



Australian Government

Australian Transport Safety Bureau

Propeller blade collar failure involving de Havilland DHC-8, VH-ZZA

Near Darwin, Northern Territory, on 3 December 2019

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Addendum

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Safety summary

What happened

On 3 December 2019, a de Havilland Canada DHC-8-202 (Dash 8) aircraft registered VH-ZZA departed Darwin Airport, Northern Territory to conduct aerial work. During the early stages of the climb, the flight crew heard a loud bang. There were no issues with systems or controllability, so the flight was continued without further incident. Subsequent inspections of the aircraft revealed the number 2 blade collar on the right propeller was missing. There was also damage on the number 1 blade and the ice shield on the fuselage. Removal of the ice shield revealed that the fuselage had been penetrated in two places.

What the ATSB found

The ATSB identified that the propeller blade collars on the number 2 and number 3 blades were last repaired in the field, having been found loose. Following this occurrence, both blades were examined. There was evidence of inadequate cleaning/preparation on the number 2 blade shank, and the collar on the number 3 blade was loose due to adhesive remaining from a prior repair.

Based on those observations, it was likely that issues with surface preparation during field repairs resulted in a lack of adhesion between the number 2 blade and its collar, allowing it to separate in flight. The blade collar then struck the number 1 blade, accelerating the fragments of the collar forcefully into the aircraft's fuselage.

What has been done as a result

As a result of this occurrence, the operator released an engineering notice requiring the entire blade assembly to be replaced in the event of a loose or cracked blade collar. If a serviceable blade assembly was not available, collars were to be replaced in consultation with the relevant Technical Services Engineer, and in strict accordance with the component maintenance manual.

Safety message

Due to constraints on equipment, time, and experience, field repairs can be a source of added risk to an aircraft. To minimise risk, maintenance manuals should be closely followed when conducting field repairs, and operators should consider alternatives such as replacement over repair whenever practical.

This occurrence also illustrates that in-flight damage may not always be apparent to flight crew and the risks posed by incorrect attribution. Serious consideration should be given to terminating the flight following any unexplained abnormal indication.

The investigation

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 investigation was conducted in order to produce a short investigation report, and allow for greater industry awareness of findings that affect safety and potential learning opportunities.

The occurrence

On 3 December 2019, a de Havilland Canada DHC-8-202 (Dash 8) aircraft, registered VH-ZZA (ZZA) and operated by Cobham Aviation Services Australia (Cobham), departed Darwin Airport, Northern Territory shortly before 1200 Central Standard Time¹ to conduct aerial work. At 1200, on climb between 1,000 and 2,000 ft above mean sea level, the flight crew heard a loud bang. One crewmember saw something fly past the window, and assumed a birdstrike had occurred. There were no issues with controllability and all systems were functioning normally, so the crew elected to continue with the mission.

The aircraft landed without further incident, but an engineering inspection subsequently found damage to the right propeller and to the ice shield on the right side of the fuselage. Subsequent removal of the ice shield revealed that the fuselage had been penetrated in two places (Figure 1).

Figure 1: Fuselage penetration



Source: Cobham

¹ Central Standard Time (CST): Coordinated Universal Time (UTC) +9.5 hours

The right propeller showed signs of damage on the leading edge of the number 1 blade, and the number 2 blade collar was missing. Cobham's engineering team reported that the collar had separated from the number 2 blade and struck the number 1 blade. No pieces of the collar were found and there were no other components missing from the aircraft that could have damaged the fuselage.

Context

Blade collar design

The blade collar was a plastic component fixed to each propeller blade to improve aerodynamic performance. The two halves of the collar, such as those shown in Figure 2, were screwed together and secured to the blade shank by an adhesive. The two approved adhesives for installation were RTV157 and PR-1826 Class B.

Figure 2: Blade collar halves



Source: Cobham Aviation Service Australia

In 2015, the blade manufacturer, Collins Aerospace, released an updated design for the blade collar as the original design was not dimensionally stable, which prevented consistent bonding with the blade. This in turn caused a number of collars to separate from the blade shank during service. The new design was only to be installed using RTV157 adhesive.

To reduce the potential loss of adhesion, Collins Aerospace also released Action Item D9274-AI07499 on October 3, 2019. This item added the use of primer SS4004P during the collar bonding operation.

Propeller maintenance history

An overhauled Hamilton Sundstrand 14SF propeller was fitted to the right engine of ZZA in 2016. The blade collars were the original design, as the updated collars were unavailable. On 2 March 2018, the number 2 and number 3 blade collars were found to be loose. Cobham's engineering team inspected and refitted both collars in a field repair, as the updated blade collars had limited availability.

Nine days later, on 11 March 2018, the number 2 blade collar was found to have moved around the blade, indicating it had de-bonded. Cobham subsequently replaced it with the updated collar design in another field repair. At this time, the use of primer had not yet been included in the component maintenance manual. There was no further maintenance performed on either the number 2 or number 3 blades, and prior to the incident they were last inspected on 15 October 2019.

Post-occurrence inspection

Following the collar separation, the number 2 blade was sent to Cobham's propeller repair vendor for examination. The number 3 blade was also sent for examination because it had last been repaired at the same time as the number 2 blade.

While the number 2 blade collar was never recovered, the impression left in the remaining adhesive indicated that the collar had been abraded prior to installation, as required. The adhesive remaining on the blade was RTV157, the correct type for the updated collar design. The vendor also noted, however that:

The remaining adhesive was easily peeled from the blade shank, indicating poor adhesion.

The vendor determined that this was most likely due to insufficient surface preparation/cleaning prior to adhesion. Figure 3 shows the adhesive being peeled off the number 2 blade shank where the separated collar was previously attached.

Figure 3: RTV157 adhesive being peeled off the number 2 blade shank



Source: Propeller repair vendor

The number 3 blade collar was the original design, so both adhesives were permitted. The rear half was securely bonded to the blade with PR-1826, however the front half had been re-attached with RTV157. PR-1826 still coated the blade shank and the vendor reported no adhesion between the different adhesives. As a result, the front collar half was loose.

The component maintenance manual required old adhesive to be removed from the blade shank before a collar was re-attached.

Similar occurrences

A search of the ATSB's database found similar occurrences involving blade collar separation from the same propeller type fitted to Dash 8 aircraft:

ATSB investigation [200304918](#)

In 2003, a Dash 8 experienced an in-flight blade collar separation shortly after take-off from Sydney, New South Wales. The subsequent examination revealed that the adhesive used had been contaminated. The source of the contamination could not be identified. The same operator experienced another collar separation in 2004. Subsequent inspections on the rest of the fleet indicated five other aircraft with at least one loose blade collar. As a result, the operator initiated a repetitive collar inspection regime on their fleet.

ATSB occurrence 201203474

In 2012, on final approach into Port Macquarie Airport, New South Wales, the flight crew of a Dash 8 heard an impact noise on the left side of the aircraft. Engineering later determined that a blade collar had separated from the left propeller before striking a blade and then the engine nacelle. No potential reason for collar separation was provided to the ATSB.

Internationally, de Havilland Canada identified one occurrence in which the fuselage of a DHC-8 aircraft may have been penetrated by collar fragments. In October 2011, a post-flight inspection of

a DHC-8-314 revealed part of a blade cuff missing, along with damage to one of the propeller blades and two holes in the fuselage. While no debris was found, it was concluded that fragments of the collar or attaching hardware likely struck the blade and was propelled into the fuselage.

Analysis

The adhesive remaining on the number 2 blade was not well bonded to the blade shank, likely due to problems with the preparation/cleaning of the bonding surfaces prior to adhesion. The lack of adhesion between the collar and blade shank resulted in the collar becoming loose and separating in flight. Similar problems were observed on the number 3 blade, where adhesive from a previous field repair prevented adequate bonding between the blade and collar.

The number 2 blade collar was the only component found missing from the aircraft during the post-flight inspection. Given that the number 1 blade was also damaged, it follows that the number 1 blade accelerated the detached collar fragments into the fuselage with sufficient force to penetrate it. This appears to be consistent with a previous occurrence, where it was determined that fragments of blade collar likely struck a propeller blade, accelerating them into the fuselage.

This incident illustrates that component failure and in-flight damage may not always be apparent to flight crew, and there are potential risks in incorrectly attributing the cause of events such as a loud bang. As such, serious consideration should be given to terminating the flight following any unexplained abnormal indication, especially if it occurs in proximity to a suitable airport.

Findings

ATSB investigation report findings focus on safety factors (that is, events and conditions that increase risk). Safety factors include 'contributing factors' and 'other factors that increased risk' (that is, factors that did not meet the definition of a contributing factor for this occurrence but were still considered important to include in the report for the purpose of increasing awareness and enhancing safety). In addition 'other findings' may be included to provide important information about topics other than safety factors.

These findings should not be read as apportioning blame or liability to any particular organisation or individual.

From the evidence available, the following findings are made with respect to the propeller blade collar failure of a de Havilland DHC-8-202, registered VH-ZZA, that occurred near Darwin, Northern Territory, on 3 December 2019.

Contributing factors

- When the number 2 blade collar was replaced, there was a lack of adhesion between the collar and blade, likely due to improper preparation of the bonding surfaces. This resulted in the collar debonding and separating in flight.
- The detached number 2 propeller blade collar struck the number 1 propeller blade. This accelerated collar fragments into the aircraft's fuselage with sufficient force to penetrate it.

Safety issues and actions

Whether or not the ATSB identifies safety issues in the course of an investigation, relevant organisations may proactively initiate safety action in order to reduce their safety risk. The ATSB has been advised of the following proactive safety action in response to this occurrence.

Safety action by Cobham Aviation Services Australia

As a result of this occurrence, Cobham released an engineering notice in March 2020 requiring the entire blade assembly to be replaced in the event of a loose or cracked blade collar. If a serviceable blade assembly was not available, Cobham required collars to be replaced in

consultation with the relevant Technical Services Engineer, and emphasised that all preparation instructions from the component maintenance manual were to be observed during the repair.

Sources and submissions

Sources of information

The sources of information during the investigation included:

- Cobham Aviation Services Australia
- the propeller repair vendor
- Collins Aerospace
- De Havilland Canada.

Submissions

Under section 26 of the *Transport Safety Investigation Act 2003*, the ATSB may provide a draft report, on a confidential basis, to any person whom the ATSB considers appropriate. That section 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 following directly involved parties:

- the flight crew
- Cobham Aviation Services Australia
- De Havilland Canada
- Collins Aerospace
- the propeller repair vendor
- the Civil Aviation Safety Authority
- the Transportation Safety Board of Canada.

Submissions were received from:

- the flight crew
- Cobham Aviation Services Australia
- Collins Aerospace.

The submissions were reviewed and, where considered appropriate, the text of the report was amended accordingly.

General details

Occurrence details

| | | |
|--------------------------|---|-------------------------|
| Date and time: | 3 December 2019 – 1200 CST | |
| Occurrence category: | Incident | |
| Primary occurrence type: | Propellers/rotor malfunction | |
| Location: | Near Darwin Airport, Northern Territory | |
| | Latitude: 12° 24.88' S | Longitude: 130° 52.6' E |

Aircraft Details

| | | |
|-------------------------|---|------------------|
| Manufacturer and model: | de Havilland Aircraft Pty Ltd DHC-8-202 | |
| Registration: | VH-ZZA | |
| Operator: | Cobham Aviation Services Australia | |
| Serial number: | 419 | |
| Type of operation: | Aerial Work | |
| Departure: | Darwin Airport | |
| Destination: | Darwin Airport | |
| Persons on board: | Crew – 4 | Passengers – Nil |
| Injuries: | Crew – Nil | Passengers – Nil |
| Aircraft damage: | Minor | |

Australian Transport Safety Bureau

About the ATSB

The ATSB is an independent Commonwealth Government statutory agency. It is governed by a Commission and is entirely separate from transport regulators, policy makers and service providers.

The ATSB's purpose is to improve the safety of, and public confidence in, aviation, rail and marine transport through:

- 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, as well as participating in overseas investigations involving Australian-registered aircraft and ships. It prioritises investigations that have the potential to deliver the greatest public benefit through improvements to transport safety.

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

Purpose of safety investigations

The objective of a safety investigation is to enhance transport safety. This is done through:

- identifying safety issues and facilitating safety action to address those issues
- providing information about occurrences and their associated safety factors to facilitate learning within the transport industry.

It is not a function of the ATSB to apportion blame or provide a means for determining 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. The ATSB does not investigate for the purpose of taking administrative, regulatory or criminal action.

Terminology

An explanation of terminology used in ATSB investigation reports is available on the ATSB website. This includes terms such as occurrence, contributing factor, other factor that increased risk, and safety issue.