Australian Government
Australian Transport Safety Bureau

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Australian Transport Safety Bureau
PO Box 967, Civic Square ACT 2608
Australia

1800 020 616

+61 2 6257 4150 from overseas

www.atsb.gov.au

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ATSB TRANSPORT SAFETY REPORT
Aviation Occurrence Investigation AO-2008-042
Final

In-flight shutdown, VH-QOA 84 km N of Lockhart River Aerodrome, Queensland 20 June 2008

Abstract

On 20 June 2008, a Bombardier DHC-8-402 aircraft, registered VH-QOA, with four crew and 59 passengers on board, departed Horn Island for Cairns, Queensland on a scheduled passenger flight. During the climb, the right propeller electronic control (PEC) caution light illuminated with an associated right propeller overspeed warning. The right engine was shutdown in accordance with the operator's Quick Reference Handbook and the crew diverted the aircraft to Weipa.

During the approach to Weipa, the aircraft's right hydraulic system failed requiring the landing gear to be manually lowered. Due to the loss of hydraulic system services, the nosewheel steering was not available and the aircraft required ground crew assistance to tow the aircraft to the parking area.

As a result of a number of similar occurrences experienced by international and domestic operators , the propeller manufacturer developed a number of software changes which, when introduced, will allow the continued operation of an engine by the crew after the primary propeller speed signal is lost. The aircraft operator intends incorporating that modification into its DHC-8 fleet once training and other resource considerations are satisfied.

In addition, the aircraft manufacturer has incorporated a modification in the aircraft to ensure that the power transfer unit is started before the loss of the No. 2 hydraulic system pressure.

FACTUAL INFORMATION

Sequence of events

On 20 June 2008, a Bombardier DHC-8-402 aircraft, registered VH-QOA, with four crew and 59 passengers on board, departed Horn Island for Cairns, Queensland on a scheduled passenger flight. About 84 km north of Lockhart River, while passing 16,500 ft above mean sea level (AMSL) in the climb, the crew observed a right propeller 'No.2 PEC'[1] caution light illuminate, accompanied by the right propeller overspeed warning.

A precautionary shutdown of the right (No. 2) engine was carried out by the flight crew in accordance with the operator's Quick Reference Handbook (QRH), and a decision was made to divert to Weipa. A PAN[2] was declared with Brisbane Air Traffic Control and the Weipa emergency services were placed on local standby.

During the approach, the aircraft's landing gear failed to extend normally, consistent with the indication of a loss of No. 2 hydraulic system pressure. As a result, the landing gear was lowered using the alternate extension system.

After landing, the pilot in command moved the aircraft clear of the runway and shut down the aircraft as a result of the lack of nosewheel steering. The passengers were disembarked and

1 Caution and warning light denoting a problem with the affected propeller electronic control (PEC) system.

2 A radio transmission indicating uncertainty or alert.

the aircraft towed to the parking area. There were no reported injuries.

Aircraft information

Power transfer unit

In the event of a No. 2 engine failure or shutdown, or No. 2 hydraulic system pressure loss, the PTU system logic automatically activated the PTU when the aircraft's flaps were extended. Activation of the PTU allowed the No. 2 hydraulic system to be pressurised by an alternate hydraulic pump that was driven by a hydraulic motor. That motor was powered by the No. 1 hydraulic system.

Propeller overspeed and engine shutdown

Depending on the nature of a malfunction in the electronic control system for the respective propeller, the design allowed for the affected propeller to increase to about 104% or 1,068 RPM indicated. At that RPM, the affected propeller's RPM was controlled by the over-speed governor. The propeller and engine components were certified to run at that RPM.

However, to ensure pilot type rating commonality between the various DHC-8 models, the DHC-8 manufacturer's QRH required the crew of all models to shut down the affected engine in the event of a loss of the propeller speed signal, and subsequent propeller overspeed.

Aircraft and component examination

An initial examination of the aircraft and systems was carried out by the operator's maintenance personnel at Weipa, and included the interrogation of the aircraft's BITE[3]. That data recorded a PEC fault code that was consistent with the earlier illumination of the No. 2 PEC caution light.

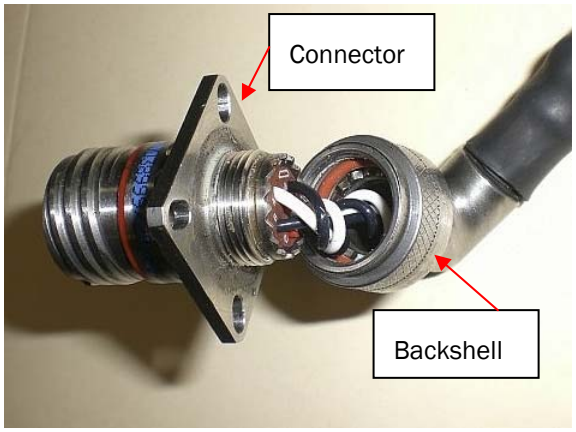
The propeller speed magnetic pick-up unit (MPU) assembly was changed and the 'No. 2 PEC' fault cleared.

Examination of the MPU

An initial examination of the MPU by the operator's maintenance personnel identified an intermittent electrical fault in the MPU harness. The unit was forwarded to the component manufacturer in the United Kingdom (UK) for more detailed testing under the supervision of the UK Air Accident Investigation Branch.

The manufacturer's testing identified an insulation breakdown between the electrical connector pins and the No. 1 coil connector backshell[4] in the MPU-to-PEC wiring harness (Figure 1). In addition, during disassembly, a previous reassembly anomaly was identified that was considered by the manufacturer's team to have been introduced during the operator's initial maintenance inspection. A number of manufacturing quality issues were also identified that the manufacturer stated would not have contributed to the occurrence.

Figure 1: MPU-PEC wiring harness backshell and connector



Examination of the PTU

The PTU was removed from the aircraft by the operator and forwarded to the PTU manufacturer in the United States for technical examination.

3 Built In Test Equipment. A design feature of modern computer-controlled equipment to allow maintenance interrogation for fault finding and rectification purposes.

4 A housing on an electrical connector that covers the area where the cable conductors connect to the connector contacts/pins

Figure 2: PTU with bronze transfer

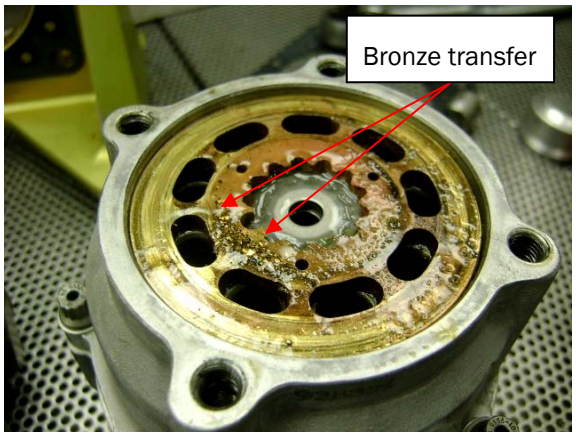
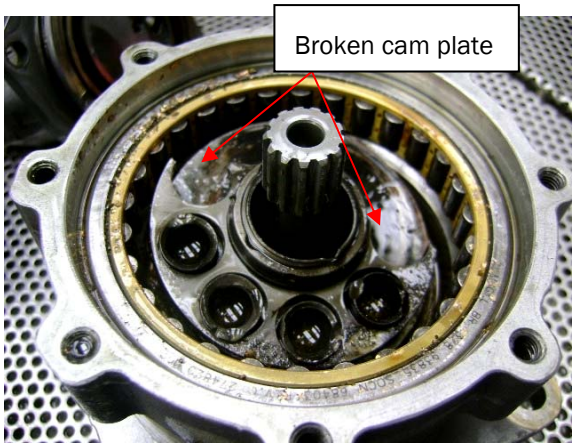


Figure 3: Cam and piston subassembly damage



The results of that examination included that:

- the hydraulic motor was in good condition with no signs of wear or damage
- there was damage to the hydraulic pump, including the failure of the pump:
  - barrel and port cap fluid bearing, with associated 'bronze transfer'[5] (Figure 2)
  - cam and piston subassembly (Figure 3), with resulting wear to the piston shoes and cam plate.

The manufacturer's examination concluded that the PTU sustained an over-speed failure as a result of an air pocket forming at the pump inlet; a failure mode that had been observed previously on a number of other PTUs. The manufacturer indicated that a lack of No. 2 hydraulic system reservoir pressure during PTU start up resulted in pump cavitations and an overspeed of the PTU.

The operator queried that conclusion, commenting that the pump had operated normally on the previous sectors, and that there was no loss of hydraulic fluid evident. In addition, the operator indicated that the in-service maintenance procedures suggested an inconsistency with the manufacturer's assumed lack of No. 2 hydraulic system pressure.

Additional information

Similar PEC-related occurrences have been experienced by a number of international and domestic operators of DHC-8 aircraft that required the in-flight shutdown of affected engines. An examination of seven of those occurrences determined that:

- in three cases, the MPU was replaced, the fault cleared and the aircraft was returned to service
- in one case, the PEC was replaced, the fault cleared and the aircraft was returned to service
- in the remaining cases, the fault-finding was inconclusive.

ANALYSIS

Propeller overspeed and engine shutdown

The loss of the speed signal from the magnetic pick-up unit (MPU) meant that the control of the right (No. 2) propeller RPM reverted to the over-speed governor, with a maximum RPM of 104% or 1,068 RPM indicated. Despite the certification of the propeller and engine components to run at that RPM, the aircraft manufacturer's desire for pilot type rating commonality between DHC-8 models required the shutting down by flight crews of otherwise serviceable engines. That meant that the remainder of any affected flights would be completed with one engine operating.

Power transfer unit failure

The failure of the power transfer unit was a result of a previously identified failure mode. That failure deprived the crew of the use of a number of hydraulically-powered services; including the

5 The transfer of bronze material to another material as a result of the rubbing of two metal surfaces, one of which includes bronze.

assisted lowering of the landing gear and the use of the nosewheel steering once on the ground

FINDINGS

From the evidence available, the following findings are made with respect to the in-flight shutdown of the right (No. 2) engine of Bombardier DHC-8-402 aircraft, registered VH-QOA about 84 km north of Lockhart River, Queensland on 20 June 2008 and should not be read as apportioning blame or liability to any particular organisation or individual.

Contributing safety factors

- The aircraft manufacturer's desire for standard operating procedure commonality between its DHC-8 models required the flight crew to shut down the otherwise serviceable engine, with the effect that the flight was completed with one engine operating. *[Minor safety issue]*
- The power transfer unit failure deprived the crew of the use of the No. 2 hydraulic system services, including the assisted lowering of the landing gear and the nosewheel steering. *[Minor safety issue]*

Other key findings

- The loss of the speed signal from the magnetic pick-up unit meant that the control of the propeller RPM reverted by design to the overspeed governor, setting a maximum of 104% or 1,068 RPM indicated.
- The failure of the power transfer unit was a function of a known failure mode.

SAFETY ACTION

The safety issues identified during this investigation are listed in the Findings and Safety Actions sections of this report. The Australian Transport Safety Bureau (ATSB) expects that all safety issues identified by the investigation should be addressed by the relevant organisation(s). In addressing those issues, the ATSB prefers to encourage relevant organisation(s) to proactively initiate safety action, rather than to issue formal safety recommendations or safety advisory notices.

All of the responsible organisations for the safety issues identified during this investigation were given a draft report and invited to provide submissions. As part of that process, each organisation was asked to communicate what safety actions, if any, they had carried out or were planning to carry out in relation to each safety issue relevant to their organisation.

Loss of propeller speed signals from the magnetic pick-up unit

Safety Issue

The aircraft manufacturer's desire for standard operating procedure commonality between its DHC-8 models required the flight crew to shut down the otherwise serviceable engine, with the effect that the flight was completed with one engine operating.

Action taken by aircraft manufacturer

The aircraft manufacturer has issued Service Letter DH8-400-SL-61-008A dated 7 May 2009, which outlined a software upgrade that will derive propeller RPM from the propeller gearbox when the magnetic pick-up unit signal is lost. This will negate the operation of the propeller at the overspeed governor setting of (1,068 RPM indicated) 104 % and should minimise the potential for nuisance overspeed triggers and subsequent in-flight shutdowns.

Action taken by the aircraft operator

The aircraft operator advised the ATSB that the software upgrade would be incorporated into the company's aircraft once appropriate operator personnel training had been conducted and specialist hardware was available. The operator also advised that all spare propeller electronic control units would be modified at the propeller manufacturer's facility to incorporate the upgrade.

On 21 June 2010, the operator advised the ATSB that the software upgrade has been incorporated into the company's aircraft following the manufacturer's new personnel training on specialised hardware. The operator also advised that all spare propeller electronic control units have been modified at the propeller manufacturer's facility to incorporate the upgrade.

Aircraft manufacturer

Power transfer unit failure

Safety Issue

The power transfer unit failure deprived the crew of the use of the No. 2 hydraulic system services, including the assisted lowering of the landing gear and the nosewheel steering.

Action taken by aircraft manufacturer

The power transfer unit (PTU) manufacturer advised that the aircraft manufacturer was developing a modification to start the PTU before hydraulic reservoir pressure was lost. The revised autostart logic is planned to start the PTU upon failure of the right (No. 2) engine or of the respective engine-driven pump. The new PTU autostart logic was not available at the time of the occurrence.

ATSB assessment of action

The ATSB is satisfied that the action taken by the airframe manufacturer will, when incorporated, adequately address the safety issue.

SOURCES AND SUBMISSIONS

Sources of Information

The sources of information during the investigation included the:

- aircraft operator
- aircraft manufacturer
- propeller system supplier
- power transfer unit manufacturer
- United Kingdom Air Accident Investigation Branch (UK AAIB).

Submissions

Under Part 4, Division 2 (Investigation Reports), Section 26 of the *Transport Safety Investigation Act 2003*, the Australian Transport Safety Bureau (ATSB) may provide a draft report, on a confidential basis, to any person whom the ATSB considers appropriate. Section 26 (1) (a) of the Act allows a person receiving a draft report to make submissions to the ATSB about the draft report.

A draft of this report was provided to the flight crew, the aircraft operator, the component manufacturers, the UK AAIB and the Civil Aviation Safety Authority. The submissions were reviewed and, where considered appropriate, the text of the draft report was amended accordingly.