ACCIDENT

Aircraft Type and Registration:	Beech B200 Super King Air, G-BYCP
No & Type of Engines:	2 Pratt & Whitney PT6A-42 turboprop engines
Year of Manufacture:	1981
Date & Time (UTC):	24 March 2007 at 1635 hrs
Location:	Southend Airport, Essex
Type of Flight:	Commercial Air Transport (Passenger)
Persons on Board:	Crew - 2 Passengers - 5
Injuries:	Crew - None Passengers - None
Nature of Damage:	Damage to nose fuselage, the nose landing gear and doors, and propeller tips
Commander's Licence:	Commercial Pilot's Licence
Commander's Age:	44 years
Commander's Flying Experience:	3,800 hours (of which 2,200 hrs were on type) Last 90 days - 137 hours Last 28 days - 30 hours
Information Source:	AAIB Field Investigation

Synopsis

After selecting the landing gear to UP after takeoff from Caen, the 'gear unsafe' light remained on. The flight crew established that the nose landing gear had neither retracted nor remained locked down and, despite recycling the gear and attempting to use of the emergency gear lowering system, the crew were unable to lock the leg down. On landing at Southend Airport, the nose leg collapsed, causing damage to the fuselage nose structure and the propeller blade tips. The investigation revealed that the nose gear actuator had been affected internally by corrosion, resulting from water ingress, which led to the failure of the threads within the actuation nut of the actuator. It had completed a total of 1,449 cycles of its 8,000 cycle life, but only 532 cycles since its last 1,000 cycle check.

One Safety Recommendation is made.

History of the flight

The aircraft departed from Caen Airport in France for a flight to Stapleford Aerodrome, Essex. On board were a flight crew of two and five passengers, three of whom were young children. When the landing gear was retracted after takeoff, the crew heard an unusual noise from the vicinity of the nose landing gear bay, and noticed that the red 'gear unsafe' light in the landing gear handle remained illuminated. The main gear was seen to be up, with all three green 'gear down and locked'

lights extinguished, but the nose gear, which was visible by reflection in the engine cowlings, was not. Instead, it appeared to be extended, but at a slight angle from its normal down position.

The crew selected the landing gear down, and obtained two green lights for the main gear, but no such indication for the nose gear. They then selected it up again, but the nose gear remained in its previous position.

Initially, the flight proceeded towards Stapleford while the flight crew discussed the situation and briefed the passengers. They then decided to divert to Southend Airport, which was the site of the operator's maintenance organisation. They notified their company, contacted Southend ATC to alert them to the problem and initiated the diversion as planned.

At a range of 10 to 15 nm from Southend, the crew selected the landing gear down but, again, the main landing gears indicated down and locked but the 'gear unsafe' indication remained illuminated. They then attempted to lower the nose gear using the manual extension system, but without success. When it became clear that the aircraft would need to land with an unsafe gear, ATC instructed the crew to hold overhead Southend while the external emergency services were alerted; the airport emergency services had already been placed on standby. Whilst in the hold, the commander briefed the co-pilot on the landing and evacuation procedures. The passengers were also briefed.

The aircraft left the hold and was vectored for a Surveillance Radar Approach to Runway 06. There was a northerly surface wind of 10 kt and broken cloud at 600 ft, with a visibility of 5,000 m in haze; the crew became visual at about 600 ft and 2 nm from the airport. A normal main gear touchdown was made and, as they had previously discussed, the commander instructed the co-pilot to feather the propellers and to shut down both engines. The commander kept the nose raised for as long as possible before, at an estimated speed of 65 kt, it lowered and made contact with the runway.

After coming to a halt, the commander secured the aircraft whilst the co-pilot went back into the cabin and opened the main door. The aircraft had come to a stop on the runway in a nose down attitude, resting on the two main landing gear legs and the nose landing gear doors. Because of the aircraft's nose low attitude, there was a drop of two and a half to three feet below the integral stairs. The co-pilot descended to the ground and the adult passengers passed the children to him before they and the commander also evacuated the aircraft. The emergency services were on the scene soon after the aircraft came to rest.

Landing gear system description

The tricycle landing gear is electrically operated and controlled by the landing gear extension/retraction handle located on the right side of the instrument panel. A 28V motor/gearbox unit, located forward of the main spar, drives the main landing gear actuators via torque shafts. The nose landing gear actuator is driven via duplex chains from a sprocket attached to the motor gearbox. These chains rotate an input shaft into the actuator which, via a bevel gear, rotates a steel screw inside a lubricated aluminium bronze alloy nut. The movement of the screw through the nut extends and retracts the actuator, and in turn, the nose landing gear. Internal friction in the actuator holds the nose landing gear in the retracted position and the over-centre action of the drag brace on the nose landing gear assembly provides a positive mechanical downlock. An expanded view of the nose landing gear actuator is shown in Figure 1.

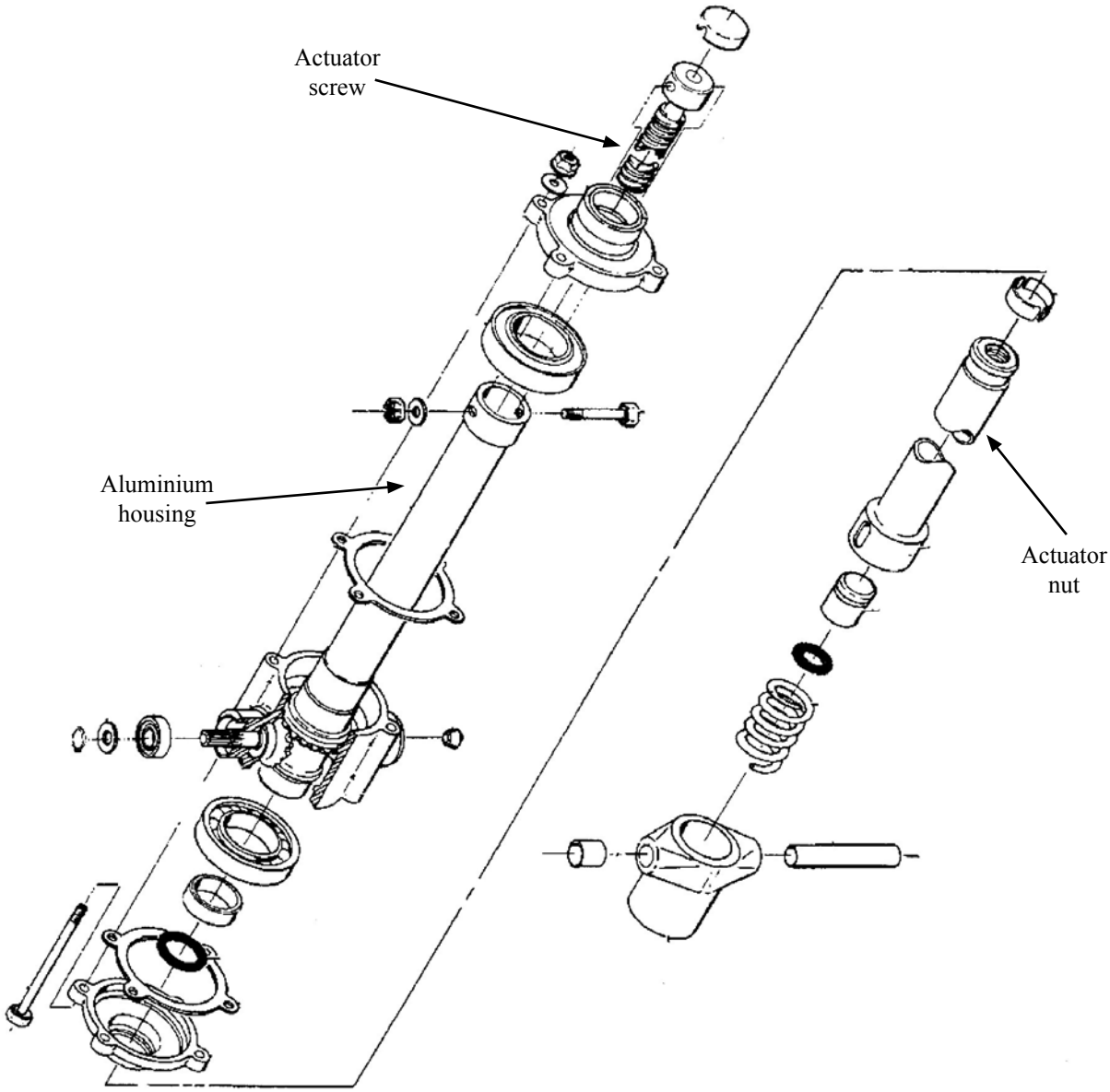

Figure 1

Nose Landing Gear Actuator Assembly

Landing gear position indication is provided by individual green GEAR DOWN annunciators. Two red indicator lights in the control handle illuminate whenever the gear is in transit or not locked; absence of handle illumination indicates that the gear is up and locked, or down and locked if combined with 'three greens'.

A separate, manually operated, chain-driven system provides emergency landing gear extension. Operation of the emergency handle disconnects the motor from the system and locks the emergency drive system of the gearbox. A ratchet handle, activated by hand pumping, drives the chain, and thus the actuators, to lower the main and nose landing gears. The system is designed to lower all three landing gears at the same time.

Aircraft examination

The aircraft had been moved into a hangar and was supported on jacks when viewed by the AAIB. Damage to the aircraft was limited to the fuselage skin around the area of the nose, the nose landing gear doors, and the propeller blade tips. The nose landing gear actuator, although still connected, was free to move and would not lock in any position. There was evidence of a contaminated liquid, with the appearance of a mix of grease and water, originating from within the actuator.

Actuator examination

The actuator was disassembled and the aluminium bronze nut assembly sectioned, to allow its interior to be examined. This revealed that the internal threads of the threaded nut (screw insert) assembly had been stripped, Figure 2.

There was evidence of compacted grease between the threads of the steel actuator screw thread along its length, and a considerable amount of aluminium bronze debris was found within this grease. Close examination of the screw showed that corrosion pitting damage was present, and that this was more extensive at the upper and lower ends of the screw, Figure 3. Corrosion was present on the apex, roots and flanks of the threads, and also observed on the internal surface of the gears within the aluminium housing.

Actuator maintenance

Prior to 2005, the manufacturer specified that the nose landing gear actuator had an overhaul life of 7,500 cycles, or a calendar life of six years, whichever occured soonest. In 2005, this was changed to introduce a calendar life 'backstop' of six years and a

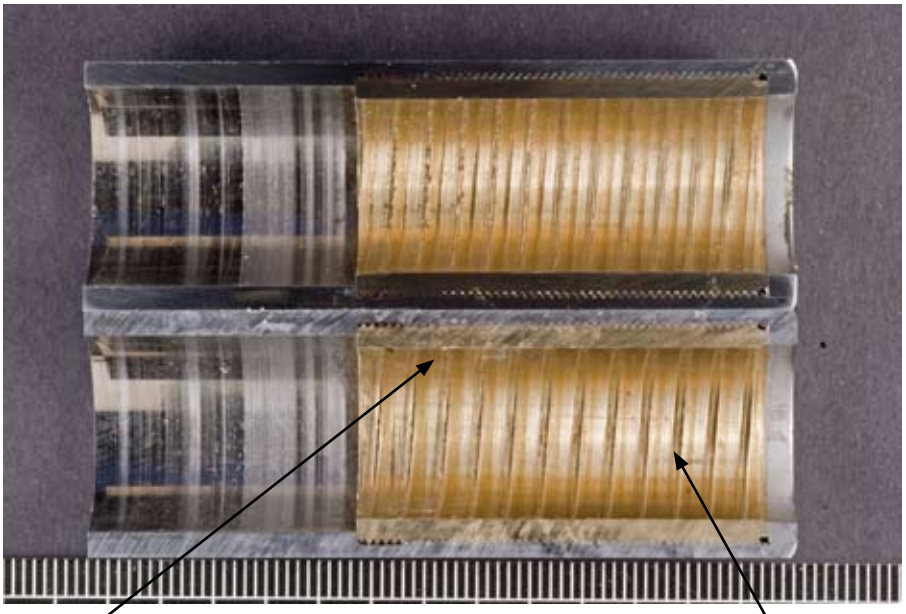

Photo: QinetiQ

Figure 2

Internal surface of threaded nut (screw insert) assembly showing stripped internal threads

Photo: QinetiQ

Figure 3

Corrosion observed on upper end of screw.

limit of 8,000 cycles. It is subject to removal every 1,000 cycles, or 30 months, for a screw-nut end play check to be performed. The Component Maintenance Manual (CMM) details this check, which is designed to measure the amount of travel or 'play' between the lubricated bronze nut and the steel screw. It states:

> *'Assembly end play, measured from the nut to housing may be a maximum of 0.005 inch greater than screw-nut end play. However, the total assembly end play shall not exceed 0.01 inch.'*

There is no requirement for routine lubrication of the actuator during its life and, unless there is evidence of grease leaking past the seals, the end play check does not call for internal lubrication or repacking of the actuator.

Actuator history

The incident actuator, Pt No 50-820208-5, batch number P12630, Serial number ALG6591, was fitted to G-BYCP on 11 April 2005. It was overhauled in the USA and a new actuator nut was installed Pt No GMD90-820015-1B. This part number is an approved replacement part for the Original Equipment Manufacturer (OEM) item, whose part number for the nut assembly is 90-820015-1.

The Federal Aviation Administration (FAA) Parts Manufacturing Approval (PMA) No PQ1586CE, dated June 1 2004, gives approval for fitment of this nose gear actuator nut to several Raytheon (Beechcraft) Models. PMA manufacturing companies are subject to FAA regulations in the design, testing, approval and manufacture of such parts.

The Hawker Beechcraft Corporation (HBC) installation uses an aluminium bronze plug (nut) with a smooth exterior surface that is attached to the outer tube using an electron beam welding procedure, not the threaded installation as found in the actuator from G-BYCP. When HBC engineers examined the actuator nut, they reported that they could find "no instance where HBC used this threaded assembly."

At the time of the accident it had completed 1,449 cycles since overhaul. A satisfactory screw end play check was performed on 8 May 2006, 532 cycles before the accident.

Previous events

Another B200, G-FRYI, belonging to the same operator as G-BYCP, suffered landing gear problems in March 2007, when the landing gear failed to retract. The landing gear was locked down using the emergency system and the aircraft landed safely. The landing gear system was checked and the nose landing gear actuator replaced. A strip examination of this unit at the overhaul agency revealed the presence of corrosion. It had been fitted in 2001 and had accumulated 5,884 cycles since overhaul; the last end play check was on 27 February 2006, since when it had operated for 629 cycles.

A Canadian registered Beechcraft King Air A100 (Be-10), C-GISH, experienced a similar occurrence in Ontario in May 2002, when the nose landing gear collapsed. Further examination showed that the thread of the aluminium bronze nut assembly had failed but, in this event, the cause of this failure was determined to be lack of lubrication. The actuator had been installed on C-GISH in January 2000, and the last end play check was completed satisfactorily on 19 March 2002; however, 89 cycles later the actuator failed. It was concluded that differences in the King Air 100 and 200 maintenance manuals may possibly have resulted in inconsistent maintenance practices.

In 1994, severe corrosion was found in the nose landing gear actuator on a B200 during maintenance, following a landing gear retraction test that was slower than normal. In this case, the cause was identified to be a failed seal, which had allowed moisture ingress to cause bearing degradation. During routine maintenance, three other similarly corroded actuators were found.

Discussion

Examination of the nose landing gear actuator revealed that a complete failure of the internal threads in the aluminium bronze nut had occurred. The threads had stripped and, hence, the input from the landing gear motor/gearbox could not cause the nut assembly to traverse the screw. A considerable amount of aluminium bronze wear debris was present in the grease on the screw thread, which suggested that the nut had been wearing over a period of time prior to failure. Examination of the grease showed that it was contaminated with water, which is likely to have reduced its lubrication properties, leading to increased wear and corrosion damage of the screw. Also, the corrosion pits formed were likely to have increased the roughness of the screw and accelerated wear of the nut. This wear would have progressively reduced the load bearing capacity of the thread to a point when it could no longer support normal operating loads, leading to a failure of the remaining thread profiles. As the problem with the nose landing gear actuator was downstream of the emergency system input, it was not possible to lock the nose landing gear down.

Other incidents on B200 aircraft also showed corrosion and increased wear, due to lack of lubrication. Although the nose landing gear actuator in G-BYCP was a PMA part, the corrosion and lack of lubrication could equally have occurred to an OEM part since the only difference in design is the method of attaching the plug (nut) insert. The presence of excessive play at the 1,000 cycle end play check would indicate increased wear and, as such, an actuator would normally be returned for overhaul. However, the actuator from C-GISH 'failed' only 89

cycles after passing an endplay check, the actuator on G-BYCP at 532 cycles and the unit on G-FRYI at 629 cycles. Therefore, as the 1,000 cycle interval between checks would not appear to ensure detection of excessive wear before an actuator fails, the following Safety Recommendation is made:

Safety Recommendation 2007-126

It is recommended that the Federal Aviation Administration require Raytheon (Beechcraft) to review the maintenance requirements of the nose landing gear actuator fitted to the Beech B200 King Air series of aircraft, and any other model using a similar design of actuator, with regard to the requirement of periodic lubrication and the periodicity of inspections.