PRELIMINARY ACCIDENT REPORT

Accident and Incident Investigations Division

Accident
- Preliminary Report -
AIID Ref No: CA18/2/3/10004

Figure 1: The Robison R44 Ravel II Helicopter ZS-RSK. (Source: https://www.jetphotos.com/)

Description:

On 14 May 2021 at approximately 1610Z, a Robinson R44 helicopter with registration ZS-RSK was destroyed during an accident which occurred while the pilot was in a descent approach phase for landing on a prepared grass strip at Vaal Marina Bay, which leads to Vaal Dam. The helicopter, which was flown too close to the water, struck the water surface in a nose-low attitude, about 200 metres from the edge of the landing site. The two occupants and the two dogs on-board the helicopter were fatally injured during the accident sequence.

INTRODUCTION

Reference Number	**:** CA18/2/3/10004
Name of Owner/Operator	**:** Gypsy Empire Properties (Pty) Ltd
Manufacturer	**:** Robinson Helicopter
Model	**:** R44 Raven II
Nationality	**:** South African
Registration Marks	**:** ZS-RSK
Place	**:** Vaal Marina Dam, Gauteng province at GPS co-ordinates: S 26º 54' 28.1", E 028º 12' 37.0"
Date	**:** 14 May 2021
Time	**:** 1610Z

Purpose of the Investigation:

In terms of Regulation 12.03.1 of the Civil Aviation Regulations (CAR) 2011, 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****.*

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.

Investigation Process:

The accident was notified to the Accident and Incident Investigations Division (AIID) on 14 May 2021 at about 1624Z. The investigator/s dispatched to Vaal Marina Dam on 15 May 2021 to conduct an on-site (full scope) investigation. The investigator/s co-ordinated with all authorities on site by initiating the accident investigation process according to CAR Part 12 and investigation procedures. The AIID is leading the investigation as the Republic of South Africa is the State of Occurrence.

Notes:
1. Whenever the following words are mentioned in this report, they shall mean the following:

- *Accident — this investigated accident*
- *Aircraft — the R44 Raven II helicopter involved in this accident*
- *Investigation — the investigation into the circumstances of this accident*
- *Pilot — the pilot involved in this accident*
- *Report — this accident report*

2. Photos and figures used in this report were taken from different sources and may have been adjusted from the original for the sole purpose of improving clarity of the report. Modifications to images used in this report were limited to cropping, magnification, file compression; or enhancement of colour, brightness, contrast; or addition of text boxes, arrows, or lines.

Disclaimer:

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ABBREVIATION	DESCRIPTION
'	Co-ordinates minutes (distance)
"	Co-ordinates Seconds (distance)
°	Degrees
°C	Degrees Celsius
AIID	Accident and Incident Investigations Division
CAR	Civil Aviation Regulations
EASA	European Aviation Safety Agency
FAGM	Rand Airport
FAWB	Wonderboom National Airport
ft	Feet
GPS	Global Positioning System
hPa	Hectopascal
kt	Knot
m	Metres
MPI	Mandatory periodic Inspection
POH	Pilot Operating Handbook
PPL	Private Pilot License
SAWS	South African Weather Service
SB	Service Bulletins
SI	Service Instructions
SIB	Safety Information Bulletin
SL	Service Letters
Z	Zulu (Term for Universal Co-ordinated Time - Zero Hours Greenwich)

1. FACTUAL INFORMATION

1.1. History of Flight

1.1.1 On 14 May 2021, a Robinson R44 Raven II helicopter with registration mark ZS-RSK was involved in a fatal accident in the Vaal Marina Bay which leads to the Vaal Dam in Gauteng province. On-board the helicopter were two occupants, the pilot-in-command who was seated on the right-side of the helicopter, and the passenger seated on the left-side, as well as two dogs, seated on the rear seats of the helicopter. The helicopter was operated privately under the provisions of Part 91 of the Civil Aviation Regulations (CAR) 2011 as amended.

1.1.2 The passenger was the pilot's sister who was from George, Western Cape. She was coming for a weekend visit with family at their weekend home in Vaal Marina Bay.

1.1.3 The helicopter took off from Rand Airport (FAGM) at approximately 1530Z with the intention to land at the pilot's residential house, located at Burgundy Bay in Vaal Marina Bay. The helicopter took off in visual meteorological conditions by day, and it approached the intended landing destination at dusk.

1.1.4 The helicopter approached from the north-westerly direction and was flying at a low height above water before making a turn (over the water) to line up for a straight-in approach for landing on an open grassy strip between the dam and the houses.

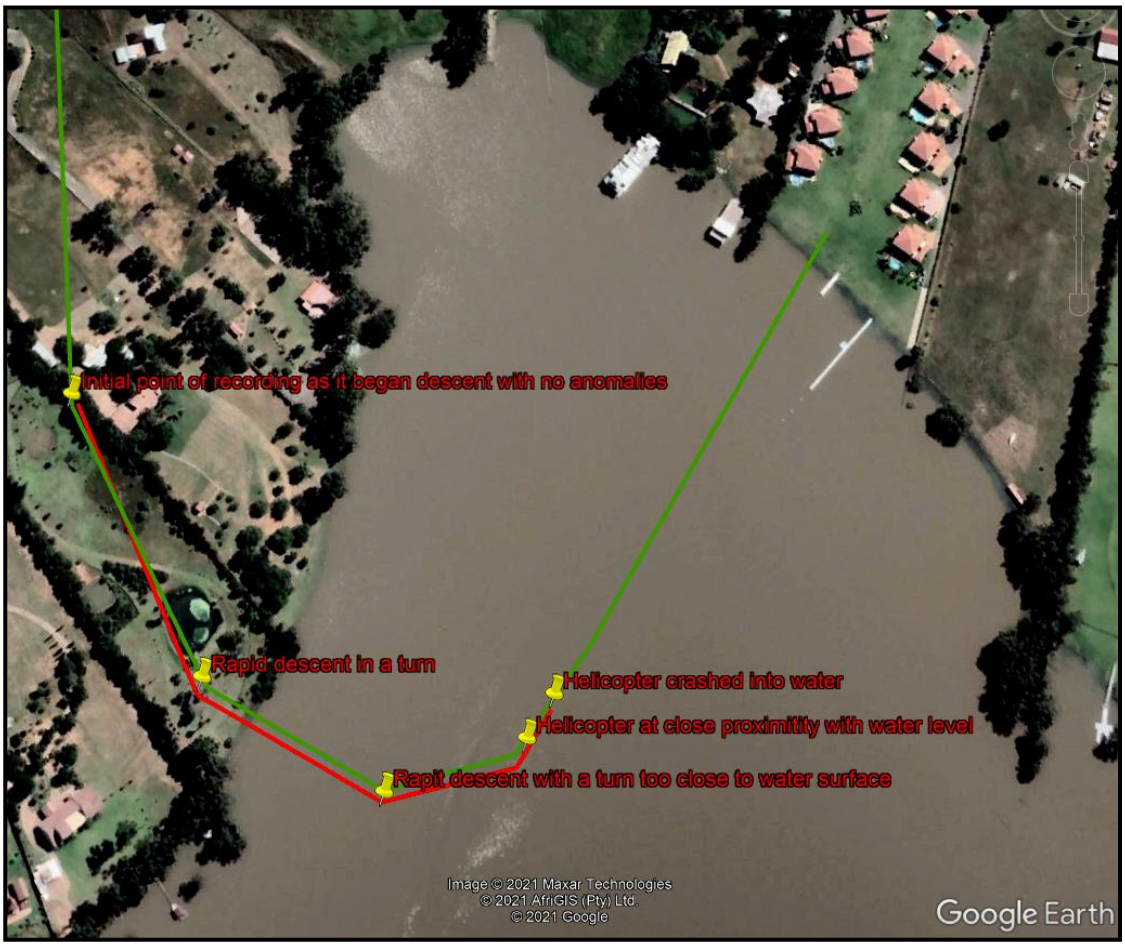

Figure 2: The helicopter route as per the video footage. (Source: Google Earth)

1.1.5 According to the statement from one of the house guests who was already at the pilot's house, about three minutes before final approach, the pilot had contacted the eyewitness via cellular phone to request that they switch on the spotlight mounted on the highest point of the house to shine a light onto the landing spot. *The spotlight faced the bay as well as the direction of approach for landing.* As per pilot's request, the light was switched on and, as expected, the helicopter approached for landing while the eyewitness made a recording of the final approach as they usually do. In the video footage, no anomalies with the engine and the helicopter operation were noted during approach; also, the water in the bay was calm and glassy, mirroring the surroundings. In the video footage, the helicopter approaches in a normal flight path as the pilot had done in the past when about to land on the site.

Figure 3: Stills of the video footage showing the helicopter's approach until the crash. (Source: Eyewitness)

1.1.6 The helicopter is then observed descending rapidly and very low towards the water surface while turning towards the landing site. It then struck the water surface, followed by a bright spark and a loud bang.

1.1.7 The loud bang audible from the video was attributed to the main rotor severing the tail boom section (the aft tail cone bulkhead, empennage, tail rotor gearbox and tail rotor assembly) which separated from the helicopter about a second before sinking. The helicopter lay on its right-side with the left skid gear on top before being completely submerged in water.

1.1.8 The bodies of the pilot and the passenger were recovered on the day of the accident. The body of the passenger was recovered by one of the fishermen who were camping on the west-side of the bay, about 150 metres (m) from where the helicopter was observed floating a few minutes after the accident before it sunk under water. The pilot's body was recovered later by the South African Police Service (SAPS) Diving Unit at a depth of 9.13m. Both occupants were confirmed fatally injured on site by emergency service personnel.

Figure 4: Left: Floating equipment attached to the helicopter; Right: The helicopter after being pulled ashore by the rescue boat.

1.1.9 The helicopter was recovered the next day (15 May 2021) in the same area where the pilot's body was found, about 200m from the edge of the shoreline. It was located 9.13m below the surface. Two floating lifting bags were attached to the helicopter to bring it up to the water surface and was then pulled to the shore using its skids.

1.1.10 One of the dogs (a smaller dog) was found in the helicopter on the floor and on the right-side rear seat. All personal belongings on-board, including the helicopter documents, were still in the helicopter (wreckage) and were handed to the family in the presence of the investigating authorities. The helicopter was recovered from the accident site to a secured hangar at Wonderboom Airport (FAWB).

1.1.11 The helicopter sustained substantial damage to its fuselage structure. The main rotor blades were bent as a result of impact with water and, later, broke off after striking the aft tail-boom section. The right-side windshield had detached completely from its frame. The edges of the left-side windshield remained in the frame, with some shattered smaller pieces of the windshield glass found in the wreckage, while some larger pieces were recovered with multiple fractures.

1.1.12 The second dog (a larger dog), the pilot's cellular phone and the tail boom with the tail rotor drive shaft were recovered on Wednesday, 19 May 2021 (four days after the accident). The dog and the cellular phone were handed to the family, and the tail boom and drive shaft were transported to FAWB.

1.1.13 The accident occurred at dusk during visual meteorological conditions by day at during approach for landing in Vaal Marina Bay, Gauteng province, at Global Positioning System (GPS) co-ordinates determined to be S 26º 54' 28.1" E 028º 12' 37.0" at an elevation of 4900 feet (ft).

1.2. Injuries to Persons

1.2.1 The pilot and the passenger on-board the helicopter were fatally injured.

Injuries	Pilot	Crew	Pass.	Total On-board	Other
Fatal	1	-	1	4	2 (dogs)
Serious	-	-	-	-	-
Minor	-	-	-	-	-
None	-	-	-	-	-
Total	1	-	1	4	-

Note: Other means dogs on-board.

1.2.2 The helicopter also had two dogs on-board, which were on the rear seats. The dogs were fatally injured as well.

1.3. Damage to Aircraft

1.3.1 The helicopter sustained substantial damage to the fuselage structure, the main rotor blades, aft tail-boom section which was severed, and the windshield during the accident sequence.

Figure 5: The accident helicopter after recovery.

1.4. Other Damage

1.4.1 The water was contaminated by oil and fuel which spilled out of the accident helicopter.

1.5. Personnel Information

1.5.1 The pilot was qualified and licensed for the flight; the helicopter type was endorsed on his licence. His licence was valid and was issued by the Regulator on 10 March 2021 with an expiry date of 30 September 2021. The pilot's Class 2 medical certificate was valid following an assessment which was conducted on 2 March 2021 with an expiry date of 31 March 2022.

Nationality	South African	Gender	Male	Age	59
Licence Number	0271062762	Licence Type	Private Pilot Licence (PPL)		
Licence Valid	Yes	Type Endorsed	Yes		
Ratings	Night rating				
Medical Expiry Date	31 March 2022				
Restrictions	VNL, Corrective lenses				
Previous Accidents	None				

Note: Previous accidents refer to past accidents the pilot was involved in, when relevant to this accident.

Flying Experience:

Total Hours	909.7
Total Past 24 Hours	1.8
Total Past 7 Days	1.8
Total Past 90 Days	12.4
Total on Type Past 90 Days	12.4
Total on Type	±900

Note: The above pilot flying hours were calculated according to available information from the helicopter flight folio and the pilot logbook.

1.5.2 Although pilot logbook was last updated on 24 April 2021, the pilot had flown the helicopter prior to this accident flight. The helicopter's flight folio information was sufficient to assist in calculating the pilot's flying hours.

1.6. Aircraft Information

The information below was extracted from the helicopter type Pilot Operating Handbook (POH)

1.6.1. The R44 is a four-place, single main rotor, single engine helicopter constructed primarily of metal and equipped with skid-type landing gear. The primary fuselage structure is welded steel tubing and riveted aluminium sheet. The tail-cone is a monocoque structure in which aluminium skins carry most primary loads. Fibreglass and the thermoplastics are used in secondary cabin structure, engine cooling shrouds, and various other ducts and fairings. The cabin doors are also constructed of fibreglass and thermoplastics.

Four right-side cowl doors provide access to the main gearbox, drive system and engine. A left-side engine cowl door provides access to the engine oil filler and dip stick. Additional access to the controls and other components for maintenance is provided by removable panels and cowlings. Stainless steel firewalls are located forward of and above the engine. The four cabin doors are removable.

Airframe:

Manufacturer/Model	Robinson Helicopter Company	
Serial Number	10174	
Year of Manufacturer	2003	
Date of Manufacture	7 October 2003	
Total Airframe Hours (At Time of Accident)	2596.5	
Last MPI (Date & Hours)	2537.5	21 July 2020
Hours Since Last MPI	58.2	
C of A (Issue Date)	31 July 2020	
C of A Expiry Date	31 May 2021	
C of R (Issue Date) (Present Owner)	20 July 2007	
Type of Fuel Used in the Aircraft	Avgas	
Operating Categories	Part 91	
Previous Accidents	None	

Note: Previous accidents refer to past accidents the aircraft was involved in, when relevant to this accident.

Engine:

Manufacturer/Model	IO-540-AE1A5
Serial Number	L-28820-48A
Part Number	IO-540-AE1A5
Hours Since New	2596.5
Hours Since Overhaul	597.2

Main Rotor:

Manufacturer/Model	Robinson Helicopter Company C005-12E	
Rotor Blades Serial Numbers	3004	2965
Hours Since New	396.5	396.5
Hours Since Overhaul	TBO not yet reached	TBO not yet reached
Transmission Type	Main rotor gearbox housing C006-6	
Serial Number/s	1396	
Hours Since New	396.5	
Hours Since Overhaul	TBO not yet reached	

Note: The original main rotor set was removed in 2013 at 2200 where most components that have reached their life span were changed.

Tail Rotor:

Manufacturer/Model	Robinson Helicopter Company C029-3	
Tail Rotor Blades Serial Numbers	1850	1856
Hours Since New	396.5	396.5
Hours Since Overhaul	TBO not yet reached	TBO not yet reached
Transmission Type	Tail rotor gearbox C021-1	
Serial Number/s	4770	
Hours Since New	396.5	
Hours Since Overhaul	TBO not yet reached	

The helicopter had reached the 2200-hour service on 7 June 2013. The service required

replacement of all components that have reached their life span, including the main and tail rotor blades and their drive systems. All serial numbers of the replaced and removed components were accounted for during this investigation.

1.6.2. A review of the helicopter's maintenance documents indicated that all published engine and airframe manufacturer's Service Bulletins (SBs) / Service Letters (SLs) / Service Instructions (SIs) were signed off during previous inspections.

1.6.3. The aircraft maintenance organisation (AMO) issued the helicopter's Certificate of Release to Service on 22 July 2020, with an expiry date of 21 July 2021 or at 2637.5 airframe hours, whichever comes first. The helicopter had a valid certificate of Airworthiness issued by the Regulator on 26 May 2020 with an expiry date of 31 May 2021.

1.6.4. The investigation found no technical defects with the airframe and engine, or installed systems and components that were recorded in the logbook or defect reports.

1.7. Meteorological Information

1.7.1. The weather information in the table below was provided by the South African Weather Service (SAWS) recorded at Vereeniging Airport (FAVV) on 14 May 2021 at 1610Z, which is the closest weather station located 43 kilometres (km) from the accident site.

Wind Direction	320°	Wind Speed	04kt	Visibility	9999m
Temperature	16°C	Cloud Cover	None	Cloud Base	None
Dew Point	01°C	QNH	1023hPa		

1.7.2. The SAWS weather report concluded that there was no indication of any significant weather conditions over the area of the accident site before and during the time of accident.

1.8. Aids to Navigation

1.8.1. The helicopter was equipped with standard navigational equipment as approved by the Regulator (SACAA) for the aircraft type. There were no recorded defects with the navigation system prior to the flight.

1.9. Communication

1.9.1. The helicopter was equipped with standard communication equipment as approved by the Regulator for the aircraft type. The pilot did not transmit any emergency calls before the accident. There were no recorded defects with the communication equipment prior to the flight.

1.10. Aerodrome Information

1.10.1. The accident did not occur anywhere near an aerodrome; it occurred in Vaal Marina Bay,

approximately 43 kilometres (km) from Vereeniging Airport in Gauteng province at GPS co-ordinates determined to be S 26º 54' 28.1" E 028º 12' 37.0" at an elevation of 4900ft.

1.11. Flight Recorders

1.11.1. The aircraft was neither equipped with a cockpit voice recorder (CVR) or a flight data recorder (FDR), nor was it required by regulation to be fitted to this aircraft type.

1.12. Wreckage and Impact Information

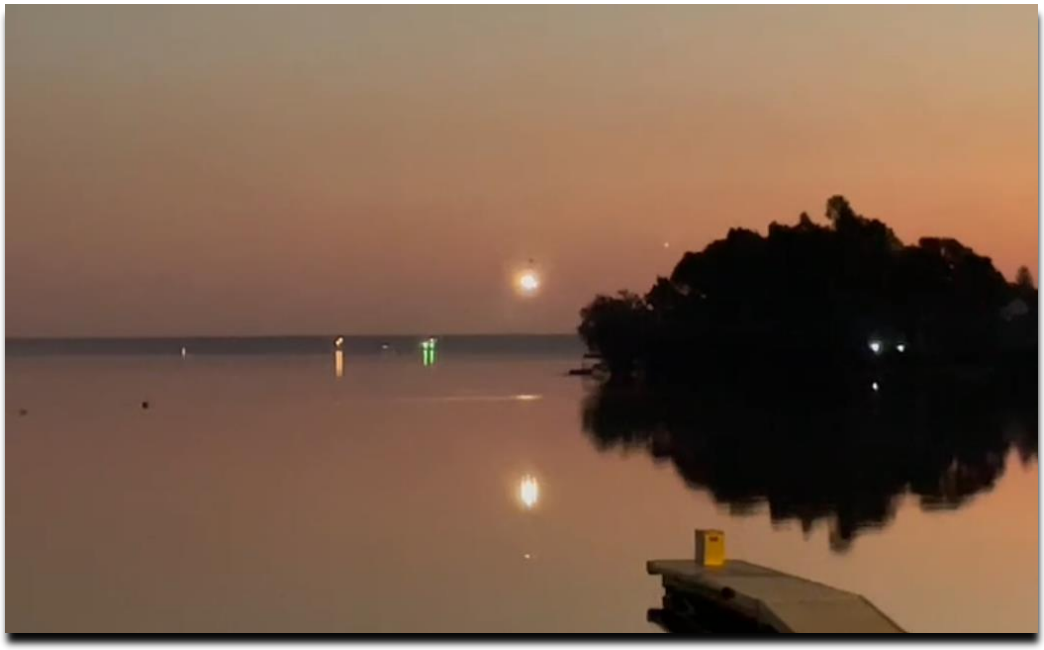

Figure 6: The image shows the calm weather conditions prevalent at the time of the accident.

1.12.1. The helicopter accident occurred at dusk during visual meteorological conditions by day over calm, glassy water surface in Vaal Marina Bay. Following impact with the water surface, the helicopter was completely submerged in water. It was only on the following day that the helicopter was recovered, oriented up-right (on its landing skid gears) from a depth of approximately 9.13m. It was attached to the floating equipment to bring it up to the water surface before being pulled out to the shoreline.

1.12.2. The helicopter was located at an elevation of about 4895ft underwater at a depth of approximately 9.13m, and 200m south-east from the shoreline of Burgandy Bay residential area.

1.12.3. **Fuselage**

- The examination of the exterior of the helicopter fuselage indicated structural damages associated with the helicopter having engine power at point of impact. The windshield was destroyed, which is consistent with impact damages during the accident sequence.

- The internal examination of the helicopter fuselage revealed more damage on the right-side of the helicopter than on the left-side. This was consistent with the helicopter impacting the water on its right-side as shown in the bottom right frame of Figure 3.

Figure 7: The severed aft tail-boom section.

- The main rotor hub and drive systems were bent towards the back, causing damage to the fire wall and the engine fuel divider. The main rotor blades were both destroyed. One of the two blades of the single main rotor severed the tail-boom aft-section near the tail navigation light. The video footage shows a high voltage spark which was concluded to have been caused by the main rotor blade's high rotation severing the strobe light on the tail cone.

- There was evidence of upward bending (coning) of the main rotor blades, indicating overpitching, which was exhibited by the compression (wrinkling) present on the main rotor blades and the backward bending caused by striking of the tail cone.

- The left-side front seat belt was found still buckled. Considering the statement that the passenger was thrown out of the helicopter on impact, it is likely that the passenger was not strapped to the seat at the time of accident. The pilot's seat belt on the right-side was extended, and the buckle clip was removed from the buckle lock. This indicates that the pilot removed the seat belt after impact as he was trying to escape. This is also supported by the fact that one of the rescue personnel found the body of the pilot near the helicopter (under water).

1.12.4. **Flight controls**

All the flight control rod ends, attaching hardware and other steel components relating to the cyclic, collective and tail rotor controls were found intact and secure. The flight controls were moved freely without restriction.

- The cyclic control lever and the two rudder pedals were only connected to the right-side of the control cockpit. This means that the pilot was flying the helicopter from the right-

side, which was expected. The extra collective lever, the cyclic and the two rudder pedals were found packed in the baggage compartment under the rear seat.

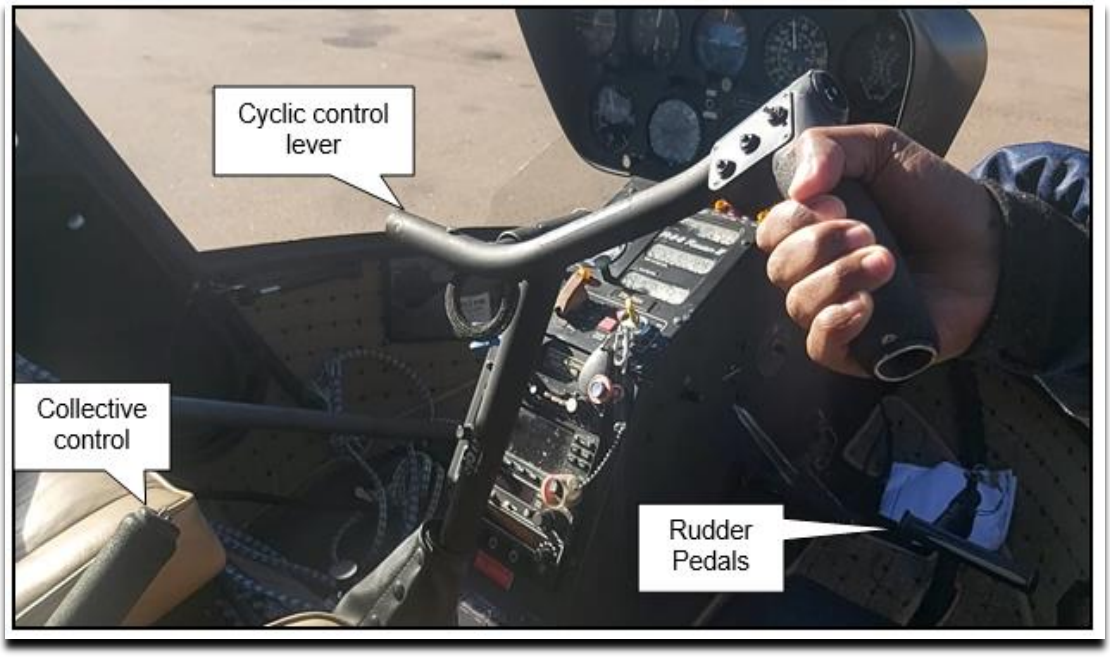

Figure 8: Controls on the right-side of the cockpit.

- The collective control lever was found in the full-up position. This shows that the pilot pulled the collective control lever up prior or during contact with water as it was in a descent transition.

Figure 9: The governor switch in ON position.

Figure 10: The collective controller raised at full-up position.

- The governor switch on the collective control lever was also found in ON position. The governor circuit breaker switch was found in a popped position; this could be because of impact with water.

- The engine was intact with little to no damage. There was visible damage to the fuel divider component. The third cylinder manifold outlet gasket seal was damaged due to impact forces. Following the recovery of the helicopter, the engine start-up attempt was conducted, however, the helicopter could not fully run because of the damage on the fuel divider. The damage on the engine components was due to impact forces.

1.12.5. **Break-up sequence**

• The tail rotor shaft had detached from both the engine mounting and the tail rotor gear box attachment during impact; it got pulled through the tail-cone (tail-boom). Three pieces of the tail rotor drive shaft as well as the aft-tail boom section were distributed to the east of the main wreckage. They were recovered by the SAPS Diving Unit on Wednesday, 19 May 2021.

Figure 11: The aft-tail boom section, damaged tail rotor and the drive shaft.

- The break-up of the helicopter likely started with the main rotor blade striking and separating the tail cone from the airframe. The strike occurred while the tail rotor drive shaft was rotating; this is indicated by a section of the drive shaft with torsional failure.

- The tail rotor drive shaft had fractured into three sections between the intermediate and aft flex plate. Both flex plates had tension failure (pulled apart) and the drive shaft was pulled through the damper assembly. The separation points of the tail rotor drive shaft were examined; they displayed bending fracture failures.

- The failures of the tail rotor drive shaft in shearing indicated torsional damage towards the tail rotor. Moreover, the flex plates and rotational scoring to the drive shaft indicated that there was likely high engine power and rotor speed at the time the main rotor blades struck the tail cone.

1.13. Medical and Pathological Information

1.13.1. To be discussed in the final report.

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 not survivable as the helicopter was submerged in water and both occupants (and two dogs) remained in the water until they were recovered by first responders.

1.16. Tests and Research

1.16.1. A preliminary engine test was conducted on 17 May 2021 following recovery of the helicopter. A start-up pre-inspection was conducted, and the engine was started and ran without any restriction. Although the engine could not be fully started due to the damaged fuel supply divider unit, the engine rotated freely with no indication of obstruction. It was determined that the fuel supply divider unit was damaged during the accident sequence as the gearbox shifted from its original position. The test confirmed that the engine did not have any anomalies prior to and during the accident sequence.

1.16.2. **Flying low over water is very hazardous**

The information below is extracted from the *Robinson R44 II Pilot Operating Handbook* (POH) section 10: Safety tips and notices, which included the following safety notice information of interest to the investigation:

Safety Notice SN-19:

Many helicopter accidents have occurred while manoeuvring low over water. Many pilots do not realise their loss of depth perception when flying over water. Flying over calm glassy water is particularly dangerous, but even choppy water, with its constantly varying surface, interferes with normal depth perception and may cause the pilot to misjudge his height above the water.

MAINTAIN 500FT AGL WHENEVER POSSIBLE AND AVOID MANEUVERS OVER WATER BELOW 200FT AGL.

1.17. Organisational and Management Information

1.17.1. The helicopter was operated privately under the provision of Part 91 of the Civil Aviation Regulations (CAR) 2011 as amended. The helicopter had a valid Certificate of airworthiness issued by the Regulator on 26 May 2020 with an expiry date of 31 May 2021.

1.17.2. The helicopter was maintained by the AMO that was in possession of an AMO certificate issued by the Regulator on 13 November 2019 with an expiry day of 30 November 2020.

1.18. Additional Information

1.18.1 Helicopter emergency floatation devices (EFS) - https://www.skybrary.aero/index.php/Helicopter_Emergency_Floatation_Systems_(EFS)

Definition

Emergency Floatation Systems (EFS) *are designed to minimise the chances that a helicopter which is involved in either a controlled ditching or a water impact sinks or capsizes as a result.*

Description

The fitting of an EFS based on floats is well established but the problem of instability on anything but a calm water surface has always been problematic. This is because of the relatively high centre of gravity of helicopters due to the location of the rotors, the transmission and the engines.

The floats which provide EFS buoyancy are either packed within spaces inside the airframe or fitted as externally mounted packs on the lower structure. Inflation is provided by gas stored in pressurised cylinders which are carried on board. The need for rapid inflation is met by the inclusion of helium in the gas but it is usually blended with other gases.

1.19. Useful or Effective Investigation Techniques

1.19.1. None.

2. FINDINGS

2.1 General

From the available evidence, the following preliminary findings were made with respect to this accident. These shall not be read as apportioning blame or liability to any organisation or individual.

To serve the objective of this investigation, the following sections are included in the conclusions heading:

- **Findings —** are statements of all significant conditions, events, or circumstances in this accident. The findings are significant steps in this accident sequence, but they are not always causal or indicate deficiencies.

2.1.1 The pilot was licensed and qualified for the flight. The pilot was familiar with the area of the intended landing site as he flew there regularly before the accident.

2.1.2 On-site evidence indicated that the engine was producing power at the time of accident. The helicopter displayed no evidence of pre-existing damage to control linkages, and the tail rotor gearbox shafts could be rotated without resistance. All components from the helicopter were found at the accident site. There was no evidence of a pre- or post-impact fire.

2.1.3 There were no pre-existing mechanical faults with either the engine, main rotor or tail rotor systems recorded in the flight folio and defect logs that could have contributed to the accident. Additionally, there were no snags recorded in the flight folio and defect logs with either the navigation or communication systems prior to the accident flight.

2.1.4 The flight was conducted under VFR by day at dusk. The weather conditions at the time of the accident did not indicate any significant weather conditions in the area that would have contributed to the accident.

2.1.5 Based on the video footage, the helicopter flew over calm, glassy waters that mirrored the surroundings. The glassy waters illusion could have given the pilot the perception that they were higher than they actually were, causing the pilot to reduce the height, resulting in the helicopter touching the water. This is known as a loss of depth perception while flying over calm, glassy waters.

3. On-going Investigation

3.1 The AIID investigation is on-going and the investigator/s will be looking into other aspects of this occurrence which may or may not have safety implications.

4. Recommendation(s):

4.1 It is recommended that the Director of Civil Aviation mandates the fitment of emergency flotation devises on helicopters operating over water (including those which approach, land or take-off over a large mass of water).

This report is issued by:

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