BAe ATP, G-OBWN

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Aircraft Type and Registration:	BAe ATP, G-OBWN
No & Type of Engines:	2 Pratt & Whitney Canada PW-126A turboprop engines
Year of Manufacture:	1993
Date & Time (UTC):	20 June 2000 at 1015 hrs
Location:	Stansted Airport
Type of Flight:	Public Transport
Persons on Board:	Crew - 4 - Passengers - 49
Injuries:	Crew - None - Passengers - None
Nature of Damage:	None
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	41 years
Commander's Flying Experience:	9,400 hours (of which 1,340 were on type) Last 90 days - 52 hours Last 28 days - 24 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot and AAIB telephone enquires

History of the flight

During the take-off roll, at a speed estimated to have been around 55 kt, the aircraft began an uncommanded deviation to the right. The commander, who was steering the aircraft through the tiller, eased this to the left whereupon the aircraft departed violently to the left, this being concurrent with a severe vibration. He called STOP to his co-pilot, but the vibration worsened and the aircraft continued to the left in spite of the use of differential braking and power. However, he was able to bring the aircraft to a halt and shut it down on the runway. Upon entering the cabin the commander became aware that two passengers had been slightly injured by some of the many detached trim panels. First aid was given by a Medic who attended with the Airport Fire Service but as there appeared to be no imminent danger, the passengers remained on board until a bus arrived to transport them to the terminal.

The aircraft was towed to a maintenance facility on the airfield where it was examined by representatives of the manufacturers and the operator. It was apparent that both nose landing gear (NLG) tyres had remained inflated, although both showed signs of distress. Detailed inspection

revealed no evidence of structural damage to either the NLG itself or the airframe, but tests on the nosewheel steering system showed the NLG weight-on-wheels switch to be unserviceable. A manufacturer's investigation into this failure revealed the presence of green coloured deposits associated with the wire attachments to the switch and that these had effectively shorted it out to continuously signal the AIR position. As a result, the steering selector valve would have been signalled to OFF. Although this investigation is on-going, it was reported that the deposits appeared to be associated with the ingress of moisture and switches from the same batch have been withdrawn from stock/service.

An event with similar symptoms which occurred to ATP G-MANG on landing was reported upon in detail in AAIB Bulletin 4/99, pages 8 to 23 (a full copy of which may be found on the AAIB Web site), where an extremely violent shimmy caused the NLG support structure in the aircraft to fail and the NLG to collapse. It was established during that investigation that the NLG weight on wheels switch assembly had also failed, but in a different manner, full details of which are contained in the above mentioned report.

The Flight Data Recorder (FDR), a Plessey PV1584, was replayed by a commercial organisation on behalf of the operator. The data showed the aircraft accelerate to a maximum speed of 54 kt, and then start to decelerate but data was lost below an airspeed of 45 kt. This was probably due to the vibration experienced by the airframe and transmitted to the FDR, during the shimmy. A similar loss of data was seen in the shimmy accident which occurred to G-MANG where the corruption of the data, leading to data losses, was due to tape speed fluctuations within the DFDR. This is not an uncommon problem on this type of recorder; there have been several cases where the data has been difficult to retrieve in high vibration or high 'g' loading situations.

Nosewheel oscillation (shimmy)

Torsional oscillation of a nosewheel is effectively a feature which can occur on virtually any design employing a castoring system of mounting. It can manifest itself as a low-amplitude oscillation which the crew may sense as a vibration. In such cases, if judged worthy of comment, maintenance staff would check such things as tyre pressure or look for abnormal wear in bushes and bearings, all of which can have an influence on the susceptibility of any given installation to such an instability. Whilst, at the design stage, attempts are made to minimise any tendency towards torsional vibratory modes, but in practice with steerable nose landing gears, some form of damping is required to suppress these modes. It is normal for aircraft with hydraulically steered nosewheels to use this system to also provide damping against torsional oscillation.

Although such oscillations are commonly referred to as 'shimmy', designers tend to reserve this term for the more potentially damaging modes in which the frequency of the forced oscillation approaches the natural frequency of the landing gear and mounting structure. In this mode, the vibration can become progressively more violent, usually varying with speed, until the forces required to react the oscillation become intolerable and some part of the system breaks. Often it is the torque link connecting the oleo to the barrel, through which the steering of the wheels is accomplished, which fails but occasionally the aircraft structure may be damaged.

NLG steering system

The nosewheels on ATP aircraft can be steered from the left crew position only using a tiller mounted on the left side console. Three switches, connected in series, are required to be made before the steering system will receive pressure and function; the nosewheel steering selector

switch must be turned to ON by the crew, the NLG weight on wheels switch and the NLG downlock switch must be made, ie, aircraft on the ground, to open the pressure supply valve. Rotary movement of the tiller is transmitted through a series of linkages to the hydraulic steering control valve mounted on the NLG, this being powered by a single hydraulic system. Inputs to this valve port hydraulic pressure to the steering jack which then moves the wheels in the appropriate direction. During the design of the system, a compensator was introduced into the circuit so that fluid would always be retained in the steering jack and control valve. In the event of a hydraulic pressure loss this would provide shimmy damping by forcing fluid in response to the forced oscillatory movement through restrictors connecting each side of the steering jack. If fluid is not present, then hydraulic damping is not effective. Pressure in the aircraft's single hydraulic system is not required for cruise flight and this is de-pressurised whenever the landing gear is UP and locked. To prevent fluid from bleeding away by internal leakage through the return line, the compensator fitted in the steering control system return line operates such that this is closed off whenever its pressure falls to 250 psi.

Prior to this event it was recognised that this minimum pressure could also bleed away through internal leakage in other components and so, in 1996, the landing gear manufacturer prepared a modification to fit a non-return valve to the steering valve pressure supply line to prevent this occurring. For various reasons neither this modification or a subsequent one were fitted to either G-MANG or G-OBWN. Thus in both cases, when on the ground, pressure/fluid was absent from the steering jack as a result of the weight on wheels switch failing to signal the steering selector valve to OPEN and pressurise the steering jack, and both the steering and shimmy damping functions were lost. It would appear that, with respect to the incident to G-OBWN, the switch failure occurred during the take-off roll as up to that time the aircraft reportedly steered normally. At the time of writing, the manufacturer is about to issue a modification that will ensure fluid is fully retained within the steering jack circuit whenever the pressure supply from the aircraft system is absent. In the meantime, a Notice to Aircrew has been issued advising minimum use of nosewheel steering in the event of a hydraulic system failure.