Australian Government

Australian Transport Safety Bureau

ATSB TRANSPORT SAFETY REPORT

Aviation Occurrence Investigation – AO-2006-007

Final

In-flight engine failure
93km N of Perth Airport, WA
27 November 2006
Beechcraft King Air 200, VH-XDB

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In-flight engine failure – 93km N of Perth Airport, Western Australia – 27 November 2006 – Beechcraft King Air 200 – VH-XDB

Prepared By

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Abstract

On 27 November 2006, a Beechcraft King Air 200 aircraft, registered VH-XDB and carrying two crew and six passengers, was on a flight from Mount Hale to Perth, Western Australia. Shortly after commencing the decent into Perth airport, the right engine failed catastrophically.

An engineering examination of the failed Pratt and Whitney Canada PT6A-41 turboprop engine was performed and revealed that the first-stage 'sun' and 'planet' gear set within the propeller reduction gearbox had decoupled from the power turbine. The decoupling allowed the power turbine to overspeed, which resulted in destruction and shedding of the turbine blades. Several blade fragments punctured the outer gas generator case.

A metallurgical examination of the failed first-stage gear set revealed that a mismatch in service histories between the sun gear and planet gears was the most likely contributor to the failure. The engine manufacturer had been alert to the occurrence of reduction gearbox distress due to gear mismatching at overhaul.

Following this incident, the aircraft operator initiated a review of their system of maintenance with respect to monitoring of life-limited engine components, for all PT6A engines in their fleet.

THE AUSTRALIAN TRANSPORT SAFETY BUREAU

The Australian Transport Safety Bureau (ATSB) is an operationally independent multi-modal bureau within the Australian Government Department of Infrastructure, Transport, Regional Development and Local Government. ATSB investigations are independent of regulatory, operator or other external organisations.

The ATSB is responsible for investigating accidents and other transport safety matters involving civil aviation, marine and rail operations in Australia that fall within Commonwealth 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 fare-paying passenger operations.

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 enhance safety. To reduce safety-related risk, ATSB investigations determine and communicate the safety factors related to the transport safety matter being investigated.

It is not the object of an investigation to determine blame or liability. However, 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.

Developing safety action

Central to the ATSB's investigation of transport safety matters is the early identification of safety issues in the transport environment. The ATSB prefers to encourage the relevant organisation(s) to proactively initiate safety action rather than release formal recommendations. However, depending on the level of risk associated with a safety issue and the extent of corrective action undertaken by the relevant organisation, a recommendation may be issued either during or at the end of an investigation.

The ATSB has decided that when safety recommendations are issued, they will focus on clearly describing the safety issue of concern, rather than providing instructions or opinions on the method of corrective action. As with equivalent overseas organisations, the ATSB has no power to implement its recommendations. It is a matter for the body to which an ATSB recommendation is directed (for example the relevant regulator in consultation with industry) to assess the costs and benefits of any particular means of addressing a safety issue.

About ATSB investigation reports: How investigation reports are organised and definitions of terms used in ATSB reports, such as safety factor, contributing safety factor and safety issue, are provided on the ATSB web site www.atsb.gov.au.

FACTUAL INFORMATION

History of the flight

On 27 November 2006, a twin-engine turboprop King Air 200 aircraft, registered VH-XDB and carrying two crew and six passengers, was en route from Mount Hale to Perth, Western Australia.

At approximately 1800 Western Standard Time[1], the pilot in command of the aircraft commenced the decent into Perth airport from flight level 230 (FL230). Shortly after, elevated vibrations were felt through the controls and increased noise was heard emanating from the right side of the aircraft. A visual scan of the gauges on the cockpit instrument panel revealed rapidly reducing oil pressure within the right engine. The pilot subsequently initiated an emergency shutdown of the right engine, setting the engine condition lever to CUT OFF and feathering the propeller.

After the right engine was shut down, an uneventful one-engine inoperative approach and landing was made at Perth airport. Following the disembarkation of the passengers, the aircraft was taxied to the operator’s hanger for inspection.

Aircraft damage

A post-flight inspection of the aircraft by the operator's engineering staff found that the right engine had sustained an uncontained failure, with one large and three smaller perforations of the engine case. It was noted that the propeller was able to be rotated freely by hand without producing any corresponding rotation from within the power turbine of the engine, suggesting an internal failure within the engine’s reduction gearbox.

Damage external to the engine was limited to light impact indentations on the right wing leading edge of the aircraft. Superficial scratching of the fuselage and several cabin windows on the right of the aircraft was also evident. The right engine was removed from the aircraft and sent to an overhaul facility in Brisbane for subsequent teardown and further detailed inspection.

Engine examination

The failed right engine, a Pratt and Whitney Canada (PWC) model PT6A-41, was disassembled and inspected at a PWC overhaul centre, under the supervision of Australian Transport Safety Bureau (ATSB) investigators. The disassembly revealed the following major detail:

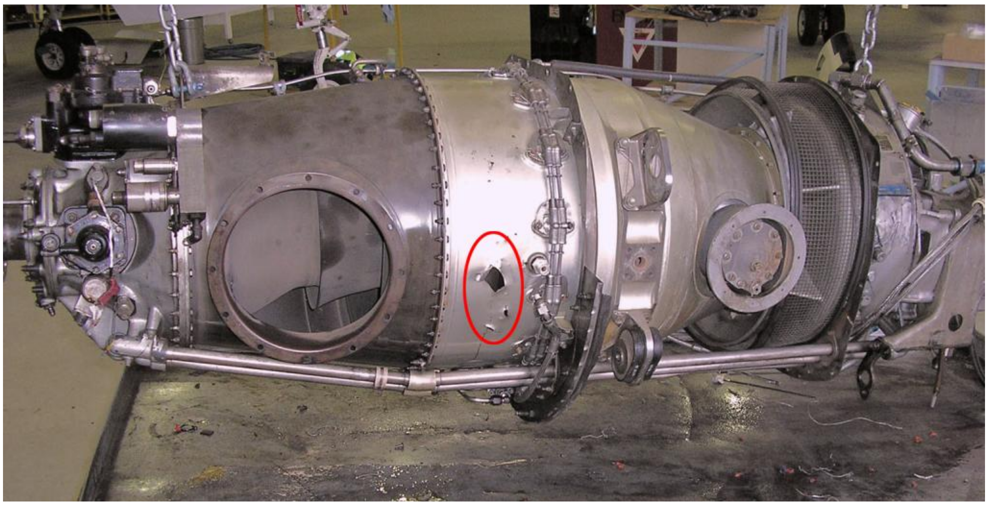
- The power turbine (PT) had sustained a total failure of the blade assembly, with the fracture and loss of nearly all of the first- and second-stage blades near their airfoil platforms.

1 The 24-hour clock is used in this report to describe the local time of day, Western Standard Time (WST), as particular events occurred. Western Standard Time is Coordinated Universal Time (UTC) + 8 hours.

- The PT housing had been outwardly deformed in line with the trajectory path of the liberated first- and second-stage PT blade assembly.
- As a consequence of the PT blade fractures, the gas generator outer case had been outwardly punctured. One large (~25 mm by ~25 mm) and three smaller holes had been produced in the case.
- The PT housing had moved axially into the combustion liner of the gas generator, resulting in multiple perforations of the blade containment section.
- The internal threads from the slotted lock nut that was used to secure the first stage PT disk assembly onto the rear end of the PT shaft, had been 'stripped'. That loss in security allowed the PT disks to shift axially along the PT shaft.
- The sun gear that coupled the power turbine shaft to the first-stage planetary gear set was severely damaged. All of the sun gear teeth that normally intermeshed with the planet gears had been heavily worn during the failure event.
- All of the first-stage planet gears displayed significant mechanical damage with many of the teeth either chipped or fractured.
- Both the magnetic chip detector to the reduction gearbox and the engine oil filter, were found to be heavily contaminated with metal.

Figures 1 through 6 show the major features of the damage sustained by the engine components during the failure sequence. The engine was subsequently packaged for examination at the engine manufacturer's Canadian facilities. A report detailing the PWC[2] findings was subsequently made available to the ATSB.

Figure 1: The failed engine as removed from VH-XDB. Note the punctures (circled) in the gas generator case



[2] Pratt and Whitney Canada, Engine / Component Investigation Report Number ETC-10245, 2/07/2007.

Figure 2: View of the power turbine after engine teardown showing complete first-stage and majority second-stage blade loss

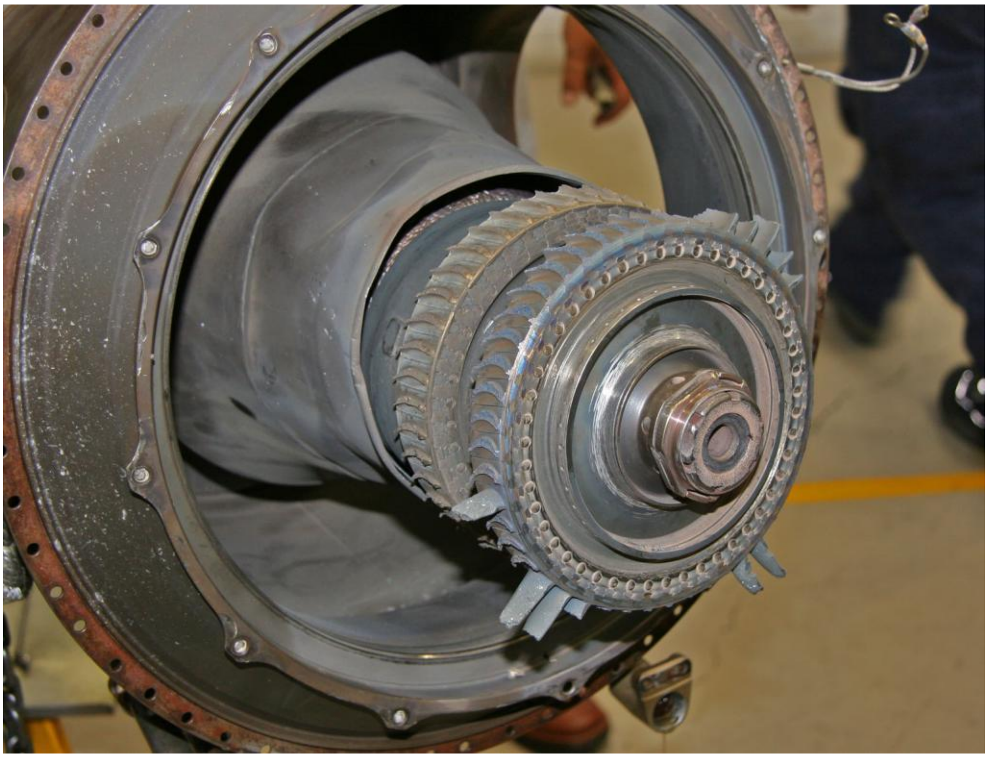


Figure 3: Close-up of the ruptured gas generator case showing the exit path of the fractured power turbine blades

Figure 4: Decoupled sun gear showing complete loss of the teeth

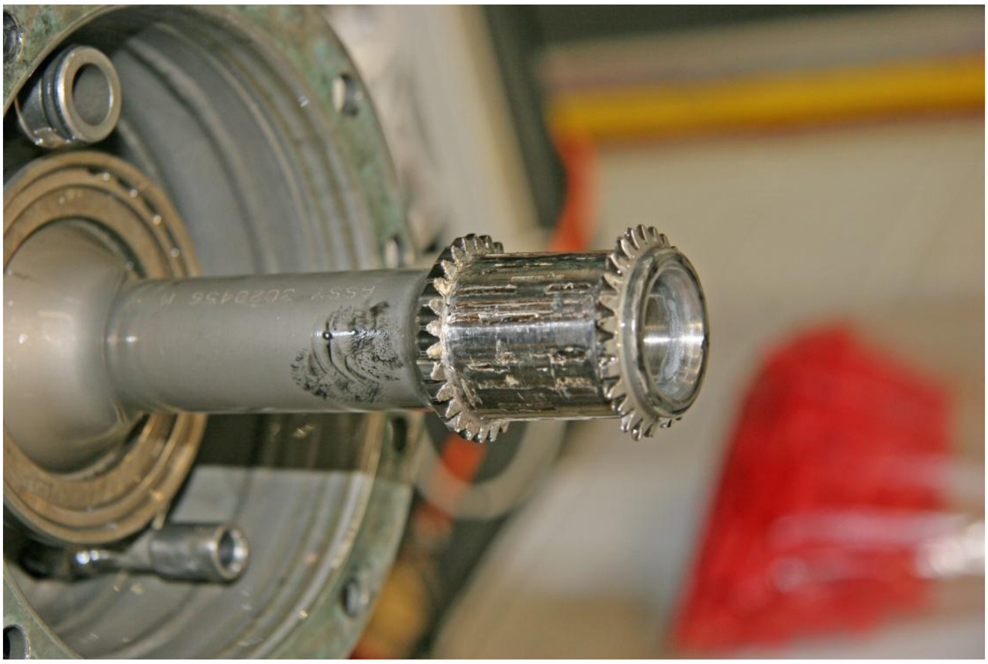


Figure 5: A first-stage planet gear, as-removed

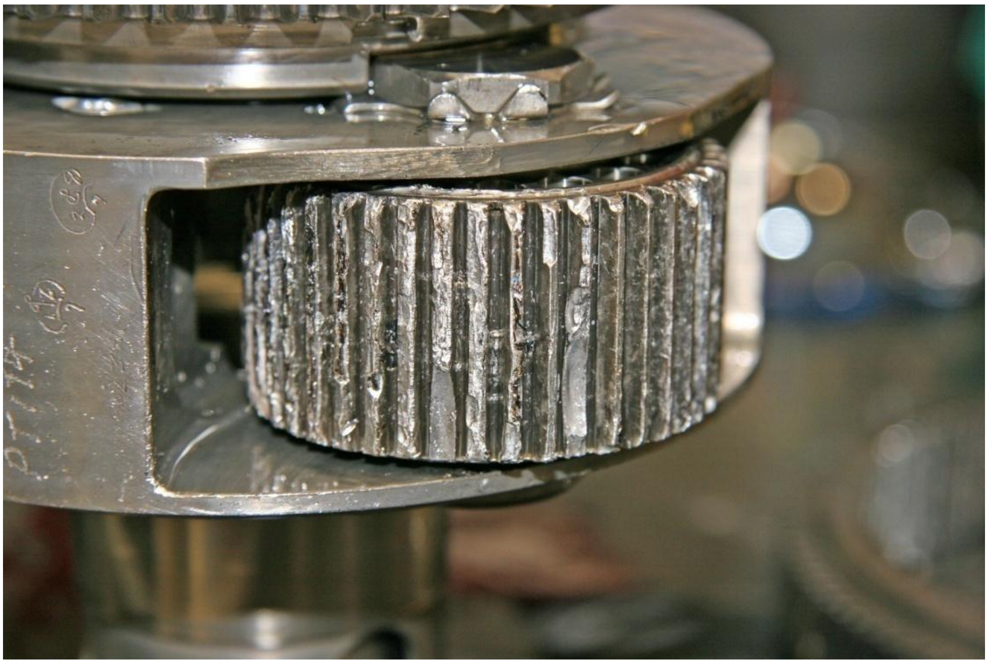
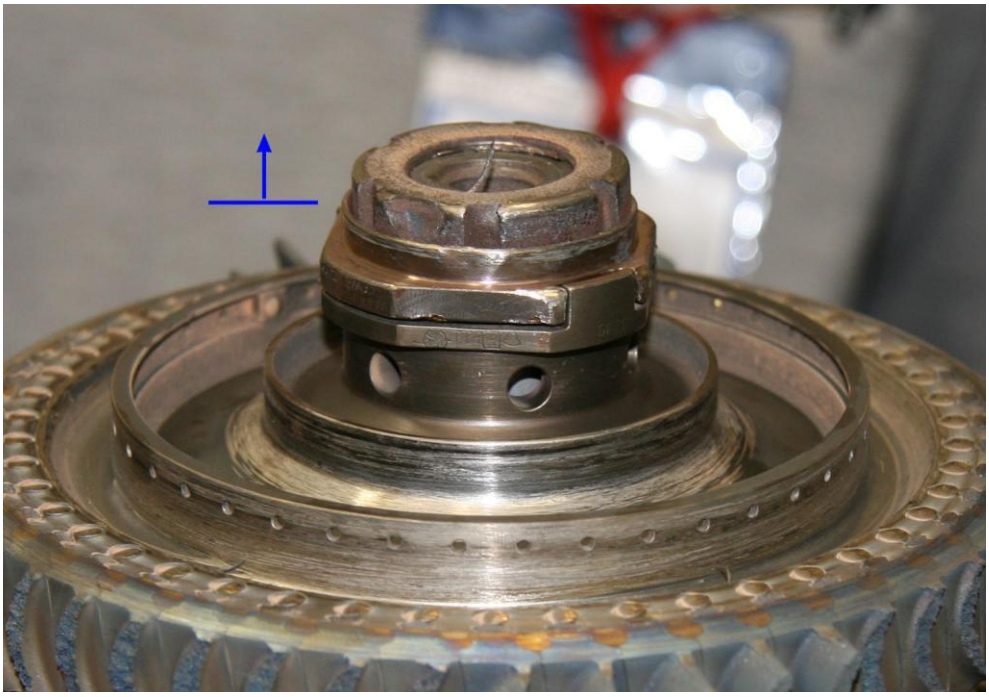


Figure 6: The slotted lock nut on the end of the power turbine shaft was found shifted rearward from its normally installed position (arrowed) and is shown with 'stripped' threads



Aircraft and engine information

The Beechcraft King Air 200 aircraft was manufactured in the United States (US) in 1979 and was first registered in Australia in 1987. At the time of the occurrence, the aircraft had accumulated a total time in service of about 26,100 hours. The aircraft had been fitted with two PWC PT6A-series engines.

Since original manufacture in 1976, the failed right engine had been installed on numerous aircraft. During that time, the engine had accumulated a total of 13,822 hours and 12,671 cycles[3]. See Table 1 for a summary of the specific engine detail.

Table 1: Right engine detail

Manufacturer	Pratt and Whitney Canada (PWC)
Model	PT6A-41
Type	Turboprop
Serial Number	79102
Time / cycles since overhaul	4,369 hours / 3,378 cycles

3 One complete sequence of events for an aircraft that involves: start-up, taxi, takeoff, climb, cruise, descent, landing, taxi and shutdown.

Engine configuration

The failed engine was classed as a ‘free-turbine’ engine with two independent counter-rotating assemblies; the compressor and the turbine.

The basic design of the engine allowed inlet air to be pneumatically compressed by the compressor section. Air exiting the compressor was then mixed with fuel and ignited within the combustion chamber. Once the air/fuel mixture was ignited, the hot combustion gases were directed into the compressor turbine and subsequently the power turbine, to enable rotational movement of the engine accessories and provide drive to the propeller through the reduction gearbox (RGB).

In order to suitably reduce the power turbine speed for propeller operation (33,000 RPM down to ~ 2,000 RPM), the PT6A-41 engine used a two-stage planetary gear system (Figure 7). Torque from the power turbine section was transmitted through the power turbine shaft and turbine coupling to the first-stage sun gear.

The first-stage sun gear consisted of a short hollow steel shaft with an integral spur gear at the front, which coupled to an intermeshing three-piece planetary gear set. The second-stage within the RGB was similar to the first but used five planet gears and was splined[4] onto the propeller shaft.

Figure 7: Exploded diagram showing the arrangement between the sun gear and first-stage reduction gear set from the PT6A-series engine

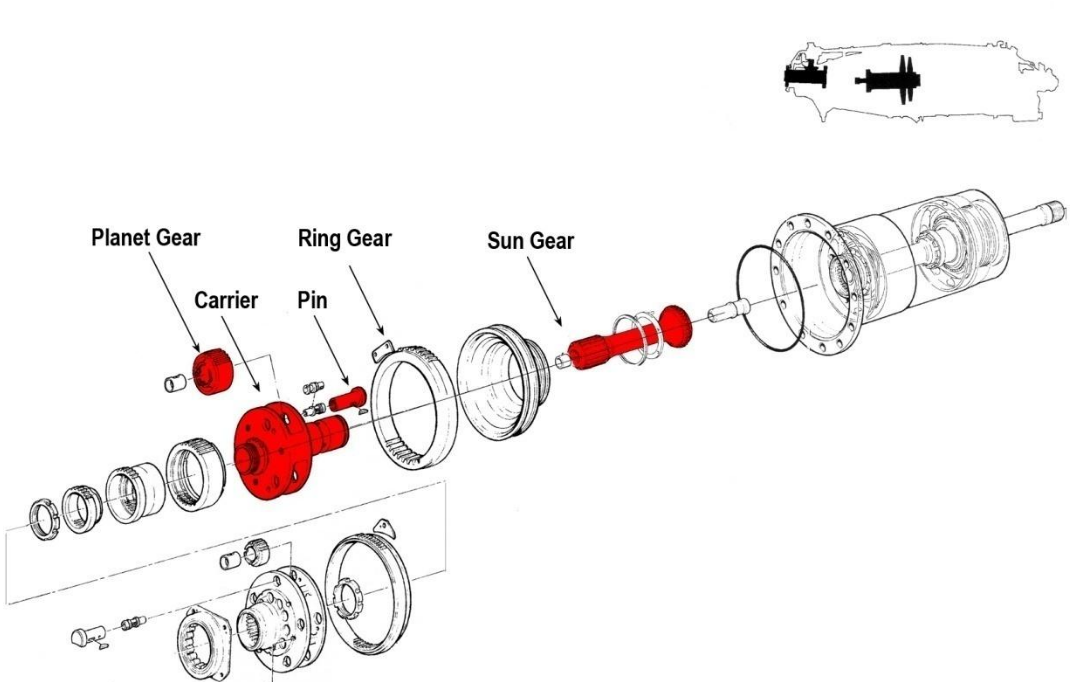


Image source: Pratt and Whitney Canada

[4] A splined shaft uses a series of grooves that mesh with and equalise the rotation speed of a mating piece, thereby transferring torque.

Technical examination: right engine components

A number of components from the failed PT6A-41 engine were retained for detailed technical examination at the ATSB engineering facilities in Canberra.

Power turbine

Examination of the first- and second-stage PT blade fracture surfaces revealed only features consistent with the application of a single excessive loading occurrence. No pre-existing defects were associated with the fractured blades. The entire first-stage blade set (43 in total) had fractured in the region of the fir-tree root form.

Examination of the second-stage PT blade set (47 in total) showed that 36 of the blades had also fractured in a similar manner; close to the blade root. The remaining 11 second-stage blades had fractured through the airfoil section. In the absence of any pre-existing defects, the fracture features observed were indicative that the turbine blade assembly had been exposed to excessive stresses created by an over speed of the power turbine.

First-stage planet gears

The first-stage sun and planet gears removed from the engine were identified by the hand engraved numbers and letters as shown in Figure 8 and Table 2.

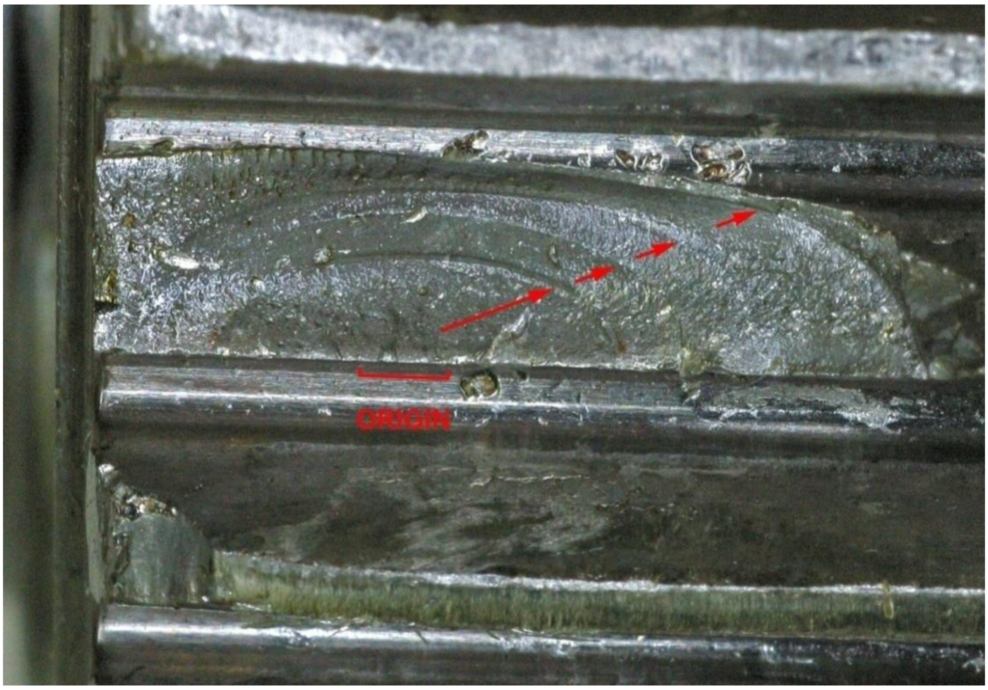
Figure 8: The sun gear and planet gear set from the first-stage reduction gear assembly

Table 2: First-stage planet gear and sun gear component detail

Item	Serial Number	Part Number	Other Detail
Planet Gear	2843	ASSY 3024473 A	PFAEC #454 X CPWA 2163024471A
Planet Gear	3437	ASSY 3024473 A	PFAEC #454 Y CPWA 253024471A
Planet Gear	3511	ASSY 3024473 A	PFAEC #454 Z CPWA 8035187
Sun Gear	840319	ASSY 3028456 M	3028455 J

Examination of the first-stage planet gears showed that the five teeth from the ‘Z’ first-stage planet gear (serial number 3511) had fractured due to the initiation and propagation of fatigue cracking. An example of one of the fatigue fractured gear teeth is shown in Figure 9. The origin of fatigue crack growth was at the base of the driven surface in the root radii. The direction of crack growth indicated that uni-directional bending loads from engine operation had allowed the cracks to grow.

Figure 9: Fractured tooth surface from a first-stage planet gear showing clear evidence of fatigue cracking (arrowed)

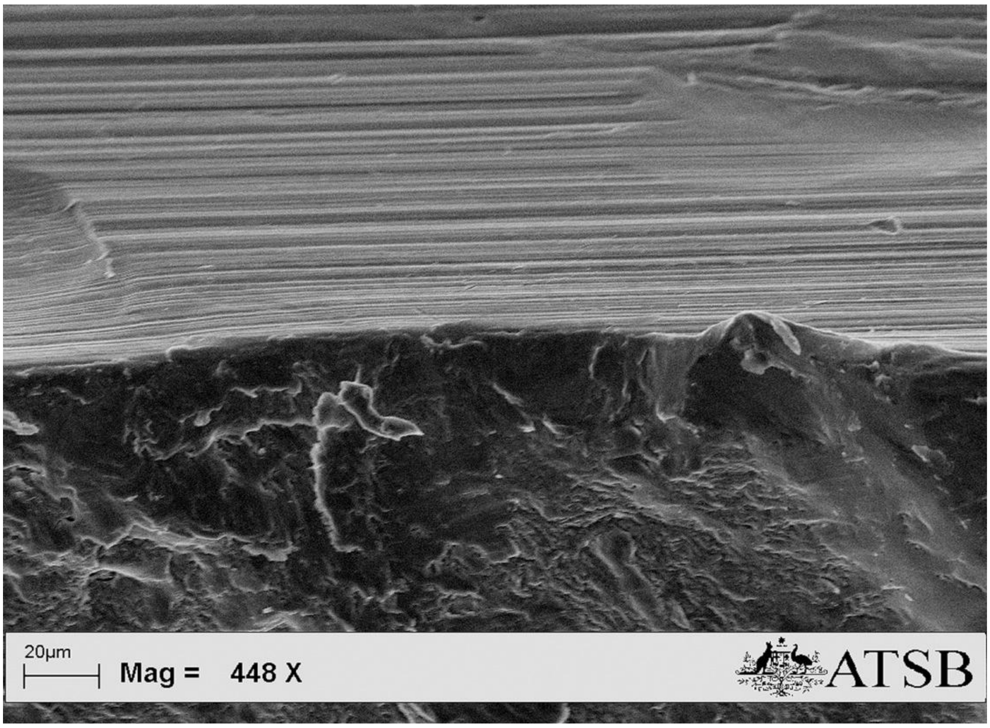


The fatigue crack fracture surfaces were examined at high magnification using a scanning electron microscope (SEM). The surface finish in the root radii at the origin of each fatigue crack was in the as-manufactured condition (Figure 10). Residual marks from the machining process were present. No evidence of mechanical abuse or corrosive attack was present that would otherwise indicate a mechanism for cracking to initiate.

In addition to the fatigue damage, all three first-stage gears had sustained numerous tooth chips and fractures to their profile. It was evident that such damage had been produced by fractured tooth sections that had either impacted or become enmeshed with the first-stage gear train during engine operation. In the case of the fractured teeth, the mode of fracture was assessed as either from bending or shear, which indicated that severe loads had been present within the gear set when the engine failed.

It was noted that a bronze-lined bearing had had been installed in each gear. Grit blasting had been applied within the bore of each planet gear surrounding the bronze bearings. No overspray damage from that abrasive process was identified on any of the gear surfaces that may have otherwise contributed to the gear failure (Figure 11).

Figure 10: High magnification SEM image of a fatigue crack origin in one of the planet gear teeth. Horizontal machining marks associated with original manufacture can be seen at the tooth root



First-stage sun gear

Examination of the first-stage sun gear showed that all of the teeth had been cleanly 'machined' through excessive wear against those sections that had engaged with the first-stage planet gears (Figure 12). It was noted that the sun gear's teeth were longer than the planet gear teeth. Those regions of the sun gear that did not engage with the planet gear teeth were undamaged. Due to the level of damage sustained to the sun gear, a failure mechanism for the sun gear could not be positively identified.

Second-stage reduction gear set

Examination of the gears that comprised the second stage of the reduction gear set did not reveal any indications of unusual wear. The driven[5] surface of each tooth

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[5] The driven surface of a gear tooth is the face that receives transmitted loads by direct contact with the teeth of an adjacent intermeshing gear.

exhibited a polished appearance that was consistent with normal contact wear. No anomalies were noted.

Figure 11: Photograph of a planet gear face showing the clear delineation of the extent of grit blasting (arrowed) near the bronze bearing bore

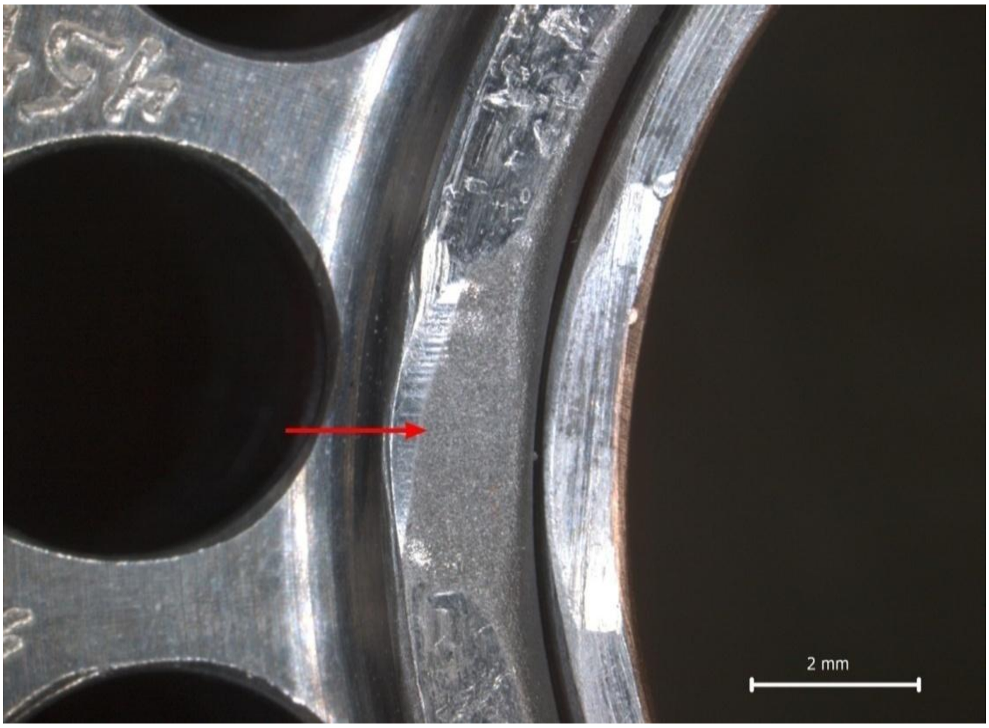

Figure 12: Photograph of the sun gear showing complete 'machining' wear of the teeth that had normally engaged with the planet gears

Engine maintenance history

A review of the operator's maintenance records revealed that during October 1998, the engine had been overhauled in the US. In March 2003, the engine was first installed onto VH-XDB where it was operated for approximately 2,100 hours on that airframe until failure. At the time of the failure event, the engine had accumulated 4,369 hours since the last overhaul. The next scheduled engine overhaul was due in a further 630 hours of service.

The last recorded maintenance action performed on the engine was a boroscopic inspection of the hot-section, about 10 hours prior to the event. An inspection of the engine's reduction gearbox chip detector was last performed approximately 64 hours prior to the engine failure. No anomalies were indicated by the chip detector inspection, suggesting that there were no significant mechanical defects within the gearbox at that time.

It was noted that the service history of the first-stage planet gear set was not recorded in the operator's maintenance records for the failed engine. A comprehensive review[6] of those records was subsequently conducted to establish the service life of the failed first-stage planet gears (Table 2).

Table 2: Right engine major maintenance timeline

1976	Engine manufactured	TSN[7]: 0 hours
06-1978	Repaired for broken diffuser pipe, RGB not accessed	TSN :1,005 hours
05-1980	Engine overhauled	TSN: 1,999 hours
03-1983	Engine overhauled, first-stage planet gears inspected and found serviceable	TSN 3,998 hours
09-1990	Engine overhauled, bronze bushing installed in first-stage planet gears[8]	TSN: 6,014 hours
10-1994	Engine removed for metal contamination, first-stage sun gear replaced	TSN: 8,110 hours
10-1998	Engine overhauled, first-stage sun gear replaced, no indication that the planet gears were replaced	TSN: 9,513 hours
03-2004	Engine first fitted to King Air 200 (VH-XDB)	TSN: 11,300 hours
11-2006	Engine failure	TSN: 13,882 hours

6 The maintenance history for the sun and planet gears from the right engine could only be established through records obtained with assistance from the US National Transportation Safety Board (NTSB), and Pratt and Whitney Canada.

7 Time Since New (TSN).

8 Pratt and Whitney Canada, Service Bulletin 3216, 'Improved first-stage planet gear sleeve bearings (pre-machined bronze) – Introduction of', August 1986.

Information supplied by the engine manufacturer indicated that the engineering drawing for the first-stage planet gears (part number 3024473) was made obsolete in 1981. With no record of the first-stage planet gears ever having been replaced in the failed engine, it is likely that they were installed when the engine was first assembled in 1976. This would imply that the first-stage planet gears had accumulated 13,882 hours of service. Examination of the records showed that the sun gear had been installed into the engine in October 1998 and it had accumulated 5,772 hours service.

PT6A-series life extension program

The failed engine had been maintained on a life extension program that had been introduced by the Civil Aviation Safety Authority (CASA) under airworthiness directive AD/ENG/5. The purpose of AD/ENG/5 was to provide operators of PT6A-series turbine engines the opportunity to extend the time between overhauls (TBO) up to a maximum of 5,000 hours. For operators that were not utilising the AD/ENG5 life-extension program for their engines, the TBO as recommended by PWC, was dependant on the modification status of the engine. For a PT6A-41 engine, the variation in the manufacturer's TBO interval ranged from a basic 2,500 hours up to a maximum of 3,600 hours.

In order to participate in the AD/ENG/5 life-extension program, operators and maintainers were required to implement an enhanced system of maintenance in order to safely extend the life of their PT6A-series engines. AD/ENG/5 contains numerous instructions for compliance. One particular requirement of AD/ENG/5 states the following:

> All life limited components shall be replaced at engine manufacturer's published life limits per AD/ENG/7.

CASA airworthiness directive AD/ENG/7[9] states the following:

> Record the operating hours since new and the operating cycles since new for each life limited component in accordance with the applicable engine manufacturer's document that details component life limits.

The applicable document published by PWC the engine manufacturer that details the life limitations for rotating engine components was contained in service bulletin 3003R20[10]. The life limit intervals of the first-stage sun and planet gears were restricted to 12,000 hours.

Once the life limit had been reached, both the first-stage planet gear set and the sun gear were required to be replaced at the next scheduled overhaul. In the case of the failed right engine, these gears were due to be replaced following a further 630 hours of service.

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9 CASA AD/ENG/7 was first published in January 1995.

10 Pratt and Whitney Canada, Service Bulletin Number 3003 Revision 20, 'Turboprop engine operating time between overhauls and hot section frequency', 16 July 2002.

History of related failures

As part of this investigation, a search of the CASA and the US Federal Aviation Administration (FAA) databases showed that a decoupling of the reduction gearbox was an infrequent event for the PT6A-series engine. Of the databases that were reviewed, the records indicated that only three other events of this type had been recorded where failure of the first-stage sun and planet gears allowed the power turbine to decouple and overspeed.

Despite the low number of such events for this engine type, the manufacturer was alert to occurrences of reduction gearbox distress. Such occurrences decreased the reliability of the engine and gear train.

A factor reducing the reliability of the reduction gear box identified by the manufacturer was the mismatch in service lives between the sun and planet gear sets in which new gears are installed with others that have already seen service. The manufacturer's experience had shown that following an engine overhaul, all subsequent failures of the gear set were due either to the original sun gear, planet gears, or both, being reinstalled.

In 1999, PWC issued a service information letter[11] (SIL-078) to all operators of the PT6A-38/40/41 engines advising that the first-stage sun and planet gear must be replaced as a matched set at overhaul regardless of the condition of the parts. A subsequent revision of the overhaul manual contained the following statements:

> Replacement of the first-stage sun and planet gears is mandatory at overhaul.[12]
>
> **CAUTION:** If first-stage planet gears are to be replaced for any reason, then the first stage sun gear must also be replaced.[13]

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11 Pratt and Whitney Canada, Service Information Letter Number PT6A-078, 'Replacement of first stage sun gear and planet gears at overhaul', 02 September 1999.

12 Pratt and Whitney Canada, Overhaul Manual, Part Number 3021443, 72-10-00, 'Propeller reduction gearbox – repair', page 442.

13 Pratt and Whitney Canada, Overhaul Manual, Part Number 3021443, 72-10-00, 'Propeller reduction gearbox – light overhaul', page 1309.

ANALYSIS

Accident flight

The examination of the components from the King Air 200 aircraft determined that a catastrophic failure of the first-stage sun and planet gears within the propeller reduction gearbox (RGB) was the principal contributing factor that led to the in-flight failure of the right engine. The resultant decoupling between the power section and the RGB resulted in an almost instantaneous overspeed condition within the turbine section. Once decoupled, the increase in turbine rotational speed amplified the stresses within the compressor and power turbine blades beyond their design limit, resulting in destruction and shedding of the blade assemblies.

Engine containment

While most of the fractured power turbine blades from the right engine exited via the exhaust section, several blade fragments punctured the gas generator case. It was noted that while the blades contained sufficient kinetic energy to penetrate the outer engine casing, they did not possess the energy to penetrate the nacelle of the aircraft surrounding the engine.

The containment of failed rotor blades is a complex process due to the high energy and high speed interactions with various engine components, for example, failed blades, other blades, bearings, adjacent cases and shafts. Once a rotor blade failure is initiated, secondary events cannot be accurately predicted. In this case, the blades were able to escape the containment ring because of the disruption to the slotted locking nut on the rear of the power turbine shaft. The threads on the nut had ‘stripped’ during the engine failure, which allowed both power turbine discs to shift axially to the rear, in turn allowing several fractured blades to penetrate the engine casing to the rear of the containment ring.

Reduction gearbox failure

A metallurgical examination of the recovered engine components showed that several teeth from one of the first-stage planet gears within the RGB had failed due to the initiation and propagation of fatigue cracking. No identifying features that could have initiated the cracking, such as corrosion or mechanical damage, were observed around the gear tooth fatigue crack origins.

In the absence of any contributory damage features, it is likely that the failure was related to a gear mismatch in which a new sun gear had been installed without the planet gears being replaced at the same time. A comprehensive review of the available maintenance documentation for the right engine revealed that the failed first-stage sun gear and planet gears had accumulated 5,772 hours and 13,882 hours of service respectively.

Prior to the occurrence, PWC recognised that a first-stage RGB gear set can fail due to a mismatch in service histories in which old gears and new gears are installed together. This is reflected by their publication of an all-operator service information letter (SIL-078) and also by the introduction of changes to the respective PT6A-41 maintenance documentation. PWC state clearly that the first-stage sun and planet gears should be replaced as a set. The requirement from PWC to replace the gears as a matched set was introduced in 1999. The right engine sun gear was replaced prior to the release of those maintenance instructions. Therefore, despite the gear mismatch, the engine was in compliance with the relevant pre-1999 maintenance instructions.

Maintenance

The right engine was being maintained under Civil Aviation Safety Authority airworthiness directive AD/ENG/5 which allowed the operational time between overhauls to be extended to 5,000 hours. A requirement of that directive was to record the usage of certain life-limited components, as stated by PWC in service bulletin 3003R20, including but not limited to the sun and planet gears. The first-stage sun gear and planet gears were life-limited to 12,000 hours. Should that limit be reached, that gear set was required to be replaced at the next scheduled overhaul.

During the course of the investigation, the operator of the aircraft was unable to supply to the ATSB the service age of the subject gears. While the operator failed to monitor the lifed items in accordance with AD/ENG/5, the loss of maintenance control was not considered to be a contributing factor to the RGB failure and subsequent engine overspeed event.

FINDINGS

Context

On 27 November 2006, while flying from Mount Hale to Perth, WA, the right engine on a King Air 200 aircraft failed in flight. From the evidence available, the following findings are made with respect to the engine failure on the King Air 200 and should not be read as apportioning blame or liability to any particular organisation or individual.

Contributing safety factors

- The right engine failed catastrophically due to a decoupling between the first-stage sun and planet gears within the propeller reduction gearbox.
- The right engine propeller reduction gearbox had been installed with gears that were mismatched in terms of service age and history.

Other safety factors

- The service history of the life-limited first-stage sun and planet gear set from the right engine had not been recorded by the aircraft operator. The recording of such hours was a regulatory requirement under the life extension program (CASA airworthiness directive AD/ENG/5) to which the engine was being maintained. *(Safety Issue)*

SAFETY ACTIONS

Any 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.

Aircraft operator

Monitoring of life-limited turbine engine components

Safety issue

The service history of the life-limited first-stage sun and planet gear set from the right engine had not been recorded by the aircraft operator. The recording of such hours was a regulatory requirement under the life extension program (CASA airworthiness directive AD/ENG/5) to which the engine was being maintained.

Action taken by the aircraft operator

Following this incident, the aircraft operator initiated safety actions relating to a review of their system of maintenance for all PT6A engines in their fleet. The operator advised the ATSB that they had completed the following:

- A review has been undertaken of all PT6 engines within the operator’s fleet with respect to the extension program criteria which PWC outlines as recommendations within SB3003R20.

As a result of the review, the operator has voluntarily instigated a program to only operate PT6 engines which fall within one or the other of the following criteria, namely;

a) within the basic Time between Overhaul and Inspection frequency, as recommended by PWC, and observing all life-limited component limitations; or

b) if the engine components exceed the periods specified in a) above, but are within the time between overhaul and inspection frequency periods allowed by AD/ENG/5, only if all of the recommendations included in SB 3003 Revision 20 are complied with.

APPENDIX A: SOURCES AND SUBMISSIONS

Sources of information

The sources of information for this investigation included:

- the pilot-in-command of VH-XDB
- Pratt and Whitney Canada (PWC)
- aircraft operator
- National Transportation Safety Board (NTSB)
- Civil Aviation Safety Authority (CASA)

Submissions

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

A draft of this report was provided to; the pilot-in-command of VH-XDB; the aircraft operator; the Civil Aviation Safety Authority; the NTSB; PWC; and the TSB.

Submissions were received from the pilot-in-command of VH-XDB; the aircraft operator; the NTSB; and CASA. The submissions were reviewed and where considered appropriate, the text of the report was amended accordingly.