Australian Government
Australian Transport Safety Bureau

Engine power loss and collision with terrain, Bell 206B3 helicopter, VH-FHW

107 km south-west of Jabiru, Northern Territory, on 21 May 2019

ATSB Transport Safety Report
Aviation Occurrence Investigation (Defined)
AO-2019-025
Final – 26 February 2021

Released in accordance with section 25 of the *Transport Safety Investigation Act 2003*

Publishing information

Published by: Australian Transport Safety Bureau
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Addendum

Page	Change	Date
25	Corrected year of in-text citation	7 Oct 2021
38	Added reference	7 Oct 2021

Safety summary

What happened

On 21 May 2019, while engaged in a planned cull of feral animals in Kakadu National Park, Northern Territory, a crew of three were using a Bell 206B3 JetRanger helicopter for aerial platform shooting. While the helicopter was operating at about 50 ft above the ground, the engine decelerated to idle, resulting in an immediate loss of power, and subsequent collision with terrain. The three occupants (pilot, shooter and spotter) were seriously injured.

What the ATSB found

The engine power loss was due to a leak created by a loose union on an engine reference air line. During maintenance 4 days prior to install a power turbine governor (PTG), the union, which was downstream of the work completed, had not been checked for tightness. Potentially associated with distractions in the hangar at the time, an independent inspection following installation of the PTG was probably not conducted, and document verification processes did not detect that the independent inspection had not been recorded.

The cabin was not well prepared for the subsequent collision with terrain, with a range of factors exacerbating the occupants' injuries or increasing risk. For example, the Director of National Parks required shooters and spotters to wear helmets, but helmets were not provided or used on a routine basis. Safety issues were also identified with the ambiguous wording of the instrument permitting harness use (issued by the Civil Aviation Safety Authority), and renewal of aerial platform shooting approvals without recurrent emergency training.

Additionally, the ATSB found that the Director of National Parks did not actively manage the risk of the aerial culling task, or effectively supervise the operation. As a result, an increase in the number of crew, a change in helicopter type and change of helicopter operator all progressed without requisite risk management. This exposed crew to avoidable harm during low-level aerial shooting operations.

What has been done as a result

The operator ordered an immediate fleet wide check of the security of all flexible and rigid reference air lines in its engines. Additionally, the approved maintenance organisation improved delivery of human factors training for engineers by contracting an external provider to deliver the course.

The Civil Aviation Safety Authority (CASA) has planned action to resolve the ambiguity associated with the instrument permitting harness use, and to require operators to ensure task specialists are trained in normal and emergency procedures. In addition, the operator has taken action to ensure all crew members are aware of the risk associated with using only a harness instead of a seat belt.

The Director of National Parks (DNP) immediately suspended aerial culling activities. In December 2019, the DNP commenced an internal review of standards of practice relating to aerial culling activity and personal protective equipment, and reaffirmed its requirement for the use of helmets during any future culling activities. The DNP has also undertaken a specialist aviation safety review into its aerial culling operation and is conducting ongoing review of its risk management policy and related aspects.

Safety message

Assured airworthiness and preparation of aircraft operating at low-level is paramount. Knowing that maintenance activities carry risk of error, independent inspection is a vital risk control.

Inspections must be designed and conducted in a way that will capture critical issues, and visual inspections will not always be enough.

Any organisation that requires staff to engage in high-risk aviation activities should obtain professional advice on task design, actively manage risk, and provide appropriate equipment.

Contents

The occurrence

Prior to departure

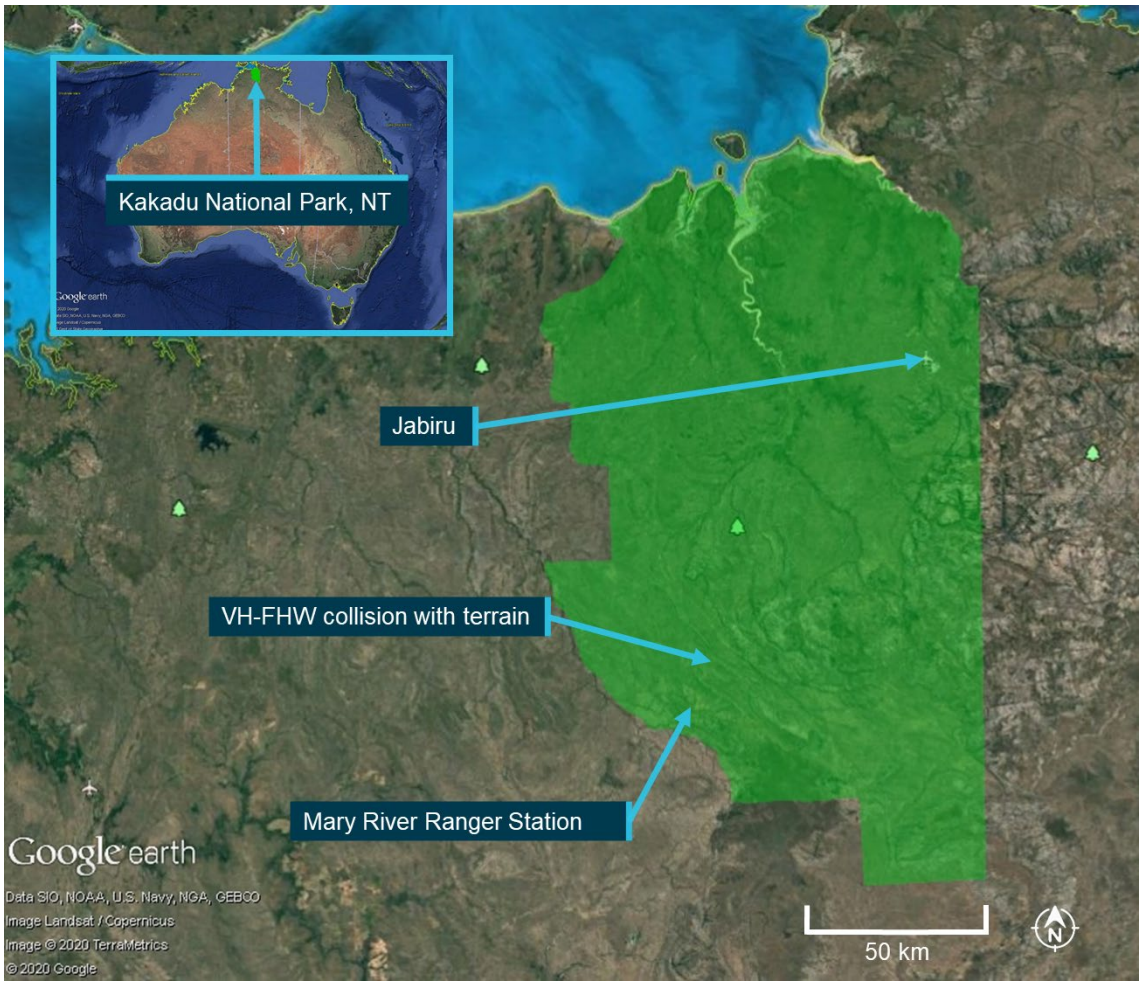
On 21 May 2019, a Bell B206B3 JetRanger helicopter, registered VH-FHW and operated by Jayrow Helicopters, was being used for an aerial (feral animal) culling task in Kakadu National Park (KNP), Northern Territory (Figure 1). The helicopter operator provided helicopters and pilots under contract to the Director of National Parks (DNP), and the other crew involved in conducting the tasks were employees of Parks Australia.

Maintenance was conducted on VH-FHW by the helicopter operator in Darwin on 16 May 2019, and the helicopter had flown 4.7 hours since that maintenance. The helicopter was repositioned to Jabiru and then Mary River Ranger Station on the afternoon of 20 May and used for aerial culling tasks.

The plan for 21 May was to use the helicopter again as an aerial platform to shoot feral animals in a prescribed area within KNP. The pilot reported that, prior to departure, they refuelled the helicopter and conducted a pre-flight inspection, and no defects were observed. The two aerial culling crew, a shooter and a spotter, both licensed aerial platform shooters and KNP rangers, loaded the helicopter with the weapons, ammunition, and supplies.

Before departure, the pilot engaged the spotter and shooter in a safety briefing. The spotter then sat in the front left seat, the pilot in the front right, and the shooter in the rear right. The pilot and spotter both wore a four-point seatbelt with upper torso restraints. The shooter wore a fall arrest harness (harness) to allow flexibility of positioning in the open doorway for the shooting task.

Figure 1: Kakadu National Park and location of accident



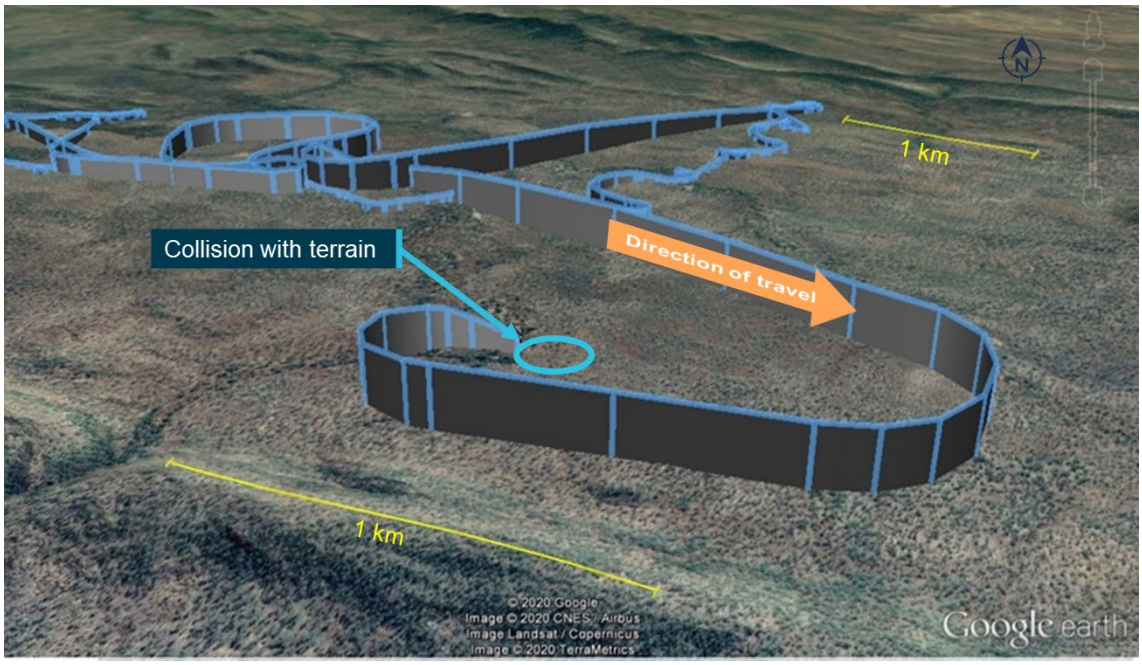
Source: Google Earth, annotated by the ATSB.

Accident flight

At about 0913 Central Standard Time,[1] the helicopter departed Mary River Ranger Station. The search for animals was conducted at 500 ft above ground level (AGL).

At 0923 the crew found a mob of feral horses, and the animals were mustered into a favourable location. The crew reported that this task went smoothly, and the animals were easy to manoeuvre. The mustering was conducted at about 300 ft AGL. Once the animals were in position, the crew began the culling task, and the shooting took place at about 50 ft AGL (Figure 2).

Figure 2: VH-FHW flight path



Source: Google Earth and the operator, annotated by the ATSB

At about 0957, 44 minutes into the flight, the helicopter was at a height of about 50 ft AGL over a lightly wooded area. The pilot reported that the helicopter's engine started decelerating to idle, and the spotter recalled hearing the engine surge. The pilot's immediate response was to ensure the throttle was fully open (which it was). The pilot quickly diagnosed the situation as a genuine emergency.

The pilot announced 'we're losing power and going over there', referring to a small clearing slightly left of the nose in their direction of travel. The pilot managed the rotational energy remaining in the rotor system and the forward speed of the helicopter to reach the clearing.

The right side of the helicopter impacted a tree on the edge of the clearing, and then landed heavily in a level attitude. All three occupants were seriously injured, and the helicopter was destroyed (Figure 3).

Post-impact events

The spotter recalled, after impact, being covered in fuel and having heavily restricted movement in the neck and body. The spotter exited the helicopter and noted that the pilot and shooter were unconscious.

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[1] Central Standard Time: Coordinated Universal Time (UTC) + 9.5 hours.

The spotter reported attempting to activate a handheld emergency position indicating radio beacon (EPIRB), but given that their corrective glasses were lost, the activation instructions were unable to be read. The spotter returned to the helicopter as the pilot and shooter became conscious. The pilot and spotter between them ensured the helicopter's emergency locator transmitter (ELT) was on, and the spotter tried to make the pilot comfortable.

The spotter tried to assist the shooter in the back of the helicopter but was unable to do so. The rifle was still in the helicopter, and the barrel had punctured the floor of the cabin. The spotter made the weapon safe by removing the magazine and selecting the safety catch. The spotter located a daypack, which contained a park radio, then made a MAYDAY call which initiated the emergency response from KNP personnel.

The joint rescue coordination centre (JRCC) detected the signal from the ELT and tasked a passing Royal Australian Air Force (RAAF) C130J to search for the source. The RAAF aircraft's crew found the wreckage of VH-FHW and directed a nearby helicopter to the scene. The crew on the second helicopter were able to provide immediate assistance. Meanwhile, the RAAF aircraft was also in communication with an inbound emergency medical service (EMS) helicopter.

The EMS helicopter arrived at the accident site about 5 minutes later. Medical professionals on board were winched from the helicopter to care for the injured personnel and prepare them for transport.

Following news of the event, the fuel supply at Jabiru was closed for testing as a precaution. This prevented the EMS helicopter from refuelling at Jabiru. Combined with limited access to site, the delays in refuelling meant extraction of the injured crew took longer than desired. The crew eventually reached hospital in Darwin at around 1900, about 9 hours after the collision with terrain.

Figure 3: VH-FHW following collision with terrain

Source: Northern Territory Police

Context

Personnel information

Pilot

The pilot held a valid Commercial Pilot Licence (Helicopter), and a current Class 1 Aviation Medical Certificate. Over a 40-year career, the pilot had accumulated over 18,000 hours flight time. The pilot first worked for the operator on a full-time basis in 1994, before then flying for other operators. More recently, the pilot was inducted to the operator as a contractor in 2014.

The pilot had a significant level of experience in low-level and remote area helicopter operations, including extensive experience in aerial shooting programs. The last proficiency check in single engine helicopters was conducted on 26 March 2018 (valid to 31 March 2020), and the last proficiency check for low-level helicopter operations was conducted on 1 November 2018 (valid to 1 November 2020). No problems were noted during either proficiency check.

Shooter and spotter

The shooter was a highly experienced Kakadu National Park (KNP) ranger who was first licenced for aerial platform shooting in 2002.

The spotter had over 30 years' experience as a KNP ranger, and became a licenced aerial platform shooter in 2000.

Both the spotter and shooter had been trained in aerial platform shooting. The Civil Aviation Safety Authority (CASA) had issued permission to both personnel for carriage and discharge of a firearm from an aircraft. The conditions of permission required that, before shooting from an aerial platform, they must:

a) have completed training a syllabus of training by an accredited aerial platform shooting training organisation; or by the pilot in command for the type of aircraft to be used (aeroplanes or helicopters); and

b) retain a copy of this training course and evidence of its completion…; and

c) within the previous 2 years:

   i. have conducted shooting from an aircraft; or

   ii. requalified under the training course mentioned above.

The permissions were valid for 3 years. The aerial platform shooting course was only undertaken once by both crew for the initial issue of their permissions. Permissions were then renewed by shooting from aircraft within the 2-year period. The crew also completed ground-based firearms safety courses. The spotter and shooter had not refreshed their emergency training for aerial platform shooting since the initial issue of their permissions in 2000 and 2002, respectively. They also had not conducted drills on the ground simulating a forced landing to prepare them for an actual event.

Organisational and management information

Kakadu National Park management

The Kakadu National Park (KNP) Board of Management developed, drafted, and monitored management plans for the park. The majority of land in the park was leased to the Director of National Parks (DNP) for management as a Commonwealth reserve. The KNP Board of Management worked with the DNP under a joint management framework.

The DNP was a corporate Commonwealth entity that existed under Part 19 of the *Environment Protection and Biodiversity Conservation Act 1999*. This entity administered, managed, and

controlled the park. The DNP was supported in carrying out its functions by the Parks Australia Division of the Department of Agriculture, Water, and the Environment.

Parks Australia staff operated in the KNP as rangers under direction from the DNP and with oversight from the Board of Management.

Helicopter operator

Jayrow Helicopters held an air operator's certificate (AOC) that authorised it to conduct a wide range of low-level aerial work activities using a wide range of helicopter types. These activities included aerial spotting and feral animal control (aerial culling).

The DNP tendered for helicopter services in late 2016, and contracted the helicopter operator to support a range of park activities under a deed of standing offer in May 2017.

The operator had provided helicopter services in remote areas of Australia for 55 years. Adaptations to the environment underpinned the expansion of its business into remote areas in the early days. Since then its services expanded to all areas of onshore and offshore helicopter operations. The operator had a quality management system and safety management system, with a full-time safety and quality manager.

The helicopter operator's operations in KNP were conducted from Jabiru, with management based in Darwin. The head office of the operator was in Melbourne, Victoria.

The DNP engaged aviation industry auditors to conduct second-party audits of the helicopter operator.

Approved maintenance organisation

The approved maintenance organisation was owned and operated by the same entity that operated the helicopters. The engineering manager, and the head of aircraft airworthiness and maintenance control, were based at head office in Melbourne. A senior base engineer and three full-time engineers were in place at the Darwin base. A contract engineer was temporarily employed to support a busy period of work at the time of the accident.

It was normal for most maintenance of the operator's helicopters to take place in Darwin.

Helicopter and maintenance information

General information

VH-FHW was one of two helicopters taking part in the aerial culling program. VH-FHW was a Bell Helicopter Company 206B3 JetRanger, serial number 2838. It was manufactured in the United States in 1979, and first registered in Australia in 1980. VH-FHW had seating for a pilot and four passengers, and it was powered by one Rolls-Royce 250-C20J turboshaft engine. At the time of the accident the helicopter had accumulated about 16,916 hours total time in service (TTIS).

For the aerial shooting task, the rear right door of the helicopter was removed.

Wreckage inspection

The ATSB did not conduct an on-site examination of the wreckage. On 30 May 2019, under the guidance of the ATSB, and supervision of the Northern Territory Police, the police, Parks Australia rangers and the operator returned to the accident site to inspect the wreckage.

During the inspection of the wreckage it was found that an engine reference air line[2] union between the power turbine governor and the accumulator was loose (Figure 4). No other pre-existing problems with the helicopter were reported to be found during the wreckage examination.

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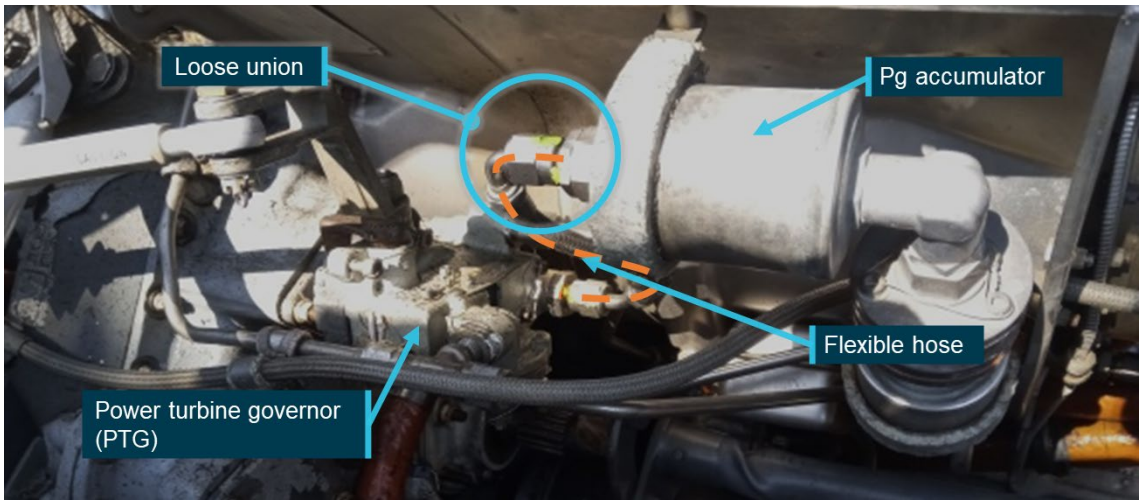
[2] Reference air line: This line provides compressor discharge pressure to the fuel control unit (FCU). If this line leaks, the air pressure signal to the FCU is reduced or lost, resulting in the engine idling, or flaming out.

Figure 4: Loose reference air union



Source: Operator, annotated by the ATSB

Maintenance information

The helicopter underwent scheduled maintenance in Darwin on 16 May 2019, 5 days prior to the accident. At that time, the helicopter had accumulated 16,911 hours TTIS. The planned maintenance included a clean of the tail rotor assembly, a 100-hour airframe inspection, and a 150-hour engine inspection.

All planned maintenance activities were recorded in a work pack. The package was prepared in advance of the maintenance and outlined the tasks to be completed. The work was conducted by four licenced aircraft maintenance engineers over a full day. The engineers signed each element as it was completed.

During this maintenance, it became apparent that the power turbine governor (PTG) and linear actuator required replacement due to stiff operation. As the PTG change was introduced on the day of maintenance, a separate work sheet was produced for that task.

Requirements of PTG install

The PTG is designed to keep the power turbine rotating assembly in a gas turbine engine rotating at a constant speed throughout changing power demands. The PTG senses engine speed changes by sensing engine reference air pressure (from the engine compressor), and it sends a signal to the fuel control unit (FCU) to adjust the fuel flow to the engine accordingly. A linear actuator assists the PTG by linking it to the pilot's controls, allowing the PTG to adapt to changing power demands more efficiently.

The maintenance instructions for the replacement of the PTG included a warning in relation to the installation (Figure 5). The engine manufacturer (Rolls-Royce) advised that this warning was repeated throughout its *250-C20 Series Operation and Maintenance* manual and applied to all union connections. This included both ends of all lines installed on the PTG. A loose union could create a leak, which would in turn cause engine power loss.

Figure 5: PTG installation warning

B. Installation

WARNING: FAILURE TO PROPERLY INSTALL, ALIGN AND TIGHTEN FUEL, OIL, AND AIR FITTINGS AND TUBES COULD RESULT IN AN ENGINE FAILURE.

Source: *Rolls-Royce 250-C20 Series Operation and Maintenance Manual*

Replacing the PTG requires removing the air carrying flexible hose and pipes from the old unit and replacing them on the new unit. It is normal practice in maintenance to disconnect the PTG and

loosen the other end of the lines (such as the engine reference air line) to allow manipulation of the lines for removal and refitting.

Replacement of the PTG on VH-FHW

The maintenance engineer that conducted the PTG replacement was a licenced aircraft maintenance engineer (LAME) with 27 years' experience in Australia and overseas. They had maintained the operator's fleet at the remote base in Darwin for 4 years.

The engineer stated that it was not necessary to loosen the other end of the flexible engine reference air line when replacing the PTG and that the reference air line adjacent to the accumulator was not touched at any point during the maintenance on 16 May 2019.

Other recent activities that could have loosened or dislodged the reference air line union were a turbine module change on 3 July 2015, a compressor module change on 6 July 2015, and a PTG change on 3 May 2018.

Human factors in engineering

The approved maintenance organisation had self-paced human factors training material for its engineers. The LAME that conducted the PTG replacement on 16 May 2019 completed that training on 12 January 2016.

In a Civil Aviation Safety Authority (CASA) published guide *(Safety behaviours: human factors for engineers)*, the stated average rate of leaving a loose nut during maintenance was one in 250. The guide stated that such lapses were most commonly encountered when a distraction was introduced to the maintenance task.

The engineer that replaced the PTG stated that distraction and interruption were existent at the engineering facility where the maintenance was conducted. Such interruptions were witnessed by ATSB investigators during the course of the investigation.

Independent inspection requirements

Civil Aviation Regulation (CAR) part 42G (*Flight control systems: additional requirements*), mandated that an aircraft's flight controls required independent inspection following maintenance activities. No other systems were required by regulation to undergo independent inspection. The qualification requirements of people conducting independent inspections were detailed in schedule 8 of CAR 42ZC (*Maintenance on Australian aircraft in Australian territory*). The qualified parties were essentially licenced engineers and pilots.

The maintenance organisation's *Engineering Procedures & Control Manual* allowed appropriate persons to conduct independent inspections as per CAR 42G. It stated that the certifying LAME was responsible for ensuring the person conducting the independent inspection was qualified, trained, and briefed. It was the engineer's responsibility to brief the pilots, and train them to conduct the independent inspections required. This was managed on an as needed basis without standardisation or formal support.

As human factors principals have been increasingly applied to the practice of aircraft maintenance over the years, the aviation industry has recognised the benefit of expanding the use of independent inspections beyond flight controls. Accordingly, many maintenance organisations have increased independent inspection requirements beyond the regulatory requirements to all critical maintenance tasks. Additionally, the Flight Safety Foundation's voluntarily adopted Basic Aviation Risk Standard (BARS) required registered operators (of that standard) to identify critical maintenance tasks (CMT), and stated:

> Maintenance tasks that involve assembly or disturbance of any system that may affect the flight path, attitude or propulsive force, which, if errors occurred, could result in a failure, malfunction, or defect that would endanger the safe operation of the aircraft must be considered as a CMT.

The maintenance organisation's *Engineering Procedures & Control Manual*, last updated 10 January 2018 and valid at the time of the accident, stated that 'second inspection' requirements were added to the manual on 7 October 2008. The manual specified additional independent inspection requirements over and above the requirements of CAR 42G. These included:

a) Main rotor, tail rotor systems and drive-train components.

b) All powerplant controls, including MFCUs, AFCUs, FCUs, EECUs, etc

c) All powerplant electrical connectors

d) All closed areas prior to refitment of panels/assemblies/components, etc.

e) Fluid line fittings.

Note: Whether the complete system or only part of a system has been disturbed, the independent inspectors should thoroughly check the system and adjacent areas, ensuring that all tools, equipment and materials have been accounted for and removed.

Independent inspection of maintenance on 16 May 2019

The work pack generated at the time of maintenance on 16 May 2019 carried space for signing off after independent inspection of critical maintenance tasks. Two tasks relating to the reassembly of the tail rotor pitch control were identified for independent inspection. These items were signed as carried out by the LAME who completed the work and signed as inspected by a second LAME.

There was no documentary evidence to show independent inspection of the PTG install had taken place. The LAME that conducted the task stated that a pilot had conducted a visual inspection of the installation, and that due to distraction from unrelated operational demands the signing of the paperwork was missed.

The pilot who was nominated as having done the inspection stated that they had done duplicate inspections at times for the engineers but it was not a common occurrence. They could not recall conducting a visual inspection of the PTG installation or any other aspect of VH-FHW during its maintenance on 16 May.

Verification of maintenance activities

The logbooks for all aircraft were held at head office in Melbourne. All maintenance documentation from the Darwin base was sent to Melbourne for verification prior to a maintenance release being issued for an aircraft. Following the maintenance on 16 May 2019, a maintenance release was issued for VH-FHW without the required independent inspection requirement being signed as completed for the PTG installation.

The last audit commission by the DNP on the helicopter operator and its maintenance organisation in September 2018 included the following observation:

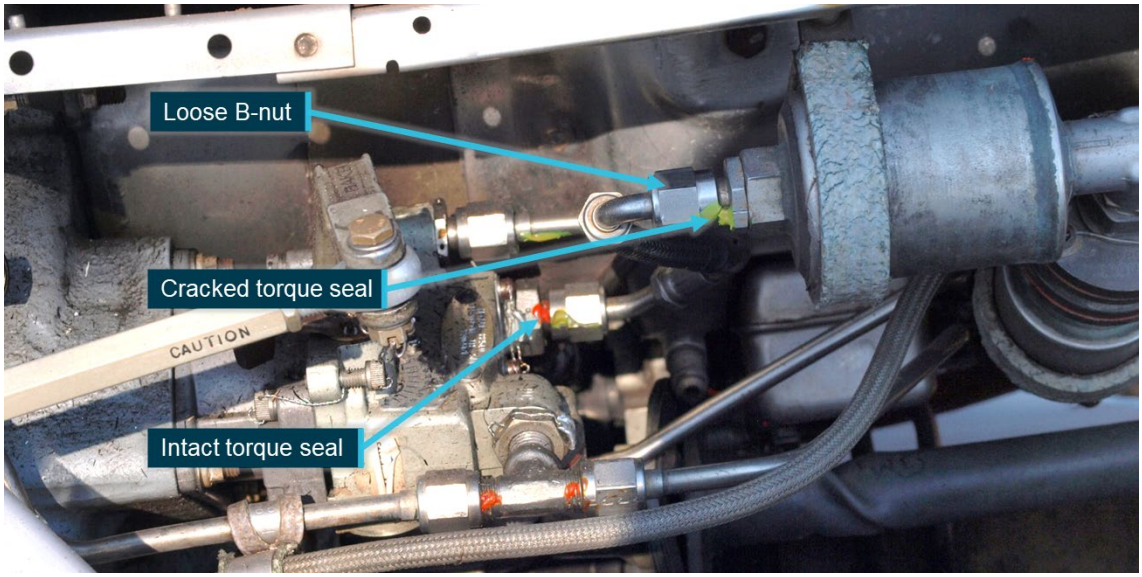
> An inspection of a recent work pack for the last service completed for (a company helicopter) showed records to be completed thoroughly and correctly. Logbooks are not kept on site and all records are scanned and sent electronically to the head office. (The operator) meet(s) the requirements of … the Deed of Standing Offer.

Torque seal

As a visual indicator of alignment, and an aid to indicate when an item has been secured, aircraft engineers often applied torque seal to that item. Pilots conducting visual inspections in the field could check the torque seal for cracks or movement. A crack or movement could indicate that the item was potentially not secure (Figure 6). However, torque seal is a hard lacquer and is not a perfect indicator. It can flake and crack due to heat or exposure to the elements (potentially providing false indications of movement), or if there is only slight movement it may only indicate hard to detect hairline cracks.

Orange torque seal had been applied to the several areas around the PTG, and these areas corresponded to the parts the engineer stated were manipulated when installing the PTG (Figure 6). There was yellow torque seal applied where the loose reference air line was located and it was observed to be cracked following the accident (Figure 6). Yellow torque seal was also present on some other parts that were not manipulated during the last maintenance.

Figure 6: Torque seal on air line unions as found on VH-FHW



Source: Operator, annotated by the ATSB

Subsequent inspections of the helicopter

Pilot inspections involved a visual check of the unions at the end of the air lines in the engine compartment, including the condition of the torque seal on air lines in-line with the PTG. However, the PTG lines were one of many components to inspect that would have torque seal applied (that is, there could be dozens of items with torque seal applied that needed to be checked during a daily inspection or similar pilot inspection).

Several visual inspections were made of VH-FHW by qualified people in the normal course of operation following the 16 May 2019 maintenance and none identified any defect. More specifically:

- On 17 May 2019, after the scheduled maintenance and replacement of the PTG had been conducted, a functional check of the helicopter's engine and aircraft was conducted on the tarmac at the operator's Darwin base. Inspection was required before the helicopter was operated, and was also done during the ground run. No defects were reported.
- On the morning of 20 May 2019, VH-FHW was flown to Jabiru and then used on a stream sampling job nearby. The pilot who conducted these flights reported that the daily inspection of the helicopter identified no defects and that the helicopter performed well.
- On the afternoon of 20 May 2019, the helicopter was left in Jabiru for the pilot contracted for the aerial culling task to collect. That pilot inspected VH-FHW before departing Jabiru for Mary River Ranger Station and stated that the helicopter presented no defects. The afternoon was spent using the helicopter for aerial culling tasks. The pilot reported that the check conducted at the end of the day identified no issues.
- On the morning of 21 May 2019, the pilot reported having ample light and time to conduct a thorough daily inspection. The pilot stated that the daily inspection was conducted and no defects were identified.

Emergency procedures

Regarding the Rolls-Royce 250-C20J engine, if the PTG fails on the high side (high RPM), and puts too much fuel into the engine, the engine will overspeed. The pilot can decrease the throttle to reduce the fuel flow and therefore manage RPM.

As in the case of the accident on 21 March 2019, if the PTG fails on the low side (low RPM), and restricts the amount of fuel going to the engine, there is no adjustment the pilot can make to increase the fuel flow for this engine type. The pilot must instead treat the problem like an engine failure. When operating at a low height above ground, this means controlling rotor RPM with collective pitch and cyclic, and managing the helicopter for the best available outcome.

Meteorological conditions

The pilot reported that there was limited internet connectivity at the Mary River Roadhouse so was unable to obtain updated weather information online. The pilot was familiar with the area and, given the conditions, they were satisfied that the weather was suitable for the planned flight.

The Bureau of Meteorology (BoM) provided automated weather reports for Jabiru for the morning of 21 May 2019. The reports indicated an east to north-easterly wind at 12 kt, nil cloud, temperatures from 28 °C to 30 °C, and visibility greater than 10 km. The weather was typical for the Northern Territory dry season and conducive to flying.

Cabin safety information

Occupant injuries

All three occupants of VH-FHW received serious injuries. The pilot received serious back and foot injuries, as well as chemical burns to the body from leaked fuel. The spotter received a serious back injury, a gash to the outside of the lower right leg, and damage to the right arm. The shooter received chemical burns from fuel, and serious injuries to the back, right hip, and scalp.

Seatbelts and harness

VH-FHW was fitted with four-point seatbelts with upper torso restraints (UTRs) in all seating positions. For the KNP shooting operations in B206B3 JetRanger helicopters, the pilot and the spotter both wore the four-point aircraft seatbelts.

The helicopter operator provided a harness for the shooter, which the shooter did not use. For reasons of comfort, the shooter instead used a harness supplied by Parks Australia, attached by way of a non-energy absorbing, webbing restraint strap of around 1 m to a specified anchor point.

The harness's design complied with ATSO-C1003[3] and was a quick release type, that could be released under load using two distinct movements (Figure 7), and it was approved under Civil Aviation Safety Regulation (CASR) 21 (*Certification and airworthiness requirements for aircraft and parts*). It was attached to the aircraft with an adjustable strap. Figure 8 shows the location of the anchor point installation in VH-FHW, which was approved by an authorised engineer under CAR 35 (*Approval of design of modification or repair*). The anchor point design required it to be installed on the left side of the cabin for use at the rear right door.

Both the shooter's harness and the anchor point in VH-FHW carried a caveat. Figure 9 shows the harness manufacturer's statement:

> Not approved for take off or landing.

Additionally, the flight manual supplement for the approved anchor point stated:

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[3] ATSO-C1003 is the Australian technical standard order for external personnel lifting devices used in aviation applications.

> The camera person/hoist operator must be restrained by his standard seat belt for take-off and landing.

The harness used by the shooter did not fail in the accident sequence, though it was noted after the accident to be past its 10-year retirement date by 3 weeks (Figure 7). The operator took immediate steps to prevent third parties using expired equipment aboard their aircraft after discovering this post-accident.

Harnesses are commonly worn in many aircraft applications. They are designed to prevent people from falling within, and from, the aircraft. They are not designed to protect the occupant during a collision or impact sequence.

Figure 7: Shooter's harness, rear view

Source: Northern Territory Police, annotated by the ATSB

Figure 8: Harness anchor point

Source: Operator, annotated by the ATSB

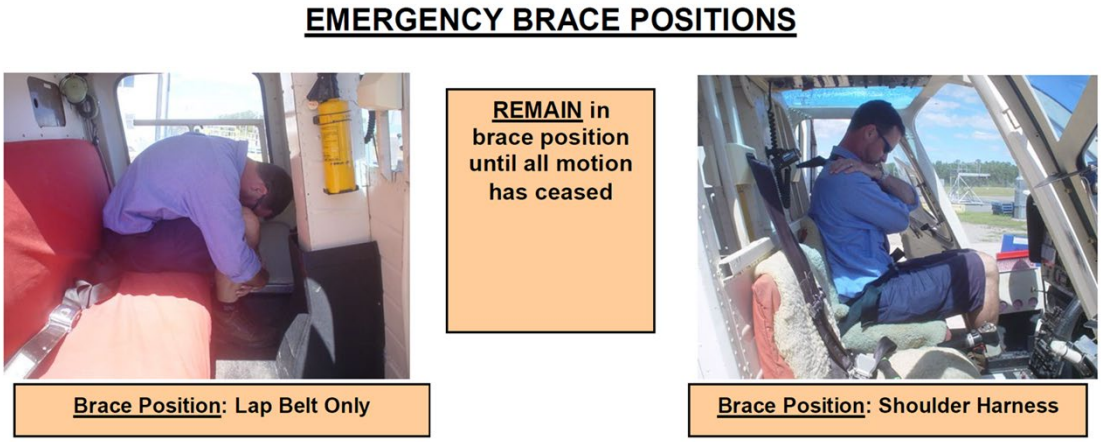
Brace positions and emergency response

The operator specified brace positions for passengers in seats fitted with a lap belt and for seats fitted with a lap belt and UTR (Figure 9).

During the occurrence, the seatbelt with UTR kept the pilot in place while they flew the aircraft for as long as they could to achieve the best outcome.

Although the spotter was aware of the brace position, and the UTR held the spotter in their seat, they reported that they lifted their legs prior to impact. In contrast, the specified brace position required the occupant's feet to be flat on the floor, as depicted in Figure 9.

Figure 9: Brace position information provided by operator



Source: Operator via the Director of National Parks

There was no universally recommended brace position for a crew member in a fall arrest harness, and the operator had not provided procedures or guidance for a brace position for a shooter wearing only a harness. The shooter reported that they crouched down as much as possible, as if they were wearing a lap belt.

A document on helicopter ditching produced by the North Atlantic Treaty Organisation (NATO) in 1989 recommended:

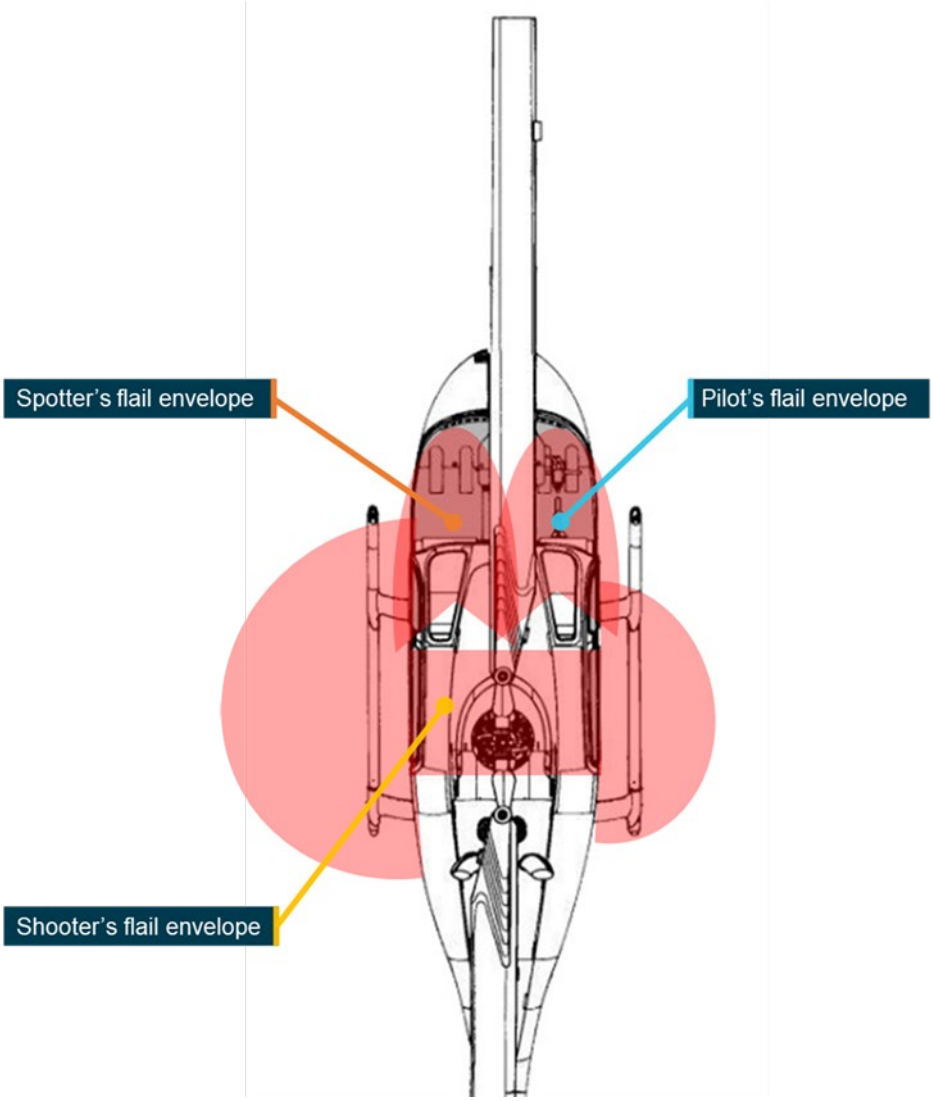
> Those unrestrained or on a long tethered harness prior to impact, should if at all possible strap into the nearest seat and assume (a standard brace position). Otherwise they should immediately lie face down flat on the floor with their heads buried in the crook of their arms.

Those actions require time and space, which may not be available when responding to an emergency at a low height above the ground in a small helicopter.

Reducing the flail envelope of an occupant is a vital part of reducing harm in an impact sequence. Even short single-point restraints have been demonstrated to allow significant flail injury to occupants (see for example AO-2014-053). Figure 10 shows the estimated flail envelopes for the occupants of VH-FHW at the time of the accident. The shooter, with a single-point restraint, had a much larger flail envelope than the two front seat occupants.

In the event of an emergency (such as an impending impact), the shooter was required to throw their weapon out of the exit. The shooter advised that they understood this requirement. However, on this occasion they brought the live rifle into the cabin and pointed the barrel down.

Figure 10: Estimated flail envelope for occupants of VH-FHW



Source: ATSB

Harness use instrument

The use of seatbelts is mandated in CAR 251 (*Seat belts and safety harness*). It stated:

> (1) Subject to this regulation, seat belts shall be worn by all crew members and passengers:
>
> (a) during take-off and landing…
>
> (c) when the aircraft is flying at a height of less than 1,000 feet above the terrain…
>
> (3) CASA may direct that a type of safety harness specified in the direction shall be worn in place of a seat belt in the circumstances set out in the direction…

Civil Aviation Order (CAO) 20.16.3 (*Air service operations – carriage of persons*) detailed technical requirements to support CAR 251. It stated:

> 3.1 Each crew member and each passenger shall occupy a seat of an approved type:
>
> (a) during take-off and landing; and …
>
> (c) when the aircraft is flying at a height less than 1000 feet above the terrain; ….
>
> 4.1 … safety harnesses, or seat belts where safety harnesses are not fitted, shall be worn by all persons at the times listed in paragraph 3.1…

Airworthiness bulletin (AWB) 25-007 issue 3 (*Personnel Harnesses, Restraint Straps and Approved Attachment Points*) alerted operators to safety issues surrounding the use of harnesses. The AWB did not offer guidance with respect to a brace position for personnel wearing only a harness.

In November 2018, CASA issued the instrument CASA.EQUIP.0029 under CAR 251(3) to the helicopter operator, exempting the operator from CAR 251(1) when certain conditions were met. It stated:

> … approved safety harnesses may be worn in lieu of seat belts in a helicopter during take-off and landing and when the helicopter is flying at a height less than 1,000 feet above the terrain.

The instrument also specified various conditions and requirements, which included:

> GENERAL CONDITIONS
>
> The direction to use the harness is applicable only to the conduct of those tasks where the assistance of the otherwise unrestrained crew member is vital to the operational safety or to the conduct of specific aerial work functions as detailed in the operator's operations manual…
>
> The harness must be worn in place of the seat belt for the minimum time commensurate with flight safety;…
>
> Procedures, drills, operating crew duties and recency requirements covering both normal and emergency operations whilst wearing a safety harness, or swapping between seat belt and safety harness, must be defined and published in the operator's operations manual…
>
> CREW REQUIREMENTS
>
> Before flight, the pilot in command must brief crew members in regard to the responsibilities applicable to both normal and emergency operations whilst wearing a safety harness, or swapping between seat belt and safety harness. The briefing must include the procedures to be adopted to afford the best protection to crewmembers in the event of a forced landing…
>
> CONDUCT OF FLIGHT
>
> An approved seat and seat belt, for use in an emergency, must be available at all times to the occupant of the safety harness…
>
> Transfer between a seat belt and a safety harness during flight must only occur above 1,000 feet AGL, where practicable, and with the cabin doors closed. These restrictions apply only if the occupant is not secured by either system during the transfer…
>
> Notwithstanding the requirements of [previous paragraph], the occupant must not be secured by more than one (1) restraint system for other than the actual transfer (Ref CAO 108.42 para 3.6) except during the conduct of specific power line aerial work functions as detailed in the operator's operations manual.
>
> OPERATOR'S RESPONSIBILITIES
>
> …The Operator must further ensure that any person wearing a safety harness pursuant to the provisions of this direction is fully apprised as to the inherent limitations and potential risks involved in the use of such a harness, when it is worn in place of a seat belt or other restraining device of a type that would otherwise be required in accordance with the provisions of CAR 251.

This instrument was a common exemption to seatbelt requirements for operators conducting aerial work in Australia. Jayrow Helicopter's instrument was initially issued in 2004.

CASA informed the ATSB that, despite the wording of the instrument, caveats on the specific equipment used (see *Seatbelts and harness*), and conditions of the instrument requiring equipment to be approved for take-off and landing, meant that a harness could not be worn in lieu of seatbelts during take-off and landing. CASA also stated that, while the wording appeared otherwise, the instrument was never intended to allow the use of a harness during take-off and landing instead of a seatbelt.

CASA advised that no risk analysis had taken place regarding the potential use of the harness instead of a seatbelt for take-off and landing when issuing this instrument, as it had not anticipated that the instrument could be interpreted that way.

CASA provided renewals of the operator's instrument every 3 years. Renewals relied on the existence of an antecedent instrument, and upon the content of the operator's operations manual providing the means to fulfil the conditions of the instrument.

Harness use below 1,000 ft

There were three distinct phases of flight mentioned in CAR 251 and instrument CASA.EQUIP.0029: take-off, landing, and flight below 1,000 ft. The use of a harness below 1,000 ft was essential for completion of the shooting task, and the operator had published aerial culling procedures and harness use procedures in its operations manual. The harness use procedures included:

- annual recertification of equipment
- visual inspection of harness and anchor point
- pilot briefing on use by senior base pilot
- instructions on proper assembly of the quick release mechanism.

The helicopter operator stated that all crew involved in the shooting tasks had received a mass brief at the beginning of the aerial culling program, and regular briefings before flights at the aircraft. The manager in Darwin advised that the mass brief included the use of the harness, operation of the quick release, and shooting procedures as well as normal flying operations. The pilot reported that the pre-flight briefings at the aircraft included avoidance of rotating parts, how seatbelts and doors worked, and location of emergency equipment, as well as task-specific points such as coordination of turning with shooting.

Parks Australia staff members reported that, aside from the method of attachment and release from the harness, there was no other guidance or information provided to the aerial culling personnel about precautions or risks when utilising the harness, with or without the aircraft seatbelt fitted.

As noted above, the CASA instrument required a person wearing a harness to be made aware of the increased level of risk they are assuming when wearing a harness and not wearing a seatbelt. Parks Australia staff members stated they did not feel this was sufficiently communicated to them.

Harness use on take-off and landing

The pilot recalled that, on the day of the accident, the shooter was wearing only the harness on departure from the ranger station. The pilot reported a preference for crew to use the seatbelt, and on this occasion allowed the shooter to use the harness for comfort.

The shooter recalled wearing the seatbelt (lap belt) over the harness during the take-off and throughout the flight. Following the accident, the shooter was found to be only wearing the harness.

Interviews with the operator's personnel and Parks Australia staff members confirmed that, in the B206B3, shooters would usually remain in the harness attached to the helicopter with the restraint strap at all stages of flight. Flight crew and Parks Australia personnel also reported that, if the aircraft seatbelt was used, it was normal to use the lap belt portion of the seatbelt in addition to the safety harness.

As noted above, the CASA instrument stated that the occupant must not be secured by more than one restraint system for other than the transfer between restraints.[4]

---

[4] To be secured by more than one approved system can increase time taken to evacuate an aircraft in the event of an emergency.

Ancillary radio install

In 2015 an ancillary radio system was installed in the front passenger footwell of VH-FHW, in accordance with a CAR 35 engineering order. The installation protruded about 8 cm into the footwell (Figure 11). The radio system was a marine VHF/UHF radio, and it was not required for the aerial culling tasks. It had sharp small radii corners, and was not padded.

The spotter reported that the ancillary radio's placement made it difficult to use the push-to-talk foot switch for the intercom system. Additionally, the large laceration to the spotter's right leg matched the small radius, metal corners and edges of the ancillary radio installation.

VH-FHW, serial number 2838, was a Bell 206B manufactured in 1979. The Bell 206B model was certified in the normal category in 1971, and its certification basis was the US Civil Aviation Regulation 6, dated December 1956, with various amendments. In terms of emergency landing conditions, that design standard stated:

> The structure shall be designed to give every reasonable probability that all of the occupants, if they make proper use of the seats, belts, and other provisions…will escape serious injury in the event of a minor crash landing In which the occupants experience the following ultimate inertia forces… Upward 1.5g (downward 4.0g)…Forward 4.0g… Sideward 2.0g.…

Consequently, modifications to the aircraft (such as for the radio installation in VH-FHW) needed only to comply with the original design standard.

From 1989, the US Federal Aviation Regulation (FAR) 27.561 requirement for helicopter types certified in the normal category were required to be designed to protect up to 16 g forward, 20 g downward, 8g sideward and 4 g upward. From 1984, FAR 27.785 also required that:

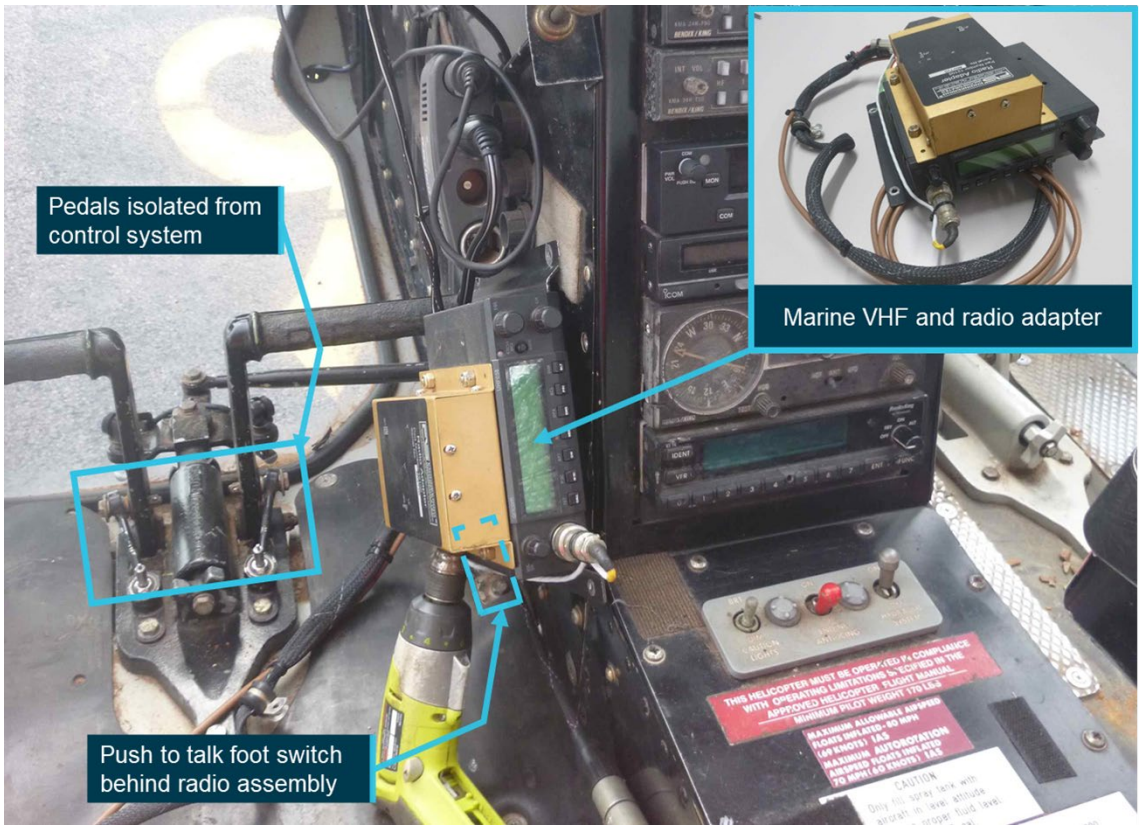
> Each seat, safety belt, harness, and adjacent part of the rotorcraft at each station designated for occupancy during take-off and landing must be free of potentially injurious objects, sharp edges, protuberances, and hard surfaces and must be designed so that a person making proper use of these facilities will not suffer serious injury in an emergency landing…

The Bell 206B3 is piloted from the right seat, however dual controls can be made available for pilot training and proficiency checks. This would require an instructor or check pilot to fly the helicopter from the left seat. US CAR 6 also required that:

> …the pilot will be able to perform all of his duties and operate the controls in the correct manner…

The pedals at the front left seat of VH-FHW were disconnected from the flight control system. That position can be equipped with flight controls for tasks that require two pilots. The protrusion of the radio installation in VH-FHW over the pedals would likely prevent a pilot from effectively operating the controls. The engineering order for the installation did not prohibit a second pilot from flying the aircraft from the left seat.

Figure 11: Exemplar radio installation showing approximate position in footwell



Source: Maintenance organisation, annotated by the ATSB

The aerial culling task

Low-level operations

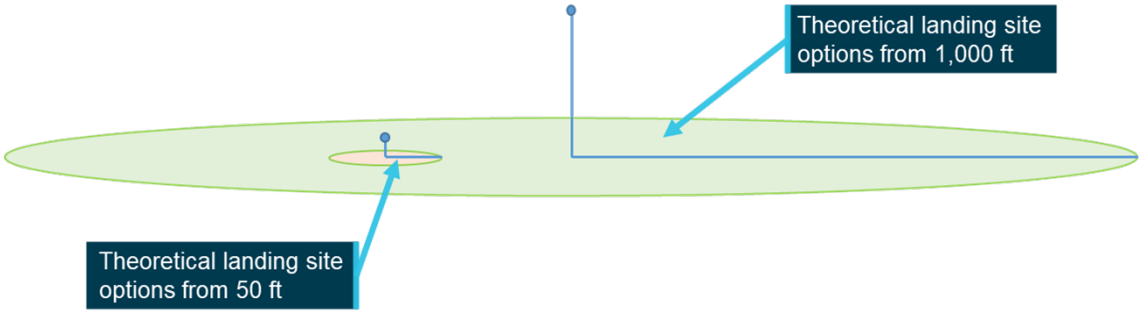
Helicopters are used extensively in low-level operations to support numerous industries in Australia. These notably include emergency services, fire suppression, and management of national parks. Low-level operation is defined as any operation below 500 ft, aside from take-off and landing.

Low-level flight brings several significant complexities to the operation, and pilots require training and approval to operate helicopters at low-level. One such complexity is management of forced landings. Both time and availability of suitable forced landing areas are significantly reduced.

During a forced landing, a helicopter can descend at around 2,000 ft/minute. From 1,000 ft, this provides around 30 seconds for preparation of the cabin for a forced landing. From 50 ft, the time is reduced to a few seconds, leaving very little (if any) effective time for warning or preparation.

Low-level flight also vastly reduces the availability of forced landing sites (Figure 12) At best glide speed (69 kt in a B206B3), a glide ratio of around 4:1 is achievable. Low-level work ordinarily occurs at lower speeds than that, and in aerial culling the pilot must match the speed of the animals, further reducing choice of forced landing areas.

Figure 12: Theoretical choice of forced landing area at best glide speed



Source: ATSB

Task design

The primary purpose of the aerial culling activity was to care for Country, and protect the habitat and people in the park from damage caused by feral animals.

It was normal practice across industry that an aerial culling task was performed with just two people on board the helicopter: a pilot and a shooter. For example, the successful brucellosis and tuberculosis eradication campaign in Australia ran for 27 years and made extensive use of aerial culling with two crew. In addition, the Northern Territory government's aerial platform shooting course guide, under which the Parks Australia shooters were trained, did not mention observers or spotters being on board an aircraft.

The pilot of VH-FHW, who had 30 years' experience in aerial culling, had ordinarily conducted shooting tasks with just two people on board. Experienced aerial shooters interviewed after the accident also stated a preference for carrying just the pilot and shooter on board to reduce risk to crew, carry more fuel to improve endurance, and do more work.

Parks Australia employees advised that aerial culling tasks in KNP were conducted in Robinson R44 aircraft with just a pilot and shooter up until 2016. In 2017, the DNP switched to a different helicopter operator, which provided a range of services using the larger Bell 206 JetRanger and Airbus Helicopters EC120B aircraft.

The DNP used the higher capacity of the larger helicopter to include the spotter position and improve data collection (in terms of information about the species, number and location of kills). A Parks Australia representative stated that it was critical that the spotter was carried for the success of the shoot, and to counter the risk of not having data for stakeholders. Accordingly, since 2017, the DNP designed the aerial culling task for three people. It required a spotter on board the helicopter in addition to the shooter and the pilot. Prior to 2017, when using the R44 helicopter, data collection was performed by the shooter.

Safe operating procedures

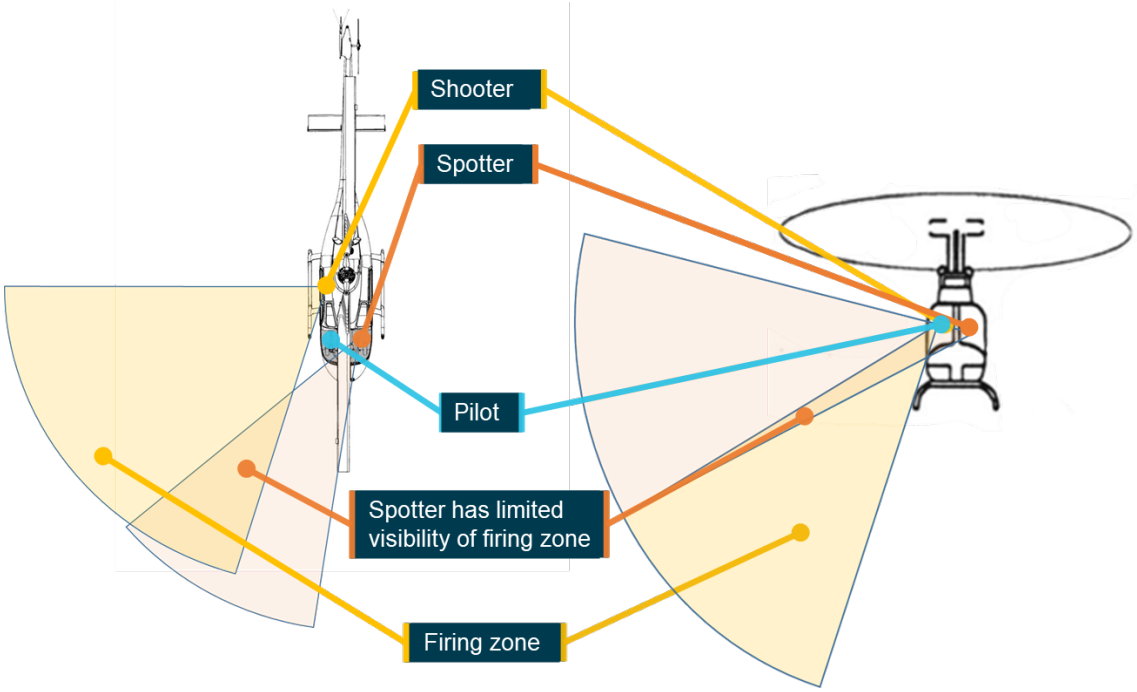
The DNP amended its safe operating procedures (SOPs) issued for aerial platform shooting in November 2016. The procedures included information relevant for conducting the task in an R44 and in a JetRanger and rated the risk to crews as high. For example, the SOPs accommodated the inclusion of the spotter (only relevant to a JetRanger), and required the shooter to wear a seatbelt at all times (which was applicable to the R44 but not how the operation was conducted in a JetRanger).

The SOPs required the spotter to have training in:

- map reading and navigation
- aerial animal welfare assessment
- locating the animals and counting kills from a helicopter.

During shooting, the pilot positioned the helicopter to the left of the mob of horses, and matched the speed and track of the helicopter to that of the animals. In a JetRanger, the spotter (seated in the front left seat) could not see what was happening on the right side of the helicopter where the shooting was taking place. The spotter would therefore require the input of the pilot and shooter to conduct the count (Figure 13).

Figure 13: Estimated firing zone and visibility



Source: ATSB

The SOPs also stated that safety equipment for the task included a flight helmet with intercom. No flight helmets were provided to the aerial shooting crew. The shooter and spotter on the accident flight reported that they were not wearing helmets and did not generally wear helmets during shooting operations. The pilot provided and wore their own helmet.

The spotter reported that they wore a headset for communicating with the pilot and shooter. The shooter reported that they also wore a headset but pushed it back when shooting, so that the earcups would not interfere with manipulation and aiming of the rifle.

Oversight of contracted helicopter operator

On award of the contract for helicopter services, and annually thereafter, the DNP commissioned an independent aviation auditing company to conduct an audit of the helicopter operator and its co-owned maintenance organisation. The audit examined the operator's ability to provide the service while observing aviation regulations, as well as observing the terms of the contract entered into between the parties.

An audit conducted in September 2018 resulted in three findings, two related to sling load equipment and aircraft parking, and a third due to the operator's emergency response plan at Jabiru not including relevant emergency contact details. The operator added the emergency contacts to its emergency response plan at the time of audit.

Oversight of shooting operations

There was limited oversight of shooting operations by the DNP. The aircraft travel plan was a document relied on by the park manager and aerial culling team for authorisation of the task, and it was detailed in the DNP aircraft safety policy as being 'a very important safety factor'. This document was required to be completed for each task, but the template had not been updated

since the change in helicopter operator in late 2016. It carried emergency contact details of the previous helicopter operator, and no contact details for the current helicopter operator.

A Parks Australia representative stated that they did not have visibility of the aerial platform shooting management process and that high turnover in the management role over the preceding years had hampered Parks Australia's ability to provide oversight in that regard. The culling team had no permanent manager in place. A manager was temporarily seconded to the team to help prepare for the culling task in the lead up to the current program, yet risk management documentation for the operation, which was to be completed at manager level, was not conducted and had last been addressed in 2015.

This situation was accepted by management because the crew were all licenced, and local debriefs took place to manage the risk. However, the SOPs did not require a debrief after shooting and there was no record of crew debriefs, no indication of what the content should be, and no internal procedures to verify they were taking place.

Risk management

The date of the DNP's last risk assessment for aerial culling was 3 August 2015, with a stated duration of 12 months. Since that time, a number of aerial culling tasks had taken place. In addition, the helicopter operator, helicopter type, crew configuration, and SOPs had all changed.

The introduction of a new helicopter operator introduced changes to elements such as:

- the integration of the standard operating procedures of the operator and the DNP's SOPs
- task management documentation (trip plan details for example)
- emergency response planning
- emergency contacts.

The helicopter type had changed from an R44 to B206B3s (JetRangers) and EC120B helicopters. This introduced changes to the:

- seating position of the shooter
- shooting position of the shooter
- restraints used by the shooter (fall restraint harness in JetRanger instead of a seatbelt in R44)
- management of role equipment
- inclusion of the spotter.

The inclusion of the spotter introduced changes to:

- available fuel load
- number of people exposed to low-level helicopter operations.

None of these changes had been formally analysed by the DNP for their effect on the risk assessment, and the risk assessment as it stood was not equipped to capture the changes. Additionally, the risk assessment did not discuss protection of the crew through provision of personal protective equipment. Also, there was no formal risk analysis of the inclusion of the spotter position, or consideration of the potential benefits of improved data collection when weighed against operational difficulties in recording data, reduced efficiencies in operation, and increased exposure of employees to risk.

Additionally, the park's radio network was cited as a mitigator for:

- injury to person on ground from stray bullet or ricochet
- inappropriate storage or transport of firearms
- incursion of people on ground into the shooting area.

However, KNP personnel reported that the park's radio was only available 10 per cent of the time to the crew in flight, and the radio network was reported by a Parks Australia representative to be

in need of maintenance and upgrade, yet upgrade required resources they did not have. If the aerial culling crew on a helicopter needed to talk to their ground support personnel, they had to land by the road to talk face-to-face. The risk management plan did not document these limitations with the mitigator or identify treatments to address the situation.

Safety analysis

Introduction

While the helicopter was operating at about 50 ft above the ground for the aerial culling task, the engine lost power and the pilot was required to conduct an emergency landing with limited options available. As a result of the collision with terrain, the three occupants (pilot, shooter and spotter) were seriously injured.

This analysis will initially discuss the factors associated with the engine power loss, including the loose reference air line and the associated inspections of this component. It will then discuss various factors that increased the risk of injury to occupants, including the preparation of aircraft for low-level operations, and design and management of the low-level aerial culling task.

Loss of engine power

Based on the available evidence, the direct initiator of the engine power loss was the loose reference air line connected to the accumulator downstream from the power turbine governor (PTG). The reference air union was found loose at the accident site, and it was considered very unlikely that this would have loosened during the impact sequence.

In addition, a loose reference air union is consistent with the descriptions of the engine power loss. It would have vented air pressure from between the PTG and the fuel control unit, which the fuel control unit recognised as a signal to reduce fuel flow to idle. Reducing fuel flow to idle would have decreased the power generated by the engine.

In summary, the ATSB concluded that the loose union on the engine reference air line unscrewed in flight, creating a leak, and this leak resulted in a loss of engine power.

There was no manual override for a low-side governor failure available to the pilot. Therefore, the reduction in engine power deprived the pilot of the power required to keep the helicopter airborne, leading to the forced landing and collision with terrain.

It is virtually certain that the union at the accumulator end of the flexible hose from the PTG would stay fastened if the attachment points were serviceable and the nut was sufficiently torqued. A failure of the attachment point would result in a crack in the hose end fitting, and no cracks were reported. Therefore, it is extremely likely that the nut was loosened at some point and not correctly retightened. It could not be definitively determined when this occurred.

The PTG was replaced on 16 May 2019, 5 days (and 4.7 flight hours) prior to the accident. The engineer who replaced the PTG reported that the engine reference air line union was not manipulated during that maintenance. They stated it was not necessary to do so, as the flexible hose could be manoeuvred at the PTG end. Regardless of whether it was intended, it is possible that the union loosened while the engineer manoeuvred the PTG end of the hose.

The warning in the PTG installation documentation, regarding tightening of fittings and tubes, meant that all lines and unions at both ends should have been checked for tightness. As the hose-to-accumulator union was not touched, it was not intentionally loosened, yet neither was it physically checked for tightness. It is likely that such a check at that time would have identified the loose union.

Maintenance, inspection, and verification

There were three opportunities for the loose air line union to be detected before release to service:

- the engineer's own verification of the PTG installation
- independent inspection by another person
- verification of completeness of the relevant documentation.

Secondary checks by installing engineers and independent inspection by other trained parties are designed to catch lapses as part of an error-tolerant system. It is common practice for engineers to double check the tightness of unions to verify their own work. It is, however, notoriously difficult to detect issues in your own work (Sarter and Alexander 2000), and research has shown that errors of omission relating to fastenings are particularly difficult to detect (Reason and Hobbs 2003).

As already noted, the engineer that conducted the PTG replacement stated that the other end of the flexible hose was not touched. As such, self-verification of the installation concentrated on the PTG end of the flexible hose and the rigid pipes. It is noted that none of the unions on the PTG end loosened.

Given the likelihood of errors during procedural tasks such as maintenance, an independent inspection is a major part of capturing problems. Accordingly, the maintenance organisation's procedures required independent inspections to be conducted for a range of activities in addition to the minimum regulatory requirements, including for fluid line fittings. In this case however, the independent inspection probably did not occur. The engineer and pilot provided differing accounts of the conduct of the inspection, and there was no paperwork to verify it had taken place.

Even if the independent inspection occurred, it is not certain that it would have identified the problem. The inspection specified was visual, and the only way to detect the loose union would be to demonstrate tightness of all unions, including unions downstream of the PTG. Tightness can only be assured by placing a spanner on the union and checking it for tightness during independent inspection. Accordingly, a thorough, well-designed independent inspection at the time of maintenance is vital in ensuring the continued airworthiness of an aircraft.

Verification of completeness of paperwork is an opportunity to detect tasks or activities that were potentially missed. Following that step, the issuance of a maintenance release is a trusted signal to all parties that the maintenance was carried out as required and that the aircraft is airworthy.

In this case, the independent inspection documentation was supplied as part of the work package, however, being a separate sheet, it may have been overlooked in the review. On this occasion, the verification of the documents did not detect that the independent inspection of the PTG installation had not been signed. As a result, a maintenance release was issued, and the aircraft was returned to service without full assurance of continued airworthiness.

Torque seal, such as was present on the engine reference air line union, would ordinarily be applied after independent inspection and demonstration of tightness. In this case, torque seal had been applied to the air line union, and it was cracked. However, the torque seal was consistent with that used on a maintenance task prior to 16 May 2019, and not consistent with the torque seal applied during the 16 May 2019 PTG replacement task.

The exact meaning of this evidence is not clear, and a range of possibilities exist. In particular:

- torque seal was applied to a loose union an at undetermined time
- torque seal was correctly applied to a tight union that was later loosened.

If the torque seal had been applied to a loose union, this would have potentially obscured a missed step in tightening the union. However, if the loose union existed prior to the 16 May 2019, it seems unclear why it would have taken so long to manifest into a leak.

Regardless of when the torque seal was applied, cracks in the torque seal were not identified during the 16 May 2019 maintenance or on other occasions. This could also be due to a variety of reasons, including:

- the torque seal was cracked but the crack was not readily detectable
- the torque seal was noticeably cracked but missed by all who later inspected the aircraft.

Following maintenance, there were further opportunities to detect a problem in the daily inspections and other inspections conducted by pilots. There are dozens of fastenings to inspect

when preparing an aircraft for flight, and it is comparatively rare to find a problem. The high number of fastenings and low expectancy of a fault can predispose people inspecting aircraft to miss items. As all inspections carried out by pilots following the release of the aircraft to service were visual, they would not have detected the fault unless they sighted clearly broken torque seal on the relevant union.

In summary, an independent inspection following installation of the power turbine governor was probably not conducted, and document verification processes did not detect that the independent inspection had not been recorded. As a result, the helicopter departed for low-level operations without assurance of continued airworthiness. The exact reasons why these errors occurred could not be determined. However, errors of omission such as omitting the independent inspection, and not completing the associated documentation, can be associated with distractions, and the investigation noted that distractions were potentially associated with work in the hangar at the time,

Preparation of aircraft and crew operating at low-level

Introduction

To conduct the shooting task, the helicopter was periodically required to operate at a height of about 50 ft over a lightly wooded area. Accordingly, the configuration of the cabin and crew at any point in such a low-level operation is likely to be the configuration for impact with terrain should anything occur. Consideration must therefore be given to:

- cabin suitability
- personal protective equipment (PPE)
- restraints
- brace positions
- other emergency procedures
- awareness of risk.

Cabin suitability

The spotter's injuries were worsened by the radio installation in the front passenger footwell. Although adopting a brace position, with feet flat on the floor would have helped reduce the injury risk, it is very likely that the spotter would have had a lower level of injury without the radio installation in that location.

It should also be noted that the crashworthiness of small helicopters and aeroplanes has improved over the years with changes in certification and manufacturing requirements. This includes improvements in requirements related to impact forces, injurious objects, restraints, fuel tanks and other aspects to reduce the risk of fire. Organisations who have personnel involved in low-level operations can consider these aspects when deciding what types of helicopters should be used for their activities.

Personal protective equipment

Personal protective equipment (PPE) should be used as the last resort to minimise injury risk, but for some aviation operations it is not possible to reduce the risk to an acceptable level without also including PPE. Low-level flight is one of those aviation operations.

Only the pilot wore a helmet, which they provided themselves. Although the pilot was unconscious following collision with terrain they had no further head injuries.

Although helmets were required by the Director of National Parks' (DNP's) safe operating procedures (SOPs) for aerial culling crews, the were not supplied to the crews, and not worn on a routine basis. It is very likely that the shooter's level of head injury would have been reduced if they were wearing a helmet.

Restraints

The seatbelts with upper torso restraints (UTRs) worn by the pilot and the spotter likely played a role in minimising the severity of upper body and head injuries.

Unfortunately, for some helicopters, such as the B206B3 JetRanger, use of a fall-arrest harness for the shooter was necessary to conduct the shooting task and a seatbelt could not be worn at the same time. However, in the event of a forced landing when in low-level flight, the shooter has no time to transfer to the seatbelt. This exposed the shooter to a higher level of risk due to the increased flail envelope. In this case, possibly due to the movement afforded by the harness, the shooter received a serious injury to their head and right hip.

Brace positions

The helicopter operator provided detailed information about brace positions for seats fitted with UTRs and seats fitted with just lap belts. In this case, probably associated with the limited time available and the surprise of the unfolding events, the spotter did not keep their feet firmly on the floor. This increased their risk of injury, particularly to their lower legs. More specifically, if they had adopted the specified brace position, it is likely the severity of their leg injury (contacting the radio installation) would have been reduced.

Under the Civil Aviation Safety Authority (CASA) instrument for using a fall-arrest harness, the helicopter operator (via the pilot) was required to provide a briefing on the procedures to be adopted to afford the best protection to crewmembers in the event of a forced landing. In this case, the aerial culling crews reported that they were not provided with any such briefing information. While briefings regularly took place, a brace position specific to a harness was not communicated.

It is acknowledged that there is very little information available, provided by CASA or other regulators, about suitable brace positions for a person wearing only a harness. Nevertheless, there is still a requirement on the operator to research and provide information on a suitable position. The extent to which a suitable brace position would have been able to reduce in jury risk in this case could not be determined.

Emergency procedures training for low-level flight

Renewal of the CASA-issued approvals for discharging firearms from an aircraft only required that the applicant had to complete an initial aerial-platform shooting course, and then have shot from an aircraft within the last 2 years.

The shooter and the spotter (who was also a shooter) had not conducted a full or refresher aerial platform shooting course, which included safe practices around helicopters, in almost 20 years. Although they had received pre-flight safety briefings numerous times, such briefings do not cover some of the essential procedures necessary to minimise risk in the aerial shooting task. Had the spotter and the shooter regularly trained and practiced in helicopter safety and emergency procedures, it is likely that they would have both been better prepared for the forced landing.

In particular, the shooter knew the rifle should be thrown from the helicopter, yet had not practiced for such an event. There was very little time for the shooter to think about throwing the rifle clear of the helicopter, and the rifle remained in the cabin. Although the barrel was pointed down, the live firearm being in the helicopter increased the potential consequences of the accident. If the action of throwing the weapon in response to an emergency had been rehearsed or drilled, it would have been more likely to be ejected from the aircraft.

Awareness of risk

The CASA instrument also required the helicopter operator to advise personnel using a harness of the ‘inherent limitations and potential risks involved in the use of such a harness’. Aerial culling personnel using the harnesses reported that they were not made aware of the risks associated with harness use, nor precautions to be taken such as brace positions.

The high time aerial culling crew involved in this accident had a good understanding of the risks of the operation and revision of the risks from the operator would probably not have altered their intent to participate. However, another crew may not have been so experienced.

Harness instrument

The language of the CASA instrument regarding use of safety harnesses appeared to allow the use of a harness in lieu of seatbelts for take-off and landing. Equipment approved under CASA regulations (such as anchor points and harnesses) can be reasonably understood to meet the conditions of the instrument. However, CASA advised that the manufacturers' caveats on use of these items of equipment meant that a seatbelt still had to be worn for take-off and landing.

CASA advised that the instrument was never intended to allow safety harnesses to be worn in lieu of seatbelts during take-off and landing, and that the conditions of the instrument prevented this from occurring. There appeared to be two specific meanings of the word 'approved' which could cloud interpretation of the instrument; one in the sense of the equipment being approved under Civil Aviation Safety Regulation 21, and the other of the equipment manufacturers approving their products for certain activities. The equipment requirements of the instrument did not make this distinction clear.

Both the language of the instrument and conflicting use of 'approved' opened the instrument to misinterpretation. The language and conditions of the instrument should be improved. Operators and pilots should be aware that, even though an instrument may appear to permit an activity, the limitations of the equipment used must be observed.

Risk management of aerial culling activities

Significant changes had been made to the Director of National Parks' aerial culling operations in the KNP in the near 4-year period between the risk management plan development in 2015, and the undertaking of the aerial culling program in May 2019. This included, in 2016, the DNP designing the aerial culling task for three crew, introducing a spotter.

Given the increased complexity and risk in low-level operations, the number of crew should be kept to a minimum. That is, only personnel essential for conducting the task should be carried. In this case, the spotter was added to the crew without any formal or systematic consideration of the increased safety risk.

When pursuing a course of action, if one particular stakeholder risk presents the greatest threat, decision makers are prone to adopt a risky strategy which directly addresses the immediate threat to the detriment of other stakeholders (Jawahar and McLaughlin 2001). The spotter had been built into the program, primarily to collect data for stakeholders. Requiring a spotter to be on board mitigated a corporate stakeholder engagement risk, yet exposed the spotter to a high-risk aviation activity. Expanding the crew beyond the industry proven two crew model should have been a trigger for a formal risk analysis and assessment of controls.

A method of data collection designed for two crew or data collection managed through communication with ground crew would have exposed less people to risk. However, no alternative methods of data collection were explored, and the quality of data between two and three crew operations was not assessed. Therefore, the DNP did not know if lower risk options for data collection were available, or know if the added value to the operation warranted the increased risk exposure.

Additionally, there was no documentary evidence of consideration of the impact of changes in helicopter or operator on the operation. The 2015 aerial culling task risk analysis indicated limited consideration of aviation safety risk, and it is likely that the implications of further changes to the operation were not well understood.

When designing aviation operations, organisations without aviation expertise should seek outside information and expertise. Although the DNP contracted an aviation auditor, their scope of work

was to audit against the deed of standing offer. Likewise, the helicopter operator was contracted to deliver services as required by the DNP. Both organisations could have provided valuable input into risk analysis and task design, and neither was called upon to do so.

Furthermore, there was no evidence of a working process to build lessons learned into the aerial culling program. The SOPs did not require task debriefs, and hazard management was not conducted. For example, the aerial culling crew and park management knew that the radio network was unsuitable for the aerial culling task, and that they were unable to remedy it. Being such an important risk control, another solution should have been documented and implemented as an alternative.

Other controls were also not managed or reviewed for effectiveness. Specifically, incorrect emergency contact details on KNP documentation used to authorise the task, expired equipment remaining available for use, and PPE being unavailable to the crew.

High turnover in the role of park manager, and the aerial-culling crew not having a line manager, were reported as reasons for there being no supervision or active management of risk. This limited level of risk management restricted the DNP’s ability to eliminate or minimise risk to the crew, meaning safety risk was not managed, nor was safety assured at an organisational level.

Findings

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

Safety issues are highlighted in bold to emphasise their importance. A safety issue is a safety factor that (a) can reasonably be regarded as having the potential to adversely affect the safety of future operations, and (b) is a characteristic of an organisation or a system, rather than a characteristic of a specific individual, or characteristic of an operating environment at a specific point in time.

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

From the evidence available, the following findings are made with respect to the engine power loss and collision with terrain of VH-FHW on 21 May 2019.

Contributing factors

- A loose union on an engine reference air line unscrewed, creating a leak. The leak caused loss of engine power in flight, resulting in a forced landing.
- During installation of the power turbine governor, 4 days prior to the accident, an adjacent downstream attachment of the engine reference air line union was loose and not checked for tightness.
- Potentially associated with distractions in the hangar at the time, an independent inspection following installation of the power turbine governor was probably not conducted, and document verification processes did not detect that the independent inspection had not been recorded. As a result, the helicopter departed for low-level operations without assurance of continued airworthiness.
- Although compliant with regulatory requirements applying to the helicopter being used, bulky, non-task related equipment was installed in the front left passenger footwell, which increased the level of injury to the spotter during the collision with terrain.
- **Although the Director of National Parks' safe operating procedures required shooters and spotters to wear helmets during aerial culling tasks, helmets were not provided or used on a routine basis.** (Safety issue)
- Associated with the limited time to prepare for the forced landing, the spotter did not adopt the brace position, with feet on the floor, increasing the level of injury to their lower legs.
- **The Director of National Parks did not actively manage the risk of the aerial culling task being conducted in the Kakadu National Park, or effectively supervise the operation. As a result, an increase in the number of crew, a change in helicopter type and change of helicopter operator all progressed without requisite risk management. This exposed crew to avoidable harm during low-level aerial shooting operations.** (Safety issue)

Other factors that increased risk

- Associated with the limited time to prepare for the forced landing, the shooter did not eject the rifle in readiness for a forced landing. As such, the cabin was not prepared for a forced landing.
- **Recurrency training and drills in aircraft emergencies were not required for reissue of an aerial platform shooting permission. Some shooters last conducted training about 20 years prior, during initial issue of their permissions.** (Safety issue)
- **Although required by the harness instrument commonly issued by the Civil Aviation Safety Authority, the operator did not appraise shooting crews of the risks of using only a harness for restraint during low-level flight.** (Safety issue)

- **A harness instrument, commonly issued by the Civil Aviation Safety Authority (CASA), stated that a harness could be used instead of a seatbelt for take-off and landing. Although not intended by CASA, this instrument was easily able to be misinterpreted as indicating that a seatbelt was not required to be used during take-off and landing.** (Safety issue)

Other findings

- To conduct the shooting task, the helicopter was periodically required to operate at a height of around 50 ft over a lightly wooded area. This reduced opportunity to prepare for and make a successful forced landing.

Safety issues and actions

Central to the ATSB's investigation of transport safety matters is the early identification of safety issues. The ATSB expects relevant organisations will address all safety issues an investigation identifies.

Depending on the level of risk of a safety issue, the extent of corrective action taken by the relevant organisation(s), or the desirability of directing a broad safety message to the aviation industry, the ATSB may issue a formal safety recommendation or safety advisory notice as part of the final report.

All of the directly involved parties are invited to provide submissions to this draft report. As part of that process, each organisation is asked to communicate what safety actions, if any, they have carried out or are planning to carry out in relation to each safety issue relevant to their organisation.

The initial public version of these safety issues and actions will be provided separately on the ATSB website on release of the final investigation report, to facilitate monitoring by interested parties. Where relevant, the safety issues and actions will be updated on the ATSB website after the release of the final report as further information about safety action comes to hand.

Helmet provision and use

Safety issue description

Although the Director of National Parks' safe operating procedures required shooters and spotters to wear helmets during aerial culling tasks, helmets were not provided or used on a routine basis.

Issue number:	AO-2019-025-SI-01
Issue owner:	Director of National Parks
Transport function:	Aviation: General aviation
Current issue status:	Open - Safety action pending
Issue status justification:	The DNP has committed to procurement of helmets and implementation of procedures for ongoing conformance to safe operating procedures and use of helmets for aerial culling tasks. This safety action will be reviewed in December 2021 or sooner if advised as completed.

Proactive safety action by the Director of National Parks

Action number:	AO-2019-025-NSA-038
Action organisation:	Director of National Parks
Action status:	Monitor

In January 2021, the Director of National Parks (DNP) advised of the following safety action:

> In December 2019, the DNP commenced an internal review of standards of practice relating to aerial culling activity and related PPE use to ensure best and consistent practice. As a result of this review, the DNP has reaffirmed its requirement for the use of helmets during any future culling activities (noting aerial culling remains suspended) and will develop and implement operational procedures to ensure their appropriate use prior to any recommencement of aerial culling operations.
>
> The DNP has also commenced a process to select and acquire helmets for staff who undertake aerial culling activity in the future. In doing so, the DNP is committed to ensuring the PPE selected is operationally sound, non-obstructive and does not create further risk for crew undertaking shooting operations or anyone else who may be impacted by the work.

The Director of National Parks risk management

Safety issue description

The Director of National Parks did not actively manage the risk of the aerial culling task being conducted in the Kakadu National Park, or effectively supervise the operation. As a result, an increase in the number of crew, a change in helicopter type and change of helicopter operator all progressed without requisite risk management. This exposed crew to avoidable harm during low-level aerial shooting operations.

Issue number:	AO-2019-025-SI-02
Issue owner:	Director of National Parks
Transport function:	Aviation: General aviation
Current issue status:	Open - Safety action pending
Issue status justification:	Engaging an aviation specialist in task design has negated the immediate risk. The DNP has developed a path and committed to the necessary steps to make proactive risk management a well-supported function in planning and developing aviation activities. This safety action will be reviewed in December 2021 or sooner if advised as completed.

Proactive safety action by the Director of National Parks

Action number:	AO-2019-025-NSA-039
Action organisation:	Director of National Parks
Action status:	Monitor

In January 2021, the Director of National Parks (DNP) advised of the following safety action:

> The DNP has undertaken a range of actions to address safety issues relating to managing risks associated with aerial culling operations. In particular, the DNP has undertaken a specialist aviation safety review into its aerial culling operation risk assessment and aviation activity services contracts, resulting in:
>
> - the overarching and continuing suspension of aerial culling operations pending the outcome of all related reviews;
> - a new requirement for DNP-level approval of any future aerial culling operations; and
> - recruitment of specialist staff to KNP to deliver work health and safety (WHS) and training solutions and improvements with a focus on high-risk activities including aerial culling operations.
>
> Helpfully informed by the ATSB's review, next steps are underway and will include:
>
> - continued review of the DNP's risk management policy (and the broad interactions with departmental and Commonwealth risk management frameworks) to address findings and recommendations in relation to the incident;
> - finalisation of a revised risk profile and risk assessment which addresses key risk areas prior to undertaking any future aerial culling operation;
> - completion of an updated suite of documentation and training specific to aerial culling operations extending to operating procedures, compliance, essential qualifications, planning and approvals; and
> - improvements to procurement and contract management processes for aviation activities including for aerial culling operations.
>
> At a local KNP [Kakadu National Park] level, the DNP has also…
>
> - undertaken a KNP-focused risk workshop and planned supplementary staff workshops/training in risk planning and mitigation to enable staff and managers to confidently and effectively plan for aerial activities.

Aerial platform shooter emergency training

Safety issue description

Recurrency training and drills in aircraft emergencies were not required for reissue of an aerial platform shooting permission. Some shooters last conducted training about 20 years prior, during initial issue of their permissions.

Issue number:	AO-2019-025-SI-03
Issue owner:	Civil Aviation Safety Authority
Transport function:	Aviation: General aviation
Current issue status:	Open - Safety action pending
Issue status justification:	The ATSB is satisfied that the proposed changes to be made on 2 December 2021 will reduce the risk of this safety issue. As this is a regulatory change, the time frame is recognised and this safety action will be reviewed in December 2021.

Proactive safety action taken by the Civil Aviation Safety Authority

Action number:	AO-2019-025-NSA-040
Action organisation:	Civil Aviation Safety Authority
Action status:	Monitor

In January 2021, the Civil Aviation Safety Authority (CASA) advised that the new Civil Aviation Safety Regulations Part 138 – Aerial work operations would commence on 2 December 2021. Part 138 will require that, where an aerial work operator carries a task specialist, the operator's operations manual will need to describe how it trains that person to ensure that they are competent in carrying out the normal, abnormal, and emergency procedures relevant to the task specialist role. The operator will also need to describe who will conduct the training of the task specialist and what the minimum qualifications are, for a person to fulfil the role of a task specialist trainer.

CASA also advised that section 25.02(1) of the of the Part 138 Manual of Standards will require:

> For subregulation 138.580 (3), the operator must ensure that, before performing unsupervised duties on a flight (the relevant duties), a task specialist is competent in carrying out the operator's normal, abnormal and emergency procedures for the aircraft and the operation that are relevant to the task specialist's duties for the flight (the relevant procedures).

Harness instrument clarity

Safety issue description

A harness instrument, commonly issued by the Civil Aviation Safety Authority (CASA), stated that a harness could be used instead of a seatbelt for take-off and landing. Although not intended by CASA, this instrument was easily able to be misinterpreted as indicating that a seatbelt was not required to be used during take-off and landing.

Issue number:	AO-2019-025-SI-04
Issue owner:	Civil Aviation Safety Authority
Transport function:	Aviation: General aviation
Current issue status:	Open - Safety action pending
Issue status justification:	The ATSB is satisfied that the proposed changes to be made on 02 December 2021 will reduce the risk of this safety issue. As this is a regulatory change, the time frame is recognised and this safety action will be reviewed in December 2021.

Proactive safety action taken by the Civil Aviation Safety Authority

Action number:	AO-2019-025-NSA-041
Action organisation:	Civil Aviation Safety Authority
Action status:	Monitor

In January 2021, the Civil Aviation Safety Authority (CASA) advised that regulatory provisions for use of seatbelts and other restraint devices such as safety harnesses for aerial work operations will be covered by the new Civil Aviation Safety Regulations Part 138 – Aerial work operations from 2 December 2021. CASR 138 will replace all individual harness instruments with a national standard.

Relevantly, section 14.03 of the Part 138 Manual of Standards will require that the harness is fit for the particular purpose of the operation and the crew member must have been trained in its use and assessed as competent before the flight.

Crew risk awareness

Safety issue description

Although required by the harness instrument commonly issued by the Civil Aviation Safety Authority, the operator did not appraise shooting crews of the risks of using only a harness for restraint during low-level flight.

Issue number:	AO-2019-025-SI-05
Issue owner:	Jayrow Helicopters
Transport function:	Aviation: General aviation
Current issue status:	Closed
Issue status justification:	The advised changes will ensure participants are aware of the risks of using a harness at low level. This will enable crew to make decisions around their safety with full knowledge of the risks they face.

Proactive safety action by Jayrow Helicopters

Action number:	AO-2019-025-NSA-042
Action organisation:	Jayrow Helicopters
Action status:	Closed

In January 2021, the operator advised:

> Jayrow will be making crews aware of the increased risk of wearing a harness instead of a seatbelt as part of the flight crew briefing. JMS Volume 4 Part D Section 19 Crewman Harness Procedures will be updated to highlight the increased risk. Forms JR122 Harness Checklist and JR145 Passenger Briefing and Permission to Land will be amended to include a statement to this effect.

The operator provided copies of the relevant amendments.

Safety action not associated with an identified safety issue

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. All of the directly involved parties are invited to provide submissions to this draft report. As part of that process, each organisation is asked to communicate what safety actions, if any, they have carried out to reduce the risk associated with this type of occurrences in the future. The ATSB has so far been advised of the following proactive safety action in response to this occurrence.

Additional safety action by Jayrow Helicopters

Following inspection of VH-FHW on site, the helicopter operator:

- immediately actioned a fleet wide check and retorque of engine flexible and rigid oil, air and fuel lines/hoses/pipes attachments
- improved procedures for use of third party harnesses aboard company aircraft
- outsourced human factors training for engineers which expanded quality and content of the training.

Additional safety action by Director of National Parks

Following the accident, the Director of National Parks immediately suspended aerial culling activity.

In January 2021, the DNP advised of the following safety actions:

- upgraded handheld radios with higher wattage, providing improved communications channels through broader broadcast range for staff undertaking aviation activities. The use of these radios is prioritised for staff undertaking remote work…

As part of their broader commitment to ensuring safety in aviation activities, the DNP and department have also established a program of work relating to aviation activity risk management and mitigation. This includes:

- establishing an updated enterprise WHS Information System (WHSIS), with the planned implementation of incident reporting and hazard modules to occur in early 2021. The WHSIS will assist with recording and managing risks and hazards in relation to high-risk operational activities including aviation activity risks
- infrastructure investment in the KNP radio and telecommunications network. For example, a total of $7 million has been committed to a new tower network within KNP and planning for those infrastructure upgrades is underway; and procurement of additional handheld radios and personal tracking/emergency call devices for staff working on the park
- establishment of a Departmental Focus Group, being a group comprised of operational staff/business areas undertaking aviation activities (including aerial culling operations) and WHS/risk and business continuity specialists to take a collaborative approach to addressing WHS critical risks and controls across the portfolio. The group is planned to commence operating in February 2021.

General details

Occurrence details

Date and time:	21 May 2019 - 0957 CST	
Occurrence category:	Accident	
Primary occurrence type:	Engine failure or malfunction	
Location:	107km at 215º from Jabiru, Northern Territory	
	Latitude: S13° 26.78’	Longitude: E132° 19.29'

Aircraft details

Manufacturer and model:	Bell Helicopter Company 206B (III) JetRanger	
Registration:	VH-FHW	
Operator:	Jayrow Helicopters	
Serial number:	2838	
Type of operation:	Aerial work	
Activity:	Other agricultural	
Departure:	Mary River Ranger Station, NT	
Destination:	Mary River Ranger Station, NT	
Persons on board:	Crew – 3	Passengers – nil
Injuries:	Crew – 3 serious	Passengers – nil
Aircraft damage:	Destroyed	

Sources and submissions

Sources of information

The sources of information during the investigation included the:

- pilot of the accident flight
- pilots and Head of Flight Operations of the aircraft operator
- engineers of the approved maintenance organisation
- aerial culling crew on board the helicopter and other Parks Australia personnel
- Civil Aviation Safety Authority
- engine manufacturer
- crew restraint harness manufacturer
- aerial platform shooting subject matter experts
- Northern Territory Police
- recorded data from the GPS unit on the aircraft.

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Submissions

Under section 26 of the *Transport Safety Investigation Act 2003*, the ATSB may provide a draft report, on a confidential basis, to any person whom the ATSB considers appropriate. That section allows a person receiving a draft report to make submissions to the ATSB about the draft report.

A draft of this report was provided to the following directly involved parties:

- pilot of the accident aircraft
- aerial culling crew on board the helicopter

- helicopter operator
- approved maintenance organisation
- engine manufacturer
- Director of National Parks
- Civil Aviation Safety Authority.

Submissions were received from the:

- helicopter operator
- Director of National Parks
- Civil Aviation Safety Authority.

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

Australian Transport Safety Bureau

About the ATSB

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

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

- independent investigation of transport accidents and other safety occurrences
- safety data recording, analysis and research
- fostering safety awareness, knowledge and action.

The ATSB is responsible for investigating accidents and other transport safety matters involving civil aviation, marine and rail operations in Australia, as well as participating in overseas investigations involving Australian-registered aircraft and ships. It prioritises investigations that have the potential to deliver the greatest public benefit through improvements to transport safety.

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

Purpose of safety investigations

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

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

It is not a function of the ATSB to apportion blame or provide a means for determining liability. At the same time, an investigation report must include factual material of sufficient weight to support the analysis and findings. At all times the ATSB endeavours to balance the use of material that could imply adverse comment with the need to properly explain what happened, and why, in a fair and unbiased manner. The ATSB does not investigate for the purpose of taking administrative, regulatory or criminal action.

Terminology

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