Australian Government
Australian Transport Safety Bureau

Weather event and collision with terrain involving Robinson R22, VH-KZV

125 km east-north-east of Alice Springs Airport, Northern Territory, on 24 November 2018

ATSB Transport Safety Report
Aviation Occurrence Investigation
AO-2018-077
Final – 21 May 2020

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

Publishing information

Published by: Australian Transport Safety Bureau
Postal address: PO Box 967, Civic Square ACT 2608
Office: 62 Northbourne Avenue Canberra, Australian Capital Territory 2601
Telephone: 1800 020 616, from overseas +61 2 6257 2463 (24 hours)
Accident and incident notification: 1800 011 034 (24 hours)
Email: atsbinfo@atsb.gov.au
Internet: www.atsb.gov.au

Addendum

Page	Change	Date

Safety summary

What happened

On the morning of 24 November 2018, the pilot and passenger of a Robinson R22 helicopter, registered VH-KZV, were tasked to assist with the recovery of a motor vehicle near Quartz Hill, located about 63 km east-north-east of Ambalindum Station (departure point), Northern Territory. They were also intending to visit some water bore sites.

After departing, they landed at one bore site before continuing towards Quartz Hill. Shortly after entering the MacDonnell Ranges, the helicopter collided with terrain on a downslope (125 km east-north-east of Alice Springs Airport). The pilot was fatally injured and the passenger received serious injuries. The helicopter was destroyed.

What the ATSB found

The ATSB found that the collision with terrain was very likely the result of the helicopter encountering a strong downdraft while low flying on the lee side of higher terrain in the MacDonnell Ranges. In addition, the ATSB identified a number of factors of increased risk.

Other factors of increased risk included that it was very likely the helicopter was overloaded and beyond the forward centre-of-gravity limit, which would have reduced the helicopter's power margin and flight control available to the pilot. Secondly, there was moderate turbulence forecast at the time of the accident and the pilot did not check the weather forecast prior to departure. Thirdly, the pilot had an elevated level of alcohol in his system, which was capable of impairing his performance, and increased the likelihood of risk-taking behaviour and mishandling the helicopter in an emergency. Lastly, the helicopter's emergency locator transmitter was selected 'OFF', disabling the automatic crash-activation of an emergency signal.

Safety message

It is important for all pilots to understand that flight planning and prescribed operating limits are safety barriers designed to provide a reasonable margin of safety. Thorough pre-flight planning is essential for avoiding hazardous weather conditions. It is not only important to obtain the relevant weather information to develop a mental picture of the conditions that may be encountered, but also to assess and understand how it relates to the planned flight.

Further, as the helicopter weight and balance has the potential to influence the handling characteristics, it is critical that the loading remains within the prescribed operating limits for the entire flight. Otherwise, as the safety margin steadily erodes, even an experienced pilot may not be able to recover from a rapidly developing unsafe condition.

At low altitude, there is a lower margin for error due to obstacle avoidance. Recognising the risks and hazards of low-level flying, it should be avoided when there is no operational requirement, even if a pilot has been trained and approved to conduct low-level operations. Further information is available from the ATSB publication: *Avoidable Accidents No. 1 – Low-level flying*.

This accident is also a reminder that blood-alcohol can persist the day after significant alcohol consumption, and the residual effects of alcohol may impair performance, especially in demanding situations.

Contents

The occurrence

On the morning of 24 November 2018, the pilot and passenger of a Robinson R22 helicopter, registered VH-KZV, were tasked to assist with the recovery of a motor vehicle near Quartz Hill, located about 63 km east-north-east of Ambalindum Station (departure point), Northern Territory. The pilot was employed by the Ambalindum cattle station for general flying duties, which included cattle mustering and inspecting water bore sites. As such, the pilot was also intending to visit some water bore sites.[1]

At about 0715 Central Standard Time,[2] the pilot refuelled the helicopter with the remaining contents of a fuel drum. A station-hand assisted with preparing the helicopter for departure, which included providing the pilot and passenger with a 20 L drum filled with diesel fuel. The station-hand reported that this was stored at the passenger's feet (tail rotor pedals position). He also reported that the weather appeared to be fine for the departure.

At 0732, the pilot's global positioning system device was powered on while the helicopter was on the concrete helipad in front of the station homestead's facilities. At 0737, the helicopter departed from the helipad and conducted an air transit to the worker's accommodation block. The helicopter was on the ground next to the accommodation for 2.5 minutes before it departed from Ambalindum Station. The helicopter flew on a direct track at a height of between 500 and 1,000 ft across relatively open and flat terrain to a bore site, which was located near the boundary of the more rugged terrain of the MacDonnell Ranges.

The pilot and passenger stopped at the bore site[3] for 2 minutes and departed at 0753:50. On departure, the helicopter was levelled off at about 150 ft above ground level, which was below the peaks of the surrounding terrain as it tracked into the MacDonnell Ranges. The last recorded data point was at 0756:30, at which time the helicopter was about 142 ft above ground level with a ground speed of 79 kt. About 56 seconds later (based on the ground speed), the helicopter collided with terrain.

The passenger could not recall any details of the flight, but remembered activating the pilot's Spot Tracker[4] device after the accident. At 0811, it transmitted its location in SOS mode. A helicopter company in Alice Springs was tasked by the Australian Maritime Safety Authority's Joint Rescue Coordination Centre (JRCC) to transport a paramedic to the location and attempt a search and rescue (SAR). Ambalindum Station, which was also notified of the activation of the Spot Tracker device, dispatched two employees, the general manager and a station-hand, by road to investigate.

The SAR pilot located the helicopter wreckage at the reported location (Figure 1) and dropped the paramedic nearby to attend to the accident pilot and passenger. The SAR pilot then ferried the two station employees to the accident site. At about 1040, the paramedic found the pilot fatally injured and the passenger seriously injured. The SAR pilot and paramedic, with the assistance of the station employees, retrieved the passenger and transported him to Ambalindum Station for treatment by a retrieval doctor, before moving him to Alice Springs Hospital for further medical attention. The helicopter was destroyed.

1 The station bore water pumps were a mixture of solar powered and diesel.
2 Central Standard Time (CST): Coordinated Universal Time (UTC) + 9.5 hours.
3 Solar powered site.
4 Spot Tracker is a global positioning system tracking device that uses the satellite network to provide text messaging and tracking.

Figure 1: Accident site main wreckage

Source: ATSB

Context

Pilot information

General details

The pilot was issued with a Private Pilot Licence (Helicopter) on 10 June 2014 with an endorsement for the Robinson R22 helicopter (R22) under the *Civil Aviation Regulations 1988* Part 5 (CAR 5) licencing system. He held a Class 2 aviation medical certificate with an expiration date of 2 February 2020, with the restriction of 'Reading Correction to be available whilst exercising the privileges of his licence'. His last flight review was completed in February 2018.

On his employment application letter to Ambalindum Station in January 2018, the pilot reported having a total flying experience of 10,000 hours in gyrocopters, 350 hours in the (amateur-built) Cicaré CH-7 helicopter and 800 hours in the R22. At the time of his last medical examination in February 2018, he reported having accrued 800 flying hours. The pilot's personal diary indicated he had accumulated about 470.5 hours in his current job, which suggested he had about 1,270 hours in the R22.

Validity of qualifications

On 1 September 2014, the *Civil Aviation Safety Regulations 1998*, Part 61 pilot licencing system was introduced to replace the CAR 5 system. Part 61 included licencing, ratings and endorsements, and provided pilots with a 4-year period to transfer a CAR 5 licence to a Part 61 licence. In the period 27–29 October 2014, the pilot received low-level and aerial mustering flying training, with an endorsement made by the approved training officer in the pilot's log book and on a copy of Appendix II to Civil Aviation Order (CAO) 29.10 (2006): *Air service operations – aircraft engaged in aerial stock mustering operations – low flying permission*.

On 3 December 2014, the Civil Aviation Safety Authority (CASA) issued the pilot with an approval to conduct aerial stock mustering operations in helicopters under CAO 29.10 subparagraph 6(a). However, subsection 6 of this order was amended on 1 September 2014 by *Civil Aviation Order (Flight Crew Licencing) Repeal and Amendment Instrument 2014 (No. 1)*. The amendment stated that 'A pilot must not engage in aerial mustering operation unless the pilot is authorised under Part 61 of the Civil Aviation Safety Regulations 1998 to conduct an aerial mustering operation in that kind of aircraft'. Therefore, an approval under CAO 29.10 could no longer be granted. The equivalent authorisation under Part 61 was a low-level rating and mustering endorsement, in accordance with the Part 61 *Manual of standards*.

During the transition period, the pilot made an application for a Part 61 licence, but with evidence of a mustering endorsement conducted after 1 September 2014 in accordance with CAO 29.10, rather than the Part 61 *Manual of standards*. Therefore, his Part 61 licence was not issued and he was advised by CASA to resubmit his application with completed forms 61-2I: *Notification of issue of CASR Part 61 Operational Rating*, and 61-1507: *Low-level rating flight test*. Completed copies of these forms were required to provide evidence that his CAO 29.10 training complied with the Part 61 *Manual of standards* requirements for a low-level rating and mustering endorsement. However, CASA did not receive a copy of these forms and never issued the pilot with a Part 61 licence. The pilot was required to hold a Part 61 licence from 1 September 2018 for his licence to be valid.

72-hour history

The pilot's diary indicated that the accident occurred on his third day of work after 5 days leave. There were no flying hours recorded 2 days prior to the accident, but there was an entry of 'Chopper going…4 hours' the day prior to the accident, which suggested this was flight time. There was no indication from his diary or from his colleagues that he was working excessive hours in the week prior to the accident.

The evening prior to the accident, the pilot and station-hands had a ‘few’ alcoholic drinks before and after dinner, and then retired to their private rooms. The evening drinks were reported to be a normal habit and that nothing unusual occurred.

Helicopter information

General description

The helicopter was a two-seat Robinson R22 Beta 2 powered by a Textron Lycoming 4-cylinder O-360-J2A engine. It was manufactured in the United States in January 2010 and registered in Australia in February 2010. It was acquired by the owners on 2 August 2018.

Drive system

The engine has a V-belt sheave bolted directly to its output shaft. V-belts transmit power to the upper sheave, which has an overrunning clutch contained in its hub. The inner shaft of the clutch transmits power forward to the main gearbox, which drives the main rotors, and aft to the tail gearbox, which drives the tail rotors. Flexible couplings are located at the main gearbox input and at each end of the tail rotor drive shaft.

The V-belts are tensioned for flight after engine start by raising the upper sheave. An electric actuator, located between the drive sheaves, raises the upper sheave when the pilot engages the clutch switch. The actuator senses belt tension and automatically switches off when the V-belts are properly tensioned.

Fuel system

The helicopter was fitted with two fuel tanks, a main and an auxiliary, located behind the main rotor mast. Total usable capacity is 100 L (main – 64 L, auxiliary – 36 L). The auxiliary tank is interconnected with the main tank and with its base elevated relative to the base of the main tank, so that the auxiliary will empty first.

Maintenance

The helicopter was issued with its last maintenance release[5] on 12 October 2018, when it completed its last 100-hourly inspection, with 7,000 hours’ time-in-service. Additional work during the 100-hour inspection included replacing the number 1 cylinder, two tail rotor pitch change levers and re-rigging the main rotor flight controls. The maintenance organisation reported that the helicopter had completed four 100-hourly inspections since the last 2,200-hour major overhaul. The organisation’s licenced aircraft maintenance engineer (LAME) had completed the last two of those four inspections (since it was acquired by the new owners) and indicated that the helicopter was overall in good condition.

On 23 November 2018, the day before the accident, the LAME[6] went to Quartz Hill to replace the electric actuator fitted to the helicopter. The actuator and V-belts were replaced, followed by a cooling fan balance. No maintenance release was provided to record the work, but the pilot reported to the LAME that the helicopter had accumulated about 15 hours since the last 100-hourly inspection. The LAME returned to Alice Springs with the understanding that the pilot would phone that evening with the actual hours, but did not hear from him.

Meteorological information

When transporting the passenger from the accident site to Ambalindum Station, the SAR pilot asked him what happened. Neither the SAR pilot nor the paramedic were certain of the passenger’s reply and the passenger had no recollection of the conversation. However, the

[5] Maintenance release: an official document, issued by an authorised person as described in Regulations, which is required to be carried on an aircraft as an ongoing record of its time in service (TIS) and airworthiness status. Subject to conditions, a maintenance release is valid for a set period, nominally 100 hours TIS or 12 months from issue.

[6] The LAME was also the search and rescue helicopter pilot who responded to the accident the following morning.

paramedic recalled words to the effect that the 'wind lifted them up', that the pilot had said to him (passenger) 'look at this [expletive]', 'and we were lifted up in the air'. The SAR pilot recalled the passenger indicated that the accident pilot had told him they 'better pull-up to get a bit more height/air to make it safer'.

Planning

The station homestead had a local Wi-Fi network, so that the workforce could use their personal electronic devices, and computers located in the office area. The general manager for the company, who was at the station at the time, reported that the office computers were for management staff and not a common access area. The pilot would have been granted access to use them for flight planning purposes, but he had not requested access and the manager was not aware of him ever using them. The ATSB reviewed the pilot's iPad and iPhone. A review of applications and browsing history on the iPad and iPhone found no evidence that either was used to access any aviation-related applications or aviation-related services (such as the Bureau of Meteorology) on either the day of, or day prior, to the accident. However, both were in use in the week of the accident.

Weather forecast

The Bureau of Meteorology graphical area forecasts valid between 0230 and 1430 on 24 November included moderate turbulence below 7,000 ft above mean sea level throughout the area. The aerodrome forecast for Alice Springs Airport[7] (about 125 km east-north-east of the accident site), issued at 0249 and valid from 0330 24 November to 0330 25 November, reported CAVOK[8] conditions, but with a wind of 18 kt, gusting to 28 kt, from 320°. In addition, the remarks included moderate turbulence below 5,000 ft above mean sea level from 0630.

Reported weather conditions

On 24 November, the recorded aerodrome weather report for Alice Springs Airport between 0600 and 0730 indicated a wind direction of 330–340° at about 15 kt. However, at 0758, SPECI[9] conditions were recorded with a wind speed of 18 kt, gusting to 29 kt. The Arltunga weather station, located about 40 km east of the accident site, recorded a wind speed of 14 kt[10] from a direction of 360°, QNH 1015 hPa[11] and a temperature of 30 °C, at 0800.[12] The Ambalindum Station personnel interviewed by the ATSB reported that the weather was fine and clear in the morning at the station.

The SAR pilot reported that engine start in his Bell 206 at Alice Springs Airport was at 0940. He reported that the weather was turbulent all the way out to the accident site, and estimated it was moderate to severe in the ranges with a wind speed of 20 kt, gusting to 40 kt. He reported that, on arrival at the accident site he encountered a strong downdraft at about 100 ft above ground level.

The SAR pilot also stated that he took three approaches to land due to the turbulence at the accident site with the paramedic, but could not remember what occurred when he subsequently ferried the station-hand and general manager into the site. The paramedic recalled only one approach to land, but the station-hand recalled they took three approaches to land, that the helicopter was being thrown around and that the SAR pilot had warned him about downdrafts. The

---

7 Alice Springs Airport has an elevation of 1,789 ft.

8 Ceiling and visibility okay (CAVOK): visibility, cloud and present weather are better than prescribed conditions. For an aerodrome weather report, those conditions are visibility 10 km or more, no significant cloud below 5,000 ft, no cumulonimbus cloud and no other significant weather.

9 A SPECI is a special report of meteorological conditions, issued when one or more elements meet specified criteria significant to aviation. SPECI is also used to identify reports of observations recorded 10 minutes following an improvement (in visibility, weather or cloud) to above SPECI conditions.

10 The wind speed was a 10 minute average and therefore may not represent the maximum wind speed.

11 QNH: the altimeter barometric pressure subscale setting used to indicate the height above mean seal level.

12 The Arltunga weather station provided two observations each day, one at 0800 and the second at 1400.

general manager recalled they took one approach, but was aware that the pilot was concerned about the flying conditions.

The station-hand recalled that, while on the ground at the accident site, he felt the wind tunnelling down the ravine. He reported that it was cycling from ‘nothing, to heavy wind to slight breeze, then nothing’. In consideration of the weather forecast and reports, the ATSB requested analysis from the Bureau of Meteorology for the likelihood of mountain or lee wave activity in the area at the time of the accident.

Bureau of Meteorology analysis

The Bureau of Meteorology reported the following:

> The mean sea level pressure chart for the morning of the accident showed a deep trough and low-pressure system moving into the central and southern parts of the Northern Territory from Western Australia. Conditions ahead of the trough saw moderate to fresh north-east to north-west winds. The synoptic pattern was conducive to moderate turbulence, and, particularly after sunrise, gusty and turbulent flow was anticipated as the stronger winds from aloft mixed to the surface.
>
> At the ridge-top level of the ranges north of Alice Springs, approximately 2,000 ft to 4,000 ft above mean sea level, the winds observed at 0830 on 24 November were 25 kt. The strong north to north-west winds, being perpendicular to the ranges, were conducive to mechanical turbulence, especially in the lee of the ranges. The height of the ridge being over 1,000 ft, and the strength of the winds perpendicular to the ridge being over 25 kt, indicated the necessary requirements for the occurrence of mountain waves.
>
> The aerological diagram showed the wind strength increasing with height above the height of the ridge, as well as instability in the atmosphere above ridge-top level. However, no evidence was found for mountain waves in the cloud patterns observed on the satellite imagery. Therefore, the occurrence of mountain waves remained inconclusive.
>
> The breaking of an inversion layer can also be associated with moderate turbulence. The onset of gusty conditions at Alice Springs Airport at 0758 indicated the overnight inversion would have broken by then, with stronger winds aloft mixing down. Broadscale moderate turbulence was especially likely at that time.

Terrain-induced turbulence

According to the United States Federal Aviation Administration (2016) *Pilot’s handbook of aeronautical knowledge*, ground topography can break up the flow of the wind and create wind gusts that change rapidly in direction and speed. While the wind may flow smoothly up the windward side of higher terrain, on the leeward side it attempts to follow the contour of the terrain and is increasingly turbulent. The stronger the wind, the greater the downward pressure and turbulence. The downdrafts can be severe in valleys due to the effect of the terrain. Hence, it is recommended to avoid flying in this area when strong winds are present or likely to occur. Figure 2 depicts the potential wind conditions on the lee (right) side of terrain.

Figure 2: Potential wind conditions on the lee side of terrain

Source: Federal Aviation Administration (2012)

Recorded information

The ATSB examined the pilot's iPad, iPhone, GoPro camera and GPS devices. There was no evidence that the iPhone was in use at the time of the accident and no location data was available to create a flight path.[13]

Global positioning system data

Data was recovered from the pilot's GPS device. The flight profile on the day before the accident (23 November) revealed the pilot had been flying back-and-forth along a dry riverbed at low-level (below 200 ft) near Quartz Hill. The helicopter then tracked back-and-forth between Quartz Hill and Ambalindum Station. The last sector recorded an arrival time at Ambalindum Station helipad of 1815.

For the accident flight, the first recorded data point was from the helipad at 0732 (Figure 3).[14] After transiting to the workers' accommodation block, the helicopter departed at 0740 for the bore site.

Figure 3: Departure from the homestead

Source: Google earth, annotated by the ATSB

Figure 4 shows that, about 2 minutes after taking off from the bore site, at 0755:46, the helicopter was levelled off at about 150 ft above ground level and then entered the MacDonnell Ranges. The final data point, recorded at 0756:30, was located at a height of about 142 ft, with a ground speed of 79 kt,[15] on a direct track towards the accident site. Based on this ground speed, the ATSB estimated that the time between the last data point and the accident site was 56 seconds.

---

[13] The iPad was located at the pilot's accommodation and the iPhone, GoPro camera and GPS devices were onboard the helicopter.

[14] According to the United States government official GPS website: the government commits to broadcasting the GPS signal in space with a global average user range error of less than or equal to 7.8 m (25.6 ft) with 95 per cent probability. Actual performance exceeds the specification and on 11 May 2016, the global average user range error was less than or equal to 0.715 m (2.3 ft) 95 per cent of the time. At the time of the accident there was a favourable satellite geometry.

[15] This was an average ground speed, based on the distance and time between the point of level-off and the last recorded data point.

Figure 4: GPS track from the bore site to the accident site

Source: Google earth, annotated by the ATSB

GoPro data

The GoPro camera did not hold a recording of the accident flight. However, a total of 69 videos and 25 images were recovered, dated from 1 January 2012 to 15 June 2016. The time and date of the GoPro can be set manually or by Wi-Fi. It could not be determined if the recorded dates were correct, but the files included videos of the accident pilot flying an R22 from a different operator. It was therefore likely that the files were from his previous employment.

The video files showed the pilot engaged in low flying and cattle mustering activities throughout the time period. They included low-level contour flying between mustering tasks, along a river and along a dry riverbed (see Figure 5 example). Mustering videos included manoeuvring the R22 at up to 50° angle of bank with indeterminable pitch changes, coupled with skidding or side-slipping[16] within about 1–2 rotor diameters of the ground.

[16] Skidding pushes the helicopter out of the turn and side-slipping pulls the helicopter into the turn. Side-slipping will generate a rate of descent, and both manoeuvres will generate relative winds from the side of the helicopter, which can lead to a loss of tail rotor effectiveness (Wagtendonk 2011).

Figure 5: Example of low flying in previous employment

Source: ATSB

Wreckage and impact information

Accident site

The accident site was in the MacDonnell Ranges at an elevation of about 1,850 ft, 31 km east of Ambalindum Station. The helicopter impacted the ground on a downslope, in an easterly direction, and continued down the slope. It then came to rest on the far side of the riverbed in a southerly direction, with the left side resting against the upslope of the far bank.

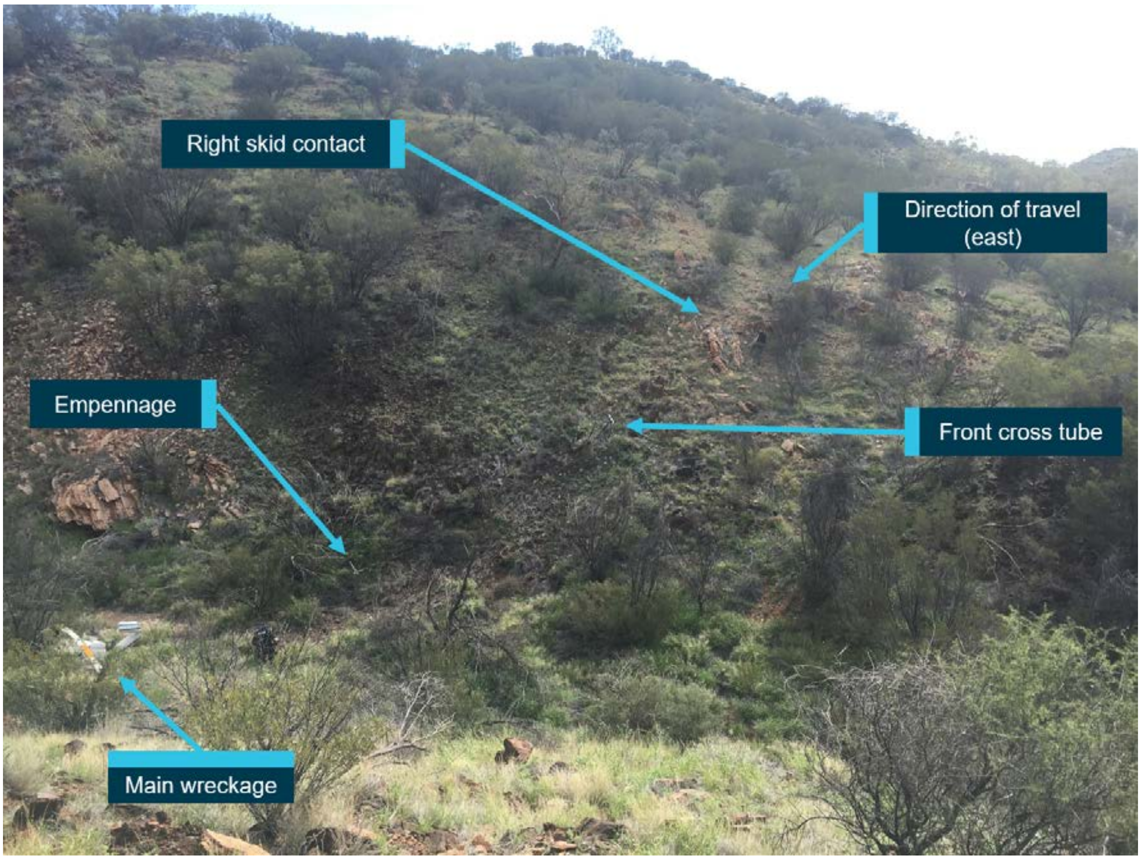
The ATSB noted there was higher terrain, orientated east-west, immediately to the north of the initial point of impact. This was the reported direction for the prevailing wind at the time of the accident.

Impact sequence

The impact sequence started with the main rotor severing the upper branches of a small tree, indicating 10–15° right bank, before the tail stinger struck a rock and was separated from the tailcone. A tail rotor blade then separated after impacting a tree branch at about the same time as the right skid contacted the ground adjacent to protruding rocks (Figure 6), which were struck by the underside of the helicopter. About half way down the slope the helicopter passed through a tree, which fragmented the cabin plexiglass and removed the front landing skid cross-tube.

Just prior to crossing the riverbed, the main rotor disc struck and separated the tail rotor driveshaft and empennage from the airframe. The empennage was located just prior to crossing the riverbed, to the right of the accident path. The driveshaft was found on the far side of the riverbed to the right of the accident path and beyond the main wreckage.

Figure 6: Impact sequence



Source: Alice Springs Helicopters, annotated by the ATSB

Wreckage examination

The helicopter's clock had stopped at about 0756 and the engine hour-meter indicated 6,893.36 hours. The helicopter was fitted with an impact activated emergency locator transmitter (ELT), which was found selected to the 'OFF' position.[17] In addition to the pilot and passenger, the helicopter was loaded with:

- a double-barrelled shotgun and bolt action rifle with ammunition
- two six-packs of beer (no evidence that any were consumed)
- empty 20 L drum (perforated, but strong diesel fuel odour)
- empty 10 L water container (used for testing water flow rate at bore sites)
- bore test equipment (data logger)
- two webbing straps and a bag of lifting equipment
- between one-third and two-thirds fuel contents in the main fuel tank and unusable fuel in the auxiliary fuel tank.[18]

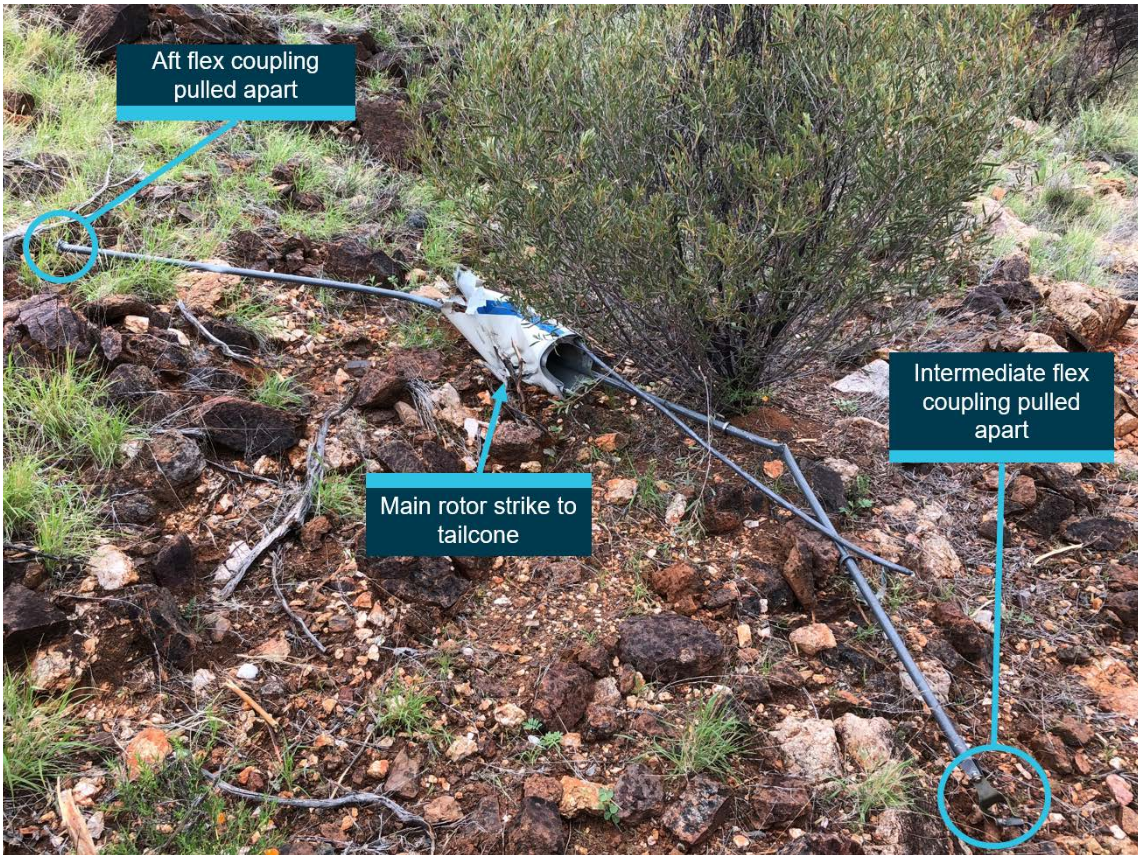
The ATSB found no pre-existing defects with the rotors, drivetrain or flight controls, which would have prevented normal operation. The tail rotor driveshaft was folded by the main rotor strike. It was also noted to have been pulled apart at the intermediate and aft flex couplings (Figure 7). This indicated a loss of energy from the main rotor system occurred at some time prior to the main

[17] The beacon had a 3-position toggle switch – OFF, ARM and ON. In the OFF position it must be manually activated and in the ARM position it is impact-activated.

[18] The resting position of the helicopter likely resulted in any fuel inside the auxiliary tank draining into the main fuel tank.

rotor striking the tailcone.[19] A fuel test on-site and at the point of departure did not identify any visual contaminates or water.

Figure 7: Tail rotor driveshaft



Source: ATSB

The engine and a majority of the airframe was retrieved from the accident site and transported to Alice Springs Airport where further inspections of the drivetrain and engine components were performed. No pre-existing defects were found to prevent normal operation. The engine was then removed from the wreckage and transported to Brisbane for further examination under the supervision of the ATSB.

Engine tests and inspections

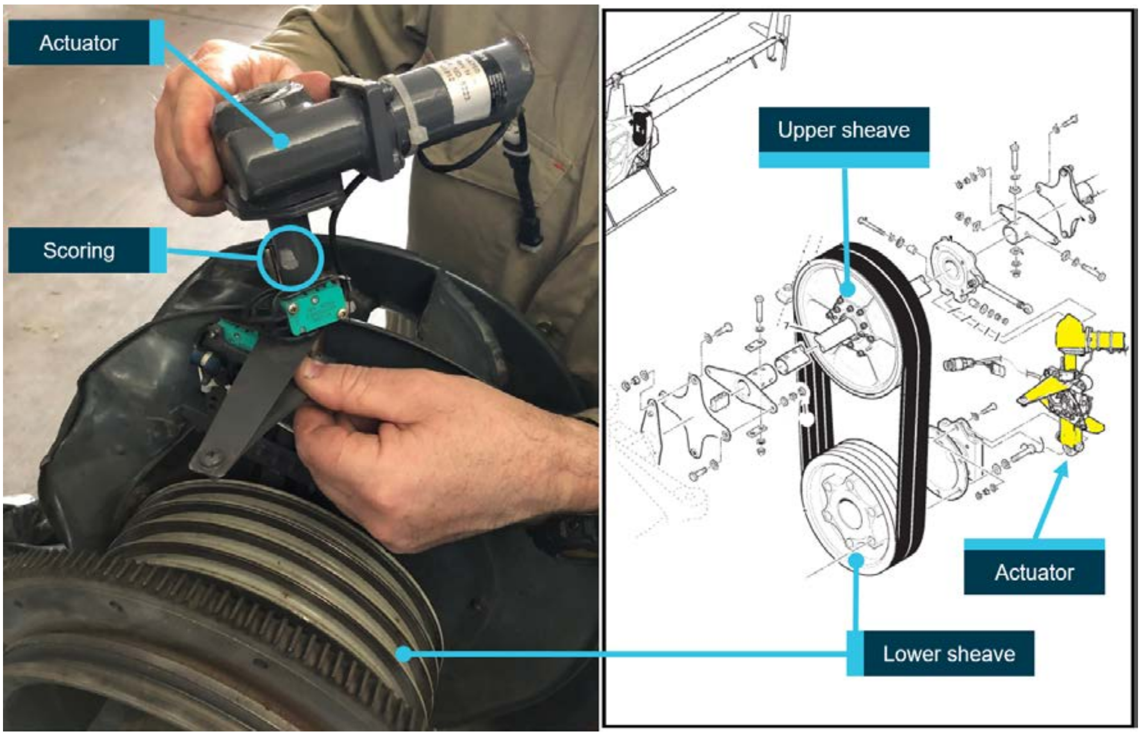
On 8 and 9 January 2019, tests and inspections were conducted on the recovered engine. No fault was identified that would have prevented normal operation of the engine. Damage to the engine-cooling fan and the presence of dirt inside the number 2 cylinder indicated the engine was operating at the time of initial impact.

The V-belts were found intact and scoring damage to the V-belt actuator was identified. Robinson advised the ATSB that the length of the actuator indicated it was extended in the normal position for flight and that the scoring was consistent with the upper sheave rotating on contact with the actuator as the helicopter's structure distorted on impact (Figure 8). This indicated that the engine was driving the V-belts and upper sheave at impact.

---

[19] Refer to ATSB investigation AO-2016-156: *In-flight break-up involving Robinson R44, VH-ZNZ, 41 km NW Mossman, Qld, 18 November 2016*, section *Wreckage and impact information: Tailcone and tail rotor system*.

Figure 8: Scoring to the clutch actuator



Source: ATSB

The lower third section of the engine-cooling fan exhibited ‘gathering’ of metal in the direction of fan rotation. This suggested that the engine was producing power at the time of impact. The exhaust was crushed and the carburettor throttle arm bent, resulting in the throttle butterfly valve being forced towards the full closed position. It was concluded that the damage to the engine components likely resulted in engine stoppage shortly after the initial ground impact.

Medical and pathological information

A post-mortem examination was conducted on the pilot at Royal Darwin Hospital. The forensic pathologist concluded that the pilot received multiple injuries, sustained during the impact sequence, which resulted in his fatality. A sample of bloodstained chest cavity fluid and urine contents were submitted for toxicological analysis.

The pilot’s toxicology results included 0.20 per cent alcohol detected in the bloodstained chest cavity fluid and 0.14 per cent alcohol detected in the urine. The forensic pathologist confirmed that the bladder was intact, but that fermentation with microbiologically generated alcohol might be an issue as decomposition had started.[20] Therefore, he advised seeking assistance from a subject matter expert for interpretation of the alcohol results. The ATSB consulted with the forensic scientist who conducted the toxicology, and engaged a forensic and aviation pathology consultant.

The forensic scientist reported that during their routine screen of the chest cavity fluid, they noted the presence of a number of compounds that are typically indicative of decomposition. She reported that alcohol can be produced during decomposition, ‘however the high alcohol levels observed for this case (especially in the urine, which is typically less prone to post-mortem alcohol production) don’t appear to suggest extensive post-mortem production of alcohol’.

The consultant reviewed the material, including the correspondence with the forensic pathologist and forensic scientist, and provided an interpretation for the alcohol results. She reported that, for

[20] Blood samples alone do not allow a distinction to be made between alcohol ingestion and post-mortem alcohol production secondary to putrefaction. Samples from effectively sterile areas such as the vitreous humour of the eye, as well as urine, are important in determining the source of any alcohol detected (Newman 2004).

the bloodstained chest cavity fluid, ‘the possibility that some of this level is not the result of ethanol [alcohol] ingestion prior to death but the result of decomposition changes in the blood occurring after death, exists. It is however, still a significant level… Urine is less susceptible to the effects of decomposition than blood and chest fluid, particularly in the absence of injury [intact bladder] suggesting that the finding is a significant indicator of ingested alcohol’.

According to the consultant, blood alcohol levels greater than 0.05 per cent have the effect of lowering caution, worsening of judgement and reasoning. Higher levels of around 0.1 per cent may affect these more and impair coordination and reaction time. Blood alcohol levels generally decrease at a rate of 0.01 per cent per hour. If the pilot was drinking heavily the evening prior to the accident flight, his blood alcohol level could still have been elevated during the flight such as to affect his piloting performance. It is possible that heavy drinkers may develop some tolerance to the effects of alcohol.

The consultant concluded that the time required to retrieve the pilot resulted in sub-optimal collection of specimens on which to perform the analysis. Both samples showed the presence of considerable amounts of alcohol, but the precise level of blood alcohol could not be ascertained. However, given the measured levels and degree of decomposition [early stages], ‘it is highly likely that alcohol was present in blood at a level capable of impairing pilot performance’.

Survival aspects

The accident occurred at about 0757 at a remote location. The main rotor tree strike, and ground impact marks, suggested the initial impact was in a relatively level attitude and survivable. However, about half way downslope, the helicopter passed through a tree, resulting in the fragmentation of the plexiglass and separation of the landing skid front cross-tube from the airframe, which compromised the liveable space of the cabin. This exposed the pilot and passenger to multiple injuries as the helicopter continued on its trajectory over rocky terrain and across a dry riverbed, before coming to rest upslope on the far side.

The pilot and passenger seats were both fitted with lap and shoulder restraints (three-point lap-sash seatbelts). The seat harnesses were found in various conditions. The pilot’s shoulder harness was cut away by first responders and his lap belt was found unbuckled. The passenger’s lap strap had completely pulled through its clasp, leaving the clasp inside the buckle without a strap attached. The occupants were not wearing helmets and both were found with head injuries.

Emergency locator transmitter

The helicopter was fitted with an ELT in the transmission bay area, above the horizontal firewall. The ELT had a protected 3-position toggle switch. The three selections were OFF, ARM and ON. The ELT was found by the ATSB to be in the OFF position. Therefore, it could only be activated by an individual accessing the device and selecting it to the ON position. The passenger reported that he was intermittently conscious following the accident and that the pilot did not regain consciousness.

In the ARM position, the ELT will automatically activate if the deceleration is sufficient in magnitude and direction. The examination of the accident site did not indicate that the helicopter was subject to either a high vertical or horizontal deceleration. In 2013, the ATSB published a review of the effectiveness of ELTs in aviation accidents, and found that even in a high deceleration impact they only activated 40–60 per cent of the time in the ARM mode.

Search and rescue sequence

Ambalindum Station staff were provided with a Spot Tracker device. The Spot Tracker is a personal tracking device, which sends a GPS location signal at a set time interval. In addition to the routine signal, the device has a button for an SOS signal to provide an alert for emergency assistance. The pilot was carrying his device on the flight, but the passenger was not. The passenger could not recall why he did not have his device. However, at about 0811, the passenger was able to activate the pilot's Spot Tracker in SOS mode.

The Spot Tracker service contacted the station owners and the JRCC. The SAR pilot was contacted by the station owners and then by the JRCC who also activated the paramedic. The paramedic met the SAR pilot at their Alice Springs Airport hangar.

The SAR pilot achieved engine start at 0940, and the paramedic arrived at the scene of the accident at about 1040, while the SAR pilot was ferrying the station personnel to the site.

The station-hand and general manager were left at the site while the pilot ferried the paramedic and passenger to Ambalindum Station, where a trauma doctor was waiting. Weather storm cells started to develop after arrival at Ambalindum Station and at 1350, the SAR pilot ferried the trauma doctor with the passenger to Alice Springs. His triage at Alice Springs Hospital was recorded as occurring at 1500.

Helicopter performance

The ATSB used the Arltunga weather station to calculate the accident site pressure altitude and density altitude, which were 1,796 ft and 4,000 ft respectively. According to the R22 *Pilot's operating handbook* (POH), the helicopter was capable of producing at least maximum continuous power, and likely take-off power, under these conditions.

Weight and balance

The published maximum all-up-weight limit for the R22 was 622 kg.[21] However, there was no record of how much fuel was on board at departure and the fuel contents at the accident site was based on visual estimates. Therefore, the ATSB calculated the weight and balance progressively from full main tank contents to empty main tank contents. The calculations included the pilot and passenger's weights, 20 L of diesel fuel at the passenger's tail rotor pedals position, and 20 kg for the additional articles.

The results provided in Table 1 indicated that at full main tank fuel, the helicopter's operating weight was above the limit for maximum all-up-weight, and the centre-of-gravity ('Arm') was beyond the forward limit. At the reduced fuel load of 1/3–2/3 main tank fuel observed at the accident site, the helicopter's operating weight was still above the maximum all-up-weight and the centre-of-gravity was further forward of the forward limit.

A negative weight margin indicates a higher weight than the maximum all-up-weight, and a negative arm indicates a centre-of-gravity position forward of the forward limit. The range of the centre-of-gravity was 160 mm from the aft limit to the forward limit.

Table 1: Weight and balance

Main tank contents	All-up-weight (kg)	Weight margin (kg)	Arm (mm)
Full	659	-37	-37.7
Two-thirds	643	-21	-46.2
One-third	626	-4	-48.2
Empty	613	9	-55.9

The high all-up-weight of the helicopter would result in a high power requirement under normal flight conditions. This would have reduced the power margin available for contingency situations, such as an emergency climb. As stated in the United States Federal Aviation Administration

21 Weight limitations are necessary to guarantee the structural integrity of the helicopter and enable pilots to predict helicopter performance accurately. Higher all-up-weights increase the power required for flight (FAA 2012; Wagtendonk 2011).

(2012) *Helicopter flying handbook* 'Excessive weight reduces the flight performance in almost every respect'.

Robinson had published a caution in the R22 POH for loading the helicopter near the forward centre-of-gravity limit, as follows:

> **CAUTION:** Fuel burn causes the CG [centre-of-gravity] to move forward during flight. Always determine safe loading with empty fuel as well as with takeoff fuel. Payload may be limited by forward CG as fuel is burned.

The caution provided by Robinson was consistent with the advice published by the United States Federal Aviation Administration in their *Helicopter flying handbook*, which provided the following information for a centre-of-gravity forward of the forward limit:

> A forward CG may occur when a heavy pilot and passenger take off without baggage or proper ballast located aft of the rotor mast. This situation becomes worse if the fuel tanks are located aft of the rotor mast because as fuel burns the CG continues to shift forward.

The handbook further indicated that the position of the centre of gravity will influence the handling characteristics of the helicopter. The fuselage acts as a pendulum suspended from the rotor, and when the centre of gravity is directly under the rotor mast, the fuselage should remain horizontal. If the centre of gravity is beyond the forward limit, the nose of the helicopter will tilt down. Consequently, a pilot would have to apply aft cyclic control to raise the nose and balance the helicopter. However, as fuel is consumed and the centre of gravity continues to move forward, a pilot could rapidly lose rearward cyclic control. In this condition:

> A pilot may also find it impossible to decelerate sufficiently to bring the helicopter to a stop. In the event of engine failure and the resulting autorotation, there may not be enough cyclic control to flare properly for the landing.

The GPS data indicated the pilot flew the approach and departure to the bore site, just prior to the accident, in a northerly direction, which was into wind. In a headwind, the forward centre-of-gravity may be less noticeable to the pilot as the cyclic is displaced forward of the nil wind position, thereby providing a greater aft cyclic range than in a nil wind or tail wind condition.

Strong winds and turbulence

Robinson has published a safety notice (SN-32) in the R22 POH on the subject of flight in strong winds or turbulence.[22] The safety notice included the following information:

> Flying in high winds and turbulence should be avoided. If turbulence is encountered, the following procedures are recommended:
>
> 1. Reduce power and use a slower than normal cruise speed. Mast bumping is less likely at lower airspeeds.
> 2. For significant turbulence, reduce airspeed to 60–70 knots.
> 3. Tighten seat belt and rest right forearm on right leg to minimize unintentional control inputs. Some pilots may choose to apply a small amount of cyclic friction to further minimize unintentional inputs.
> 4. Do not overcontrol. Allow aircraft to go with the turbulence, then restore level flight with smooth, gentle control inputs. Momentary airspeed, heading, altitude, and RPM excursions are to be expected.
> 5. Avoid flying on the downwind side of hills, ridges, or tall buildings where turbulence will likely be most severe.

[22] In addition to SN-32, the R22 POH had an airworthiness directive (FAA AD 95-26-04) to prohibit flight for low experience pilots when the surface wind exceeds 25 kt, or continued flight in moderate turbulence. However, the accident pilot's experience exceeded the requirements and therefore these restrictions were not applicable.

Employment of the pilot

In early 2018, the pilot was employed by Hewitt Cattle Australia, the owners of Ambalindum Station and the accident helicopter, in accordance with their recruitment process. This included the pilot's submission of a résumé with referee details and relevant aviation qualification documents. The documents included a copy of his CAR 5 private pilot licence, dated 10 June 2014, and a copy of his CAO 29.10 Appendix II and log book endorsements for low flying and mustering training, dated 29 October 2015. It was agreed that the pilot's completion of a flight review would satisfy the employer's requirements.

The pilot's application was vetted by his prospective employer and their insurance company. This included a check of his log book to verify he had completed the flight review as agreed. Although the pilot did not hold a commercial licence, CASA confirmed that aerial mustering may be conducted as a private operation over land occupied by the owner of the aircraft with the appropriate licence, rating and endorsement.

At the time, the pilot submitted his documents to his prospective employer, his CAR 5 licence was still valid and there was about 7 months remaining until the end of the transition period to the Part 61 licence. It was considered unlikely that the discrepancy associated with his low flying and mustering training would have been identified by anyone who did not have an intimate knowledge of the Part 61 licencing system.

Safety analysis

Introduction

While flying in the MacDonnell Ranges, Northern Territory, VH-KZV collided with terrain on a downslope. The pilot was fatally injured and the passenger received serious injuries. The helicopter was substantially damaged. The time of the accident was within a period of a weather forecast for moderate turbulence in the area.

The on-site wreckage examination and additional testing of the engine found no evidence of a pre-existing defect to prevent normal operation of the helicopter. Therefore, it was almost certain that the engine was operating and driving the rotors at initial impact.

This analysis will discuss the pilot's flight planning and loading of the helicopter, the likelihood that his performance was impaired by alcohol, and the operational state of the helicopter's emergency locator transmitter (ELT).

Collision with terrain

The pilot's global positioning system device track data, recovered from the accident site, indicated the helicopter levelled-off at about 150 ft above ground level on entry to the MacDonnell Ranges. This flight profile was maintained to the last recorded data point (less than 1 minute before the accident) at which stage the helicopter was about 142 ft above terrain. On review of the track data for the previous day, and GoPro camera footage of previous work experience, the pilot appeared to have a habit of manoeuvring his helicopter to contour fly along dry riverbeds. The helicopter's track from the bore site was towards rugged terrain with dry riverbeds and not a direct track towards their destination of Quartz Hill. Therefore, it was very likely the pilot was operating the helicopter at low-level and possibly engaged in contour flying, just prior to the accident.

The meteorological conditions at the time of departure were reported as fine, but moderate turbulence was forecast for the period of the accident flight. The final track of the helicopter placed its path on the lee side of higher ground for the prevailing winds. At about that time there was a change in weather conditions recorded at Alice Springs Airport, indicating stronger winds aloft were mixing with the surface winds. The Bureau of Meteorology's analysis indicated that these winds could have generated at least moderate mechanical turbulence, with the potential for strong downdrafts in the lee of higher terrain. This was consistent with what was experienced by the search and rescue pilot on arrival at the scene of the accident site and suggestive of the comments made by the passenger during his retrieval.

In consideration of the track data, meteorological conditions, accident site and wreckage, it was likely the helicopter encountered a downdraft when low flying in the MacDonnell Ranges with insufficient height to recover, resulting in the collision with terrain.

Flight planning

Ambalindum Station was equipped with an office and computers that had internet access. However, the employer's general manager reported that the pilot did not use, or request to use, the office computers for flight planning. Further, the ATSB found no evidence on either the pilot's iPad or iPhone to indicate he had accessed any flight planning data in preparation for the accident flight.

Consequently, the pilot was most likely unaware of the forecast conditions of moderate turbulence and strong winds for his area of operation. Prior knowledge of potentially hazardous meteorological conditions at low-level may have resulted in him selecting an alternate flight path and/or higher altitude to mitigate the associated risks.

Helicopter performance

ATSB calculations of the loading of the helicopter indicated it was likely overweight, with a centre-of-gravity beyond the forward limit, for the entire accident flight. However, the performance charts in the pilot's operating handbook did not provide results beyond the published limits, and therefore, the performance of the helicopter under the actual conditions could not be determined.

The engine was capable of producing sufficient power for normal flight in the overloaded condition, which was evidenced by the fact that the helicopter had taken off and had been flying for about 20 minutes. However, a downdraft would increase the power required if the pilot attempted to recover lost height during an uncommanded descent. In this situation, the power required by the rotors could rapidly exceed the power available from the engine, resulting in a loss of power margin and a forced descent.

The location of the fuel tanks, behind the main rotor mast, meant that the centre-of-gravity would move forward in-flight as fuel was consumed. This would reduce the range of aft cyclic movement available to the pilot, used to flare and decelerate the helicopter. The into-wind approach and departure, flown to the bore site just prior to the accident, likely increased the available aft cyclic range compared with a nil wind or tail wind condition. Therefore, the pilot may not have been aware of the reduction in aft cyclic control that had already occurred.

After departure from the bore site, the helicopter's track towards the accident site resulted in a wind direction from the left rear quarter (left of the nose between 90–130°). Any rearward component of wind, combined with a reduction of aft cyclic control, would have severely compromised the ability of the pilot to reduce the forward speed of the helicopter.

It was possible that the downdraft would have exceeded the capability of the helicopter loaded within the prescribed limits. However, without knowledge of the actual direction and strength of the downdraft encountered, it could not be determined if the overloaded condition and forward centre-of-gravity contributed to the collision with terrain. Despite this, if hazardous weather was encountered at low-level, the combination of a reduced power margin and aft cyclic control would reduce the response available, thereby increasing the risk of a collision with terrain.

Impaired pilot performance

Research conducted for the ATSB (Newman, 2004) into alcohol and human performance highlighted that:

> In simple terms, alcohol impairs human performance…
>
> It has detrimental effects on cognitive functions and psychomotor abilities. Risk taking behaviour may result, and a full appreciation of the consequences of a planned action may not be possible… Adverse effects can also persist the day after alcohol ingestion, with reductions in alertness, concentration and vestibule-ocular function, and increases in anxiety all being reported…
>
> Alcohol has been shown to impair registration, recall, and organisation of information, leading to increased reaction times and/or a greater number of errors…
>
> …performance has also been found to suffer most when an unexpected or unanticipated event occurs.

The pilot's toxicology report results indicated an elevated level of alcohol in his urine. The toxicologist, and forensic and aviation pathology consultant, concluded that the level of alcohol present was unlikely to be solely the result of decomposition. The consultant also indicated that it was highly likely there was sufficient alcohol present in his blood at a level capable of impairing his performance and that an elevated level of alcohol has the effect of lowering caution, worsening judgement and impairing coordination and reaction time, although heavy drinkers may develop some tolerance to these effects.

The ATSB noted that the evidence of previous low flying suggested his actions may have been normal behaviour and not influenced by alcohol. Therefore, it could not be concluded that his elevated level of alcohol contributed to the accident, but considered that it increased the likelihood of risk taking behaviour and mishandling the helicopter in an emergency.

Emergency locator transmitter

Emergency locator transmitters are radio beacons carried on most aircraft so that in the event of an accident in a remote location, the aircraft wreckage and its occupants can be located quickly by search and rescue (SAR) operations. Finding the aircraft wreckage quickly not only increases the chance of survival of the occupants, but also reduces the risk to pilots of SAR aircraft who commonly need to operate in marginal weather conditions and over mountainous terrain (ATSB 2013).

The inspection of the wreckage found that the emergency locator transmitter (ELT) was selected OFF, rather than ARM. The ARM mode would provide an impact-activated signal. The ELT was located in the transmission area and while selected OFF, it required an individual to access it and select the ON mode for it to transmit a signal. However, the pilot did not regain consciousness following the accident and therefore the ELT was never activated. If not for the pilot's Spot Tracker device, it was possible that the search and rescue response may not have commenced for some time after the accident, delaying medical treatment for the passenger.

ATSB research into the effectiveness of ELTs in aviation accidents (ATSB, 2013) established that they functioned as intended in about 40-60 per cent of accidents in which their activation was expected. In the accidents where it did not work effectively or at all, the ATSB found that this was due to the ELT not being armed before flight, incorrect installation or flat batteries, a lack of water or fire protection, damage to the ELT during the impact sequence, or the way in which the aircraft came to rest after the impact. Activation of the ELT in the ARM mode requires a high deceleration. Examination of the accident site and wreckage suggested it was possible that the ELT would not have activated in the ARM mode, but this could not be verified. Therefore, it could not be concluded that the OFF mode selection of the ELT would have hindered a response to the accident, but not having it selected to ARM was considered to increase the risk of a delayed response.

Findings

From the evidence available, the following findings are made with respect to the collision with terrain involving a Robinson R22, registered VH-KZV, 125 km east-north-east of Alice Springs Airport, Northern Territory, on 24 November 2018. These findings should not be read as apportioning blame or liability to any particular organisation or individual.

Contributing factors

- It was very likely that the pilot was operating the helicopter at low-level when it encountered a downdraft with insufficient height to recover, resulting in a collision with terrain.

Other factors that increased risk

- The pilot did not consult any weather forecast data before departure, which increased the risk of him selecting a flight path through the MacDonnell Ranges that was not appropriate for the forecast wind conditions and turbulence.
- It was very likely that the helicopter was overweight on departure and the centre-of-gravity was beyond the forward limit for the entire flight, which increased the risk of the pilot experiencing reduced control authority over the helicopter.
- It was very likely the pilot's blood alcohol content was capable of impairing his performance, which increased the likelihood of risk-taking behaviour and mishandling the helicopter in an emergency.
- The impact-activated emergency locator transmitter fitted to the helicopter was selected off, which increased the risk of a delayed emergency response.

Other findings

- There was no fault found with the helicopter to prevent normal operation. It was almost certain the engine was operating and driving the rotors when it collided with terrain.
- The pilot’s Private Pilot Licence (Helicopter), and low-level and aerial mustering qualifications had not been transferred to the Civil Aviation Safety Authority’s new licencing system and therefore, were not valid at the time of the accident.

Proactive safety actions

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

Operator safety management improvements

Subsequent to the accident, Hewitt Cattle Australia (HCA) elected to contract out the majority of its aviation operations to Air Operator Certificate holders, including all rotary operations.

Through their recently appointed a work health and safety manager, they commenced a review of their aviation safety system. A third party aviation expert consultant was engaged to lead the review. As a result of that review, HCA developed further improvements to their aviation safety system in order to enhance the safety standards, which included the development of:

- An aviation safety management system, which borrows elements contained in Civil Aviation Advisory Publication SMS-01 v1.1: *Safety management systems for regular public transport operations*.
- An aviation safety management manual, which is based on the recommended framework contained in the International Civil Aviation Organization's safety management manual, and incorporates best practice from the Flight Safety Foundation basic aviation risk standard, and the International Association of Oil and Gas Producers aircraft management guidelines. The manual has been tailored for HCA's operations, with a specific focus on the areas of safety policy, risk management procedures, hazard and occurrence reporting, 'just culture', and assurance, specifically focused on the audit of service providers and suppliers.
- A revised safe operating procedure for pilots, which is integrated with the HCA safety management system (in which pilots operating HCA aircraft have been inducted). This includes a number of additional requirements designed to decrease the likelihood of similar accidents in the future, including: pilot minimum experience requirements based on industry best practice; the basic aviation risk standard pilot runway and helicopter landing site assessment process; a process for the conduct of an abbreviated risk assessment by pilots; safety occurrence reporting requirements; Civil Aviation Safety Authority drug and alcohol training for pilots (which pilots operating HCA aircraft have undertaken); adverse weather policy; approved and prohibited flying activities; and restriction on carriage of passengers.

The aviation safety management manual creates a framework to allow for open reporting of safety occurrences based on the 'just culture' philosophy. This is aimed at shaping the behaviour and the culture of pilots to ensure that activities, which are not in line with HCA's expectations, are less likely to occur. HCA considers that this cultural shift is important as the remote and expansive location of its aviation operations affect management's ability to constantly view and assess a pilot's general and specific flight conduct. The manual also provides a process for monitoring and auditing the currency of pilot training, ratings and endorsements on HCA's training management system.

General details

Occurrence details

Date and time:	24 November 2018 – 0757 CST	
Occurrence category:	Accident	
Primary occurrence type:	Collision with terrain	
Location:	125 km east-north-east of Alice Springs Airport, Northern Territory	
	Latitude: 23º 24.400' S	Longitude: 135º 3.050' E

Pilot details

Licence details:	Private Pilot Licence – Helicopter (invalid from 1 September 2018)
Endorsements:	R22 (invalid from 1 September 2018)
Ratings:	Nil
Medical certificate:	Class 2, valid to 2 February 2020
Aeronautical experience:	Approximately 1,270 hours in the R22
Last flight review:	February 2018

Aircraft details

Manufacturer and model:	Robinson Helicopter Company R22 Beta II	
Registration:	VH-KZV	
Operator:	Hewitt Cattle Australia Pty Ltd	
Serial number:	4454	
Type of operation:	Private	
Departure:	Ambalindum Station, Northern Territory	
Destination:	Quartz Hill, Northern Territory	
Persons on board:	Crew – 1	Passengers – 1
Injuries:	Crew – 1 (fatal)	Passengers – 1 (serious)
Aircraft damage:	Destroyed	

Sources and submissions

Sources of information

The sources of information during the investigation included the:

- Alice Springs Helicopters
- Bureau of Meteorology
- Civil Aviation Safety Authority
- Forensic and aviation pathology consultant
- Forensic Science South Australia
- Hewitt Cattle Australia employees
- Northern Territory Police
- Robinson Helicopter Company
- Royal Darwin Hospital
- St John Ambulance – Northern Territory.

References

Australian Transport Safety Bureau 2019, AO-2016-156: In-flight break-up involving Robinson R44, VH-ZNZ, 41 km NW Mossman, Queensland, 18 November 2016, ATSB, Canberra.

Australian Transport Safety Bureau 2013, AR-2012-128: A review of the effectiveness of emergency locator transmitters in aviation accidents, ATSB, Canberra.

Newman, DG 2004, *Alcohol and human performance from an aviation perspective: A review*. Retrieved from https://www.atsb.gov.au/publications/2004/alcohol_and_human_performance/

Federal Aviation Administration 2016, *Pilot's handbook of aeronautical knowledge, chapter 12: weather theory* (FAA-H-8083-25B), US Department of Transportation, Oklahoma City United States.

Federal Aviation Administration 2012, *Helicopter flying handbook* (FAA-H-8083-21A), US Department of Transportation, Oklahoma City United States.

Wagtendonk WJ 2011, *Principles of helicopter flight*, 2nd edn, Aviation Supplies & Academies, Inc. Washington United States.

Submissions

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

A draft of this report was provided to Alice Springs Helicopters, Bureau of Meteorology, Civil Aviation Safety Authority, the forensic and aviation pathology consultant, Forensic Science South Australia, Hewitt Cattle Australia, Northern Territory Police, Robinson Helicopter Company, Royal Darwin Hospital, St John Ambulance Northern Territory and the United States National Transportation Safety Board.

Submissions were received from Hewitt Cattle Australia, the Civil Aviation Safety Authority, and Forensic Science South Australia. The submissions were reviewed and, where considered appropriate, the text of the report was amended accordingly.

Australian Transport Safety Bureau

The ATSB is an independent Commonwealth Government statutory agency. The ATSB is governed by a Commission and is entirely separate from transport regulators, policy makers and service providers. The ATSB's function is to improve safety and public confidence in the aviation, marine and rail modes of transport through excellence in: independent investigation of transport accidents and other safety occurrences; safety data recording, analysis and research; fostering safety awareness, knowledge and action.

The ATSB is responsible for investigating accidents and other transport safety matters involving civil aviation, marine and rail operations in Australia that fall within the ATSB's jurisdiction, as well as participating in overseas investigations involving Australian registered aircraft and ships. A primary concern is the safety of commercial transport, with particular regard to operations involving the travelling public.

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

Purpose of safety investigations

The object of a safety investigation is to identify and reduce safety-related risk. ATSB investigations determine and communicate the factors related to the transport safety matter being investigated.

It is not a function of the ATSB to apportion blame or determine liability. At the same time, an investigation report must include factual material of sufficient weight to support the analysis and findings. At all times the ATSB endeavours to balance the use of material that could imply adverse comment with the need to properly explain what happened, and why, in a fair and unbiased manner.

Developing safety action

Central to the ATSB's investigation of transport safety matters is the early identification of safety issues in the transport environment. The ATSB prefers to encourage the relevant organisation(s) to initiate proactive safety action that addresses safety issues. Nevertheless, the ATSB may use its power to make a formal safety recommendation either during or at the end of an investigation, depending on the level of risk associated with a safety issue and the extent of corrective action undertaken by the relevant organisation.

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

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

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

Terminology used in this report

Occurrence: accident or incident.

Safety factor: an event or condition that increases safety risk. In other words, it is something that, if it occurred in the future, would increase the likelihood of an occurrence, and/or the severity of the adverse consequences associated with an occurrence. Safety factors include the occurrence events (e.g. engine failure, signal passed at danger, grounding), individual actions (e.g. errors and violations), local conditions, current risk controls and organisational influences.

Contributing factor: a factor that, had it not occurred or existed at the time of an occurrence, then either:

(a) the occurrence would probably not have occurred; or

(b) the adverse consequences associated with the occurrence would probably not have occurred or have been as serious, or

(c) another contributing factor would probably not have occurred or existed.

Other factors that increased risk: a safety factor identified during an occurrence investigation, which did not meet the definition of contributing factor but was still considered to be important to communicate in an investigation report in the interest of improved transport safety.

Other findings: any finding, other than that associated with safety factors, considered important to include in an investigation report. Such findings may resolve ambiguity or controversy, describe possible scenarios or safety factors when firm safety factor findings were not able to be made, or note events or conditions which ‘saved the day’ or played an important role in reducing the risk associated with an occurrence.