SERIOUS INCIDENT

Aircraft Type and Registration:	DHC-8-402, G-PRPH
No & Type of Engines:	2 Pratt & Whitney Canada PW150A turboprop engines
Year of Manufacture:	2010 (Serial no: 4323)
Date & Time (UTC):	26 May 2017 at 1030 hrs
Location:	On descent into Manchester Airport
Type of Flight:	Commercial Air Transport (Passenger)
Persons on Board:	Crew - 4 Passengers - 53
Injuries:	Crew - None Passengers - None
Nature of Damage:	None
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	33 years
Commander's Flying Experience:	4,000 hours (of which 330 were on type) Last 90 days - 185 hours Last 28 days - 40 hours
Information Source:	AAIB Field Investigation

Synopsis

Towards the end of the flight the Central Warning System indicated an oil pressure loss on the No 2 engine. The engine was shut down and an uneventful single engine landing was carried out. It was found that a cap locating the propeller overspeed governor test solenoid had detached, allowing most of the oil from the No 2 engine lubrication system to be lost. Investigation of the component revealed that the four cap securing bolts had failed, predominantly in fatigue. Extensive investigation failed to identify conclusively the root cause of the bolt fatigue damage. Although three similar in-service failures of these bolts have occurred on other aircraft types utilising this design of governor, no others have been recorded on DHC-8-400 types and all those that have occurred have been on units of an earlier modification state.

History of the flight

The commander reported that, whilst descending through FL120, the warning system emitted a 'triple chime' with a red Central Warning System indication of No 2 engine oil pressure low. He checked the engine display and noted an indicated oil pressure of 17 psi, which was decreasing. He reduced power, although being in the descent the engine was already operating at close to the flight idle setting. As the oil pressure continued to drop, he elected to shut down the No 2 engine, taking over the flying of the aircraft from the co-pilot before doing so. The flight crew carried out the Vital Actions and ran through the QRH. The commander communicated with the cabin crew,

carried out a 'NITS[1]' brief, informed ATC and obtained the destination weather. He then addressed the passengers. A normal landing was carried out following radar vectoring to the ILS.

Aircraft information

The propellers on the DHC-8-400 are each controlled by a hydraulic system incorporating an overspeed governor (Figure 1). This increases blade pitch should excessive propeller speed be detected. The function may be tested at a lower engine speed by operating a solenoid valve on the overspeed governor, controllable from the flight deck. Operation of the solenoid causes movement of a hydraulic nose, realigning hydraulic ports and enabling the overspeed governor to perform its function, but at a reduced propeller speed which is within the normal operating range. All propeller control functions are achieved utilising the same oil supply as used for lubrication of the engine bearings and reduction gear.

Functional testing of the overspeed governor is carried out on the first flight of the day by most DHC-8-400 operators.

During examination of the No 2 engine on G-PRPH after the landing, it was observed that the propeller overspeed governor ground reset solenoid valve cap had separated from the body of the unit. Engine oil had therefore leaked under pressure until most of the system contents were lost.

Figure 1

General view of propeller overspeed governor unit

Footnote

[1] The NITS briefing is an emergency briefing given to cabin crew; it stands for Nature, Intention, Time, Special Instructions.

Overspeed governor unit examination

The No 2 engine overspeed governor unit was removed from the reduction gearbox and sent to the AAIB. Examination showed that the cap over the ground reset solenoid had detached as a consequence of failure of the four ultra-high tensile steel bolts securing it to the body of the governor unit (Figure 2). The hydraulic nose had fractured approximately in the plane of the bolt failures. The component was examined by the manufacturer in the presence of the AAIB. It was noted that considerable fretting was present on the shim under the end cap and on the mating faces. The separated heads of the four bolts remained joined in pairs by wire locking and were recovered.

The failed bolts were forwarded to a specialist laboratory for examination. One bolt showed evidence of predominant fatigue failure, a second started as fatigue then changed to serial overload. The third started in fatigue in the reverse direction to the previous two, whilst the fourth was a complex fracture, probably indicating this was the last of the four to fail. Attempts at fatigue striation counting indicated that one of the bolts had suffered in excess of 7,000 cycles to failure. The numbers of cycles to initiation are not known.

Examination of the wire locking that both secured the bolt heads and joined them in pairs indicated that, though not in conflict with the production drawings, the orientation on this unit resulted in different pairs being joined from the norm. Consequently, the length of wire locking between two of them was greater and the routing was less direct.

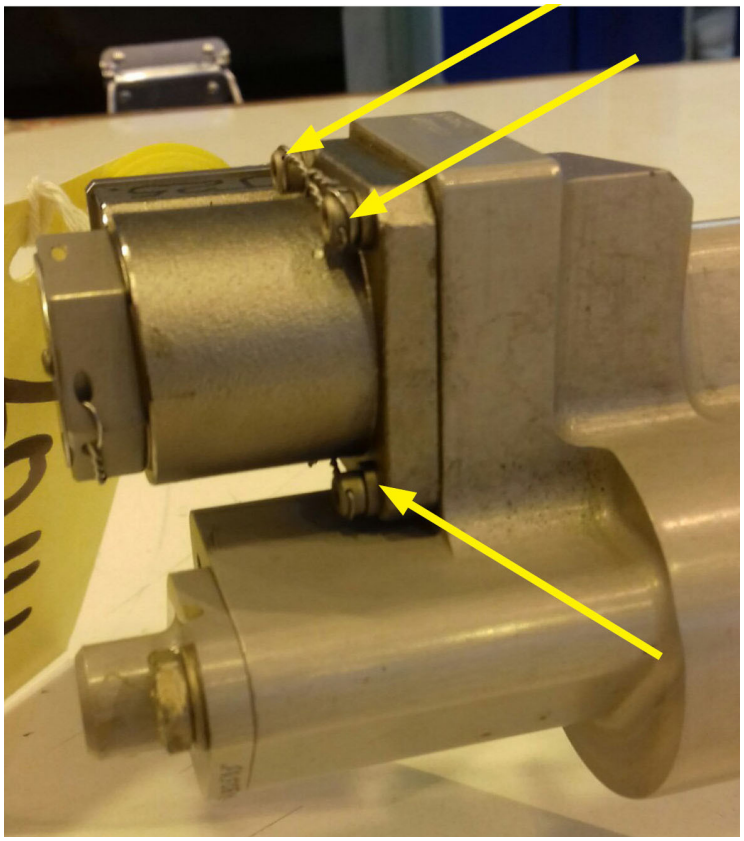

Figure 2

Arrows showing position of bolt group which failed on G-PRPH

Further analysis indicated that such alternative locking wire orientation was necessitated, on infrequent occasions, when dictated by the final rotational position of locking wire holes in the bolt heads once correctly torque tightened. It is possible that a significant number of units in service have this orientation of wire locking.

No 2 engine overspeed governor history

The component manufacturer's records indicate that no workshop activity involving disturbance of the four bolts had occurred since 2011, when the unit was built.

It was determined from build records that, at the time this unit was built, a shortage of the correct bolts had necessitated a Production Permit to be obtained for use of an alternate type of bolt. The principal difference between the alternative bolt type and that specified on the original manufacturing drawings was that the former utilised machined, rather than rolled threads. The creation of a Production Permit required the suitability of the substitute component to be assessed by the manufacturer's stress office. The alternative bolt has now been utilised for a considerable period and it was determined that a substantial number of units have been dispatched with the bolts having machine cut threads.

Other information

The component manufacturers supplied the information that significant tensile loading on the bolts as a result of internal pressure only occurs when the solenoid is energised to function the overspeed governor. They also reported that they were aware of three other instances of this type of failure. All were to units on different (earlier) aircraft/engine combinations, and all were on units manufactured before a shim was introduced to compensate for the solenoid's central core standing proud of the coil housing with adverse tolerances.

The governor operates in a vibratory environment with the potential for inflicting fatigue damage to components such as the cap attachment bolts.

Discussion

Functional testing of the governor is carried out regularly by flight crew, generally on a first flight of the day basis. Exact policies on the frequencies of these operational tests, however, differ between operators. Consequently, given the limited number of overspeed tests likely to have been carried out in the life of the unit, it is unrealistic to presume that a significant proportion of the fatigue damage observed during laboratory examination (over 7,000 cycles) was sustained as a result of such tests during service.

The amount of fretting of mating surfaces below the cap of the failed unit indicates that reduced tension in the bolts had been present for an extended period of operation. The fatigue damage to the bolts is also consistent with a reduced tension being present, along with cyclic loading. Since the striation count on the most fatigued of the failed bolts demonstrates a number of load cycles significantly in excess of the likely number of operational loadings, it is presumed that the vibratory environment accounted for the cyclic loading and hence the fatigue damage.

The manufacturer determined that the use of machined thread bolts rather than rolled thread bolts should not result in a reduced life in this application. In addition, a significant proportion of units manufactured have now been assembled using such bolts, with no adverse consequences in service. Hence it does not appear that the choice of bolt type has influenced this failure.

In the absence of an obvious cause for the failure, the possibilities are as follows:

1 Environmental
   (a) Impact of the solenoid during transit, installation or maintenance
   (b) Excessive vibration

2 Tampering
   (a) Removal of the solenoid since original unit manufacture

3 Assembly
   (a) Inadequate or incorrect bolt wire locking
   (b) Excessive torque application
   (c) Insufficient torque application

There was no evidence of damage sustained by an impact and there have been no reports of excessive vibration on aircraft equipped with this particular governor during recent years of service.

Undocumented removal of the solenoid is unlikely, since it would serve no useful purpose that could not be served by removal of the complete overspeed governor.

The slightly unusual, but not incorrect, wire locking was originally suspected to be significant but this was ruled out following further consideration as the wire locking was still effective.

Excessive bolt torque application tends not to create a fatigue condition unless thread damage occurs, whereas a low assembly torque creates the conditions for fatigue failure of bolts working in tension and subjected to cyclic loading. It was not possible to establish if incorrect torque application on the assembly was a factor, as low bolt torque leaves no conclusive evidence.

Conclusion

The loss of oil pressure on the No 2 engine was because a cap locating the propeller overspeed governor test solenoid had detached due to failure of the attachment bolts, predominantly in fatigue. The cause of the bolt group fatigue failure was not established, but the possibility that a lower than specified assembly torque tightening figure was used on one or more bolts during assembly could not be ruled out.

ACCIDENT

Aircraft Type and Registration:	Europa, G-MIME	
No & Type of Engines:	1 Rotax 912 ULS piston engine	
Year of Manufacture:	2001 (Serial no: PFA 247-12850)	
Date & Time (UTC):	28 September 2017 at 1500 hrs	
Location:	Grove Farm, Wolvey, Warwickshire	
Type of Flight:	Private	
Persons on Board:	Crew - 1	Passengers - 1
Injuries:	Crew - 1 (Fatal)	Passengers - 1 (Fatal)
Nature of Damage:	Aircraft destroyed	
Commander's Licence:	National Private Pilot's Licence	
Commander's Age:	55	
Commander's Flying Experience:	546 hours (of which 48 were on type) Last 90 days - 12 hours Last 28 days - 1 hour	
Information Source:	AAIB Field Investigation	

Synopsis

The aircraft landed a significant distance down the runway at Grove Farm and was unable to stop before the end. The aircraft passed through a hedge and caught fire before coming to rest in the field beyond the end of the runway. Although both the pilot and passenger survived the accident, both subsequently died of the burns they sustained.

History of the flight

The pilot and passenger arrived at Grove Farm, where the aircraft was kept in a hangar, just after 1400 hrs. Witnesses stated that the purpose of the flight was to fly over a local site where both the pilot and passenger were working. There were no witnesses to the preparation or flight of the aircraft. It was picked up by radar for the first time at 1443 hrs and for the last time at 1445 hrs, and the radar track indicated that it took off from Runway 29, flew a circuit and made an approach back to Runway 29.

Just after 1500 hrs witnesses saw the pilot and passenger in the yard of the farm on which the strip is located; both were severely burnt. The aircraft had passed through the hedge at the end of Runway 29 after landing and come to rest in the field beyond. It was severely disrupted and had suffered significant damage from fire. Both the pilot and passenger subsequently died of the burns they sustained.