SOUTH AFRICAN CIVIL AVIATION AUTHORITY

Section/division Accident and Incident Investigations Division Form Number: CA 12-57

LIMITED OCCURRENCE INVESTIGATION REPORT – FINAL

Reference Number	CA18/2/3/10272					
Classification	Accident	**Date**	21 February 2023	**Time**	0620Z	
Type of Operation	Aerial Work Operations – Game Darting (Part 137)					
Location						
Place of Departure	Brisbane Farm near Pomfret, North West Province	Place of Intended Landing	Brisbane Farm near Pomfret, North West Province			
Place of Occurrence	Brisbane Farm near Pomfret in the North West Province					
GPS Co-ordinates	Latitude	25°42'28.10" S	Longitude	023°33'59.51" E	Elevation	3 575 ft
Aircraft Information						
Registration	ZS-RTH					
Make; Model; S/N	Robinson Helicopter Company; R44 Raven II (Serial Number: 10269)					
Damage to Aircraft	Substantial		Total Airframe Hours	2 630.0		
Pilot-in-command						
Licence Type	Private Pilot Licence (PPL)		Gender	Male	Age	64
Licence Valid	Yes	Total Hours on Type	2 412.0	Total Flying Hours	2 412.0	
Total Hours 90 Days	8.8		Total Hours on Type Past 90 Days	8.8		
People On-board	1 + 1	**Injuries**	0	**Fatalities**	0	**Other (on ground)** 0

What Happened

On Tuesday morning, 21 February 2023, a pilot and a veterinarian on-board a Robinson R44 Raven II helicopter with registration ZS-RTH took off on a game darting operation from Brisbane farm, near Pomfret in the North West province, with the intention to land at the same farm. The pair was working together with a team on the ground. The flight was conducted under visual meteorological conditions (VMC) by day and under the provisions of Part 137 of the Civil Aviation Regulations (CAR) 2011 as amended.

The pilot was seated at the front right seat, and the veterinarian was seated at the back seat behind the pilot. The doors of the helicopter were removed before the flight. The pilot stated that whilst flying at a height of approximately 40 feet (ft) above ground level (AGL), he positioned the helicopter such that the veterinarian could dart the buffalos. Once they had completed the darting operation, the pilot turned downwind and, during the turn, the main rotor revolutions per minute (RPM) low audio warning sounded. But because the helicopter was in proximity to the ground, the pilot was unable to recover from the anomaly and the helicopter impacted the bushy terrain (this was evidenced by the entire skid gear assembly which was ripped out from the lower fuselage). During an attempted flare prior to

ground impact, the main rotor blades which were rotating below the normal operating range/speed flapped down and severed the aft tail boom. The helicopter came to rest after it rolled over to the right.

The helicopter was substantially damaged during the accident sequence. The pilot and the veterinarian were not injured; however, the veterinarian's right foot was trapped when the helicopter rolled over. He was freed by members of the ground team when the helicopter was brought to an upright position.

The accident occurred during daylight on the pilot's farm, 6.6 nautical miles (nm) north of Pomfret in the North West province at Global Positioning System (GPS) co-ordinates determined to be 25°42'28.10" South 023°33'59.51" East, at an elevation of 3 575 feet (ft).

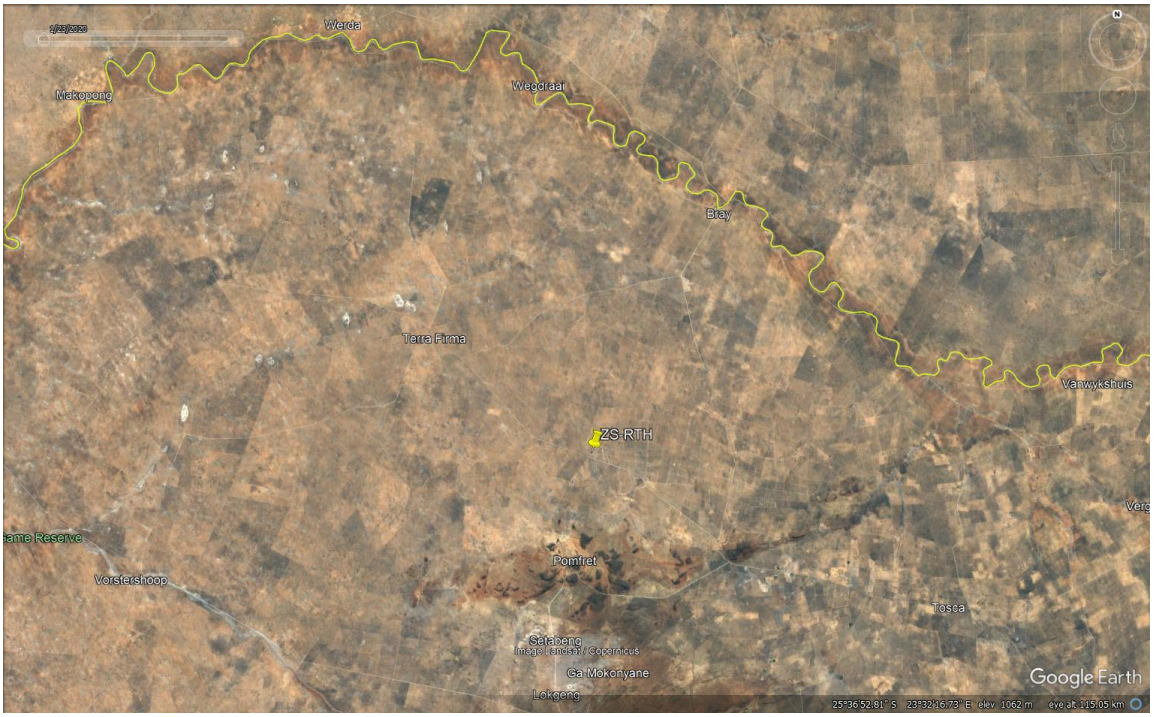


Figure 1: The yellow pin indicates the position of the accident site. (Source: Google Earth)

Figure 2: The helicopter after it was brought to an upright position. (Source: Pilot)

Figure 3: The right-side of the helicopter after it was positioned upright. (Source: Pilot)

Figure 4: The aft view of the helicopter showing the severed tail boom. (Source: Pilot)

Findings

1. Personnel Information

1.1 The pilot was issued a Private Pilot Licence (PPL) Helicopter. The initial issue of the pilot's licence was on 5 May 2009. His licence was renewed on 30 April 2021 with an expiry date of 30 April 2023. The pilot had flown a total of 2 412.0 hours.

1.2 The pilot had a Class 2 aviation medical certificate that was issued on 21 July 2022 with an expiry date of 20 July 2023. The pilot was restricted to wear corrective lenses for defective distant, intermediate and near vision.

1.3 The pilot was properly licensed and medically fit for the flight in accordance with the existing regulations.

2. Aircraft Information

2.1 The last maintenance inspection that was carried out on the helicopter prior to the accident flight was certified on 11 August 2022 at 2 596.7 airframe hours by an aircraft maintenance organisation (AMO). Since the inspection, a further 33.3 hours were flown with the helicopter.

2.2 The helicopter had a valid Certificate of Airworthiness (C of A) which was issued on 26 March 2004. The latest C of A had an expiry date of 31 March 2023. The helicopter was airworthy when it dispatched for the flight.

2.3 The helicopter's Certificate of Registration (C of R) was issued on 25 March 2004.

2.4 The helicopter was issued a Certificate of Release to Service (CRS) on 11 August 2022, which was valid until 10 August 2023 or at 2 694.9 airframe hours, whichever occurs first.

2.5 Safety Notices from the Robinson Helicopter Company:

ROBINSON
HELICOPTER COMPANY

Safety Notice SN-10

Issued: Oct 82 Rev: Feb 89; Jun 94

FATAL ACCIDENTS CAUSED BY LOW RPM ROTOR STALL

A primary cause of fatal accidents in light helicopters is failure to maintain rotor RPM. To avoid this, every pilot must have his reflexes conditioned so he will instantly add throttle and lower collective to maintain RPM in any emergency.

The R22 and R44 have demonstrated excellent crashworthiness as long as the pilot flies the aircraft all the way to the ground and executes a flare at the bottom to reduce his airspeed and rate of descent. Even when going down into rough terrain, trees, wires or water, he must force himself to lower the collective to maintain RPM until just before impact. The ship may roll over and be severely damaged, but the occupants have an excellent chance of walking away from it without injury.

Power available from the engine is directly proportional to RPM. If the RPM drops 10%, there is 10% less power. With less power, the helicopter will start to settle, and if the collective is raised to stop it from settling, the RPM will be pulled down even lower, causing the ship to settle even faster. If the pilot not only fails to lower collective, but instead pulls up on the collective to keep the ship from going down, the rotor will stall almost immediately. When it stalls, the blades will either "blow back" and cut off the tailcone or it will just stop flying, allowing the helicopter to fall at an extreme rate. In either case, the resulting crash is likely to be fatal.

No matter what causes the low rotor RPM, the pilot must first roll on throttle and lower the collective simultaneously to recover RPM **before** investigating the problem. It must be a conditioned reflex. In forward flight, applying aft cyclic to bleed off airspeed will also help recover lost RPM.

ROBINSON
HELICOPTER COMPANY

Safety Notice SN-24

Issued: Sep 86 Rev: Jun 94

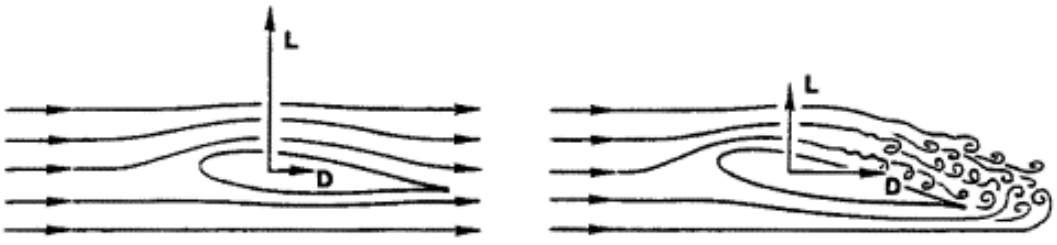
LOW RPM ROTOR STALL CAN BE FATAL

Rotor stall due to low RPM causes a very high percentage of helicopter accidents, both fatal and non-fatal. Frequently misunderstood, rotor stall is not to be confused with retreating tip stall which occurs only at high forward speeds when stall occurs over a small portion of the retreating blade tip. Retreating tip stall causes vibration and control problems, but the rotor is still very capable of providing sufficient lift to support the weight of the helicopter.

Rotor stall, on the other hand, can occur at any airspeed and when it does, the rotor stops producing the lift required to support the helicopter and the aircraft literally falls out of the sky. Fortunately, rotor stall accidents most often occur close to the ground during takeoff or landing and the helicopter falls only four or five feet. The helicopter is wrecked but the occupants survive. However, rotor stall also occurs at higher altitudes and when it happens at heights above 40 or 50 feet AGL it is most likely to be fatal.

Rotor stall is very similar to the stall of an airplane wing at low airspeeds. As the airspeed of an airplane gets lower, the nose-up angle, or angle-of-attack, of the wing must be higher for the wing to produce the lift required to support the weight of the airplane. At a critical angle (about 15 degrees), the airflow over the wing will separate and stall, causing a sudden loss of lift and a very large increase in drag. The airplane pilot recovers by lowering the nose of the airplane to reduce the wing angle-of-attack below stall and adds power to recover the lost airspeed.

The same thing happens during rotor stall with a helicopter except it occurs due to low rotor RPM instead of low airspeed. As the RPM of the rotor gets lower, the angle-of-attack of the rotor blades must be higher to generate the lift required to support the weight of the helicopter. Even if the collective is not raised by the pilot to provide the higher blade angle, the helicopter will start to descend until the



Wing or rotor blade unstalled and stalled.

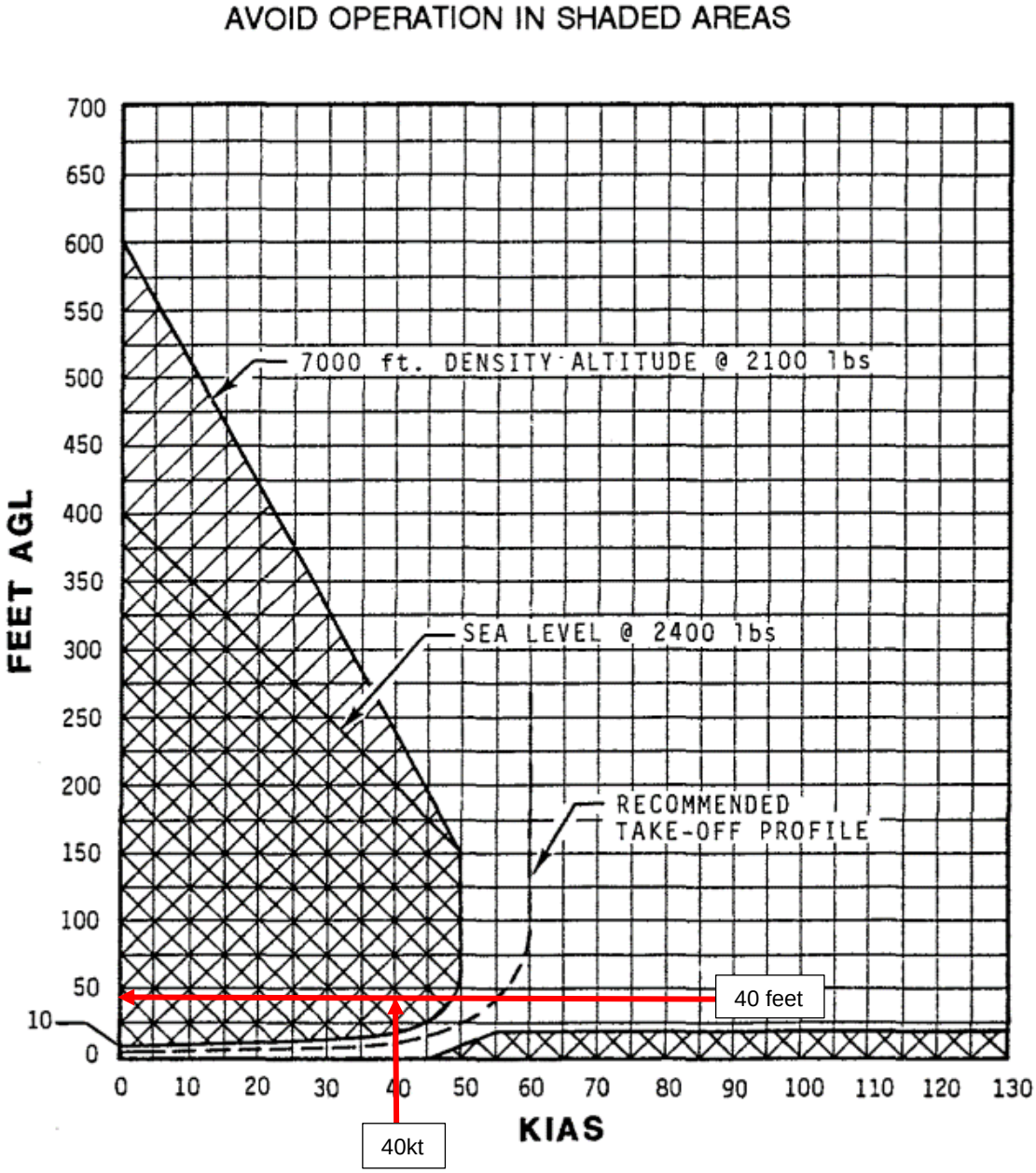
ROBINSON
HELICOPTER COMPANY

Safety Notice SN-24 (continued)

upward movement of air to the rotor provides the necessary increase in blade angle-of-attack. As with the airplane wing, the blade airfoil will stall at a critical angle, resulting in a sudden loss of lift and a large increase in drag. The increased drag on the blades acts like a huge rotor brake causing the rotor RPM to rapidly decrease, further increasing the rotor stall. As the helicopter begins to fall, the upward rushing air continues to increase the angle-of-attack on the slowly rotating blades, making recovery virtually impossible, even with full down collective.

When the rotor stalls, it does not do so symmetrically because any forward airspeed of the helicopter will produce a higher airflow on the advancing blade than on the retreating blade. This causes the retreating blade to stall first, allowing it to dive as it goes aft while the advancing blade is still climbing as it goes forward. The resulting low aft blade and high forward blade become a rapid aft tilting of the rotor disc sometimes referred to as "rotor blow-back". Also, as the helicopter begins to fall, the upward flow of air under the tail surfaces tends to pitch the aircraft nose-down. These two effects, combined with aft cyclic by the pilot attempting to keep the nose from dropping, will frequently allow the rotor blades to blow back and chop off the tailboom as the stalled helicopter falls. Due to the magnitude of the forces involved and the flexibility of rotor blades, rotor teeter stops will not prevent the boom chop. The resulting boom chop, however, is academic, as the aircraft and its occupants are already doomed by the stalled rotor before the chop occurs.

Height-Velocity Diagram for Robinson R44 Raven II (Source: Pilot's Operating Handbook [POH], Section 5, Performance, Pg. 5-6)



The pilot indicated that he was flying at a height of approximately 40ft above ground level (AGL) and at a low forward speed of about 40 knots (kts) when he encountered a sudden decay in engine and main rotor RPM.

3. Meteorological Information

3.1 The weather information in the table below was obtained from the pilot questionnaire.

Wind Direction	045°	Wind Speed	10 kt	Visibility	9999 m
Temperature	18°C	Cloud Cover	Nil	Cloud Base	CAVOK
Dew Point	10°C	QNH	1019hPa		

3.2 Density Altitude (https://wahiduddin.net/calc/calc_da.htm)

The temperature of 18°C provided by the pilot was used for the following calculations.

Elevation	3 575ft (1 090m)
Air Temperature	18°C
Altimeter Setting	1019 hPa
Dew Point	10°C
Density Altitude	**4 726ft (1 441m)**

Probable Cause

During a game darting operation whilst the pilot manipulated the flight controls, the main rotor RPM decayed, which resulted in the helicopter losing height, followed by a crash-landing as there was insufficient height available to restore the main rotor RPM to cushion the landing.

Contributing Factors

- Low-level operation within the danger area of the height-velocity diagram.
- Pilot turned downwind at low-level and low-speed.
- Engine power required exceeded the power available to maintain engine and main rotor RPM within the green arc (safe operating range).

Safety Action

None.

Safety Recommendation/Message

None.

About this Report

The decision regarding whether to investigate and the scope of an investigation are based on many factors, including the level of safety benefit likely to be obtained from an investigation. For this occurrence, a limited scope, fact gathering investigation was conducted to compile this limited report and allow for greater industry awareness of potential safety issues as well as possible safety action/s that the industry might want to consider in preventing a reoccurrence.

In terms of Regulation 12.03.1 of the Civil Aviation Regulations (CAR) 2011, this report was compiled in the interest of the promotion of aviation safety and the reduction of the risk of aviation accidents or incidents and ***not to apportion blame or liability****.*

All times given in this report are Co-ordinated Universal Time (UTC) and will be denoted by (Z). South African Standard Time is UTC plus 2 hours.

Disclaimer

This report is issued by:

Accident and Incident Investigations Division
South African Civil Aviation Authority
Republic of South Africa