Australian Government
Australian Transport Safety Bureau

Engine malfunction involving De Havilland Aircraft of Canada DHC-8-315, VH-XKJ

near Perth Airport, Western Australia on 23 April 2019

ATSB Transport Safety Report
Aviation Occurrence Investigation
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Addendum

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Safety summary

What happened

On 23 April 2019, a De Havilland Aircraft of Canada DHC-8-315, registered VH-XKJ and operated by Skippers Aviation, was conducting a charter flight from Perth Airport to the Duketon Gold Mine, Western Australia.

Shortly after take-off, the flight crew heard a banging sound and detected a reduction in power from the left engine. At about the same time, the pilot flying experienced a yaw through the aircraft controls. The crew also noted a gradual reduction in right engine power. The flight crew elected to conduct a return to Perth Airport, where an uneventful landing was conducted.

What the ATSB found

Following the occurrence, both engines were inspected and erosion damage was noted to the high-pressure turbines. While both engines displayed erosion damage, the damage to the left engine was more pronounced. The erosion damage to the turbine likely disrupted the airflow through the left engine, inducing the symptoms reported by the crew and recorded in the aircraft flight data.

The decision not to shut down the malfunctioning engine immediately allowed the flight crew to concentrate on continuing the climb, during a period of increased workload. The left engine responded to an increase in power. However, the crew elected to return to the departure airport.

The ATSB determined that the gradual reduction in power on the right engine was not likely the result of a mechanical issue in the engine.

Safety message

A partial power loss presents a more complex scenario to flight crew than a complete engine failure. The engine is still providing some power, however the power may be unreliable and the reliability may be difficult to assess. This occurrence highlights the benefits of timely and appropriate flight crew action in response to a power loss on take-off.

In this case, the affected engine appeared to return to normal operation, however the flight crew continued with the return. Abnormal engine operation, even if only transient, can be an indication of a developing fault and therefore the safest course of action is to discontinue the flight as soon as possible.

The occurrence

What happened

On the morning of 23 April 2019, a De Havilland Aircraft of Canada DHC-8-315, registered VH-XKJ (XKJ) and operated by Skippers Aviation, was being prepared for a charter flight to Duketon Gold Airport, about 750 km north-east of Perth, Western Australia. At about 0615 Western Standard Time,[1] XKJ departed Perth Airport with two flight crew, two cabin crew and 51 passengers on board.

Shortly after take-off, as the aircraft was climbing through approximately 250 ft above ground level, the first officer (FO), who was the pilot monitoring,[2] retracted the landing gear. At about this time, both flight crew detected a popping or banging sound from the vicinity of the number one (left) engine. The captain (pilot flying) also noted a slight left yaw[3] through the flight controls. The FO observed a reduction in torque, to just below 60 per cent on the left engine. The FO reported a 'failure', but further advised 'it's not indicating a failure', as there was no associated master warning.[4]

The captain reviewed the left engine instrumentation and noted that torque was 58 per cent. Other indications, such as fuel flow, appeared relatively normal. The captain then advised that, because the left engine was still producing some power, they would not shut it down, but would conduct a return to Perth. As the aircraft climbed through a height of approximately 800 ft, the flaps were retracted and the FO transmitted a PAN PAN[5] call. Perth air traffic control acknowledged and the captain elected to return via a right circuit.

At about this time, the captain noted that the torque on the right engine was indicating lower than expected for the phase of flight. The captain advised the FO that they might need to upgrade to a MAYDAY.[6] The throttles on both engines were then advanced to approximately 80-90 per cent, with both engines responding as expected. In addition, the banging sound in the left engine ceased.

In preparation for landing, and to reduce airspeed, the throttles on both engines were retarded to about 30 per cent. The flight crew noted that, with this reduction in power, the banging sound in the left engine returned. Following a normal landing, the aircraft was taxied to the terminal, under power from both engines.

Context

Recorded Data

The aircraft's flight data recorder (FDR) was downloaded by the operator and a copy of the relevant data provided to the ATSB. The flight data showed a sharp reduction in left engine torque as the aircraft climbed through 250 ft (see Figure 1). This was followed by a period of torque fluctuations, which aligned with the time that the flight crew reported hearing the banging sound coming from the left engine. The torque fluctuation was also coincident with minor fluctuations in

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1 Western Standard Time (WST): Universal Coordinated Time +8 hours.

2 Pilot flying (PF) and pilot monitoring (PM): procedurally assigned roles with specifically assigned duties at specific stages of a flight. The PF does most of the flying, except in defined circumstances; such as planning for descent, approach and landing. The PM carries out support duties and monitors the PF's actions and the aircraft's flight path.

3 Yawing: the motion of an aircraft about its vertical or normal axis.

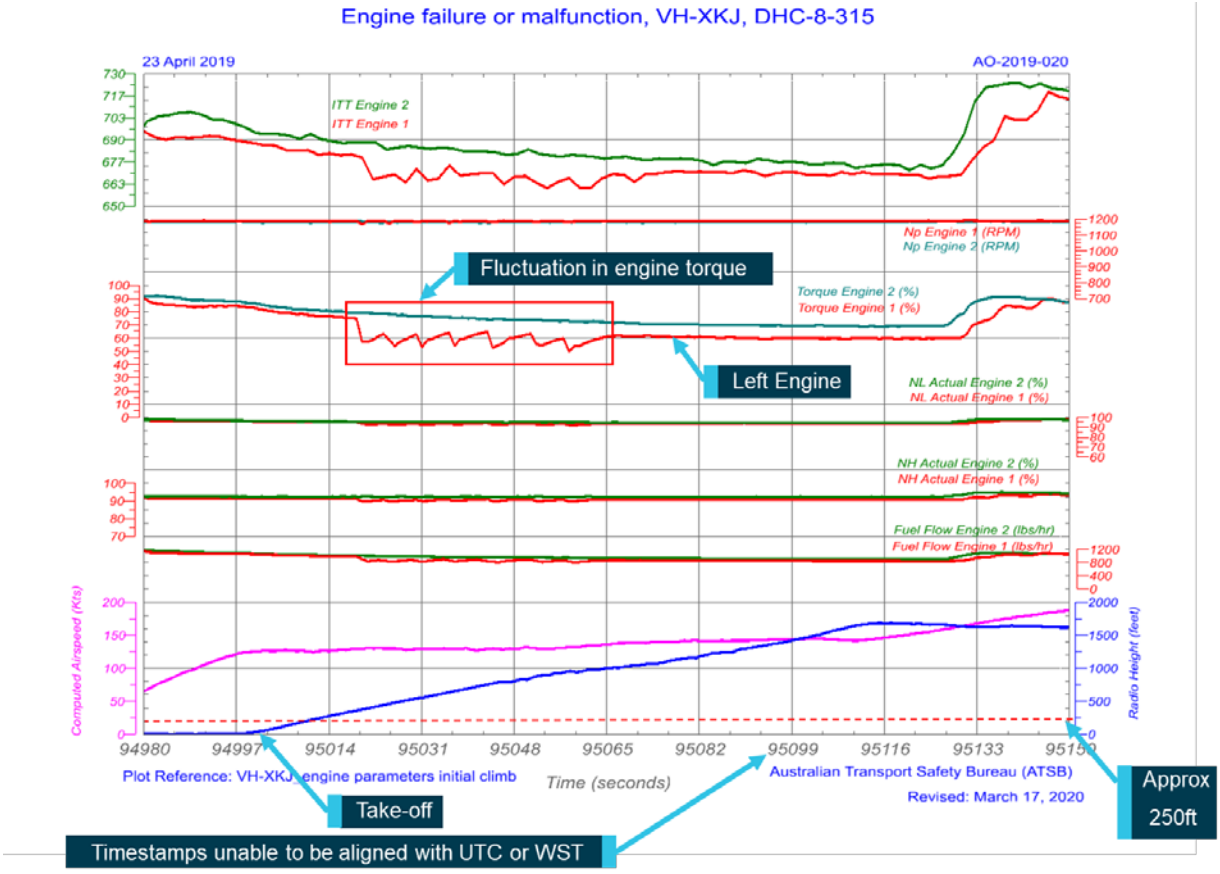
4 The Master Warning system indicates abnormalities or failures of critical systems, such as the engines.

5 PAN PAN: an internationally recognised radio call announcing an urgency condition which concerns the safety of an aircraft or its occupants but where the flight crew does not require immediate assistance.

6 MAYDAY: an internationally recognised radio call announcing a distress condition where an aircraft or its occupants are being threatened by serious and/or imminent danger and the flight crew require immediate assistance.

the left engine inter turbine temperature (ITT), fuel flow, compressor (N_L) and turbine (N_H) percentages.

Figure 1: VH-XKJ occurrence flight showing fluctuating engine parameters



Source: Australian Transport Safety Bureau

A slow reduction in right engine torque and ITT also occurred for the duration of the left engine power fluctuations, and until the torque increase on both engines was observed.

Engine Information

The aircraft was fitted with two Pratt & Whitney Canada (PWC) PW123E turboprop engines. These engines, serial numbers AW0067 (left engine) and AW0065 (right engine), had accumulated 19,212 and 20,354 hours in service respectively at the time of the incident.

The operator utilised an engine condition trend monitoring (ECTM) system to track the health of the various engines throughout its fleet of aircraft. This system allowed them to track trends in engine parameters over time and respond to them as necessary. The system also provided alerts in the event that there was a deviation from the trend in any of these parameters.

The engine maintenance manual (EMM) required that borescope inspections (BSI) be conducted every 1,500 hours for monitored engines and every 1,000 hours for unmonitored engines. In this case, while monitoring their engines using the ECTM system, the operator elected to align the BSI with other maintenance items and carry out the inspections every 1,000 hours under normal conditions.

In late August 2018, the ECTM system detected a change in the trend for both engines. The status changed from 'Trend Normal' to 'Notification', based on an increase in ITT and decrease in the N_H. This trend shift prompted the operator to conduct an out-of-cycle BSI and perform a power assurance run (PAR). This inspection was carried out in early September and both engines were found to have leading edge and tip erosion damage to the high-pressure turbine (HPT) blades.

The damage to the left engine was more pronounced and a defect was raised in the engine's maintenance log. Based on the guidance in the EMM, the left engine erosion damage required an increased inspection frequency for the BSI and PAR to every 300 hours from the previous 1,000-hour interval. In December and within the 300-hour interval, the next BSI revealed increased damage. It was judged, however, to still be within the required limits for continued operation, with the increased inspection frequency. At the time of the occurrence, the engine had accumulated a further 211 hours in service.

Post-incident maintenance

Following the occurrence, both engines underwent inspection and ground runs to ascertain possible contributors to the engine issue, including bird strike and component malfunction. A detailed examination of the left engine was then conducted by an engine overhaul organisation in consultation with the engine manufacturer. The examination noted the erosion damage to the leading edges and tips of the HPT blades. It also noted heavy erosion damage to the HPT shroud. Further, the HPT tip clearances[7] were described as 'excessive', however it was noted that no tip clearance limits were prescribed in the EMM. Hot section repairs were carried out to rectify this issue.

While the erosion damage on the right engine was less than that of the left, it was deemed viable to carry out hot section repairs at the same time. Both engines were subsequently refitted and the aircraft was returned to service, with no further issues noted.

Operational Information

A section of the operator's flight operations manual, *Abnormal and emergency procedures,* detailed actions to be taken in a variety of abnormal situations, including engine failure after take-off. In addition, the quick reference guide detailed procedures for 'engine fail/fire/shutdown (in flight)'. There was no specific information dealing with a partial power loss or abnormality in one or both engines.

The flight crew commented that the partial loss of power on one engine presented a more complex scenario than an engine failure. In that event, the crew would have completed the engine failure drill, as per their training, and could refer to the operator's flight manual or the quick reference guide, if required. As this was not the case, there was some discussion in the cockpit and the decisions were made following assessment of the available information.

The flight crew advised the ATSB that including unusual events of this type in the training program would be of benefit. However, they also noted that it would involve addition to an already extensive training and check program.

The operator advised the ATSB that they considered the flight crew's actions, in returning to the departure airport as soon as the problem was detected, was appropriate.

Safety analysis

Post-flight internal inspection of the engines revealed erosion damage to the high-pressure turbine blades of both engines. Given the high operating temperature/speed and low clearances that exist within turbine engines, erosion degradation over time is expected. However, this deterioration affects the optimum airflow through the engine and reduces the overall engine efficiency. In this case, the erosion to the left engine high-pressure turbine is likely to have contributed to the power loss and banging sound experienced by the crew and the engine parameter variation recorded in the FDR data.

Skippers Aviation conducted engine condition trend monitoring on their fleet of aircraft. A change in the trend for the left engine triggered an alert, which prompted an internal borescope inspection

[7] Tip clearance is the distance between the outer edge of the turbine blade and the shroud or casing that encloses the turbine.

and power assurance run to be conducted. Erosion to the high-pressure turbine was noted and an enhanced maintenance program to monitor the damage had been initiated. Technical documentation available to Skippers Aviation assisted with the detection and monitoring of the damage. However, there was no specific tip clearance limit given in the engine maintenance manual. The ATSB noted that, while this occurrence happened when the engines were under close monitoring, the enhanced maintenance program was in accordance with the engine manufacturer's requirements.

The crew also reported a reduction in right engine power. It was determined that, while a possible exacerbating factor, it did not affect the crew's decision to conduct the return, as the PAN call and return to Perth had been initiated before the right engine low power was noted. The subsequent engine inspection identified erosion to the high-pressure turbine. However, it was less than that of the left engine. Additionally, the flight crew reported that the right engine responded normally to the power lever increase and operated as expected for the remainder of the flight. Based on that evidence, the ATSB concluded that the decrease in right engine power was unlikely due to a mechanical issue with the engine.

Possible causes for this reduction included, a transient engine issue, technical failure of the throttle mechanism, flight crew deliberate action or flight crew distraction. However, because the FDR did not record throttle position data the reason for this reduction could not be determined.

Findings

These findings relating to the engine malfunction and return of the Skippers Aviation DHC-8-315 registered VH-XKJ should not be read as apportioning blame or liability to any particular organisation or individual.

- Excessive erosion to the left engine's high-pressure turbine blades likely resulted in the power loss.
- At the time of the occurrence, the maintenance program for the detected erosion was in accordance with the manufacturer's maintenance manual requirements.
- The aircraft experienced an uncommanded gradual reduction of torque in the right engine, a mechanical issue with the engine as the cause was considered unlikely.

General details

Occurrence details

Date and time:	23 April 2019 – 0615 WST	
Occurrence category:	Serious incident	
Primary occurrence type:	Engine Failure or Malfunction	
Location:	Perth Airport, Western Australia	
	Latitude: 31º 56’ 25'S	Longitude: 115º 58' 01’ E

Manufacturer and model:	De Havilland Aircraft of Canada DHC-8-315	
Registration:	VH-XKJ	
Operator:	Skippers Aviation	
Serial number:	588	
Type of operation:	Charter - Passenger	
Departure:	Perth, WA	
Destination:	Duketon Gold, WA	
Persons on board:	Crew – 4	Passengers – 51
Injuries:	Crew – Nil	Passengers – Nil
Aircraft damage:	Nil	

About the ATSB

The ATSB is an independent Commonwealth Government statutory agency. The ATSB is governed by a Commission and is entirely separate from transport regulators, policy makers and service providers. The ATSB’s function is to improve safety and public confidence in the aviation, marine and rail modes of transport through excellence in: independent investigation of transport accidents and other safety occurrences; safety data recording, analysis and research; fostering safety awareness, knowledge and action.

The ATSB is responsible for investigating accidents and other transport safety matters involving civil aviation, marine and rail operations in Australia that fall within the ATSB’s jurisdiction, as well as participating in overseas investigations involving Australian registered aircraft and ships. A primary concern is the safety of commercial transport, with particular regard to operations involving the travelling public.

The ATSB performs its functions in accordance with the provisions of the *Transport Safety Investigation Act 2003* and Regulations and, where applicable, relevant international agreements.

Purpose of safety investigations

The object of a safety investigation is to identify and reduce safety-related risk. ATSB investigations determine and communicate the factors related to the transport safety matter being investigated.

It is not a function of the ATSB to apportion blame or determine liability. At the same time, an investigation report must include factual material of sufficient weight to support the analysis and findings. At all times the ATSB endeavours to balance the use of material that could imply adverse comment with the need to properly explain what happened, and why, in a fair and unbiased manner.

About this report

Decisions regarding whether to conduct an investigation, and the scope of an investigation, are based on many factors, including the level of safety benefit likely to be obtained from an investigation. For this occurrence, a limited-scope, fact-gathering investigation was conducted in order to produce a short summary report, and allow for greater industry awareness of potential safety issues and possible safety actions.