LIMITED OCCURRENCE INVESTIGATION REPORT – FINAL

Reference Number	CA18/2/3/10495										
Classification	Accident			**Date**	16 September 2024			**Time**	1520Z		
Type of Operation	Private (Part 91)										
Location											
Place of Departure	Doornhaag Farm near Vryburg, North West Province			Place of Intended Landing	Tswalu Nature Reserve, Northern Cape Province						
Place of Occurrence	Uneven terrain at Doornhaag Farm										
GPS Co-ordinates	Latitude	27°01'37.69" S		Longitude	024°31'11.52" E			Elevation	4 165 ft		
Aircraft Information											
Registration	ZT-RBY										
Make; Model; S/N	Robinson Helicopter Company; R44 Raven II (Serial Number: 14074)										
Damage to Helicopter	Substantial				Total Aircraft Hours			2259.01			
Pilot-in-command											
Licence Type	Commercial Pilot Licence (CPL)				Gender	Male		Age	29		
Licence Valid	Yes		Total Hours		3018.7	Total Hours on Type			2 700		
Total Hours Past 30 Days	103.3				Total Flying Hours on Type Past 90 Days				170.4		
People On-board	1 + 1	**Injuries**	0		**Fatalities**	0	**Other (on ground)**		0		

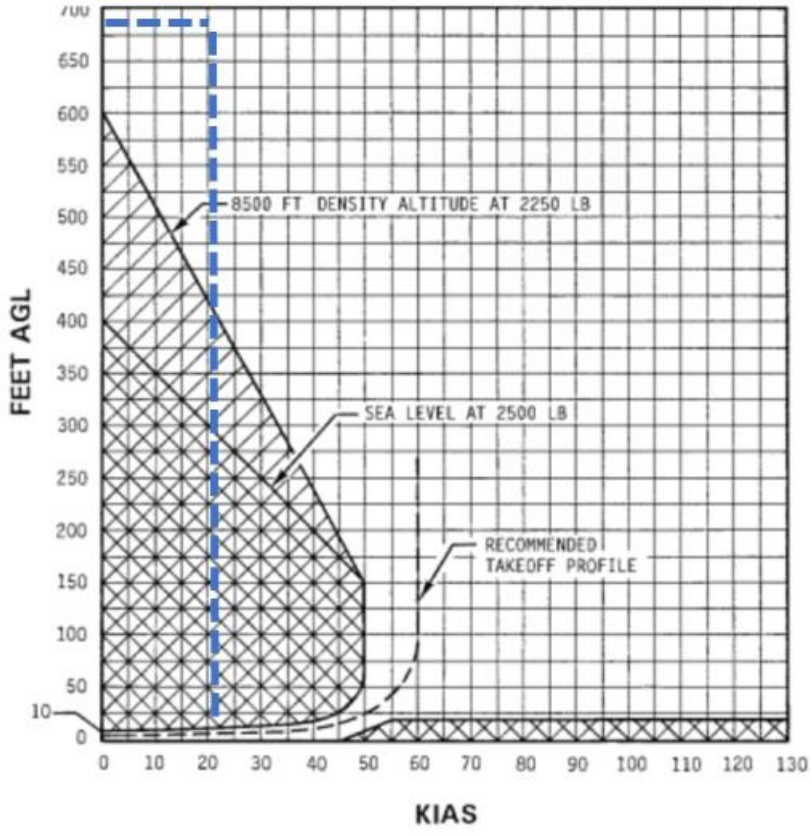
What Happened

On Monday afternoon, 16 September 2024, a pilot and a passenger on-board a Robinson R44 helicopter with registration ZT-RBY took off on a private flight from Doornhaag Farm near Vryburg in the North West province with the intention to land at Tswalu Nature Reserve in the Northern Cape province. The flight was conducted under visual meteorological conditions (VMC) by day and under the provisions of Part 91 of the Civil Aviation Regulations (CAR) 2011 as amended.

The pilot reported that whilst transitioning at approximately 20 feet (ft) above ground level (AGL) at 20 knots (kts), the low rotor revolutions per minute (RPM) warning light and horn activated; consequently, the helicopter lost height rapidly. The pilot assessed and identified an area on which to perform a forced landing in the farm. As the pilot executed the forced landing, the tail rotor blades impacted the farm's barrier fence and the helicopter landed hard, followed by the main rotor blades impacting the tail boom. The pilot and the passenger were not injured during the accident sequence. The tail boom was substantially damaged. The accident occurred at Global Positioning System (GPS) co-ordinates determined to be 27°01'37.7" South 024°31' 11.5" East, at an elevation of 4160 ft.

Figure 1: Take-off direction and accident site. (Source: Google Maps)

Figure 2: The helicopter post-accident. (Source: Operator)



Graph 1: Height Velocity Diagram.

The blue line in the graph indicate that the pilot initiated a climb into the dead man's curve before he could attain the recommended speed of climb at 50 or 60 kts.

Pressure Altitude = 4167 ft

Temperature = 28°C

Density Altitude = 6700 ft

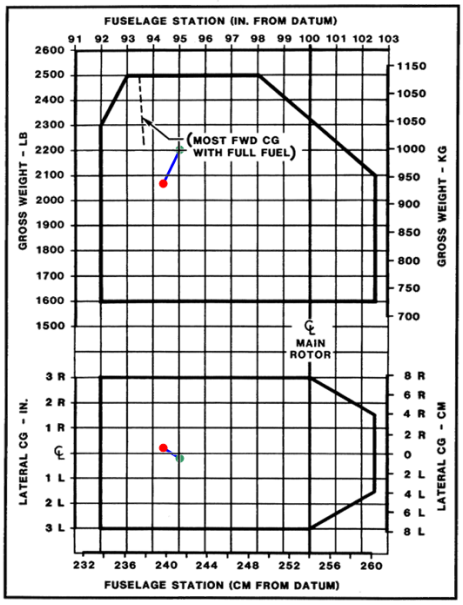
R44 II Weight and Balance

	WEIGHT	LONG. ARM	LONG. MOM.	LAT. ARM	LAT. MOM.
Empty Weight	1500.00	107.21	160815.00	0.00	0.00
Pilot	190	49.5	9405.00	+12.2	2318.00
Pilot Baggage	0	44.0	0.00	+11.5	0.00
Fore Passenger	170	49.5	8415.00	-10.4	-1768.00
Fore Passenger Baggage	0	44.0	0.00	-11.5	0.00
Right Aft Passenger	100	79.5	7950.00	+12.2	1220.00
Right Aft Baggage	0	79.5	0.00	+12.2	0.00
Left Aft Passenger	100	79.5	7950.00	-12.2	-1220.00
Left Aft Baggage	11	79.5	874.50	-12.2	-134.20
Total Weight & Balance w/Zero Usable Fuel	No Fuel Weight	No Fuel Long. C.G.	Long. Empty Moment	No Fuel Lat. C.G.	Lat. Empty Moment
	2071.00	94.36	195409.50	0.20	415.80
Main Tank	100.00	106.0	10600	-13.5	-1350
Aux Tank	33.00	102.0	3366	+13.0	429
Total Weight & Balance w/Take Off Fuel	Take Off Weight	Long. Full CG	Long. Full Moment	Lat. Full CG	Lat. Full Moment
	2204.00	95.00	209375.50	-0.23	-505.20

Fuel Availability @ Weight		Fuel Conversion Calculator			
Max. Gross Weight	2500	Main Tank Pounds	0.00	0.00	← Gallons
Payload	571	Main Tank Gallons	30.60	183.60	← Pounds
Max. Fuel (Pounds)	160.40	Aux. Tank Pounds	0.00	0.00	← Gallons
Max. Fuel (Gallons)	26.73	Aux. Tank Gallons	18.30	109.80	← Pounds
			Total 48.90	Total 293.40	

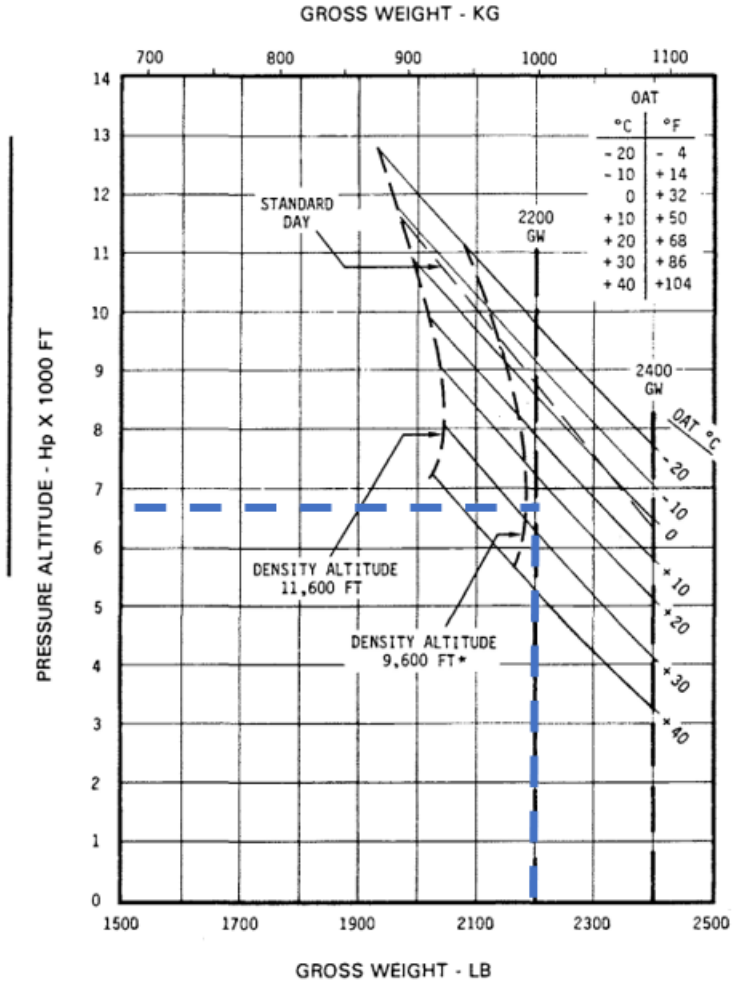
Legend
Blue = Enter Value
Red = Computed Value
Black = Constant Value
Bold Green = With Fuel
Bold Red = Without Fuel

Removable Items
☑ Pilot Door ☑ Left Fore Door
☑ Right Aft Door ☑ Left Aft Door
Left Side Controls
☑ Cyclic ☑ Collective ☑ Pedals



Graph 2: Weight and Balance

The above table is for weight and balance calculations. Although it was within weight limits as per the helicopter design specifications, the required weight limits at given condition were exceeded.



IGE HOVER CEILING VS. GROSS WEIGHT

Graph 3: Shows in effect ground hover vs gross weight

Helicopter's empty weight = 1572 pounds (lb) or 713 kilograms (kg)

Fuel = 42 United States gallons (USG) or 159 litres (l) which is equal to 118kg

Weight of the crew = equalled 94kg and 75kg, totalling 169kg

Total = 713kg + 118kg + 169kg = 1000kg or 2204lb

Pressure Altitude = 4167 ft

Temperature = 28°C

Density Altitude = 6700 ft

The following information is an extract from the Robinson's R44 helicopter Pilot's Operating Handbook (POH)

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.

Findings

Man

1. The pilot was initially issued a Commercial Pilot Licence (CPL) by the Regulator (SACAA) on 17 December 2023 with an expiry date of 31 December 2024. The pilot had flown a total 2700 hours on the helicopter type. The pilot had the helicopter type endorsed on his licence.

2. The pilot had a valid Class 1 aviation medical certificate that was issued on 24 November 2023 with an expiry date of 30 November 2024.

3. The helicopter's engine experienced low rotor RPM and the pilot decided to execute a forced landing; however, due to low height, the pilot was unable to safely recover the helicopter.

Machine

4. The Regulator issued the helicopter's Certificate of Registration (C of R) to the present owner on 21 September 2017.

5. The helicopter had a valid Certificate of Airworthiness (C of A) that was initially issued on 17 October 2017 with an expiry date of 31 October 2025.

6. The last 100-hour annual inspection was certified on 8 August 2024 at 2 200.79 total airframe hours. The aircraft was issued a Certificate of Release to Service (CRS) on 28 March 2024 at 2065.87 hours with an expiry date of 27 March 2025 or at 2165.87 hours, whichever occurs first. There were no defects recorded on the aircraft maintenance documents at the time of the flight.

7. Loss of engine power was caused by excessive power demand (demanded power exceeded the available power) at high-density altitude. The significantly increased density altitude impaired the helicopter's lift capabilities, which led to low rotor RPM.

8. The total weight at the high-end of operational limitations may have exacerbated performance issues in a high-density altitude environment.

Environment

9. The calculated density altitude at 28°C was 6700 ft and was significantly higher than the actual elevation of 4 167ft. Therefore, this affected the helicopter's performance (which was the reduced lift capability).

Probable Cause

Unsuccessful forced landing after take-off due to loss of engine rotor RPM as a result of high-density altitude. The helicopter landed hard, and the tail rotor struck the tail boom.

Contributing Factor

Density altitude.

Safety Action(s)

None.

Safety Message

This accident highlights the importance of understanding environmental factors, weight management and the effectiveness of warning systems in aviation operations. Pilots should

consistently adhere to safe flight operation practices and follow standard operating procedures by conducting comprehensive pre-flight, flight planning and risk assessments.

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