fitting, that clamps the lower part of the leg fixed housing to the pillow block had been installed upside down. The sectional profile of the cap incorporates a large chamfer at its upper corner which prevents the underside of the torque link from fouling the cap at full oleo extension. Because the cap had been installed upside down, fouling had occurred, producing deep indentations on the underside of the upper torque link.

- The lower torque link arm was very stiff to move on its lower pivot connection to the fork housing. The stiffness was caused by over-tightening of the nut (by two full flats, ie 60º) on the bolt that forms the pivot at its attachment to the fork.

- The lower torque link arm was corroded in the vicinity of the bushes installed at its hinged connection to the upper torque arm.

The operator's review of relevant maintenance records established that:

- The nose landing gear assembly, Part No 71-100-29 S/N H430 was first installed in March 1999 but on a different aircraft. In October 2003, at 4,064 hours total time, it was subject to overhaul/repair. It was subsequently installed on G-BZFP in April 2004, at 4,409 total hours and, at the time of the accident, had accumulated a total of 6,566 hours and 11,184 cycles.

- The October 2003 overhaul/repair was carried out at the operator's workshops and included an inspection for corrosion in accordance with the Component Maintenance Manual (CMM) procedures. This had led to replacement of the lower torque link arm and fork assembly, and it appeared that the over-tightening of the torque link pivot bolt occurred at that time. Both the CMM and aircraft maintenance manual required the torque arm to be checked for 'freedom of movement' after re-assembly. The torque links were inspected in August 2004 by an engineer who has since left the company.

- The non-standard rubber sealing disc, bonded to the underside of the fork locknut, was fitted at the time of the October 2003 overhaul/repair.

- In November 2006, the fork fitting was removed from the strut as part of unscheduled maintenance. This was to replace the steering collar thrust washers, which had disintegrated. The work was carried out with the gear housing in situ, but entailed removal of the locknut assembly to allow the fork fitting to be disconnected from the piston tube, and removal of the cap fitting at the strut's lower attachment to the fuselage.

- During re-assembly of the fork to the strut, the rubber disc was re-bonded over the head of the nut. When the cap fitting was re-installed, it was fitted upside down.

Safety action

The Operator has since revised its maintenance procedures as follows:

1. In light of the company's frequent operation of the Twin Otter from beach landing strips:

   a. The aircraft's maintenance program has been amended to include disassembly and inspection of the shock strut piston tube and locknut assembly, to check for corrosion, as part of the annual inspection.

   b. The operator has obtained approval from the manufacturer for wet assembly of the locknut to the piston tube, using an approved primer, in accordance with procedures laid down in the manufacturer's Corrosion Prevention Manual**.**

   c. The interval between inspections of the torque links has been reduced from 2,400 hours to 200 hours.

2. No rubber sealing disc (or any other part not called up in the appropriate documentation) is permitted to be installed, and a quality and safety notice has been issued stressing adherence to the CMM.

3. The manufacturer's attention has been drawn to the lack of guidance in the maintenance manual regarding the need to ensure that the cap fitting at the lower attachment to the fuselage is installed the correct way up. The operator comments that the shape of the cap, with its the very large chamfer giving it a tapered appearance, arguably, could appear visually more correct when installed upside down than when fitted correctly. The maintenance manual instructions called simply for the cap to be re-fitted, and contained no caution highlighting the possibility, or the implications, of it being fitted upside down. At the time of writing, the operator had received no response from the manufacturer; whilst awaiting a response, the operator has issued additional guidance, in accordance with its own internal procedures, which supplement the maintenance manual instructions in this regard.

In view of the safety actions taken, it is not thought necessary for the AAIB to make any Safety Recommendations at this time.