Australian Government

Australian Transport Safety Bureau

ATSB TRANSPORT SAFETY INVESTIGATION REPORT

Aviation Occurrence Investigation – 200606510

Final

Engine power loss
28 km NE Coolah, NSW
31 October 2006
VH-KTR
Bell 206 B3 helicopter

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Abstract

On 31 October, at approximately 1152 Eastern Daylight-saving Time, the pilot of a Bell 206 B3 helicopter, registered VH-KTR, was undertaking aerial feral animal culling operations with a feral animal shooter onboard. The pilot was lining the helicopter up for the shooter, when the engine power suddenly reduced to near idle. The shooter was able to throw his rifle out of the helicopter and brace for impact, in accordance with the Feral Animal Aerial Shooting Training (FAAST) procedures.

The helicopter descended into trees and came to rest supported by trees on the side of a steep hill. The occupants reported that the engine was still running after the helicopter came to rest, however, only at about idle power. The pilot then shut the engine down via the throttle. The pilot sustained facial and eye injuries while the shooter had minor injuries.

Examination and testing of the engine and components, and the fuel system was unable to determine what led to the sudden loss in power.

By following FAAST procedures, it is likely that the shooter reduced the danger to the pilot and to himself.

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 bodies.

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

Sequence of events

On 31 October 2006, at approximately 1152 Eastern Daylight-saving Time[1], a Bell 206 B3 helicopter, registered VH-KTR, impacted terrain, approximately 28 km north of Coolah, NSW. The helicopter was being used on aerial feral animal culling operations with the pilot and one shooter[2] on-board.

At approximately 1050, the helicopter departed from a property north of Coolah, and commenced aerial shooting operations. The pilot reported that he was preparing to return to refuel when the shooter spotted some feral animals nearby.

As the pilot lined the helicopter up close to a nearby ridge, to enable the shooter to make a culling shot, the engine power suddenly reduced to about idle and the helicopter yawed to the left. When this occurred, the helicopter was approximately 20 to 40 feet above the treetops. The shooter prepared for the impact by throwing the rifle out of the helicopter, informing the pilot of what he had done, and by adopting a braced position on the floor of the cabin, in accordance with the Feral Animal Aerial Shooting Training (FAAST) procedures.

The helicopter descended into trees on the side of a steep hill and the rotors severed several large branches, before the helicopter came to rest supported by trees (Figure 1). Both occupants reported that the engine was still running after the helicopter came to rest, however, only at about idle power. The pilot reported that he shut the engine down via the throttle and both occupants exited the helicopter. The pilot sustained facial and eye injuries during the impact, while the shooter's injuries were minor.

1 The 24-hour clock is used in this report to describe the local time of day, Eastern Daylight-saving Time (EDT) as particular events occurred. Eastern Daylight-saving Time was Coordinated Universal Time (UTC) + 11 hours.

2 The shooter was an employee of the NSW National Parks and Wildlife Service and he had undergone training to conduct aerial culling operations.

Figure 1: The helicopter after the removal of trees

On the day of the accident, the helicopter had been flown from Mudgee, NSW, to a property north of Coolah for aerial shooting operations. Once at the property, the pilot conducted a reconnaissance of the area to check for obstacles before landing and refuelling prior to the accident flight.

Wreckage examination

Due to the position of the helicopter on steep terrain, it had to be moved to level ground for further examination. The wreckage was transported to Coolah, slung in a steep nose-high attitude beneath another helicopter. During the flight, a fluid, reported as fuel, was observed to have drained from the helicopter. The wreckage was then transferred by road to a hanger in Mudgee.

All of the damage noted to the helicopter was consistent with it having occurred during the accident sequence. The evidence indicated that the main and tail rotors were rotating at impact and the helicopter's flight controls exhibited accident damage.

The engine control system was examined and appeared to be rigged correctly with only impact damage observed. The degree of accident damage to the collective control system precluded a full rigging check. However, all engine and flight control connections were assessed as having been intact prior to the accident.

Engine examination

The engine was removed from the helicopter and transported to an approved engine overhaul facility. Detailed examination of the engine found only minor accident damage to the intake and compressor areas. It was found that grease was drawn into the engine's compressor area during the accident sequence, as a result of accident damage to the transmission drive-shaft. An examination of the engine's fuel and air system plumbing found no anomalies.

The engine was placed in a test run cell to determine if it would start and operate normally.

All of the engine accessories required for normal operation were retained on the engine without adjustment or modification from the accident site. The engine started normally and after an appropriate period at idle, the engine was able to be accelerated up to normal operating power settings.

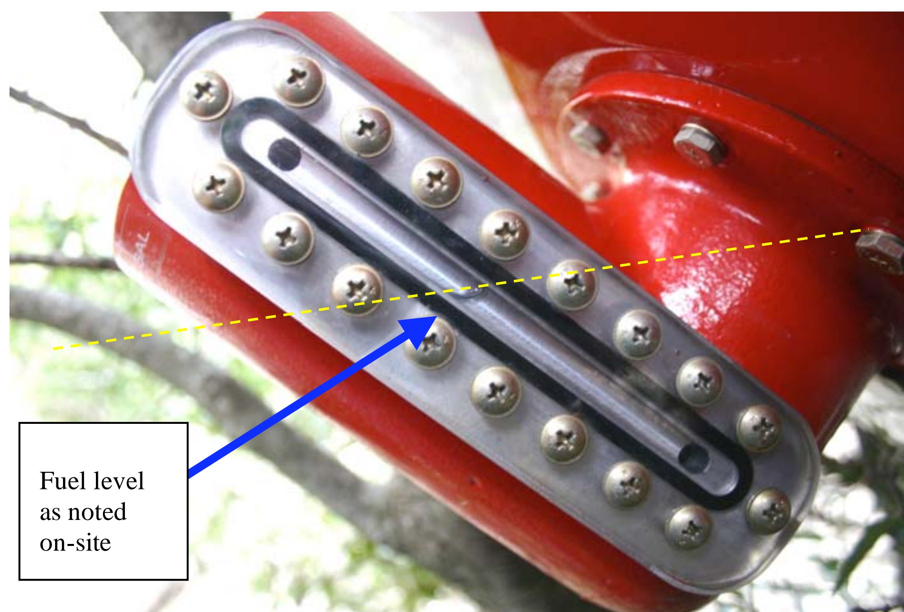
Several engine test runs were carried out and these showed that the engine operated normally but indicated slightly low on power. Following the replacement of the damaged compressor front support assembly, a subsequent engine test run showed a notable increase in power, almost consistent with normal settings.

At the completion of the test runs, all of the fuel system components were removed from the engine and bench tested and checked for normal operation. There were no significant anomalies noted during the testing of those components.

Fuel system

At the accident site, the fuel quantity could not be assessed accurately due to the precarious positioning of the wreckage. The attitude of the wreckage was measured at approximately 45º to 50º nose high and 30º right roll. Examination of the sight gauge on the front of the helicopter's fuel tank range extender unit[3], positioned on the low side of the wreckage, indicated a level of approximately 50% (Figure 2).

Figure 2: Sight gauge reading from the range extender



The operator's Civil Aviation Safety Authority (CASA) approved company fuel policy stated in part:

> FIXED RESERVE (VFR) 30 minutes, or 15 minutes in short radius, maximum load operations where fuel is available within 5 minutes flight time,

3 The range extender allowed a previously unused section of the fuel tank to be utilised. The helicopter fuel tank with the range extender could hold 366 L of useable fuel. The helicopter manufacturer considered 1.06 US Gals (4.01 L) of fuel to be unusable.

> VARIABLE RESERVE Nil
>
> NOTE: Further information relating to aircraft, fuel requirements can be found in CAAP [Civil Aviation Advisory Publication] 234-1.

The operator's procedures required that the pilot calculate the fuel for the flight based on the usage figure for a Bell 206 helicopter of 100 L/hr (26.32 US Gals/hr) for a normal cruise flight and 92 L/hr (24.34 US Gals/hr) for an agricultural operation, plus the fixed reserve.

The operator's policy for establishment of fuel onboard the helicopter stated in part:

> Unless assured that the aircraft tanks are completely full, or a totally reliable and accurately graduated dipstick or sight gauge reading can be done, the pilot should endeavour to use the best available fuel quantity cross-check prior to starting. The cross-check should consist of establishing the fuel on board by at least two different methods such as. Total volume of fuel taken on board the aircraft is to be compared with quantity increase given via the fuel gauge calibration placard with the use of dead reckoning any variation between the two shall be investigated to confirm the desired quantity is onboard the aircraft for the proposed flight to be undertaken.
>
> During the duration of the flight the endurance time calculated via the volume of fuel on board not including reserves should be monitored in comparison with the indicated volume remaining on the fuel quantity indicator to ensure there are no inconsistencies in relation to the remaining endurance.
>
> It is company policy that [the operator] does not exhaust fuel on board below the fixed reserve.
>
> [Crew] should regularly calculate fuel burn rate to examine for any inconsistency to the proscribed fuel burn rate.

The pilot reported that he calculated his fuel burn for the flight using a figure of just over 90 L/hr [agricultural operations fuel usage rate] and that the accident flight was about 63 minutes in length. The pilot reported that there was in excess of 65 L of fuel on board at the time of the accident.

The operator's daily flight return sheets indicated that prior to the accident flight there had been 112 L of fuel added to the helicopter, giving a total fuel on-board of 47 US Gals (178 L). The ATSB assessment of the fuel usage based on the higher normal cruise usage rate of 100 L/hr, calculated the total fuel remaining to be 72.9 L, including about 1 US Gal (3.78 l) unusable.

The ATSB approached the helicopter's manufacturer asking for a fuel quantity remaining estimate based on the on-site reading on the range extender gauge and the approximate attitude of the wreckage. That estimated quantity was 106.4 L (28.1 US Gals).

Draining of the fuel tank after removal from the site showed that a total of 23 L remained in the helicopter. A detailed examination of the fuel tank found no holes or perforations. Examination of the airframe fuel filter and engine fuel lines found all were full of fuel.

Helicopter fuel system

The airframe fuel filter contained some contamination in the filter bowl and filter element. These samples, together with other fuel samples taken from the helicopter, were sent to a testing laboratory for analysis. The results of that analysis showed that within the airframe fuel filter, there were fine aluminium particles and other contaminants. No particles were found downstream of the airframe fuel filter or in the engine fuel system.

The airframe fuel filter had a bypass valve fitted with a test button. That test button simulated a bypass and illuminated an indication light in the cockpit. The pilot would test the operation of the light as part of the pre-flight procedures. The pilot reported that the light had been tested on the day of the accident and that the bypass light was not illuminated at the time of the accident. The fuel bypass valve was tested post-accident and was found to be working normally.

The helicopter's fuel system utilised two electrically driven boost pumps situated in the bottom of the fuel tank to supply fuel to the engine for operation. The engine also had an engine driven pump that was capable of providing fuel for operation without the assistance of the boost pumps if the fuel tank level was above 37.9 L (10 US Gals)[4]. Fuel flowed from the boost pumps to the engine through the airframe fuel filter assembly. A fuel tank vent in the upper rear-right section of the fuel tank, vented at the bottom of the helicopter on the rear left side.

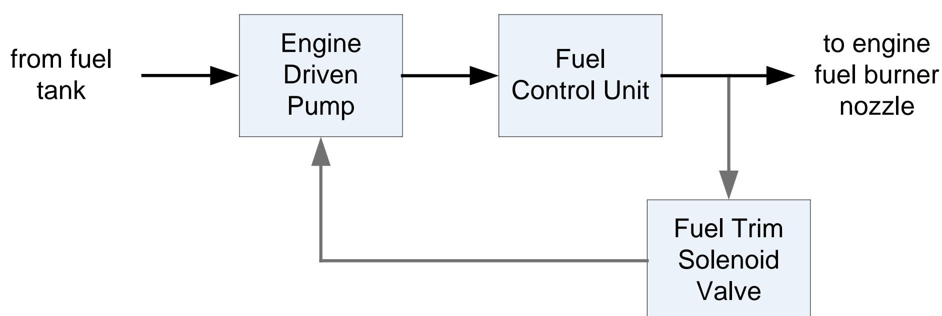
Following the accident, the fuel boost pumps were operationally tested and disassembled. Some wear was noted on one of the pumps. However, both boost pumps operated normally.

IntelliStart system

The helicopter was fitted with an IntelliStart Plus+™ system. The computer controlled system performed a dual function. One function recorded engine and flight data for download and trend monitoring purposes. Additionally, during the engine start sequence the system controlled the temperature of the engine to limit damaging thermal temperature peaks in the engine. The IntelliStart system achieved that by diverting part of the fuel supplied to the engine's fuel burner nozzle via a fuel trim solenoid valve (Figure 3). The manufacturer indicated that the system prevented inadvertent solenoid operation.

4 The manufacture gave an unusable fuel level of 4L (1.03 US Gals).

Figure 3: Connection of the Fuel Trim Solenoid Valve in the fuel system



The IntelliStart system had an indication light positioned on the helicopter's instrument panel. In normal operation, the light would illuminate on power-up and remain on until successful completion of the system self-test procedure. If the system detected a fault, the light remained illuminated. The light would flash on and off when the system was recording data, during an over temperature condition on engine start-up or, if a 'factory reset condition'[5] was detected.

The Intellistart system was installed on the helicopter on 11 September 2006. The system was working correctly when installed. However, from 29 September 2006 until the time of the accident, the system had not operated. It was reported that the system was not receiving power from one of its main power sources, possibly due to a broken wire. The operator and pilot reported that the indication light on this helicopter was on all the time.

The IntelliStart system's processor unit from the helicopter was forwarded under ATSB control to the manufacturer in the US for download and analysis. The manufacturer conducted that examination in the presence of a representative of the US Federal Aviation Administration. The processor's memory log data showed the recording of engine cycles from 14 September 2006 to 28 September 2006. There had been no logging of engine cycles on the processor unit after 28 September. The manufacturer examined the processor for serviceability and reported that the processor was capable of recording.

The fuel trim solenoid valve operated normally when tested following the accident.

When asked about the possibility of the IntelliStart system affecting the operation of the engine during flight, the manufacturer reported in part that:

> 'Initial testing has shown that in the unlikely event the FTSV [Fuel Trim Solenoid Valve] opened during flight there would only be a 0.7% -1.07% loss of engine speed, depending on application'.

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5 The factory reset condition was the condition that a processor was in when it was tested at the repair station. If a processor resets to this condition, the date would have reset to January 1, 1997 and the configuration would have been reset to an IntelliStart configuration.

Further:

> 'To provide additional failure protection the hardware has been designed to lockout the FTSV while either the Gas Generator (N1) or Main Rotor (Nr) speeds are above 60%. This way even if the software commanded the solenoid on the hardware the electronic circuits would not. A hardware failure would need to be a multiple failure in multiple circuits which has an extremely low probability. In the event it did happen the software would back up the prevention of the solenoid command logic'.

Helicopter maintenance documentation

The helicopter had a current maintenance release, issued on 30 October 2006. Examination of the helicopter's maintenance documentation revealed nothing that would have contributed to the accident.

Pilot licensing

The pilot of the helicopter was appropriately licensed and experienced for the operation being undertaken and had a valid Class 1 medical certificate.

Safety Procedures and Equipment

Aerial feral animal shooters employed by the NSW National Parks and Wildlife Service were trained and accredited by the Feral Animal Aerial Shooting Training (FAAST) programme. The FAAST programme covered the technical aspects of aerial pest control shooting, as well as safety equipment to be worn and used, and safety procedures. In accordance with the procedures, in an in-flight emergency, aerial shooters were to throw their weapons and ammunition out of the helicopter and brace for the impact.

In this accident, the shooter carried out all of the required procedures, getting rid of the rifle as soon as the engine lost power. The shooter was also wearing a full harness connected to a hardpoint on the airframe via a strop as required.

The pilot and the shooter were wearing full protective clothing, helmets, boots, gloves, and fire resistant flight suits. The shooter's clothing and harness were found to be in accordance with the FAAST procedures. The pilot's protective clothing was a requirement of the operator. At the time of the accident, the pilot did not have the visor of his helmet down.

ANALYSIS

The pilot and shooter both reported that the engine suddenly lost power and that it was still operating at about idle power following the impact. This is supported by the observation that grease from the damaged main rotor drive shaft was drawn into the engine's intake during the impact sequence.

During the initial test run, the engine operated normally although at slightly reduced power. Given that the engine performance recovered after the damaged compressor intake components were replaced, the reduction in performance was most likely the result of accident damage. Subsequent examination and testing of the fuel system components from the engine also found no anomalies. Both electrically driven boost pumps operated normally despite some wear being present.

While only 23 L of fuel was physically recovered from the helicopter's fuel tank, the assessment of the fuel remaining by the investigation determined there would have been sufficient fuel in the helicopter for continued flight at the time of the accident.

The investigation found that the airframe fuel filter and engine fuel system plumbing was full of fuel.

The witness accounts of liquid draining from the vertically oriented wreckage during its retrieval are consistent with fuel draining from the fuel tank vent and would explain the difference in the physical quantity retrieved from the aircraft and the amount that was calculated to be on board. The fuel calculations and estimates conducted by the pilot, the ATSB, and the helicopter's manufacturer all indicated that there was sufficient fuel onboard for continued flight.

While the specialist examination of fuel taken from the wreckage indicated the presence of contaminants, the airframe fuel filter was not blocked nor was the filter bypassing fuel into the engine. There was no particulate matter or blockages found in the engine fuel system and so the airframe filter had been effective. Consequently, it is highly unlikely that fuel contamination led to the engine power loss.

The IntelliStart system had not been working for some time prior to the accident flight. A feature of the IntelliStart system was that it had the ability to divert fuel away from the engine during start-up, via a solenoid. The system, however, had a number of safeguards to prevent that occurring during flight. The manufacturer advised that in-flight operation of the solenoid would have had a limited effect on engine operation. There was no evidence found to indicate that the IntelliStart system would have had an effect on the development of the accident.

After extensive examination and testing of the engine, engine accessories and the fuel from the helicopter, the investigation was not able to determine what led to the sudden loss of power.

The evidence that the shooter followed the Feral Animal Aerial Shooting Training (FAAST) procedures in this accident by disposing of the rifle overboard and bracing for impact showed that it was effective in maximising the potential for a safer outcome in the accident.

The clothing and helmets worn by the pilot and the shooter during the accident probably assisted in protected them from further injury. However, at the time of the accident, the pilot's helmet visor was up. With the pilot's visor down, he may have been protected from facial and eye injuries.

FINDINGS

Contributing safety factors

- An uncommanded power loss in the helicopter engine resulted in the helicopter impacting terrain.

Other key findings

- It is highly unlikely that the quantity or quality of the fuel on board the helicopter contributed to the uncommanded power loss in the engine.
- All damage noted on the helicopter’s flight controls was consistent with having occurred during the accident sequence. There were no pre-existing flight control problems that contributed to the accident.
- Damage to the helicopter’s main rotor drive system and the driveshaft grease drawn into the engine’s intake was consistent with the engine operating at the time of impact.
- The investigation was not able to determine the reason for the uncommanded engine power loss.
- The pilot and shooter were wearing approved protective equipment such as helmets, fire resistant flying suits, lace up boots, and gloves.
- The Feral Animal Aerial Shooter Training procedures were effective in maximising the potential for a safer outcome in the accident.