

LIMITED OCCURRENCE INVESTIGATION REPORT – FINAL

Reference Number	CA18/2/3/10520						
Classification	Accident	Date	19 October 2024			Time	1300Z
Type of Operation	Private (Part 91)						
Location							
Place of Departure	Kwaggasvlakte Farm in Thabazimbi, Limpopo Province		Place of Intended Landing	Kwaggasvlakte Farm in Thabazimbi, Limpopo Province			
Place of Occurrence	Bushy terrain, approximately 10 nautical miles north of Kwaggasvlakte Farm, Thabazimbi						
GPS Co-ordinates	Latitude	24°25'.54" S	Longitude	27°33'.00" E	Elevation	3 248 feet	
Aircraft Information							
Registration	ZS-PXS						
Make; Model; S/N	Robinson; R44 Raven II (Serial Number: 11882)						
Damage to Aircraft	Substantial			Total Aircraft Hours	4 264		
Pilot-in-command							
Licence Type	Commercial Pilot Licence		Gender	Male		Age	36
Licence Valid	Yes	Total Hours	9 800		Total Hours on Type	300	
Total Hours 30 Days	8.9		Total Hours on Type Past 90 Days	8.9			
People On-board	1 + 0	Injuries	0	Fatalities	0	Other (on ground)	0
What Happened							
<p>On Saturday, 19 October 2024, a pilot on-board a Robinson R44 Raven II helicopter with registration ZS-PXS was conducting a private flight from Kwaggasvlakte Farm in Thabazimbi to Limpopo River, both in Limpopo province, with the intention of return to the take-off farm. Visual meteorological conditions (VMC) by day prevailed at the time of the flight which was conducted under the provisions of Part 91 of the Civil Aviation Regulations (CAR) 2011 as amended.</p> <p>The pilot stated that before the flight, he conducted a pre-flight inspection of the helicopter and nothing abnormal was found. The helicopter had a total of 106 litres (l) of Avgas 100LL in the tanks. Around 1100Z, the helicopter lifted off from the helipad and headed in a north-easterly direction. The engine power was set at 103% (percent) revolutions per minute (RPM) and the manifold air pressure (MAP) indicated 20 inches of mercury. The flight to Limpopo River was uneventful; he did not land and, after approximately 2 hours of flight time whilst on his return to the farm, flying at 600 feet (ft) above ground level (AGL), the helicopter suddenly lost engine power. The pilot engaged the helicopter to enter autorotation to execute a forced landing; however, the helicopter impacted the ground hard with the skid landing gear. The helicopter tilted to the right and rested on its right side on a bushy terrain. The helicopter sustained substantial damage. The pilot was not injured, he vacated the helicopter unassisted.</p>							

The accident occurred during daylight, approximately 10 nautical miles (nm) north of the Kwaggasvlakte Farm at Global Positioning System (GPS) co-ordinates determined to be 24°25'.54" South 27°33'.00" East, at an elevation of 2 348ft.



Figure 1: The helicopter at the accident site. (Source: Pilot).

Helicopter Description (Source: Pilot Operating Handbook [POH])

The Robinson R44 Raven II is a four-seat helicopter powered by a six-cylinder fuel injected engine rated at 205 brake horsepower (BHP). It is certified for visual flight rules (VFR) operations only. The flight controls are actuated by a conventional system of push-pull rods and bellcranks. Power is transmitted from the engine to the main rotor gearbox by four rubber V-belts, mounted on two sheaves (pulleys). The lower sheave is bolted directly to the engine output shaft. The V-belts transmit power from the lower sheave to the upper sheave, which in turn transmits power forward to the main rotor and aft to the tail rotor, via a main rotor and tail rotor gearbox. The transmission is engaged and disengaged by means of a clutch, which is operated by a two-position guarded switch on the instrument panel. The main rotor flight controls are hydraulically boosted to eliminate cyclic and collective feedback forces. The system is designed to enhance the pilot's comfort by reducing vibration from the rotor head to the controls and reduces the required input forces the pilot has to make. The system is controlled by a HYD/OFF switch on the pilot's cyclic control and can be deactivated by placing the switch to OFF position. The hydraulic system operates at a pressure between 450 – 500psi. The helicopter is equipped with 15 warning lights on the instrument panel to warn the pilots of conditions requiring attention. Eight of these lights are on the top of the instruments panel and 7 are in the middle panel. The fuel system comprises two crashworthy bladder fuel tanks, the main tank has the capacity of 120l and the auxiliary tank 70l.

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

Wind Direction	036°	Wind Speed	5 knots	Visibility	9999 m
Temperature	18°C	Cloud Cover	8	Cloud Base	7 000ft
Dew Point	Unknown	QNH	Unknown		

Post-accident Examination of the Helicopter

Post-accident examination of the engine casing and components revealed nothing abnormal. The engine remained attached to the cradle and firewall after the accident. The helicopter had sufficient fuel. Fuel was found inside the gascolator (fuel strainer), and it was free of contaminants. The gascolator drain valve was locked (closed) and it showed no evidence of fuel leak. No evidence of fuel supply pipe disconnection was noted. The investigator-in-charge (IIC) had examined fuel records at the operator's facility. A fuel sample from the batch used to refuel the aircraft had passed the normal fuel quality examination. The fuel was certified for fuel density. There were no reports of fuel defects or challenges from other pilots (other aircraft) who had refuelled from the same fuel batch before or after the accident.

The fuel injection system nozzles were free of contaminants and delivered the minimum flow rate as per the engine maintenance manual requirements. Fuel was drained from the fuel control unit (FCU) return line and it was free of contaminants. The rigging on the engine controls was checked and found to be appropriate. The fuel filter element was free of contaminants.

The engine was removed from the airframe and secured to a test bench for examination. It started normally and idled for a brief time, then a magneto check was conducted. The engine's RPM decreased when the key was turned to the left magneto position; however, the RPM remained the same when the right magneto was selected. The key was then moved to the OFF position, and the engine continued to run. The key was jiggled, manipulated and even removed from the ignition switch, but the engine continued to run. The engine was shut down, and electrical continuity was established from the ignition switch to the magnetos. The grounding wires on the magnetos were examined and appeared to be properly secured. The wires were disconnected; they were pulled and manipulated and no anomalies were noted. The magneto grounding wires were tested using a Volt/ohm meter and they functioned normally. The grounding wires were reinstalled for each magneto and the engine was restarted. It operated normally with several normal magneto checks. The magnetos were removed from the engine and the caps were removed; there were no obvious anomalies noted with the internal components. The ignition switch was also removed and disassembled and no anomalies were noted. The magnetos were removed for a functional bench test and disassembly. During the bench test, their temperature was increased to 190 degrees (°) Fahrenheit and the magnetos performed normally. Disassembly of the magnetos did not reveal any anomalies with the E-gap, contact settings, condensers, coils and distributor gear timing that would have precluded normal operations.

The engine revealed no evidence of any pre-impact mechanical malfunctions or failures that would have precluded normal operation. The reason for the reported loss of engine power could not be determined.

Robinson R44 Characteristics and Emergency Procedures (Source: POH)

The Robinson R44's main rotor is considered a low-inertia rotor system. This type of rotor has a tendency to deplete its stored energy quickly, leading to the decay of main-rotor RPM (Nr). Engine power is transmitted to the main rotor through a belt system, with the engine and transmission engaged through progressive tensioning of the belts. When the main rotor ceases to be driven by the engine, the pilot must quickly lower the collective to compensate for the rapid decay in Nr and ultimately prevent an aerodynamic stall of the main rotor.

Autorotation (Source: POH)

Autorotation permits a helicopter to descend in a controlled manner after engine power loss or other catastrophic mechanical failure and still permits the pilot to carry out a safe landing. A critical aspect of autorotation is the entry manoeuvre immediately following the loss of engine power because the pilot must react quickly to conserve rotor RPM. Of the other factors affecting autorotative flight, the existence of sufficient altitude at the time of the loss of engine power is critical to a successful descent and landing. The no-engine landing after an autorotative descent is a challenging manoeuvre for any pilot since it involves skills not frequently practised.

Following a loss of engine power, the pilot must lower the collective pitch control full down in an effort to prevent loss of Nr and obtain sufficient airflow to turn the main rotor. During flight, the engine provides the power needed to drive the rotors. When the engine fails or the clutch system suffers a mechanical breakdown, some other force must be used to drive the rotors so that the helicopter can descend safely to the ground. This force, generated when sufficient air flows through the main rotor during descent to overcome blade drag, is provided by the potential energy stored by the helicopter. In other words, as the helicopter's altitude decreases, potential energy in the form of loss in altitude is traded off to place kinetic energy in the rotor system.

The Robinson R44 POH describes, as follows, the recommended procedure for an autorotation at an altitude greater than 500 ft AGL:

- *Lower collective immediately to maintain main rotor RPM and enter normal autorotation;*
- *Establish a steady glide at approximately 70 KIAS;*
- *Adjust collective to keep rotor RPM in the green arc (or lower the collective completely if the weight of the helicopter prevents the pilot from attaining more than 97% RPM)*
- *Select landing area and, if altitude permits, manoeuvre so landing is into wind*
- *At 40 feet AGL, begin cyclic flare to reduce rate of descent and forward airspeed*
- *At 8 feet AGL, apply forward cyclic to level the ship and raise collective before touchdown to cushion the landing. Touchdown in a level attitude with the nose straight ahead*

Findings		
1.	<u>Personnel Information</u>	
1.1	The pilot had a Commercial Pilot Licence (CPL) that was initially issued by the Regulator (SACAA) on 7 May 2008. The licence was reissued on 21 May 2024 with an expiry date of 31 May 2025. The pilot had flown a total of 9 800 hours of which 300 hours were on the helicopter type.	
1.2	The pilot was issued a Class 1 aviation medical certificate on 11 April 2024 with an expiry date of 30 April 2025.	
1.3	The pilot had no restrictions on his medical certificate.	
2.	<u>Aircraft Information</u>	
2.1	The last 100-hour mandatory periodic inspection (MPI) of the helicopter was conducted and certified on 22 February 2024 at 4 217.3 airframe hours. A further 46.7 hours were flown on the helicopter since the MPI.	
2.2	The aircraft maintenance organisation (AMO) that certified the last inspection was issued an AMO Certificate on 31 October 2023 with an expiry date of 30 November 2024.	
2.3	The helicopter had a valid Certificate of Airworthiness (C of A) that was initially issued on 18 September 2007. The latest C of A was issued on 30 September 2024 with an expiry date of 30 September 2025.	
2.4	The helicopter's Certificate of Registration (C of R) was issued to the present owner on 5 August 2024.	
2.5	The helicopter was issued a Certificate of Release to Service (CRS) on 22 February 2024 with an expiry date of 21 February 2025 or at 4 316.1 airframe hours, whichever occurs first.	
2.6	The reason for the reported loss of engine power could not be determined.	
Probable Cause(s)		
An undetermined engine power loss which resulted in an unsuccessful forced landing on a bushy terrain.		
Contributing Factor(s)		
It is possible that the pilot allowed the main rotor RPM to decay below the acceptable limits (97%) whilst flying back to Kwaggasvlakte Farm in Thabazimbi.		
Safety Action(s)		
None.		

Safety Message and/or Safety Recommendation/s
None.
About this Report
<p><i>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 desktop inquiries 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.</i></p> <p><i>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.</i></p>
Purpose
<p><i>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.</i></p>
Disclaimer
<p><i>This report is produced without prejudice to the rights of the AIID, which are reserved.</i></p>

This report is issued by:

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