Australian Government
Australian Transport Safety Bureau

Birdstrike and in-flight break-up involving a Bell 206L-1, registered VH-ZMF

Near Maroota, New South Wales, on 9 July 2022

ATSB Transport Safety Report
Aviation Occurrence Investigation (Short)
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Addendum

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Executive summary

What happened

On the morning of 9 July 2022, a Bell 206 L-1, registered VH-ZMF departed a private helipad at Cattai, NSW for a private flight. About 9 minutes later, the helicopter impacted terrain about 10 km to the north of the departure point. The helicopter was destroyed, and the pilot, who was the sole occupant, was fatally injured.

What the ATSB found

The ATSB found that shortly after crossing Dargle Ridge at about 500 ft above the ground and while approaching the Richmond airspace control boundary, a wedgetail eagle impacted the helicopter just below the front left windscreen. It was unlikely that the pilot saw or had time to avoid the wedgetail eagle due to sun glare and a required radio frequency change.

The pilot was likely startled and initiated abrupt control inputs leading to the main rotor severing the tail boom. This led to an inflight break-up of the airframe and collision with terrain.

Safety message

Birdstrike is sometimes an unavoidable and relatively common hazard for all aviation operations, one which is more prevalent at lower altitudes. Pilots are reminded that sound lookout and visual scanning processes, as well as avoidance of low-level flight and expected areas of large concentrations of birds are key to reducing the likelihood of birdstrike.

Maintaining effective lookout and taking steps to remove, reduce or eliminate reduced visual effectiveness will assist in maintaining better situational awareness in-flight, and also assist in providing better outcomes to see-and-avoid not only birds, but other airspace users.

The investigation

Decisions regarding the scope of an investigation are based on many factors, including the level of safety benefit likely to be obtained from an investigation and the associated resources required. For this occurrence, a limited-scope investigation was conducted in order to produce a short investigation report, and allow for greater industry awareness of findings that affect safety and potential learning opportunities.

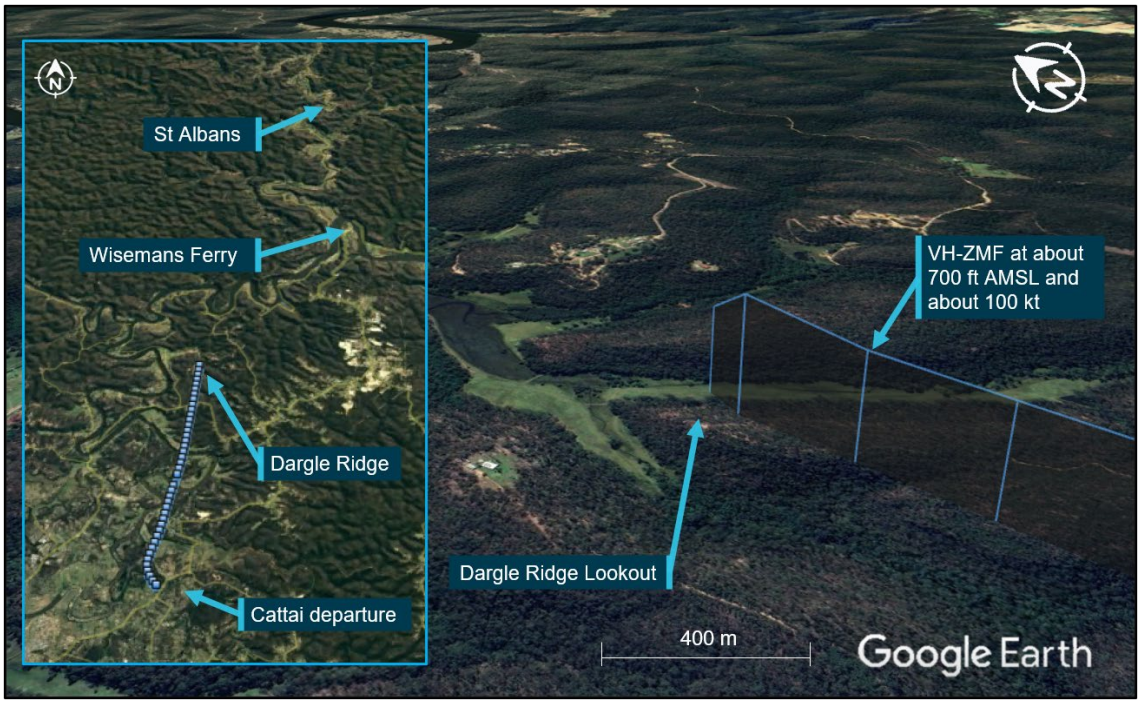
The occurrence

At about 1139 local time on 9 July 2022, a Bell 206L-1 LongRanger, registered VH-ZMF, departed a private helipad at Cattai, New South Wales, for a private flight to a property at St Albans (Figure 1). The pilot was the sole occupant on board.

The pilot obtained an airways clearance from air traffic control and recorded data showed the helicopter tracked to the north towards St Albans, climbing to about 700 ft above mean sea level (AMSL).

A witness to the south of Dargle Ridge observed the helicopter moments before the accident. They recalled it flying straight and level towards the north, and that weather conditions were good, with clear skies and light winds.

Figure 1: VH-ZMF departure and track



Source: Google Earth, with OzRunways data, annotated by the ATSB

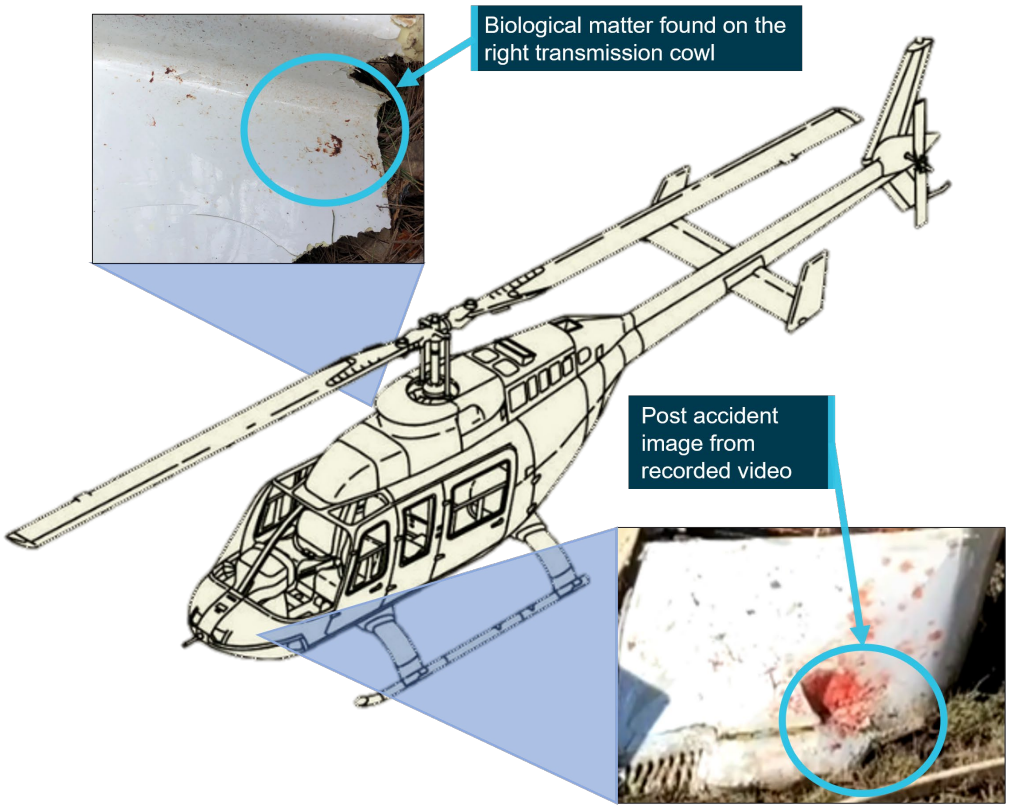
After crossing the Dargle Ridge lookout the helicopter was at about 500 ft above ground level based on the elevation. Several witnesses described seeing VH-ZMF enter into a rapid banking turn to the right while pitching up. They heard several rotor beats change tone before a final louder noise.

Witnesses then recalled the helicopter pitching and rolling while descending, with one witness describing separation of the main rotor blades from the helicopter at about the height of Dargle Ridge shortly before impact.

A short time later, smoke was observed rising from the area where the helicopter descended. The pilot was fatally injured and the helicopter was destroyed by a post-impact fire.

A nearby news helicopter, filming local flooding, was the first to arrive on scene and landed nearby to render assistance. Camera crew continued filming the accident scene before it was consumed by the post-impact fire. Biological matter was observed in that recorded video on the outside of the left nose cowl of the helicopter (Figure 2).

Figure 2: Locations of biological matter



Source: Bell, United Services, and ATSB

The landowner, who arrived at the accident scene on the top of the Dargle Ridge lookout, identified a mass of biological tissue, which appeared to be a tail section of a bird (Figure 3), which was still warm. During the on-site phase of the investigation, further biological samples were recovered below the escarpment.

Figure 3: Bird matter found near accident site

Source: NSW Police and ATSB

Context

Pilot information

Licencing

The pilot held both commercial (aeroplane and helicopter) pilot licences and was appropriately licenced to fly the Bell 206 LongRanger. The pilot held a valid class 2 medical certificate which included restrictions requiring the wearing of distance vision correction and additionally, that reading correction must also be available whilst exercising the privileges of the licence. Their most recent single engine helicopter flight review and an operational low level helicopter rating renewal was carried out on 2 June 2022.

Aeronautical experience

The pilot's electronic logbook record showed a total flying experience of 5,398.3 hours up to the last recorded flight on 19 October 2020, when the pilot ceased using electronic logbook software with a helicopter operator. Of the pilot's total flying experience, about 4,800 hours was in helicopters. VH-ZMF was used regularly by the pilot as a private aircraft, however due to a lack of recent pilot logbook records, ATSB was unable to determine the pilot's total flight experience in Bell 206 aircraft.

Recent history

The pilot had spent a number of days at their home in Cattai by themselves after returning from Adelaide to assist with the recent flood recovery efforts in the area and to ensure safety of their own property. While no one spoke to the pilot prior to them departing Cattai that morning, several text messages were exchanged with family and friends.

Post-mortem and toxicology

At the time of release of this report, a post-mortem and toxicology results were not available to the investigation.

Aircraft information

General

VH-ZMF was a Bell Helicopter Company B206L-1 LongRanger, S/N 45258 manufactured in the US in 1979. It was first registered in Australia in October 2012 as VH-MFF and then changed registration to VH-ZMF in May 2013.

VH-ZMF was a helicopter with two-bladed main rotor and tail rotor systems, powered by a single Rolls Royce 250-C30P gas turbine engine. It had hydraulically assisted flight controls, skid type landing gear and seating for a pilot and 6 passengers. The main and tail rotor blades had been replaced with carbon fibre composite blades under a supplemental type certificate (STC).[1] The helicopter was fitted with an emergency locator transmitter.

At the time of the accident, the helicopter had completed 2,964 hours in service and was certified for day VFR[2] flight only.

Airworthiness and maintenance history

A maintenance release was issued for VH-ZMF on 10 September 2021 at an aircraft time in service of 2,938.34 hours and was valid at the time of the accident.

The aircraft was retrofitted with Van Horn tail rotor blades in December 2015 and Van Horn main rotor blades in May 2021. The Van Horn blades are constructed of carbon fibre composite material which differs to the standard aluminium alloy construction by the original manufacturer. The Van Horn tail and main rotor blades were fitted under STC SR02249LA and STC SR02684LA respectively.

Meteorological conditions

Witnesses near the accident site described the weather conditions that morning to be ‘near perfect flying conditions’ with sunny conditions, light winds, blue skies and little cloud.

Another pilot who had operated through the same area about 7 minutes earlier on the day of the accident described the weather conditions as a good day for flying, with blue skies, sunny, no rain and some cloud around.

About the time of the accident, RAAF Base Richmond, located about 20 km to the south-west of the accident site, recorded wind from the west at about 4 kt and visibility greater than 10 km.

Recent heavy rainfall had swollen rivers, flooded the valleys and cut roads as substantial surface water runoff continued in the local area.

Wreckage information

The main accident site, including the engine, main cabin, and fuselage, was located in relatively flat and open farmland, between 2 ridgelines (Figure 5). The tail rotor assembly, vertical stabiliser and a section of the tail boom were found about 93 m to the north, with no signs of pre-existing component failure or damage. However, the main tail boom and drive shaft (Figure 4) were both severed at roughly the same fuselage station, consistent with a main rotor blade strike.

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1 A Supplemental Type Certificate authorises alteration to an aircraft, engine, or other item operating under an approved Type Certificate for the state of manufacture.

2 Visual flight rules (VFR): a set of regulations that permit a pilot to operate an aircraft only in weather conditions generally clear enough to allow the pilot to see where the aircraft is going.

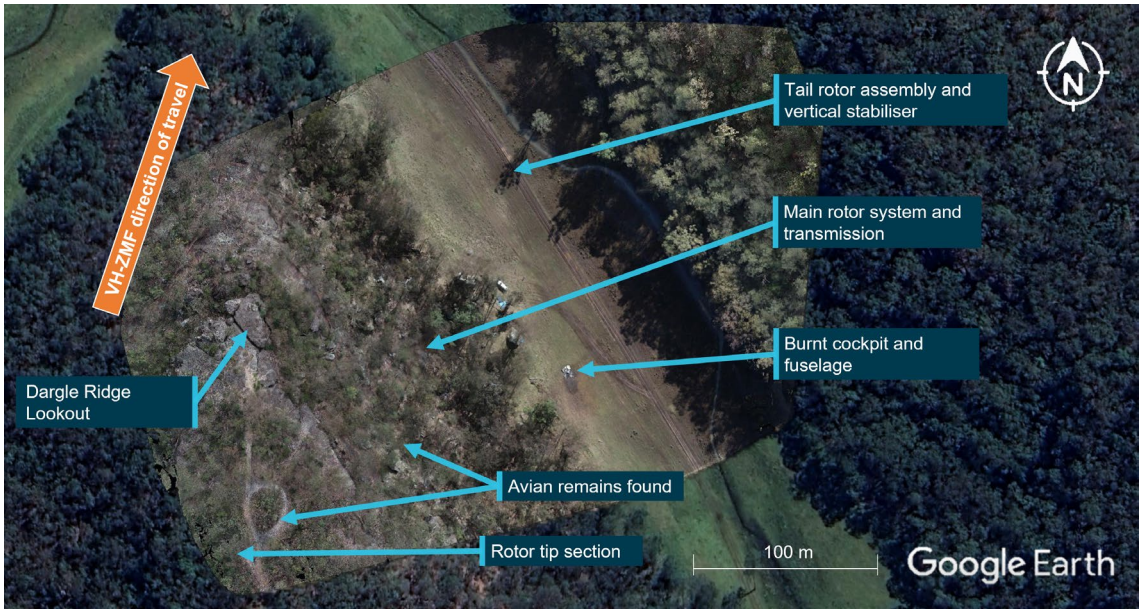
Figure 4: Tail boom impact

Source: ATSB

The main rotor system, including the transmission cowling, gearbox, and main rotor blades, was located about 68 m to the west in a heavily wooded, sloping escarpment. The teetering main rotor head was still attached to the transmission with multiple severed control rods attached to the transmission mounting structure.

The composite main rotor blades had separated just outboard of the main rotor grips and had impacted heavily with vegetation and delaminated. One of the main rotor blade tips was located about 150 m before the main wreckage on top of the ridgeline.

Figure 5: VH-ZMF accident site



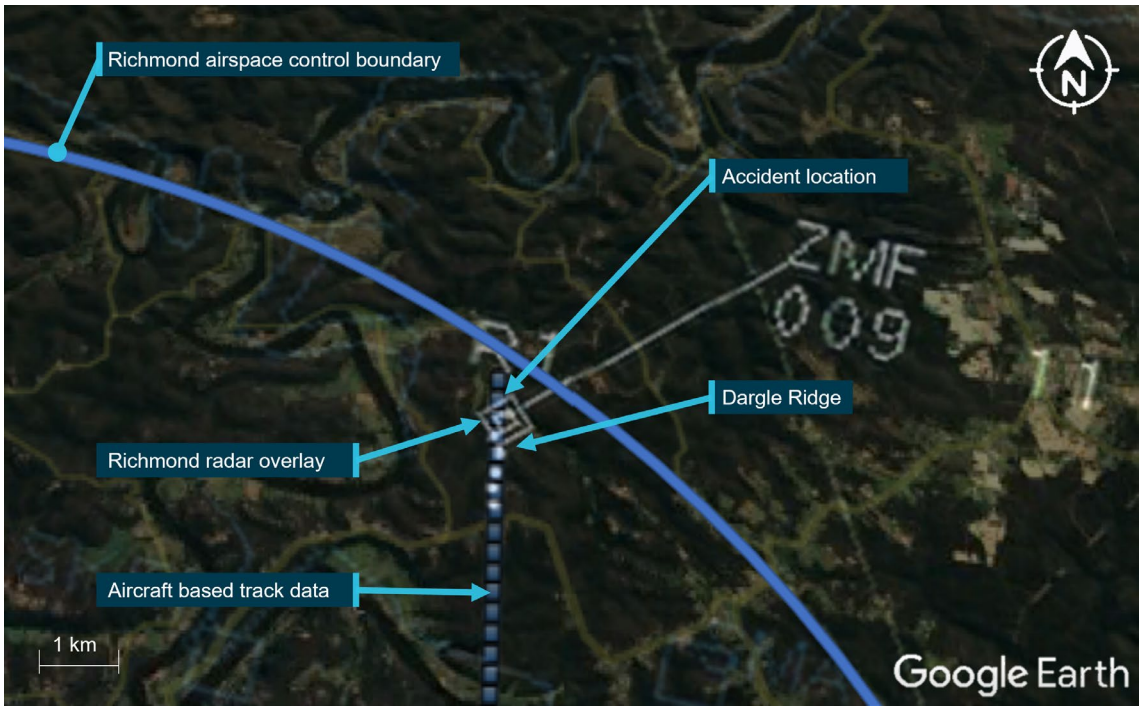
Source: Google Earth with ATSB RPAS picture overlay, annotated by the ATSB

Recorded data

Data collected from radar and aircraft-based sources indicated that VH-ZMF was travelling in a northerly direction at about 100 kt prior to crossing the Dargle Ridge Lookout. The data then showed a track deviation to the right and an increase in 100 ft of altitude coupled with rapid deceleration and an increased vertical descent rate prior to impact with terrain.

Audio from RAAF Richmond air traffic control recorded that at 1143:37 the air traffic controller advised the pilot of VH-ZMF that they were 2 NM (3.7 km) from the airspace boundary and gave the pilot traffic of another media helicopter in the vicinity of Wisemans Ferry.

Figure 6: Richmond radar overlay



Source: Google Earth with Richmond radar overlay, annotated by the ATSB

At 1143:58, the pilot confirmed that the frequency change. Three seconds later static was heard on the radio which lasted for about 2 seconds with no discernible audio. Recorded radar images show VH-ZMF approaching the control boundary before appearing to slow remarkedly and descend at 1144:12 before disappearing from radar at 1144:45.

The aircraft was also fitted with an in-flight camera system, however this was consumed by fire and it was reported that the pilot did not usually use the camera system.

Bird information

Recovered biological specimens, including the avian carcass and the biological residue found on external helicopter surfaces, were analysed by the Australian Centre for Wildlife Genomics, Airstrike section of the Australian Museum. The carcass and samples taken from the helicopter's main transmission cowling were identified as *Aquila* audax, commonly known as a wedge-tailed eagle.

The Australian Museum identifies the wedge-tailed eagle as Australia's largest bird of prey with a wingspan of up to 2.3 m, with females growing up to 5.3 kg.

Their habitat is defined as:

> The Wedge-tailed Eagle is found from sea level to alpine regions in the mountains, but prefers wooded and forested land and open country, generally avoiding rainforest and coastal heaths. Eagles

> can be seen perched on trees or poles or soaring overhead to altitudes of up to 2000 m. Wedge-tailed Eagles build their nest in a prominent location with a good view of the surrounding countryside. It may be built in either a live or dead tree, but usually the tallest one in the territory.

The landowner and several local witnesses also described the long-term presence of an indigenous pair of wedgetail eagles known to inhabit the Dargle Ridge escarpment for a number of years, raising 1 or 2 chicks per breeding season and often seen soaring and hunting together over the ridges and valleys.

The landowner also reported seeing another large eagle in the vicinity of Dargle Ridge shortly after witnessing the accident.

Birdstrike Statistics

Over the 15 years between 2008 and 2022, 24,106 birdstrikes were reported to ATSB for all modes of aviation.

The ATSB research paper *Australian aviation wildlife strike statistics* (AR-2018-035) identified that for the 10 years between 2008 and 2017 that there were 28 reported birdstrikes involving wedge-tail eagles for all aircraft, however there was only one of these that resulted in an aircraft being destroyed.

More recently, for the 5 years between 2018-2022, 212 birdstrikes reported to the ATSB involving helicopters. However this accident was the only one involving a birdstrike on a helicopter.

Limitations of see-and-avoid

During VFR flight, effective lookout and visual scanning by pilots is used to see and avoid airborne hazards, from other aircraft to wildlife or weather events. However, there are significant limitations of the 'see and avoid principle'.

These include, the limitations of the human visual system itself, cockpit demands in operating the aircraft, and physical and/or environmental conditions which when combined, decrease the likelihood of effective see and avoid.

An ATSB research report 'Limitations of the see-and-avoid principle' (Hobbs, 1991) highlights that:

> Visual scanning involves moving the eyes in order to bring successive areas of the visual field onto the small area of sharp vision in the centre of the eye. The process is frequently unsystematic and may leave large areas of the field of view unsearched.

Avoidance of any airborne threat first requires identification by direct visual detection, and then must be identified as a collision risk, before the pilot then needs to decide what action to take. The pilot must then make the required control inputs and allow the aircraft to respond to avoid the object. The physiologically inherent limitations of the human visual and information processing system also increase the time taken to respond to a threat.

Tasks requiring pilot attention inside the cockpit also reduce a pilot's capacity to visually identify and avoid an airborne threat.

Sun position

After the departure of VH-ZMF from the Cattai helipad, the aircraft tracked north at about 005° towards the St Albans property and climbed to about 700 ft AMSL. Calculation of the time of day and sun position relative to the aircraft's altitude and track direction indicated that VH-ZMF was flying directly into the sun during the last 30 seconds of straight and level flight. Analysis also identified that due to the size and shape of the helicopter windscreen, that the sun was almost directly at the top of centre of the pilot's field of view.

Direct glare from an unwanted light source can significantly reduce the identification of potential airborne hazards, an ATSB research report (Hobbs, 1991) stated that:

> When the glare source is 5 degrees from the line of sight, visual effectiveness is reduced by 84 per cent (Hawkins, 1987). In general, older pilots will be more sensitive to glare.

The use of helmet visors, sunglasses or glare shields may lessen the severity of the impact of glare, however it is still likely to significantly degrade visual effectiveness.

It was unable to be determined if the pilot was wearing sunglasses or using a sun visor to mitigate the glare from the sun position.

Helicopter rotor aerodynamics

Under normal flight conditions in two bladed, teetering head type helicopter rotor systems, the risk of the main rotor blades flexing to the point of contact with the tail boom is extremely low. However, the consequences of contact between the spinning rotor and the tail boom are potentially catastrophic. This may also lead to main rotor separation from the mast in-flight.

The amplitude of the blade flexing or flapping is increased by one or more of the following factors:

- environmental conditions, such as gusts
- sudden attitude changes and abrupt cyclic inputs
- maximum speed sideways flight
- unloading the main rotor disc with low to negative g[3] conditions.

In a low g situation (for an anticlockwise-rotating main rotor system), aerodynamic forces from the tail rotor often produce a right roll, which if countered with left cyclic further reduces the clearance between the main rotor and the tail boom. Under normal positive g in-flight conditions this would produce the desired effect of rolling the aircraft level. In the case of a low-g load flight manoeuvre this increases the risk of the main rotor hub contacting the main rotor mast, commonly referred to as mast bumping. At the point of mast bump, the main rotor blades can flex further, allowing the main rotor blade/s to contact the tail boom.

Mast bumping is described in many helicopter aerodynamic publications, additionally however Wagtendonk (Wagtendonk, 1996) states:

> Airplane pilots who have recently transitioned to helicopters are at a higher risk for mast bumping accidents because reactions honed by years of airplane flying are not necessarily conducive to safe helicopter flying. For example, if the pilot must descend suddenly to avoid another object, say, a bird, helicopter technique is to rapidly lower collective. The airplane/helicopter pilot is prone to push the cyclic forward in the same situation. Lowering the nose of the helicopter into a dive, as he would an airplane. Such a push-over is the exact formula for mast bumping.

Safety analysis

This analysis will explore the circumstances pertaining to the in-flight break-up of VH-ZMF, the probability of an airborne birdstrike, its likely effect on the continued operation of the aircraft, and aircraft operation after the collision.

Sun position and visual effectiveness

The track of VH-ZMF on its way to St Albans placed the cockpit directly into the direction of the sun. It is likely that the position of the sun was almost directly at the top centre of the pilot's field of vision, increasing the risk of glare from the sun and substantially reducing the pilot's visual effectiveness.

[3] G load: the nominal value for acceleration. In flight, g load represent the combined effects of flight manoeuvring loads and turbulence and can have a positive or negative value.

As VH-ZMF approached the control boundary for Richmond airspace, a radio frequency change was required. The pilot needed to shift their vision and attention from outside of the cockpit to inside cockpit to change the frequency on the radio.

This task, combined with the sun glare likely reduced the chance that the pilot was able to visually identify the airborne threat and take appropriate avoiding action.

Birdstrike

Analysis of biological samples found on external surfaces of the helicopter and nearby the accident site, confirmed the airborne contact with a wedge-tailed eagle (*Aquila* audax). First responder film footage of the cockpit and fuselage impact site, prior to being consumed by fire, indicated a large external impact of biological matter on the front left nose cowl of VH-ZMF, indicating a likely initial impact point of the birdstrike.

It is almost certain that this initial impact location, approximate weight and speed of the bird would not have been of sufficient magnitude to significantly damage the helicopter and lead to a loss of controlled flight.

In-flight break-up

It was likely that the pilot was startled by seeing the large bird close to impacting or/and the actual birdstrike and attempted avoiding action during a period of reduced visual effectiveness. Witness recollection and analysis of recorded data identified that VH-ZMF began a pronounced climb and right roll before pitching forward.

Abrupt cyclic inputs and low to negative g rotor loading are a well-documented and accepted limitation of two-bladed teetering rotor head systems commonly used in light to medium helicopters. Analysis of the impact marks on the tail boom of VH-ZMF and the separation of rotor blade tips, indicate that the tail boom was impacted and severed by contact with its own main rotor blades. This led to further break-up of the aircraft in flight, such as the main rotor system and transmission due to severe rotational forces of a compromised and unbalanced main rotor assembly. Numerous witnesses observed and heard the impact of the main rotor blades on the tail boom and described the uncontrolled nature of the in-flight break-up.

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). In addition ‘other findings’ may be included to provide important information about topics other than safety factors.

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 birdstrike and in-flight break-up involving a Bell 206L1 LongRanger, registered VH-ZMF, near Maroota, NSW, on 9 July 2022

Contributing factors

- Sun position and pilot workload at the control zone boundary likely resulted in the pilot not identifying a potential airborne collision risk.
- While cruising at about 700 ft AMSL, the aircraft struck a wedgetail eagle just below the left windscreen.

- The pilot was likely startled by the birdstrike resulting in an abrupt control input, which led to the main rotor blades contacting the tail boom and subsequent in-flight break-up.

General details

Occurrence details

Date and time:	9 July 2022 – 1135 AUS EST	
Occurrence class:	Accident	
Occurrence categories:	Collision with terrain, In-flight break-up, Birdstrike	
Location:	19.9 km 40 degrees from Richmond, NSW	
	Latitude: 33.46343000°S	Longitude: 150.91960000° E

Aircraft details

Manufacturer and model:	Bell Helicopter Co 206L-1	
Registration:	VH-ZMF	
Serial number:	45285	
Type of operation:	Part 91 General operating and flight rules-Other	
Activity:	General aviation / Recreational-Sport and pleasure flying	
Departure:	Cattai, NSW	
Destination:	Upper MacDonald, NSW	
Persons on board:	Crew – 1	Passengers – 0
Injuries:	Crew – 1 (fatal)	Passengers – 0
Aircraft damage:	Destroyed	

Sources and submissions

Sources of information

The sources of information during the investigation included the:

- aircraft co-owner
- chief pilot of a helicopter operator
- Civil Aviation Safety Authority
- New South Wales Police Force
- aircraft manufacturer
- maintenance organisation for VH-ZMF
- Airservices Australia
- accident witnesses
- Australian Defence Force
- Australian Museum
- OzRunways.

References

Hawkins, F. H. (1987). *Human Factors in Flight.* Gower: Aldershot.

Hobbs, A. (1991, 04 01). *Limitations of See-and-Avoid Principle.* Canberra: ATSB. Retrieved from www.atsb.gov.au: https://www.atsb.gov.au/sites/default/files/media/4050593/see_and_avoid_report_print.pdf

Wagtendonk, W. J. (1996). *Priciples of Helicopter Flight.* Washington: Aviation Supplies & Academics, Inc.

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:

- Civil Aviation Safety Authority
- Bureau de la sécurité des transports du Canada
- Australian Defence Force
- Bell Helicopter.

Submissions were received from:

- Civil Aviation Safety Authority
- Bureau de la sécurité des transports du Canada
- Bell Helicopter

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.