Australian Government
Australian Transport Safety Bureau

Engine failure involving a Eurocopter AS350-BA VH-SFX

Whyanbeel Valley, Queensland | 2 November 2015

Investigation

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Aviation Occurrence Investigation
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Addendum

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Safety summary

What happened

VH-SFX at accident site

Source: ATSB

On the afternoon of 2 November 2015, a Eurocopter AS350-BA helicopter, registered VH-SFX, was performing a low-altitude aerial weed spotting operation over dense forest in the Whyanbeel Valley, Queensland. On board the helicopter were the pilot, a navigator and two aerial spotters.

While conducting the work, the helicopter yawed twice in an uncommanded manner. In response, the pilot climbed and increased the helicopter's forward airspeed and attempted to return to his base of operations. Subsequently, the engine failed, which required the pilot to conduct an autorotation and emergency landing.

The passengers adopted the brace position and the helicopter landed heavily with the skids digging into the uneven terrain and breaking off. The navigator in the front seat received minor injuries and the pilot received serious back injuries from the impact forces.

What the ATSB found

The ATSB found that the emergency landing was handled in a competent and proficient manner. The pre-departure briefing gave the passengers the necessary knowledge to prepare for the emergency by adopting the brace position and exiting the helicopter only when it was safe to do so.

Analysis of the engine identified that the aircraft lost power due to a front bearing failure in the turbine module. The failure was due to an accumulation of coke particles in an oil jet. The ATSB was unable to conclude specifically why the coke particles had formed.

The severity of the engine failure was increased through the fracture of the power turbine shaft and the subsequent separation of the turbine disc. This was due to a lack of adhesive on the splined nut that was threaded to the rear of the power turbine shaft.

A service information bulletin issued by the helicopter manufacturer in 2010 recommended that AS350 helicopter operators consider the safety benefits of installing energy-absorbing seats. Had these seats been installed, the forces imparted to the pilot during the accident sequence may have been reduced.

What's been done as a result

The engine manufacturer (Safran Helicopter Engines) has amended their procedure manual to include systematic cleaning of the power turbine front bearing assembly oil jet and oil jet supply pipe. Safran HE have initiated a number of training and process changes to ensure the adhesive bonding between the power turbine and the rear nut is maintained during service.

Safety message

This investigation highlights that responding to an emergency in a timely and proficient manner can minimise the consequences of an accident. Similarly, providing emergency procedures briefings enables passengers to react appropriately in an emergency.

In this occurrence, the reason for the engine oil jet coking leading to the engine failure was not specifically determined. However, a range of factors can affect engine oil coking. These factors should be considered to ensure normal ongoing engine operation.

Contents

The occurrence

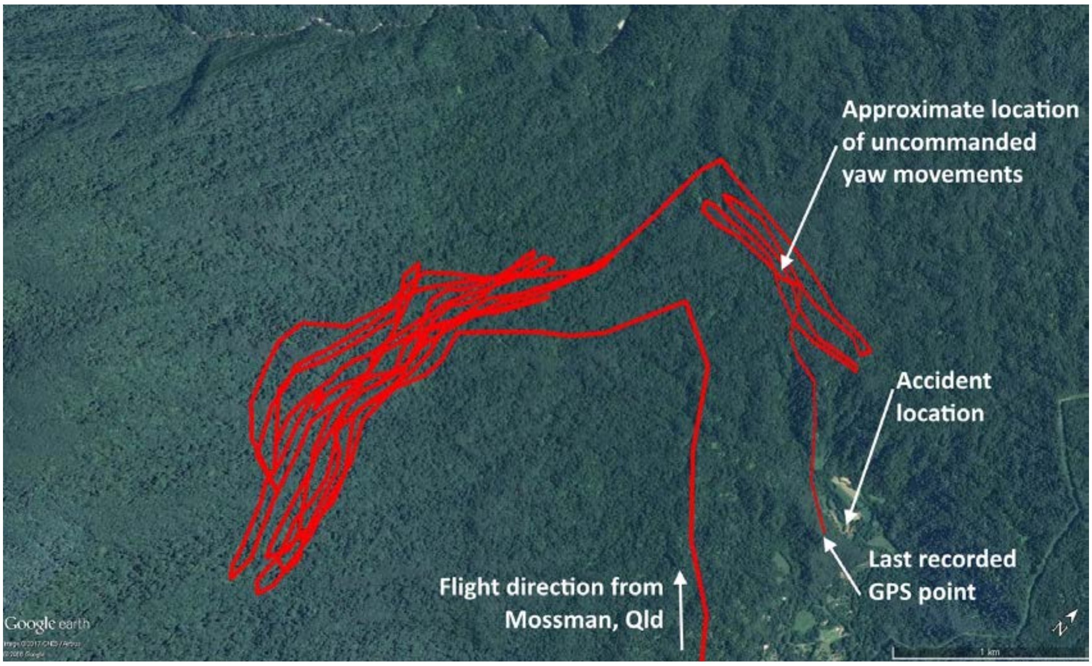
On 2 November 2015, a Eurocopter AS350-BA helicopter, registered VH-SFX, was performing aerial work to identify noxious plants in dense forest within the Whyanbeel Valley (Figure 1), Queensland (Qld). The nature of the aerial work required the helicopter to operate at a low altitude and airspeed. On board the helicopter was the pilot, a navigator and two aerial spotters. The base of operations was in Mossman, Qld.

At approximately 1620 Eastern Standard Time,[1] during the fourth flight of the day, the helicopter momentarily yawed twice within a short period in an uncommanded and unusual way. The pilot, concerned with the uncommanded movements, ceased the operation, climbed and increased the helicopter's forward airspeed. The pilot then elected to head back towards the base of operations (approximately 11km away) and, if required, land along the way if a suitably safe area along the flight path presented.

Shortly after, the chip detector light[2] illuminated on the instrument panel, prompting the pilot to search for a suitable landing area. As the helicopter continued to climb through approximately 200 ft, the engine stopped producing power.

The pilot identified the most suitable area to land, given the limited available height and airspeed, and commenced an emergency autorotation. The identified area was uneven, overgrown with plants, and surrounded by tall trees. During the landing sequence, the skids of the helicopter dug into the terrain and were broken off. The helicopter came to rest about 10 m after first touching down. The passengers received nil to minor injuries and waited until the rotor blades had ceased turning before evacuating the helicopter. The passengers then assisted the pilot who had received serious back injuries. The helicopter was substantially damaged.

Figure 1: The helicopter's GPS track, arriving in the area of operations, its flight path around the forested terrain in the Whynabeel valley, and the accident site.



Source: Google earth, modified by the ATSB

1 Eastern Standard Time (EST): Coordinated Universal Time (UTC) + 10 hours.

2 A device, often a permanent magnet that is used to gather metallic fragments from the engine or transmission lubrication oil. Depending on the configuration, the chip detector can be linked to an in-cockpit indicating light.

Context

Pilot training and experience information

The pilot held a valid Commercial Pilot (Helicopter) Licence that was issued on 6 January 2004 and a valid Class 1 Aviation Medical Certificate. The pilot's last flight review was issued on 17 February 2014 and was valid until 29 February 2016.

The pilot had a total flying experience of about 6,200 hours, of which over 3,000 hours were in the AS350 series helicopter. This included a substantial amount of experience conducting low-level operations. In the previous 90 days, the pilot had flown 9 hours on type, and in the previous 24 hours the pilot had flown 6 hours on type. The pilot reported feeling rested and alert prior to the occurrence flight.

Helicopter information

The helicopter was a Eurocopter AS350-BA helicopter, manufactured in 1981 and first registered in Australia on 16 June 2005. At the time of the occurrence, the airframe had accumulated approximately 10,518 hours total time in service (TTIS).

Wreckage and impact information

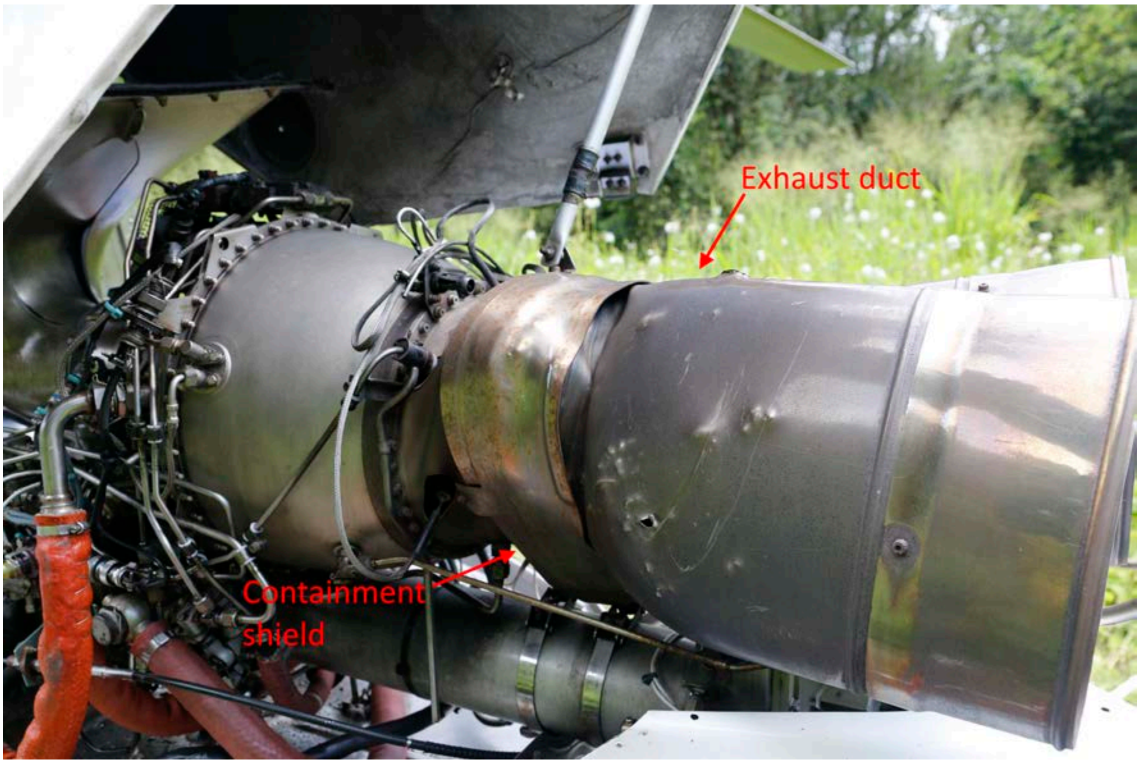
The on-site examination found that the helicopter struck the ground tail rotor first, with the skids subsequently digging into the uneven terrain and separating from the fuselage (Figure 2).

The engine had sustained damage consistent with a high-energy failure. The power turbine separated from the disc and the containment shield was twisted and deformed. The exhaust duct was bulged and puncture marks from internally liberated engine debris was evident (Figure 3).

Figure 2: VH-SFX at the accident site

Source: ATSB

Figure 3: View of the helicopter engine at the accident site

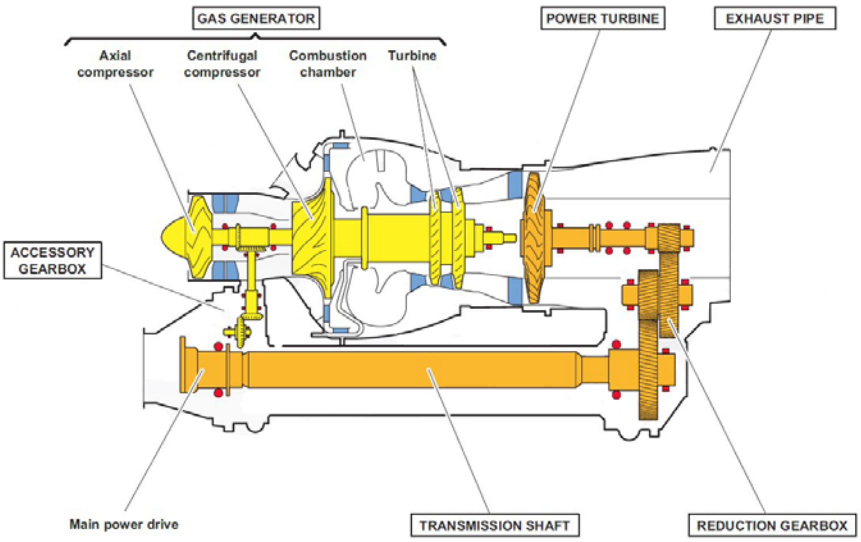


Source: ATSB

Engine information

The helicopter was powered by a Turbomeca[3] Arriel (model 1B) engine, located above and to the rear of the passenger compartment. The Arriel 1B engines feature a modular design with the major modules consisting of an axial and centrifugal compressor, an annular combustion chamber, a two-stage axial turbine, a single-stage axial power turbine and a reduction gearbox (Figure 4). This occurrence related to a failure within the power turbine.

Figure 4: General arrangement of a Turbomeca Arriel 1B turboshaft engine showing the locations of the major sub-components



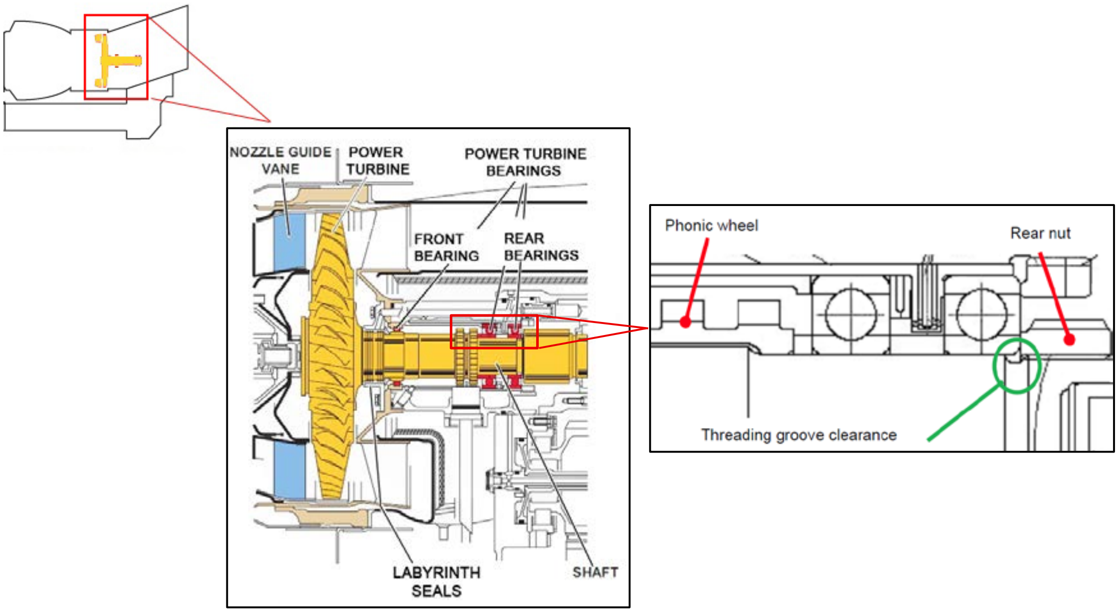
Source: Turbomeca, modified by the ATSB

[3] Turbomeca is now known as Safran Helicopter Engines (Safran HE)

Power turbine information

Gases from the two-stage axial turbine are directed downstream to the power turbine. The power turbine disc and shaft is a cantilevered design supported by front and rear bearings (Figure 5). Surrounding the power turbine is a containment shield to prevent high-energy engine debris from exiting the engine in the event of a blade fracture or disc separation from the shaft. The fractured turbines blades did not penetrate the containment shield in this occurrence.

Figure 5: General arrangement of the power turbine showing the relative location of the major parts including; the guide vanes, labyrinth seal, power turbine shaft, rear nut, and the front and rear bearings.



Source: Turbomeca, modified by the ATSB

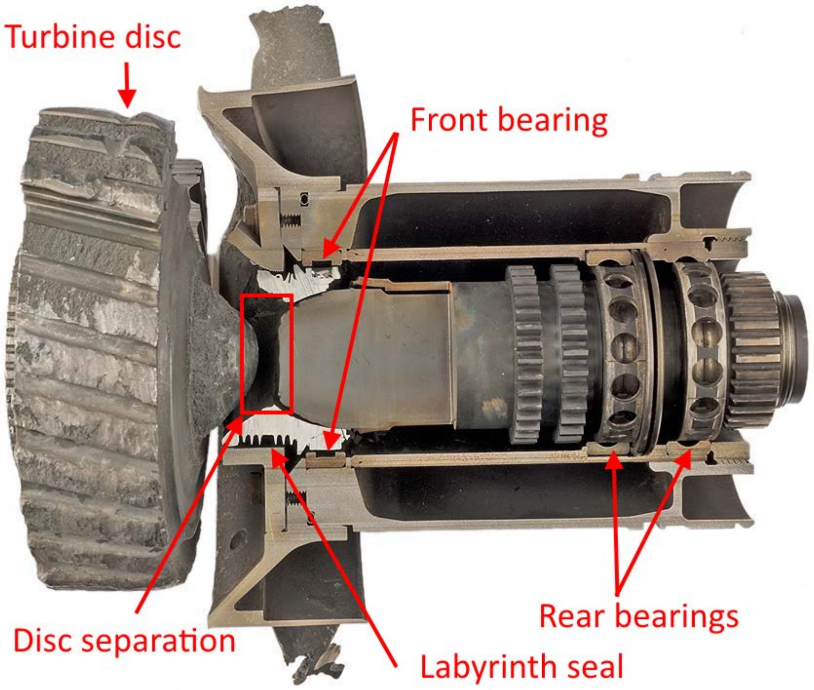
Engine examination

The engine was removed from the helicopter and a preliminary examination was completed at the engine manufacturer's facilities in Sydney, New South Wales. The power turbine shaft assembly of the engine was subsequently transported to the manufacturer's facilities in France. The assembly was inspected in detail under the supervision of the French aviation investigation agency, the Bureau d'Enquêtes et d'Analyses pour la sécurité de l'aviation civile (BEA). The examination determined that:

- The power turbine disc had fractured in overstress and separated from the power turbine shaft (Figure 6). The power turbine disc sustained a complete loss of power and the turbine blades had separated from their respective stations. Fracture of many of the blade inter-recesses within the disc had also occurred.
- The front bearing of the power turbine shaft had totally seized (Figure 7). Evidence of roller skidding, metal contamination and gross overheating was found within the bearing assembly. The accumulation of hardened coking products and varnish deposits from oil degradation was also found within the rolling elements.
- As a result of extreme frictional heating, the oil-air labyrinth seal, just forward of the front bearing, had melted and fused with the power turbine shaft.
- Metallurgical analysis of the power turbine shaft showed that it had been exposed to temperatures in excess of 1,300°C. That temperature was several hundred degrees above the normal maximum operating temperature of the engine.

- Examination of the oil jet and surrounding oil ducts to the front bearing of the power turbine shaft identified that the jet outlet was blocked with an accumulation of coke particles (Figure 8).
- Examination of the splined nut that was threaded to the rear of the power turbine shaft assembly revealed evidence that it had tightened. The location of the nut determined the position of the shaft and any potential axial preload of the shaft bearings. No evidence was found of the adhesive that was required to have been applied between the threads on the rear shaft and the nut (Figure 9).

Figure 6: Cross-section through the power turbine assembly from the engine showing that the disc had separated from the shaft and the blades had fractured



Source: Turbomeca, modified by the ATSB

Figure 7: The seized front bearing and labyrinth seal, showing blackening from severe heat distress, flattening of the rollers, deformation of the cage and sealing fins

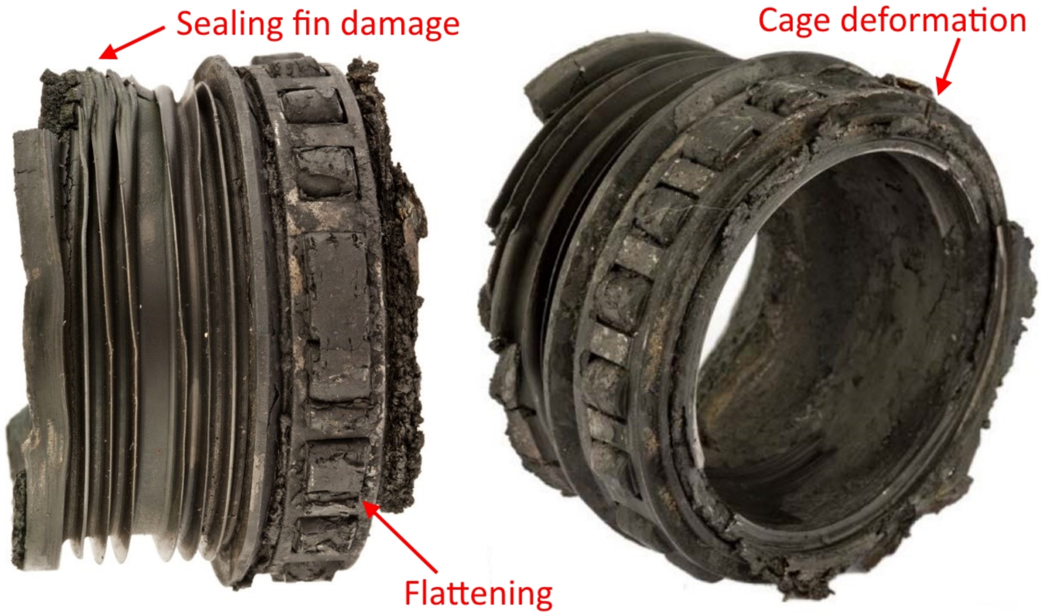


Image source: Turbomeca, modified by the ATSB

Figure 8: Close up of the blockage (circled) at the oil jet to the front bearing, as positioned in the general arrangement view

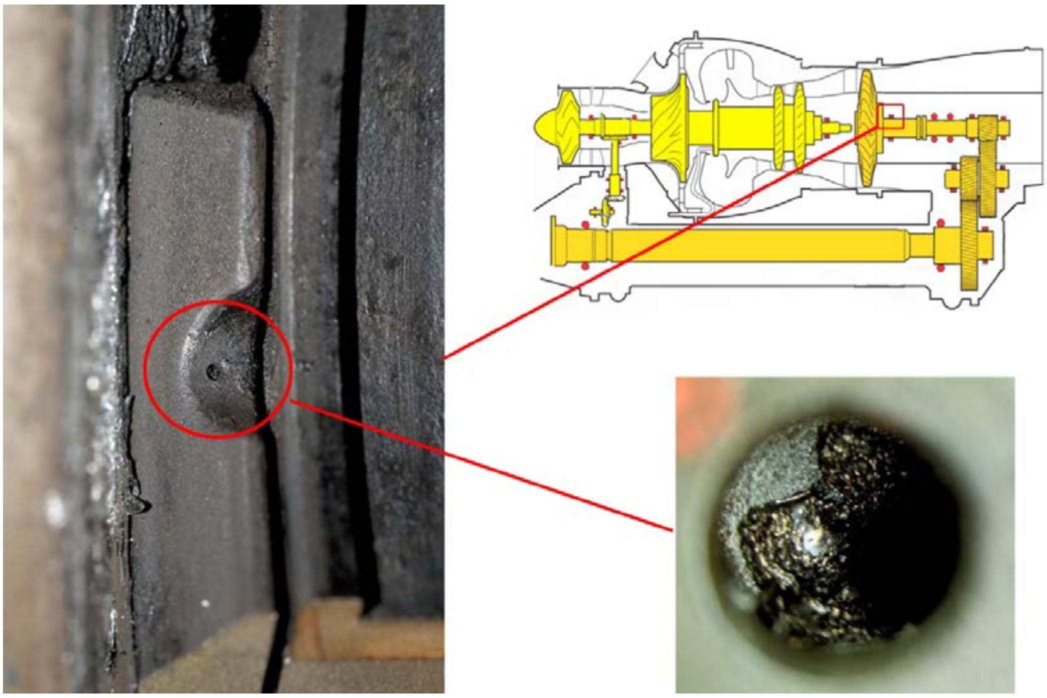
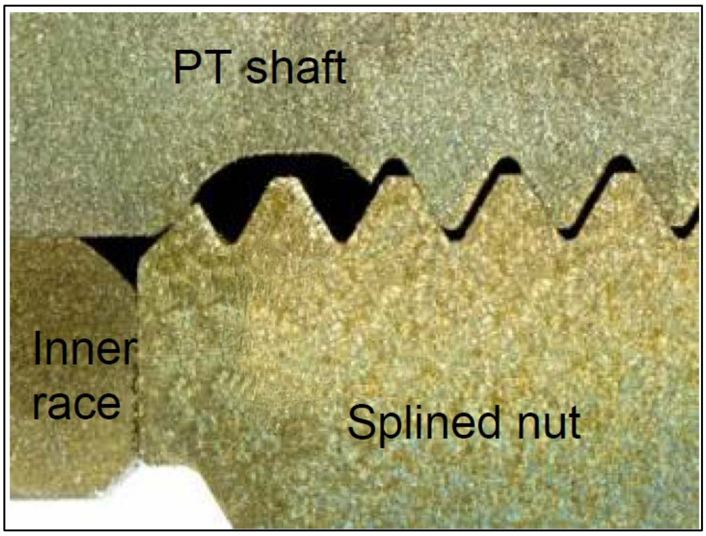


Image source: Turbomeca, modified by the ATSB

Figure 9: Cross-section of the rear splined nut contacting the rear bearing inner race



Source: Turbomeca

Power turbine rear nut adhesive bonding

The engine manufacturer had intended for an adhesive to be used in order to secure the rear nut into position. The adhesive was only applied during maintenance at a Turbomeca overhaul facility when the power turbine was overhauled.

Failure to adequately bond the nut could result in a tightening of the rear nut when abrupt changes in torque occur, leading to axial displacement of the turbine shaft in excess of the designed amount. This displacement would result in contact between the turbine shaft and the front bearing inner race, resulting in frictional heating, and damage to the turbine shaft.

The engine examination identified that the rear nut fitted to the rear of the power turbine shaft had not been adhesively bonded, as required.

Oil coking

The observed coking of the front bearing and its oil jet duct was likely a result of the engine oil exposure to abnormally high temperatures in the area. While there were clogging inspection procedures of the power turbine rear bearings, no preventative maintenance actions existed that allowed for the identification of coking within the front bearing.

Coking is an artefact from exposure to abnormally high temperatures that leads to oxidation and chemical breakdown of the oil. Coking can form as a thin-film layered deposit (as was the case in the oil duct) or in thicker clumps (which resulted in the clogging of the oil jet). It forms within the oil distribution channels and pipes, and can shed from the wall surface leading to reduced or obstructed oil flow. Determining the initiating source of coke formation is difficult as it can be attributed to a combination of influences, including:

- operational conditions such as hot shutdown
- design traits such as abrupt changes in oil flow direction and areas of low fluid velocity that can lead to reduced oil flow rates
- low-drainage areas resulting in conductive or convective oil temperature increases post-shutdown
- reductions in cross-sections such as scavenge ports that increase the likelihood of blockage
- prolonged aircraft inactivity leading to moisture absorption of coke deposit.

The manufacturer of Arriel engines had published guidance for the thermal stabilisation of engines at shutdown. The guidance involved throttling the engine back until the engine was at ground idle for at least 30 seconds prior to shutdown. Stabilising an engine after operation allows for the temperature to reduce and thermally balance, while maintaining sufficient oil-scavenging capability and oil flow rates to minimise the potential for coke formation. Non-compliance with the manufacturer’s stabilisation recommendations may lead to coking.

The helicopter operator’s manual referred to the correct shutdown procedure in the AS350 flight manual. However, an appendix to the operator’s manual included a checklist that referred to a two minute idle time before shutdown. The engine manufacturer advised that a two minute shutdown would not adversely affect the formation of coke particles.

The engine manufacturer reported that a design trait of the power turbine is that the fluid velocity is lower at the bottom of the oil jet duct to the front bearing. For a given volume, this trait can lead to increased convective heating of the oil and depending on the temperatures in that region, may lead to coking.

In the period January 2000 to September 2015, there were 13 cases of Arriel engine deterioration in the power turbine shaft front bearing due to oil jet clogging. However, this is the only accident that has resulted in the failure of the turbine shaft.

Engine maintenance

The most recent significant maintenance involved removal of the engine from the airframe for repair after it sustained foreign object damage in February 2015 (7,786 hours TTIS). The centrifugal compressor and gas generator were replaced in May 2015. The engine was not operated during this period.

The last scheduled engine maintenance was performed on 30 October 2015 (8,060 hours TTIS), two days prior to the accident. Among the maintenance actions performed at that time, a clogging check of the gas generator rear bearing was conducted along with an inspection of the oil return line strainer. No anomalies were recorded in the maintenance documentation. The helicopter subsequently accumulated an additional 5 hours flight time up until the accident. There was no overdue maintenance requirements or declared defects.

Oil and filter analysis program

The helicopter operator had been monitoring the internal health of the engine components by participating in a spectrometric oil and filter analysis program (SOAP). That program relied on detecting the type and quantity of wear-material products within the engine oil and oil filter. The wear-material is generated from the breakdown mechanisms of internal engine components. SOAP checks were recommended by the engine manufacturer at intervals not exceeding 100 hours of service.

The most recent oil sample was collected and analysed approximately 10 hours prior to the engine failure. The previous sample to that was taken approximately 100 hours prior to the failure. Those checks indicated no unusual trends or signs that internal damage had been developing.

Emergency Procedures

The AS350 flight manual defined the emergency procedures for the illumination of the ‘ENG CHIP’ chip detector light and an autorotation landing. As per the AS350 flight manual, upon the Illumination of the ‘ENG CHIP’ caution light the pilot was required to:

> *“Land as soon as possible: land at the nearest site at which a safe landing can be made.”*

A successful autorotation is dependent on the pilot’s airmanship and the helicopter’s speed and altitude relative to the airspeed-height envelope.

Airspeed-height envelope

The airspeed-height envelope defines a region within the helicopter’s flight envelope where there is insufficient energy (height and/or airspeed) for a successful autorotation to be completed. Section 5.1 of the AS350 flight manual defines the airspeed-height envelope for the helicopter. The envelope is determined using the density altitude and weight of the helicopter. The resulting envelope outlines the avoidance zone (Z); operating in the avoidance zone as defined in the FAA *Rotorcraft Flying Handbook* (FAA-H-8083-21A) ‘“may not allow enough time or altitude to enter a stabilised autorotative descent.’

Helicopters are not restricted from conducting operations in the avoidance zone, however, a pilot should always evaluate the risk of the manoeuvre versus the operational value.

In this case, the helicopter was equipped with a Garmin GPSMAP 195 portable device capable of storing track data for flights. During the operational portion of the flight, the helicopter was inside the avoidance zone. This was due to the aircraft being required to travel at a low airspeed and altitude such that the aerial spotters were able to identify the noxious plants.

The GPS track data for the accident ended while the aircraft was still airborne. At the time of the last track point, the aircraft was approximately 295 ft above the terrain travelling at approximately 65 kts groundspeed. This was outside the avoidance zone defined as per the flight manual.

Survival aspects

The passengers had received the pre-departure briefing and adopted the brace position. The navigator in the front seat received minor injuries and the pilot received serious back injuries from the impact forces. No objects were located underneath the front or rear seats.

Helicopter seating

The helicopter was fitted with the original seats installed by the manufacturer (Figure 10). The rear passenger seats had deformed during the accident and likely absorbed some of the energy during the impact. The seat-belt attachments remained intact during the accident sequence. There was no observable deformation to the front seats of the helicopter.

In 1999, the helicopter manufacturer released a service letter (SL No. 1424-25-99) to inform all helicopter operators of the optional availability of redesigned seating for the pilot and copilot. The improved seat design increased the strength of the seat and attachments, and depending on the installed option, introduced energy-absorbing seat installations.

The manufacturer also published a service bulletin (EC SB AS350 No. 25.00.57) recommending the installation of the energy-absorbing seats on AS350 helicopters. A European Aviation Safety Authority (EASA) safety information bulletin, SIB 2010-05, reiterated the safety benefits associated with the installation of energy absorbing seats.

According to the EASA SIB, the modification of the helicopter in accordance with the SL would:

> increase the pilot and co-pilot’s seat strength and crashworthiness and thus to provide an increased level of protection to the occupants in case of impact during an accident.

Figure 10: VH-SFX front seats (left) and rear passenger seats (right)

Source: ATSB

Emergency equipment

The helicopter was fitted with an emergency locator transmitter (ELT) that could be activated by a switch on the instrument panel, an emergency position indicating radio beacon, and a first aid kit. Just prior to touchdown the pilot activated the ELT. After the landing, two passengers proceeded on foot to search for persons/households to contact emergency services. About 30-45 minutes after the accident occurred, the passengers were met by emergency services, who were responding to the ELT transmissions. The pilot received medical treatment onsite and was transported to hospital for further treatment. There were no other communication devices available, such as a satellite phone, for contacting emergency services.

Safety analysis

Introduction

While conducting aerial weed spotting operations at low level, the helicopter's engine failed necessitating an emergency landing into unfavourable terrain. The ground impact resulted in substantial damage to the helicopter. The pilot received serious injuries and the passengers sustained nil to minor injuries.

This analysis will examine why the engine failed, why an impending failure was not detected, the pilot's handling of the emergency, and how occupant injuries can be reduced in the event of a hard landing.

Engine failure

The uncommanded yawing of the helicopter was the result of the engine failing from a seizure of the front bearing to the power turbine. The failure commenced rapidly when the oil supply to the front bearing became obstructed due to clogging of the bearing's oil jet by the accumulation of coke particles (a solid residue from the breakdown of the engine oil).

During this period of transient engine operation, it is likely that the abrupt changes in torque from the power turbine and the lack of adhesive, led to a progressive tightening of the rear nut (fitted to the rear of the shaft). The tightening resulted in an axial coupling between the front bearing, stop, and labyrinth seal. That contact generated additional frictional heating and a further temperature rise within the shaft.

The combined effects of the front bearing seizure and the axial coupling of the components led to excessive heating and a subsequent critical reduction in mechanical properties for the shaft. Consequently, the turbine shaft was unable to sustain the operating stresses and it eventually fractured at the interconnection with the disc.

Oil coking

Coke formation is influenced by a range of complex factors (as mentioned in the coke formation section). The engine had been removed from the aircraft due to foreign object damage early in 2015 and spent several months out of operation. The ATSB was not able to determine if coke deposits were present at this point in time. Similarly, it was unknown if inactivity had impacted on moisture absorption of any coke deposits. The manufacturer has subsequently added an additional operation in their maintenance procedures which include the systematic cleaning of the turbine shaft front bearing assembly oil jet and oil jet supply.

While non-compliance with the stabilisation time before engine-shutdown can result in coke formation, the operator's procedures, included a stabilisation time of not less than 30 seconds and it was reported that flight crew followed these procedures. As such, the ATSB was unable to determine to what extent (if any) the compliance with stabilisation times affected the formation of coke particles.

The service history of the Arriel-series engine indicates there have been multiple instances of deterioration of the turbine shaft front bearing as a result of the front oil jet clogging. The geometry around the oil jet was such that in the event of front bearing degradation due to clogging, temperature rises in this area would occur. This induced variations in the oil fluid velocity and led to conditions that were favourable to coking and the formation of hardened deposits. The use of the manufacturer specified oil and continuous monitoring for metal particles should have limited the effect of this phenomenon. However, the metal particle detection checks (SOAP) were not intended for assessing the presence of coke particles, but rather the breakdown of engine components. In this instance, clogging of the oil jet likely occurred before the breakdown of the engine components. The ATSB was unable to determine to what extent the geometry of the area affected the formation of coke particles.

Due to the complex combination of factors that can affect coke formation, the ATSB was unable to determine a specific source that led to the coke formation and oil clogging of the front oil jet.

Adhesive bonding of the power turbine rear nut

The engine manufacturer had intended for an adhesive be used in order to secure the rear nut into position. The adhesive was only applied during maintenance at a Turbomeca overhaul facility when the power turbine was overhauled. The engine examination identified that the rear nut fitted to the rear of the power turbine shaft had not been adhesively bonded, as required.

The engine would still have ceased operating if the appropriate adhesive had been present on the rear splined nut. However, the likelihood of the shaft failing would have been reduced and the failure sequence less severe. The failure sequence would likely have been extended, allowing greater time for the pilot to respond to the failing engine.

Flight operation

The operation necessitated the helicopter to operate at a low altitude and airspeed. At the time of the uncommanded yaw movements and subsequent ‘ENG CHIP’ light illumination, the helicopter was inside the avoidance zone. According to the helicopter operating manual, an ‘ENG CHIP’ light illumination necessitates the pilot to land the helicopter ‘as soon as possible’. This should be interpreted *as soon as safe landing is possible*. The pilot immediately increased airspeed and altitude and brought the aircraft out of the avoidance zone. This allowed the pilot to conduct a successful autorotation when the engine failed.

At the time, the helicopter was over densely forested and steep terrain, making it unsuitable for a safe landing. The pilot had elected to head back towards the base of operations (approximately 11 km away) and land if there was a suitably safe area along the flight path. Given the location of the helicopter and the surrounding terrain, returning to a known safe landing area (the base of operations), with the possibility of identifying a safe landing area during transit, provided an appropriate option in the difficult circumstances.

The pilot’s actions while responding to the emergency situation likely prevented serious injuries to the passengers.

Helicopter seating crashworthiness

The rear passengers had adopted the brace position prior to the impact and the seats had absorbed some of the energy from the hard landing. These passengers received nil injuries. Similarly, the passenger in the front seat braced for the landing and received only minor injuries.

The helicopter was fitted with the original front basic seats installed when it was manufactured. The basic seats complied with the minimum performance standard of the applicable certification bases.

As aerospace technology and design has evolved since the original certification, new certification rules have been enacted to better protect the occupant’s safety in the event of an accident. The manufacturer of the helicopter had installation options available to operators to install energy-absorbing seats. Energy absorbing seats reduce the amount of energy transferred to their occupants in the event of an accident.

In the case of this accident, there was not enough information on the impact forces and dynamics to determine whether energy-absorbing seats would have reduced the injury severity to the pilot.

Findings

From the evidence available, the following findings are made with respect to the engine failure involving a Eurocopter AS350BA helicopter, registered VH-SFX that occurred in the Whyanbeel Valley, Queensland on 2 November 2015. These findings should not be read as apportioning blame or liability to any particular organisation or individual.

Contributing factors

- The helicopter lost power due to a failure of the Arriel 1B engine. The failure was a result of coke particles that had clogged the front oil jet from the power turbine shaft, preventing oil flow, and leading to a total seizure of the front bearing. The specific source that led to the coke formation and oil clogging of the front oil jet could not be determined.
- The rear-splined rear nut had not been adhesively bonded to the power turbine shaft, as required. When the front bearing failed, the lack of adhesive led to a progressive tightening of the nut and additional frictional heating of the shaft from contact with the static engine components. The consequential reduction in material strength from the heating allowed the power turbine shaft to fracture and the disc to separate, further increasing the severity of the engine failure.

Other factors that increased risk

- The helicopter was not fitted with energy absorbing front seats, which may have reduced the risk of injury to occupants during an accident.

Other findings

- The ATSB found that the emergency landing was handled in a competent and proficient manner. The decision by the pilot to increase forward airspeed and altitude, after the uncommanded and unusual yaw movements, removed the helicopter from within the avoidance zone and likely prevented serious injuries to the passengers.

Safety issues and actions

Proactive safety action

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.

The engine manufacturer (Safran Helicopter Engines) has amended their practices to include:

- Periodic cleaning of the power turbine front bearing assembly oil jet and oil jet supply pipe. This reduces the occurrence probability for oil jet clogging by removing any accumulated deposits from these locations.
- Degreasing of the threaded surfaces prior to application of the adhesive bonding and assembly of the parts. Maintenance and overhaul personnel have been informed of the importance of degreasing the surfaces before bonding the nut to the power turbine shaft.

Safran Helicopter Engines is also studying the use of heating equipment to obtain a more repeatable polymerization.

General details

Occurrence details

Date and time:	02 November 2015 – 1622 EST	
Occurrence category:	Accident	
Primary occurrence type:	Engine failure	
Location:	Whyanbeel Valley, Queensland	
	Latitude: 16° 21.935' S	Longitude: 145° 19.373' E

Pilot details

Licence details:	Commercial Pilot (Helicopter) Licence, issued 6 January 2004
Endorsements:	Retractable Undercarriage, Gas Turbine Engine
Ratings:	Night VFR rating, low level sling rating, and low level winch rating
Medical certificate:	Class 1, valid to 19 March 2016
Aeronautical experience:	Approximately 6,200 hours
Last flight review:	29 February 2015

Aircraft details

Manufacturer and model:	Aerospatiale AS350-BA	
Year of manufacture:	1982	
Registration:	VH-SFX	
Serial number:	1529	
Total Time In Service	10,512.8 as at last maintenance inspection carried out 30 October 2015	
Type of operation:	Aerial work	
Persons on board:	Crew – 1	Passengers – 3
Injuries:	Crew – 1 (serious)	Passengers –1 (minor), 2 (nil)
Damage:	Substantial	

Sources and submissions

Sources of information

The sources of information during the investigation included the:

- Safran Helicopter Engines (formerly Turbomeca)
- Airbus Helicopters (formerly Eurocopter)
- the Civil Aviation Safety Authority
- the aircraft operator
- the pilot
- the passengers.

Submissions

Under Part 4, Division 2 (Investigation Reports), Section 26 of the *Transport Safety Investigation Act 2003* (the Act), 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 pilot, the passengers, the aircraft operator, the Civil Aviation Safety Authority, Airbus helicopters, Safran Helicopter Engines ,and the Bureau d'Enquêtes et d'Analyses pour la sécurité de l'aviation civile (BEA).

Submissions were received from the pilot, the aircraft operator, Safran Helicopter Engines, the Civil Aviation Safety Authority and the BEA. The submissions were reviewed and where considered appropriate, the text of the report was amended accordingly.

Australian Transport Safety Bureau

The Australian Transport Safety Bureau (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 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 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.

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 initiate proactive safety action that addresses safety issues. Nevertheless, the ATSB may use its power to make a formal safety recommendation either during or at the end of an investigation, depending on the level of risk associated with a safety issue and the extent of corrective action undertaken by the relevant organisation.

When safety recommendations are issued, they focus on clearly describing the safety issue of concern, rather than providing instructions or opinions on a preferred method of corrective action. As with equivalent overseas organisations, the ATSB has no power to enforce the implementation of its recommendations. It is a matter for the body to which an ATSB recommendation is directed to assess the costs and benefits of any particular means of addressing a safety issue.

When the ATSB issues a safety recommendation to a person, organisation or agency, they must provide a written response within 90 days. That response must indicate whether they accept the recommendation, any reasons for not accepting part or all of the recommendation, and details of any proposed safety action to give effect to the recommendation.

The ATSB can also issue safety advisory notices suggesting that an organisation or an industry sector consider a safety issue and take action where it believes it appropriate. There is no requirement for a formal response to an advisory notice, although the ATSB will publish any response it receives.

Australian Transport Safety Bureau

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Investigation

ATSB Transport Safety Report
Aviation Occurrence Investigation

Engine failure involving a Eurocopter AS350-BA, VH-SFX, Whyanbeel Valley, Queensland, 2 November 2015

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