SOUTH AFRICAN CIVIL AVIATION AUTHORITY

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

LIMITED OCCURRENCE INVESTIGATION REPORT – FINAL

Reference Number	CA18/2/3/10370								
Classification	Accident		**Date**	30 September 2023		**Time**	1525Z		
Type of Operation	Commercial (Part 127)								
Location									
Place of Departure	One United Sports Ground in Pine Ridge, Mpumalanga Province		Place of Intended Landing	Burgersfort, Limpopo Province					
Place of Occurrence	On Gazania Street in Pine Ridge Suburb, Emalahleni, approximately 1 nautical mile (nm) north of FAWI, Mpumalanga province								
GPS Co-ordinates	Latitude	25º48'57.38" S	Longitude	029º11'.46.36" E		Elevation	4 908 feet		
Aircraft Information									
Registration	ZS-RXY								
Make; Model; S/N	Robinson Helicopter Company R44; Raven II (Serial Number: 10910)								
Damage to Aircraft	Substantial			Total Aircraft Hours		2 428.4			
Pilot-in-command									
Licence Type	Commercial Pilot Licence (CPL)		Gender	Male		Age	61		
Licence Valid	Yes	Total Hours	1 657.2	Total Hours on Type		1 405.1			
Total Hours 90 Days	15.3		Total Flying on Type Past 30 Days	15.3					
People On-board	1 + 2	**Injuries** 0	**Fatalities**	0	**Other (on ground)**	0			

What Happened

On Saturday afternoon, 30 September 2023, a pilot and two passengers on-board a Robinson R44 Raven II helicopter with registration ZS-RXY were on a commercial charter flight from One United sports ground in Pine Ridge, approximately 1 nautical mile (nm) north of Witbank Aerodrome (FAWI) in Mpumalanga province, with the intention to fly to Burgersfort in Limpopo province when the accident occurred. Visual meteorological conditions (VMC) by day prevailed at the time of the flight which was conducted under the provisions of Part 127 of the Civil Aviation Regulations (CAR) 2011 as amended.

The pilot reported that around 1054Z on Saturday morning 30 September 2023, he collected two passengers from Pietersburg Civil Aerodrome (FAPI) in Polokwane, Limpopo province, and thereafter flew to Groblersdal Aerodrome (FAGL), also in Limpopo province, to refuel the helicopter. The first passenger was seated on the left front seat and the second passenger was seated on the rear seat behind the pilot (front right side). The flight to FAGL was uneventful. About 93 litres (l) of Avgas 100LL fuel was uplifted at FAGL. The helicopter took off again to Pine Ridge, Emalahleni, and landed at One United sports ground. The duration of the flight was 1.1 hours.

The two passengers disembarked from the helicopter, and the pilot remained behind awaiting their return. Around 1504Z, the two passengers returned to the sports ground where the helicopter was

parked; they requested that the pilot fly them to Burgersfort in Limpopo province. The pilot performed a pre-flight inspection, and no abnormalities were noted. Once on-board, the pilot conducted a safety briefing and made sure that the passengers were properly harnessed before he started the engine. He allowed it (the engine) to warm up until all the instruments had stabilised and were within the normal operating limits (green arch). At 1520Z, the helicopter lifted off and the pilot kept an eye on the bystanders at the sports ground.

Whilst approximately 30 feet (ft) above ground level (AGL) at a forward speed of approximately 25 knots, the revolutions per minute (RPM) light illuminated which indicated low main rotor RPM, this was followed by the audio warning buzzer. The helicopter lost height and crash-landed on Gazania Street in Pine Ridge before it rolled over to the right. As it rolled, the rotor blades struck the ground. The helicopter came to rest on its right side. The pilot turned off the master and fuel switches. No pre- or post-impact fire was reported. All the occupants disembarked from the helicopter through the left front door and windscreen; they were taken to Emalahleni Hospital for medical assessment. They were later released from hospital; none of them was injured. The helicopter was substantially damaged.

The accident occurred during daylight on a public road at Global Positioning System (GPS) co-ordinates determined to be 25º48’57.38” South 029º11’46.36” East, at an elevation of 4 908 ft.

Figure 1: Aerial view of the take-off and the accident site. (Source: Google Earth Maps)

Figure 2: The helicopter at the accident side. (Source: Operator)

Figure 3: The open right front door and a broken wind screen. (Source: Operator)

The helicopter information (Source: Pilot's Operating Handbook [POH])

The Robinson R44, Raven II is four-place light helicopter powered by a Lycoming IO-540-EA1A5 six-cylinder fuel injected engine, bearing serial number L-30488-48A. The helicopter comprises the skid-type landing gear and has a counter-clockwise rotating two-bladed main rotor, with a diameter of 10.06 metres (m), and a two-bladed tail rotor, with a diameter of 1.47m. A cyclic control stick is located between the front seats and operated via a control grip in front of the pilot. The control grip is fitted to a cross tube connected to the cyclic control stick. A collective control lever is located to the left of each front seat; a twist-grip throttle control is located on each collective lever. An RPM governor assists in controlling the engine RPM under normal conditions and can be over-ridden by the pilot using the throttle twist-grip.

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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.

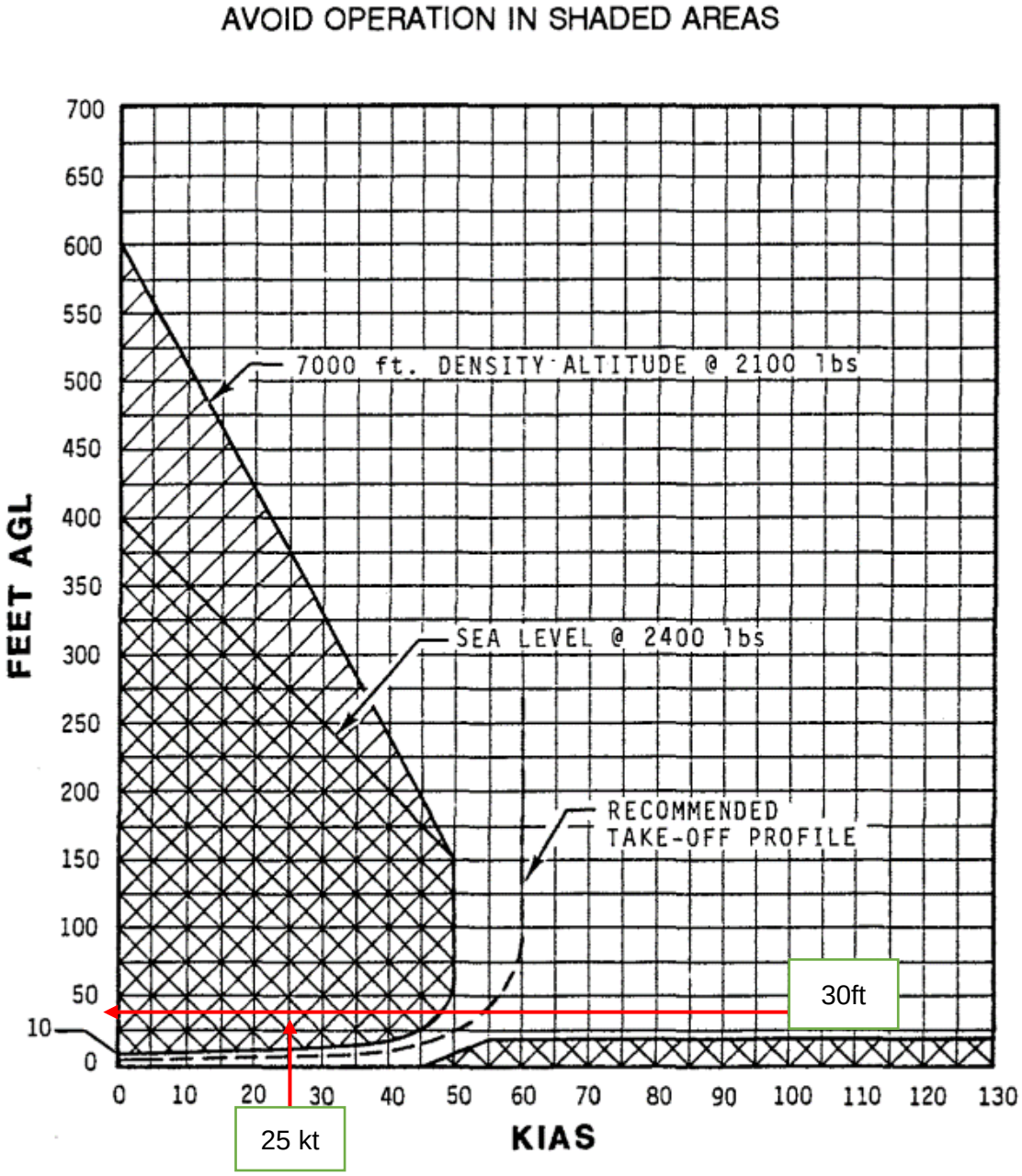
The R22 and R44 have demonstrated excellent crashworthiness as long as the pilot flies the aircraft all the way to the ground and executes a flare at the bottom to reduce his airspeed and rate of descent. Even when going down into rough terrain, trees, wires or water, he must force himself to lower the 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.

Height-Velocity Diagram for Robinson R44, Raven II

Source: POH, Section 5, Performance, Pg. 5-6



The pilot indicated that he was flying at a height of approximately 30 ft AGL and at a forward speed of approximately 25 knots when he encountered a sudden decay in engine and main rotor RPM.

Meteorological Information

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

Wind Direction	280º	Wind Speed	10 kt	Visibility	9999 m
Temperature	35ºC	Cloud Cover	Nil	Cloud Base	CAVOK
Dew Point	1ºC	QNH	1024hPa		

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

The temperature of 35ºC which was provided by the pilot was used for the calculation below.

Elevation	4 908 ft (1 638m)
Air Temperature	35ºC
Altimeter Setting	1024 hPa
Dew Point	1ºC
Density Altitude	**7 961ft (2 426m)**

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Safety Notice SN-24

Issued: Sep 86 Rev: Jun 94

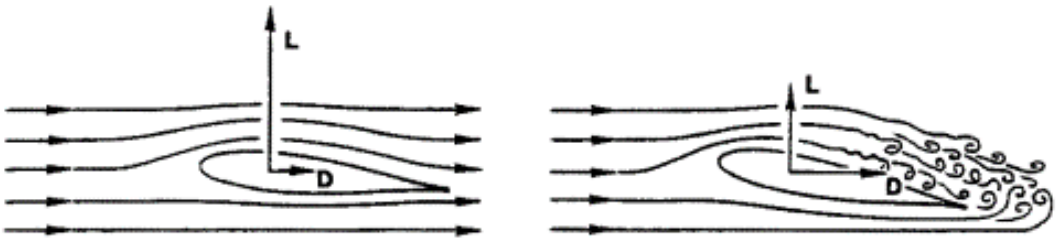
LOW RPM ROTOR STALL CAN BE FATAL

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.

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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.

Findings

1. The pilot was issued a Commercial Pilot Licence (CPL) Helicopter. The initial issue of the pilot licence was on 28 May 2012. He had flown a total of 1 657.2 hours, of which 1 405.1 were on type.

2. The pilot had a Class 1 aviation medical certificate that was issued on 5 June 2023 with an expiry date of 30 November 2023. He was required to wear corrective lenses for defective distant, intermediate and near vision.

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

4. The pilot was subjected to the proficiency check by the operator on 30 September 2023 with an expiry date of 31 March 2024. The proficiency check certificate is valid for six months.

5. The last 100-hour mandatory periodic inspection (MPI) that was conducted on the helicopter prior to the accident flight was certified by an approved maintenance organisation (AMO) on 20 September 2023 at 2 414.6 airframe hours. Since the inspection, the helicopter was flown a further 13.8 hours.

6. All the applicable Service Bulletins (SBs) and Airworthiness Directives (ADs) published by the engine and helicopter manufacturers were complied with.

7. The helicopter had a valid Certificate of Airworthiness (C of A) which was issued on 11 May 2022 with an expiry date of 10 May 2024. The helicopter was airworthy when it dispatched for the flight.

8. The helicopter's Certificate of Registration (C of R) was issued on 3 March 2022.

9. The helicopter was issued a Certificate of Release to Service (CRS) on 20 September 2023, which was valid until 16 July 2024 or at 2 419.9 airframe hours, whichever occurs first.

10. The operator was issued an Air Operating Certificate (AOC) by the South African Civil Aviation Authority (SACAA) on 20 March 2023 with an expiry date of 31 March 2024. The helicopter was authorised on the Operations Specifications certificate, which was issued by the SACAA with an effective date of 20 March 2023 with an expiry date of 31 March 2024.

11. The letter from the sports ground owner, dated 20 September 2023, revealed that the operator was granted permission to land on the premises (One United sports ground) on the day of the accident.

12. On the height velocity diagram, it is evident that one needs to increase the air speed or forward speed to 50 knots before attempting a climb out.

Probable Cause

The main rotor RPM decayed as the helicopter climbed out before it reached an air speed of 50 knots as outlined in the height velocity diagram; as a result, there was loss of lift and the subsequent crash-landing on the street.

Contributing Factors

Low-level operation within the danger area of the height velocity diagram.

Safety Action

None.

Safety Recommendation/Message

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

This report is issued by:
Accident and Incident Investigations Division
South African Civil Aviation Authority
Republic of South Africa