AIRCRAFT ACCIDENT REPORT AND EXECUTIVE SUMMARY

				Reference:	CA18/2/3/8470		
Aircraft Registration	ZS-RTK	**Date of Accident**	7 April 2008		**Time of Accident**	0610Z	
Type of Aircraft	Robinson R44 Raven II (Helicopter)		**Type of Operation**		Private		
Pilot-in-command Licence Type	Private		**Age**	33	**Licence Valid**	Yes	
Pilot-in-command Flying Experience	Total Flying Hours	1 224.0			Hours on Type	147.0	
Last point of departure	Oryx Safari Game Farm (near Kuruman, Northern Cape)						
Next point of intended landing	Oryx Safari Game Farm (near Kuruman, Northern Cape)						
Location of the accident site with reference to easily defined geographical points (GPS readings if possible)							
Oryx Safari Game Farm (GPS position: South 27°32,392', East 023°21,728') Elevation 4 698 feet							
Meteorological Information	There was no wind reported; Temperature: 12°C; Visibility: 10 km						
Number of people on board	1 + 2	**No. of people injured**	0	**No. of people killed**	0		

Synopsis

The pilot, accompanied by two passengers, was engaged in a private flight on a game farm when the accident occurred. He stated that he observed a herd of antelope on his left-hand side so decided to turn towards them. During the turn, the main rotor RPM started to decay.

He attempted to recover from this low rotor RPM situation, but was unsuccessful. He had no option but to execute a forced landing in an open field, which resulted in a hard landing. The helicopter skidded for approximately 5 metres before rolling over onto its left side.

The aircraft was substantially damaged, but nobody on board was injured.

Probable Cause

Following an abrupt manoeuvre by the pilot, the main rotor RPM decayed and the pilot was unable to recover, making impact with the ground inevitable.

IARC Date		Release Date	

AIRCRAFT ACCIDENT REPORT

Name of Owner/Operator	**:** G.R. Eccles
Manufacturer	**:** Robinson Helicopter Company
Model	**:** R44, Raven II
Nationality	**:** South African
Registration Marks	**:** ZS-RTK
Place	**:** Oryx Safari Game Farm, Kuruman
Date	**:** 7 April 2008
Time	**:** 0610Z

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 of the Investigation

In terms of Regulation 12.03.1 of the Civil Aviation Regulations (1997), 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 establish legal liability****.*

Disclaimer

This report is produce without prejudice to the rights of the CAA, which are reserved.

1. FACTUAL INFORMATION

1.1 History of Flight

1.1.1 The pilot, accompanied by two passengers, was engaged in a private flight when the accident occurred. According to the pilot, he had been flying at a height of between 50 and 100 feet above ground level (AGL) when he observed a herd of antelope on his left-hand side. He immediately turned left and in the turn, the main rotor RPM started to decay.

1.1.2 He attempted to recover from this low main rotor RPM situation but was unsuccessful.

1.1.3 He then opted to land, which resulted in the aircraft landing hard. It skidded and rolled over onto its left side.

1.1.4 The accident occurred during daylight conditions at geographical position South 27°32’392” East 023°21’728”, at an elevation of 4 698 feet above mean sea level (AMSL).

1.2 Injuries to Persons

Injuries	Pilot	Crew	Pass.	Other
Fatal	-	-	-	-
Serious	-	-	-	-
Minor	-	-	-	-
None	1	-	2	-

1.3 Damage to Aircraft

1.3.1 The aircraft was substantially damaged.

Figure 1: The extent of the damage to the aircraft.

1.4 Other Damage

1.4.1 There was no other damage caused.

1.5 Personnel Information

1.5.1 Pilot-in-command

Nationality	South African	Gender	Male	Age	33
Licence Number	**********	Licence Type	Private		
Licence valid	Yes	Type Endorsed	Yes		
Ratings	Game/Livestock Cull Rating				
Medical Expiry Date	30 November 2009				
Restrictions	Must wear hearing protection				
Previous Accident/s	Yes (2)				

1.5.2 The two accidents that the pilot was previously involved in occurred on 13 September 2006 and on 3 November 2006 respectively. The pilot was flying Robinson R22-type helicopters during both occurrences. In the first accident, the pilot stated that he experienced a severe down draft whilst flying through a ravine during a game counting exercise, which led to a decay in main rotor RPM. In the second accident, the pilot was engaged in a scenic private flight over a farm when the port side skid made contact with overhead electrical wires during a turn.

Flying Experience

Total Hours	1 224.0
Total Past 90 Days	109.8
Total on Type Past 90 Days	15.7
Total on Type	147.0

1.6 Aircraft Information

1.6.1 Airframe

Type	Robinson R44, Raven II	
Serial Number	10298	
Manufacturer	Robinson Helicopter Company	
Date of Manufacture	8 March 2004	
Total Airframe Hours (at time of accident)	344.5	
Last MPI and Rebuild (Hours & Date)	310.0	4 December 2007
Hours since Last MPI	34.5	
C of A (Issue Date)	19 December 2007	
C of R (Issue Date) (Present Owner)	20 December 2007	
Operating Categories	Standard	

1.6.2 The helicopter was involved in an accident on 8 November 2004, and was at first considered destroyed. It was repaired, however, and certified serviceable and airworthy by Aircraft Maintenance Organisation (AMO) No. 905 on 3 December 2007.

1.6.3 Engine

Type	Lycoming IO-540-AE1A5
Serial Number	L29207-48A
Hours since New	344.5
Hours since Overhaul	TBO not yet reached

1.6.4 The pilot did not report any defect or malfunction with the engine prior to or during the flight that could have contributed to or caused the accident. He switched the engine off after the helicopter came to rest following impact with the ground.

1.6.5 Weight and Balance

	Weight (lbs)	Arm (inches)	Moment (in-lbs)
A/C empty weight	1 505.7	106.2	159 905
Pilot (85kg)	187.0	49.5	9 257
Fwd passenger (70kg)	154.0	49.5	7 623
Aft passenger (80kg)	176.0	79.5	13 992
Baggage (3.0kg)	6.6	79.5	525
Fuel main tank (21kg)	33.2	106.0	3 519
Fuel aux tank (14kg)	22.2	102.0	2 264
Weight at time of accident	**2 084.7**	**94.5**	**197 085**

The maximum certificated take-off mass for the helicopter as stipulated in Section 2, page 2-3 of the POH (Pilot's Operating Handbook) is given as 2 500 pounds (1 134 kg).

Centre of Gravity (CG) = Total Moment ÷ Weight
= 197 085 ÷ 2 084.7
= 94.5

The helicopter's weight at the time of the accident was calculated to be 415.3 pounds (178 kg) below its maximum certified take-off weight.

1.7. Meteorological Information

1.7.1 The information reflected below was obtained from an official weather report that was issued by the South African Weather Services.

Wind direction	None	Wind speed	None	Visibility	+10 km
Temperature	12℃	Cloud cover	None	Cloud base	None
Dew point	02℃				

1.8 Aids to Navigation

1.8.1 The helicopter was fitted with standard navigation equipment as approved at the time of certification by the regulator, and no defects were entered against this equipment prior to the accident or during the accident flight.

1.9 Communications

1.9.1 The aircraft was fitted with standard communication equipment as approved at the time of certification by the regulator, and no defects were entered against this equipment prior to the accident or during the accident flight.

1.10 Aerodrome Information

1.10.1 The accident did not occur at or near an aerodrome, but at geographical position South 27° 32' 392" East 023° 21' 728", at an elevation of 4 698 feet above mean sea level (AMSL).

1.11 Flight Recorders

1.11.1 The helicopter was not fitted with a flight data recorder (FDR) or cockpit voice recorder (CVR). Neither was required by regulation to be fitted to this helicopter type.

1.11.2. According to the pilot, there was a global positioning system (GPS) unit on board, but it was not switched on for the flight. The usual track, altitude and flight path information that is saved on the non-volatile memory of the unit was not available for download.

1.12 Wreckage and Impact Information

1.12.1 As the pilot attempted to land, the helicopter rolled to the right and the right skid touched the ground. The aircraft levelled out briefly, then rolled to the left hand side, and the left skid struck the ground.

1.12.2 The helicopter skidded for about 5 metres, breaking the left skid. The aircraft eventually came to a halt, lying port-side down, after impacting with the bushes.

1.12.3 The tail boom and tail rotor sustained damage as a result of the impact. The right-hand skid was partially broken and the left-hand skid broke off completely. The main cabin was also deformed, and there was damage to the firewall.

1.12.4. The picture shows the impact and skid marks left on the grass by the helicopter.

Figure 2: The ground impact markings.

1.13 Medical and Pathological Information

1.13.1 The pilot and passengers sustained no injuries. There was no evidence that physiological factors or incapacitation affected the performance of the pilot.

1.14 Fire

1.14.1 There was no evidence of a pre-or post-impact fire.

1.15 Survival Aspects

1.15.1 The accident was considered survivable and the cockpit and cabin area sustained very little damage. The occupants had made use of the helicopter-equipped safety restraining harnesses. They also managed to disembark from the wreckage unassisted.

1.16 Tests and Research

1.16.1 The aircraft was recovered to AMO No. 846, which is an approved AMO. The AMO confirmed that there was nothing wrong with the engine by cranking it after the accident.

1.17. Organisational and Management Information

1.17.1 The aircraft had a valid Certificate of Airworthiness, which was issued on 19 December 2007, and valid until 18 December 2008.

1.17.2 The last Mandatory Periodic Inspection (MPI), post repair carried out on the aircraft prior to the accident, was certified on 4 December 2008 at 310 airframe hours, and was certified by AMO No. 1053.

1.17.3 AMO No. 1053 was in possession of a valid AMO Approval, with an expiry date of 30 September 2008.

1.17.4 The major repairs on the aircraft after the previous accident were carried out by AMO No. 905, and were certified on 3 December 2007.

1.17.5 AMO No. 905 was in possession of a valid AMO Approval, with an expiry date of 31 October 2008.

1.18. Additional Information

1.18.1 Fuel Load

According to the investigating team, there was enough fuel on board the helicopter for the intended flight. According to available evidence of fuel uplift records in the flight folio, and fuel leaking from the wreckage, it was established that there was an

adequate amount of fuel onboard for this flight.

1.18.2 The Steep Turn

Reference: *Principles of Helicopter Flight* by W.J. Wagtendonk, pp 119, 120

The steep turn involves angles of bank of 45° or more. Provided the turn is level at a given altitude, the increased angle of bank must be associated with a larger total thrust so that the vertical component continues to equally oppose the aircraft weight. The associated centripetal force is then larger, meaning that the radius of the turn is smaller and the rate of turn is greater.

When an aircraft maintains a perfect constant-radius turn, the centripetal force inward must have an equally opposing force outward. There is much dispute about the name of this force but consistent with other texts, we call it centrifugal force.

Figure 15-4 below shows two forces acting beneath the helicopter in a turn. Weight acts vertically to the centre of the earth and centrifugal force acts horizontally in opposition to centripetal force. When these forces are added as vectors, a resultant force, load factor, is formed.

In a level balance turn, the load factor is equal and opposite to total rotor thrust and has a relationship to weight. The greater the angle of bank, the greater the load factor compared to weight as shown in the following table.

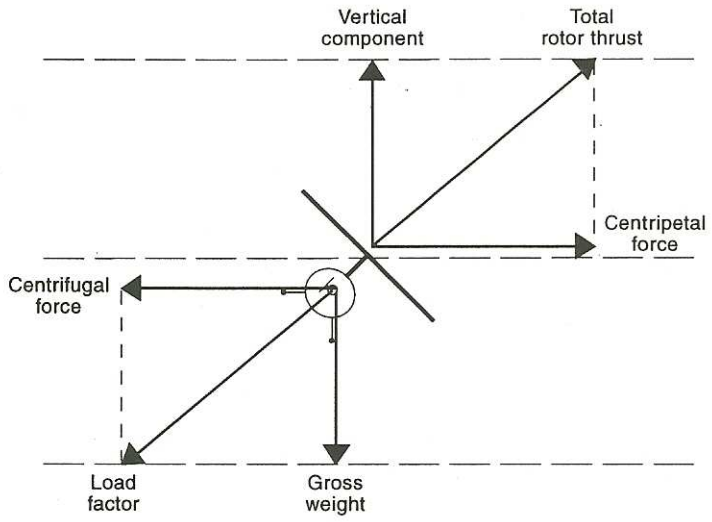

Figure 15-4. *Arrangement of forces in a steep turn*

Angle of bank	Load Factor
30°	1.2 or 20% greater than weight
45°	1.4 or 40% greater than weight
60°	2.0 or 200% greater than weight
75°	4.0 or 400% greater than weight

Power Requirement

As the angle of bank increases in a level steep turn, the increasing demand for total rotor thrust can be met only by increasing blade angles. Larger blade angles cause the total reaction to depart further from the axis of rotation, causing more rotor drag, which requires more power. The main reason for the added power requirement is the increasing induced drag as collective is raised. This type of drag is directly proportional to the lift coefficient and induced flow. Since raising collective increases these factors, induced drag increases.

The steeper the sustained level turn, the greater the total rotor thrust required, the higher the collective position and the greater the demand for power.

Since power has a limit, the ultimate factor that decides the maximum steepness of a sustained, level and balanced steep turn is the availability of surplus power. Consistent with this, for maximum-rate (minimum radius) turns, pilots should use the speed that allows the greatest surplus in power, which is the minimum straight and level (endurance) power speed.

1.19 Useful or Effective Investigation Techniques

1.19.1 None.

2. ANALYSIS

2.1. The helicopter was in a serviceable condition prior to and during the flight, according to the pilot, and no defect or malfunction was recorded that could have contributed or have caused this accident.

2.2. Fine weather conditions prevailed at the time of the flight and were not considered to have had a bearing on this accident.

2.3. According to the pilot, the flight was conducted at a height of between 50 to 100 feet AGL. The intention of the flight was private with the primary focus on game-viewing. The pilot observed a herd of antelope and immediately turned left towards the herd. It is the Investigator's opinion that this could have resulted in an abrupt turn at a steep angle of bank. Depending on the bank angle, this would most probably have increased the weight of the helicopter to a value exceeding its certified take-off weight. This can be illustrated by the following calculation. If the abrupt turn had been conducted at 30°, the weight of the helicopter would have increased by 191.2 kg, which would have brought the total weight to 1 147.2 kg, exceeding the certified take-off weight of the helicopter by 13 kg. If the turn had been conducted at 45°, the weight of the helicopter would have increased by 382.4 kg, which would have brought the total weight to 1 338.4 kg, exceeding the certified take-off weight of the helicopter by 204.4 kg or 18%. For the pilot to have maintained a level turn he had to increase his power demand. Due to this manoeuvre and the sudden increase in weight (induced by the manoeuvre), the power demand exceeded the power available to maintain the main rotor rpm within the green arc and it started to decay. With the pilot flying at low level, he was unable to address the low rotor rpm as he was required to by first levelling the helicopter and then reducing the load on the

disc by going down on collective.

2.4. Taking into account the fact that this was the pilot's third accident, certain questions could be asked about his attitude towards flying and the utilisation of the helicopters he flies in correlation to the design envelope. The pilot has also been involved in the game-capturing business for some time where there would not be more than two people in the helicopter at a given time. It is a well-known fact that most of the game capture flights are conducted at low speed and low altitude, often placing the helicopter within the dangerous shaded area of the height velocity diagram and allowing no room for error. Should a mistake be made, there is no chance to recover – as was shown in this accident, which did not allow time or altitude to recover from the low rotor rpm situation. The pilot attempted to execute a forced landing to the best of his ability with the little energy he had available in the rotor system, but a hard landing followed. This deformed the skid gear, which subsequently failed and the helicopter rolled over.

3. CONCLUSION

3.1 Findings

3.1.1 The pilot was the holder of a valid private pilot's licence with the helicopter type endorsed in his logbook.

3.1.2 The pilot had been involved in two previous accidents, one of which was of a similar nature to this accident.

3.1.3 The aircraft had a valid Certificate of Airworthiness, which was issued on 19 December 2007, with an expiry date of 18 December 2008.

3.1.4 The last Mandatory Periodic Inspection (MPI), post repair carried out on the aircraft prior to the accident, was certified on 4 December 2007, at 310 airframe hours, and was certified by AMO No. 1053.

3.1.5 The AMO to which the aircraft was recovered confirmed that there was nothing wrong with the engine by cranking it after the accident.

3.1.6 AMO No. 1053 was in possession of a valid AMO Approval, with an expiry date of 30 September 2008.

3.1.7 The major repairs on the aircraft after the previous accident were carried out by AMO No. 905, and were certified on 3 December 2007.

3.1.8 AMO No. 905 was in possession of a valid AMO Approval, with an expiry date of 31 October 2008.

3.1.9 Weather was not considered to be a factor in this accident.

3.2 Probable Cause/s

3.2.1. Following an abrupt manoeuvre by the pilot, the main rotor rpm decayed and the pilot was unable to recover from the condition, rendering ground impact inevitable.

4. SAFETY RECOMMENDATIONS

4.1. None

5. APPENDICES

5.1 There are no appendices to this report.

Report reviewed and amended by Advisory Safety Panel: 28 July 2009.

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