LIMITED OCCURRENCE INVESTIGATION REPORT – FINAL

Reference Number	CA18/2/3/10202					
Classification	Accident	**Date**	9 August 2022	**Time**	0720Z	
Type of Operation	Aerial Work Operations – Game Capturing (Part 137)					
Location						
Place of Departure	Stone Hill Game Farm, North West Province	Place of Intended Landing	Stone Hill Game Farm, North West Province			
Place of Occurrence	Stone Hill Game Farm					
GPS Co-ordinates	Latitude 26°39'29.15" S	Longitude	026°30'36.15" E	Elevation	4 730 ft	
Aircraft Information						
Registration	ZS-RSO					
Make; Model; S/N	Robinson Helicopter Company, R44 Raven II (Serial Number: 10145)					
Damage to Aircraft	Substantial	Total Aircraft Hours	3 039.9			
Pilot-in-command						
Licence Type	Commercial Pilot Licence (H)	Gender	Male	Age	35	
Licence Valid	Yes	Total Hours	1 248.6	Total Hours on Type	873.6	
Total Hours 30 Days	76.0	Total Flying Hours on Type Past 90 Days	94.5			
People On-board	1 + 1	**Injuries**	1	**Fatalities**	0	**Other (on ground)** 0

What Happened

On Tuesday morning, 9 August 2022, a pilot and a passenger on-board a Robinson R44 Raven II helicopter with registration ZS-RSO took off on a game capture operation from Stone Hill Game Farm near Klerksdorp in the North West province, with the intention to land back at the same game farm. The pair were 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 game capture team on the ground had erected a boma. The intention was to capture five earmarked giraffes that were to be pointed out by the passenger (a game manager) on-board the aircraft.

The pilot stated that whilst flying at approximately 50 feet (ft) above ground level (AGL) as they rounded up the last giraffe into the boma, the giraffe turned and stopped, facing the helicopter. The pilot conducted a quick stop and pulled up the collective controls aggressively to gain height with the intention to hover at a safer height as the helicopter was too close to the boma 'curtain'. The pilot, who was also trying to move away from the boma curtain as the main rotor blade downwash was preventing the ground team from closing it, encountered a decay in the main rotor revolutions per minute (RPM) which activated the low main rotor RPM warning. The pilot attempted to recover from

the condition, but he was unable to as the helicopter height was too low. He then aimed for the gravel road to executive an emergency landing but collided with a barbed wire fence before the helicopter landed hard on the ground. During impact, the main rotor blades severed the tail boom. The visible damage on the main rotor blades indicated a low main rotor RPM inertia impact. The cockpit and the cabin area were severely damaged, whilst the skid gear was flattened.

The pilot complained of back pain after the accident; he was taken to the hospital in Klerksdorp where a magnetic resonance imaging (MRI) scan was performed. He was kept in hospital for two days before he was discharged. The farm manager was not injured during the accident sequence.

Figure 1: The helicopter wreckage after the accident. (Source: Pilot)

The Pilot

The pilot was initially issued a Commercial Pilot Licence (CPL) by the Regulator (SACAA) on 10 September 2018. After he completed a skills test on 12 July 2022, the licence was reissued with an expiry date of 31 August 2023. The helicopter type and the game/cull rating were endorsed on his licence. The pilot was issued a Class 1 aviation medical certificate on 27 May 2022 with an expiry date of 31 May 2023. The pilot had flown 873.6 hours on the helicopter type.

The Helicopter

The last maintenance inspection on the helicopter was certified on 26 May 2022 at 2 946.5 airframe hours. Thereafter, the helicopter was issued a Certificate of Airworthiness (C of A) on 3 June 2022 with an expiry date of 31 May 2023. The helicopter's Certificate of Release to Service (CRS) was issued by an approved aircraft maintenance organisation (AMO) on 26 May 2022 with an expiry date of 25 May 2023 or at 3 046.5 airframe hours, whichever occurs first. The helicopter was flown a further 93.4 hours since the last maintenance inspection.

Weather Information

The pilot reported the weather conditions as follows—wind direction: easterly; wind speed: 7kts; visibility: 10km; temperature: 19ºC; cloud cover: clear/none.

The pilot stated that whilst at 50 feet (ft) AGL, he aggressively manoeuvred the helicopter by conducting a quick stop and pulling up the collective to move out of the downwash so as to hover at a safer height. This action involved manipulating the collective and cyclic controls. The aggressive manoeuvre and pulling up of the collective advanced the helicopter to settle with power, and also impeded the power, preventing the helicopter from attaining the required lift. *The helicopter's governor does not respond well to sudden/ aggressive inputs*. The deflected rotor blade's high angle-of-attack encountered a high drag resistance (relative air flow) which reduced the rotor's RPM to a critical point. In turn, the helicopter settled with power; however, it could not sustain the required lift following the manoeuvres. Instead, it lost height rapidly due to the induced low rotor condition.

The copy below is an extract from the R44 Pilot's Operating Handbook: Safety Notice SN-10 and SN 24, Issued: October 82, Revision: February 1989; June 1994:

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 descend. 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 tail cone 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.

SN-24: The rotor stall on a helicopter occurs due to low rotor RPM instead of low airspeed. As the RPM of the rotor gets lower, the angle-of-attack of the 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 descent until the upward movement of air to the rotor provides the necessary increase in the 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. As the helicopter begins to fall, the upward flow of air under the tail surfaces tends to pitch the helicopter 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 tail boom 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 academic as the helicopter and its occupants are already doomed by the stalled rotor before the chop occurs.

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.

According to emergency procedures:

If the helicopter experiences any power failure during flight between 8ft and 500ft, lower collective immediately to maintain rotor RPM. Adjust collective to keep RPM between 97% and 108% or apply full down collective if light weight prevents attaining above 97%. Maintain airspeed until ground is approached, then begin cyclic flare to reduce rate of descent and forward speed. At about 8ft AGL, apply forward cyclic to level the helicopter and collective just before touchdown to cushion landing. Touchdown in level attitude with nose straight ahead.

At the time of the flight, the helicopter was operated in a low height-velocity and low forward speed, indicated by the shaded area in the diagram below.

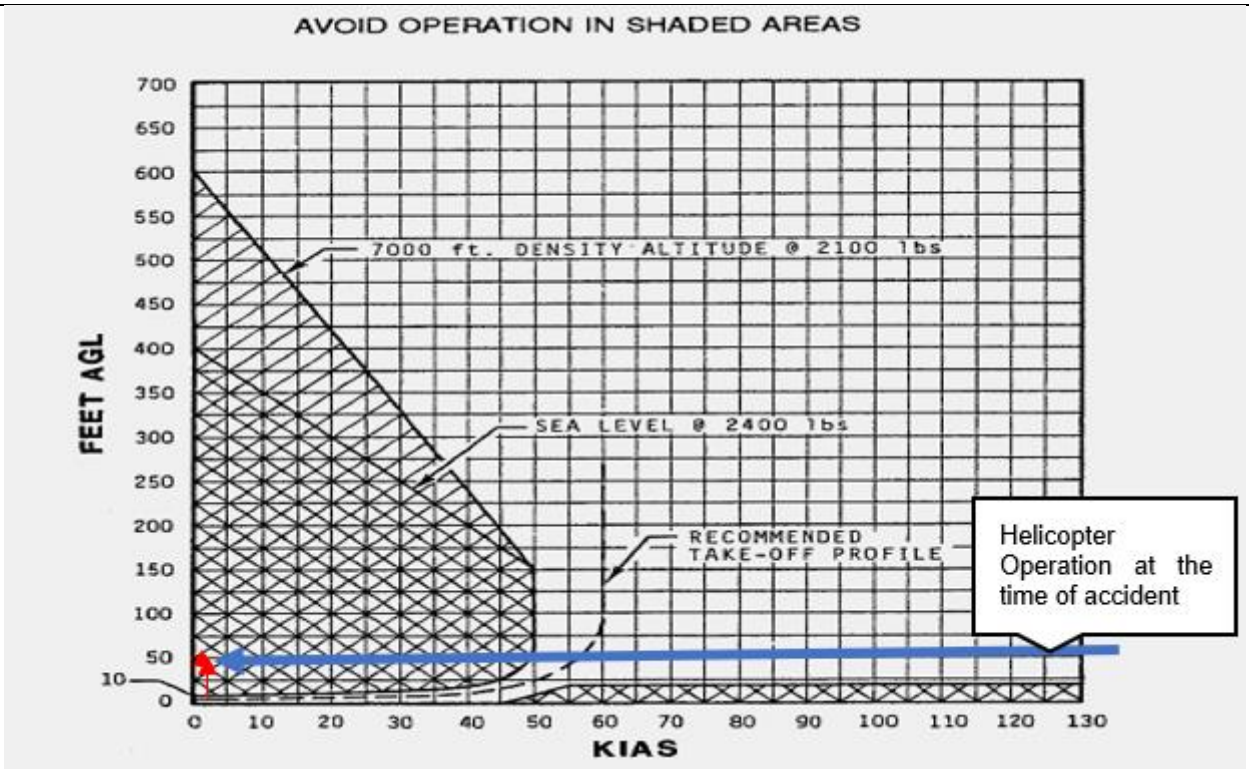

Diagram 1: Height-velocity of the helicopter at the time of the flight.

Findings

(i) The pilot was issued a Commercial Pilot Licence (CPL) by the Regulator on 12 July 2022 with an expiry date of 31 August 2023.

(ii) His Class 1 medical certificate was issued on 27 May 2022 with an expiry date of 31 May 2023.

(iii) The pilot had flown a total of 1 248.6 hours of which 873.6 hours were on the helicopter type.

(iv) The pilot had a game/cull rating on his licence, and the helicopter type was endorsed on it.

(v) The last maintenance inspection that was carried out on the helicopter prior to the accident flight was certified on 26 May 2022 at 2 946.5 airframe hours. A further 93.4 hours were flown on the helicopter since the said inspection.

(vi) The helicopter was issued a C of A on 3 June 2022 with an expiry date of 31 May 2023.

(vii) The helicopter sustained substantial damage during the accident sequence.

(viii) The pilot suffered back pain during the accident and was admitted to the hospital; he was kept for observation for two days before he was discharged.

(ix) Clear and good weather conditions prevailed at the time of the flight.

(x) The flight was conducted under the provisions of Part 137 of the CAR 2011 as amended.

Probable Cause

During a game capture operation whilst the pilot manipulated the flight controls, the main rotor RPM decayed, which resulted in the helicopter losing height and crash-landing as there was insufficient height available to recover.

Contributing Factor(s)
None.
Safety Action(s)
None.
Safety Message and/or Safety Recommendation/s
None.
About this Report
The decision to conduct a limited investigation is based on factors, including whether the cause is known and the evidence supporting the cause is clear, the level of safety benefit likely to be obtained from an investigation and that will determine the scope of an investigation. For this occurrence, a limited investigation has been conducted, and the Accident and Incident Investigations Division (AIID) has relied on the information submitted by the affected person/s and organisation/s to compile this limited report. The report has been compiled using information supplied in the initial notification, as well as from follow-up desk top enquiries to bring awareness of potential safety issues to the industry in respect of this occurrence, as well as possible safety action/s that the industry might want to consider in preventing a recurrence of a similar occurrence. *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.*
Purpose
In terms of Regulation 12.03.1 of the Civil Aviation Regulations (CAR) 2011 and ICAO Annex 13, 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.
Disclaimer
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This report is issued by:

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