SOUTH AFRICAN CIVIL AVIATION AUTHORITY

Section/division **Accident and Incident Investigations Division** Form Number: CA 12-41

AIRCRAFT ACCIDENT SHORT REPORT

CA18/2/3/9812: The helicopter impacted the water surface following a manoeuvre which caused the pilot to lose height due to the helicopter being above required weight.

Date and time	:	11 August 2019; 0935Z
Aircraft registration	:	ZS-TTC
Aircraft manufacturer and model	:	Robinson Helicopter Company, R44 Raven II
Last point of departure	:	Private Farm in Vaalwater, Limpopo Province
Next point of intended landing	:	Private Farm in Vaalwater, Limpopo Province
Location of incident site with reference to easily defined geographical points (GPS readings if possible)	:	S24°08'44.75" E28°18'02.81" at an elevation of 4279 ft
Meteorological information	:	Wind: 280°/7kt; Temperature: 21°C; Dew Point: 6°C, Visibility: CAVOK; QNH: 1026hPa
Type of operation	:	Commercial Helicopter Operations (Part 127)
Persons on-board	:	1 + 2
Injuries	:	1 passenger – minor injuries
Damage to aircraft	:	Sustained substantial damage

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 (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.***

Disclaimer:

Figure 1*:* The Robinson R44 Raven II helicopter.
(Source: https://www.flickr.com/photos/34709414@N02/28439504065)

1. SYNOPSIS

1.1. On 11 August 2019 at 0930Z, the pilot and two passengers were engaged in a scenic flight on-board a Robinson R44 Raven II helicopter in the Vaalwater area in Limpopo province.

1.2. The pilot stated that after take-off, he got into a hover and, as he transitioned (north-easterly direction) forward between 10 and 20 knots (kts) while flying along the left-hand side of the Vaalwater Dam with some trees lining the right-hand side (of the dam), the wind as well as the trees disrupted the airflow into the tail rotor system from behind.

1.3. The pilot further stated that the main rotor revolutions per minute (RPM) decreased, causing a slight drop in engine power which required more collective control input to maintain a stable transition. The pilot performed a flare attitude to allow more wind into the main rotor system to increase the main rotor RPM. However, the flare led to the tail rotor system guard (stinger) impacting the water surface; the main rotors flapped downwards and severed the tail boom.

1.4. The investigation revealed that the helicopter took off in a direction where there were high trees ahead. The helicopter's performance was reduced by being above the required weight, thus, it could not clear the obstacle; the pilot manoeuvred the helicopter to the left before reaching the flying speed (of 50kts). However, the helicopter lost lift, resulting in an impact with the water surface as well as severing its tail boom.

2. FACTUAL INFORMATION

2.1. HISTORY OF FLIGHT

2.1.1. On 11 August 2019 at approximately 0930Z, the pilot and two passengers took off from a private farm in Vaalwater on a scenic flight around the area. The helicopter took off with a total weight of 2390 pounds (lbs), with both fuel tanks full (30 gallons in the main fuel tank and 18 gallons in the auxiliary fuel tank).

2.1.2. After take-off, the pilot stated that he got into a hover and, as he transitioned (north-easterly direction) forward between 10 and 20 knots (kts) while flying along the left-hand side of the Vaalwater Dam with some trees lining the right-hand side (of the dam), windy conditions as well as the trees lining the dam caused a disruption of the helicopter's airflow in the tail rotor system from behind.

2.1.3. The pilot further stated that the main rotor revolutions per minute (RPM) decreased, causing a slight drop in engine power, which required more collective control input to maintain a stable transition. The pilot performed a flare attitude to allow more wind into the main rotor system to increase the main rotor RPM. However, the flare led to the tail rotor system guard (stinger) impacting the water; the main rotors flapped downwards and severed the tail boom.

2.1.4. The pilot stated that as the left-hand side of the main rotor system was over the dam and the right-hand side of the main rotor system was over land, he attempted to perform an emergency landing over the dam as it was not possible to maintain directional control with the tail rotor system severed by the main rotor blades. But the emergency landing was unsuccessful.

2.1.5. The helicopter was pulled out of the dam and recovered to a hangar in Wonderboom Aerodrome (FAWB). The helicopter sustained damage to the tail boom (tail rotor section), main rotor system, left-side front window and skids.

2.1.6. The pilot and one passenger did not sustain any injuries, whilst the second passenger sustained minor injuries and was taken to the hospital.

2.1.7. The weather conditions on the day of the accident were as follows: Wind: 280°/7kt; Temperature: 21°C; Dew Point: 6°C; Visibility: CAVOK; Query Nautical Height (QNH): 1026hPa.

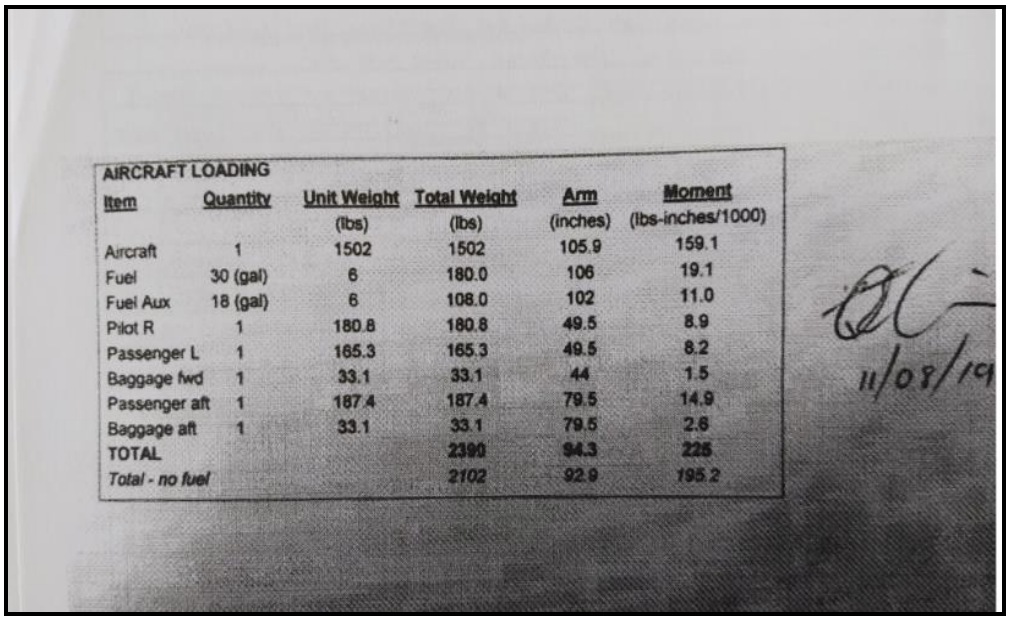
2.1.8. The accident occurred during daylight at a geographical position determined to S24°08'44.75" E28°18'02.81" at an elevation of 4279 feet (ft).

Figure 2: The helicopter as it was recovered.

Figure 3: The helicopter after recovery with damage to the main rotor system and tail rotor system.

2.1.9. Pressure altitude (PA) = (QNH – Standard pressure) X 1000ft + Field Elevation, therefore, PA = (30.38-29.92) X 1000ft + 4279ft = 4739ft. The outside air temperature was 20ºC and that means the gross weight was supposed to be approximately 2120lb.

2.1.10. Calculated weight of the helicopter:



AIRCRAFT LOADING

Item	Quantity	Unit Weight (lbs)	Total Weight (lbs)	Arm (inches)	Moment (lbs-inches/1000)
Aircraft	1	1502	1502	105.9	159.1
Fuel	30 (gal)	6	180.0	106	19.1
Fuel Aux	18 (gal)	6	108.0	102	11.0
Pilot R	1	180.8	180.8	49.5	8.9
Passenger L	1	165.3	165.3	49.5	8.2
Baggage fwd	1	33.1	33.1	44	1.5
Passenger aft	1	187.4	187.4	79.5	14.9
Baggage aft	1	33.1	33.1	79.5	2.6
TOTAL			2390	94.3	225
Total - no fuel			*2102*	92.9	195.2

11/08/19

Figure 4: The helicopter weight was 2390lb as submitted by the pilot and confirmed by investigators.

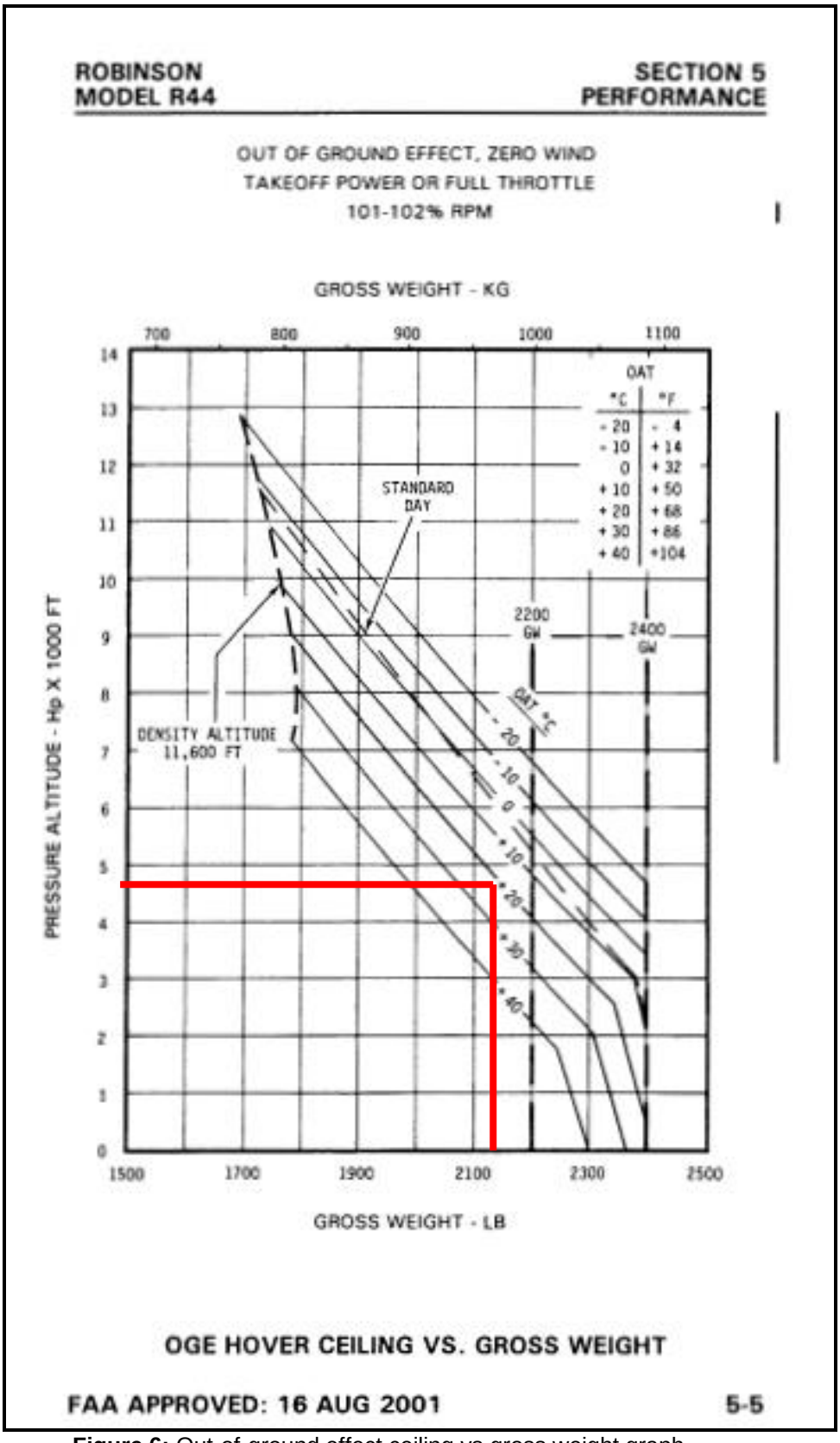


Figure 6: Out-of-ground effect ceiling vs gross weight graph.

2.1.11 Review of the weight calculation submitted by the pilot and the out-of-ground effect (OGE) ceiling vs gross weight chart indicated that the weight of the helicopter should have been at or below 2120lb but was 270lb over the required weight.

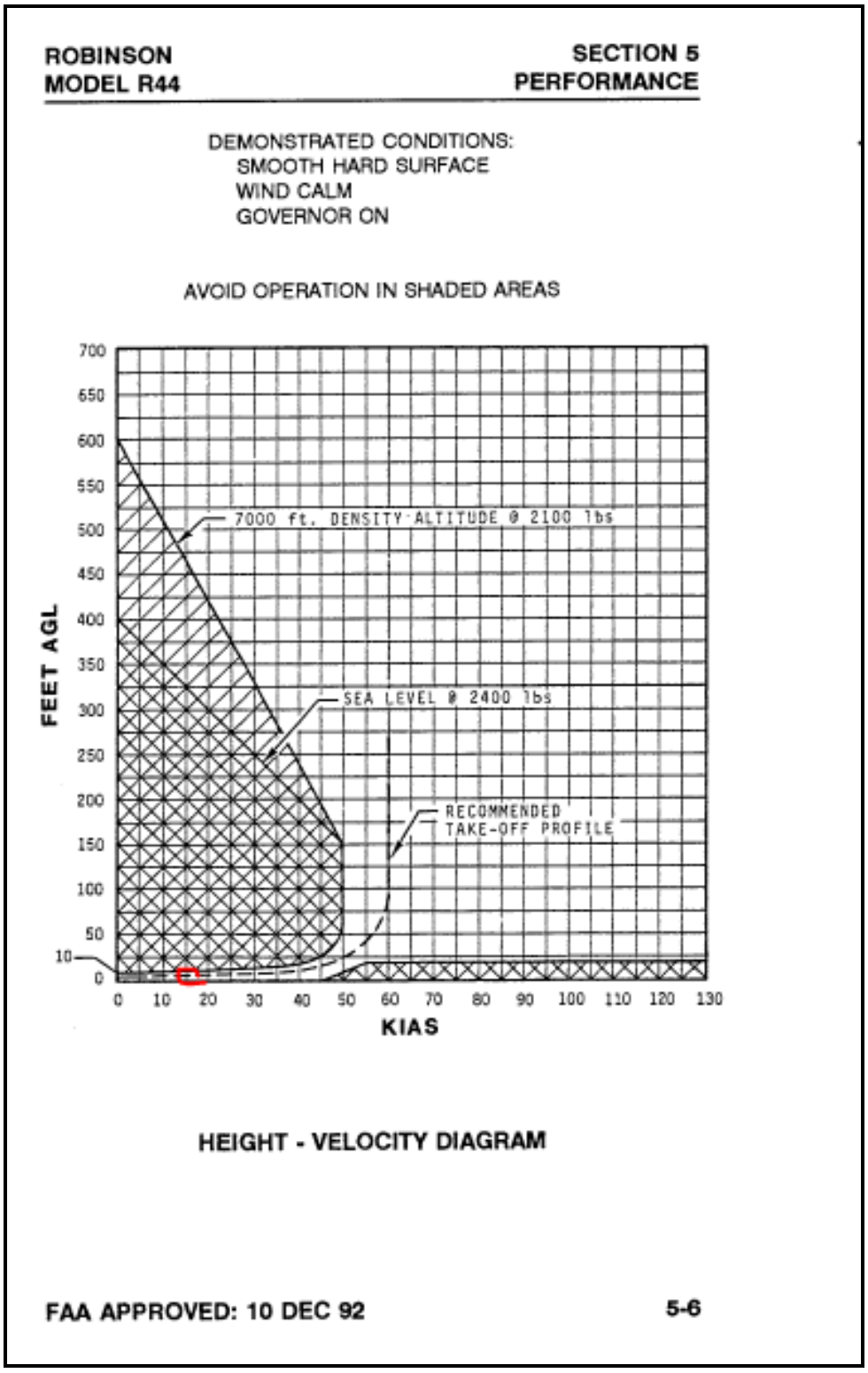


Figure 6: Height velocity diagram.

2.1.12 The helicopter was flying between 10 and 20kts when the accident occurred. For a safe transition and climb out, the helicopter would require an indicated airspeed of 50kts or above. The graph on Figure 6 advises against operating in the shaded area.

2.1.13 **Aircraft Gross Weight** (Source: Wagtendonk, W.J., 2006 – Principles of Flight, Page 250).

Increases in aircraft gross weight go hand in hand with requirements for higher angles of attack and demand for more power. Any high gross weight situation limits the helicopter's performance. This is particularly important when considering flight at high altitudes, where the power in use is already relatively high. The limited surplus power available when at high gross weight places a great restriction on the helicopter's ability to hover, do steep turns, vertical climbs and manoeuvres. The high-power requirement in the hover when at high gross weight also affects the required performance from the anti-torque (tail) rotor. It is possible that a large left pedal deflection may be needed to produce the required anti-torque. Under such conditions the take-off needs to be preceded by a check for adequate directional control. If any yaw occurs with the left pedal fully forward when the helicopter becomes light on the skids, some weight should be offloaded. Operations at high altitudes accentuate this problem. High gross weight situations also affect the maximum height that the helicopter can operate in ground effect for a given power availability. Under these conditions, the heavier the aircraft, the lower the maximum hover height.

2.1.14 **RECOVERY FROM LOW ROTOR RPM (**Source: Wagtendonk, W.J., 2006 – Principles of Flight, Page 171)

Pilots who find themselves in a low rotor rpm condition (leading to a possible rotor stall) must react quickly. The recovery procedure is simple:

- *lower the collective to reduce blade pitch angles while simultaneously*
- *rolling on throttle to increase power output and rotor rpm*

Rotor stalls, like vortex ring state and mast bumping, are entirely avoidable mishaps. The rotor rpm at which the stalled condition becomes critical is significantly below normal operating rotor rpm and should be easy for pilots to avoid. Proper pilot training and complete comprehension of the aerodynamics involved is all the cure that is needed. Fitting of governors has reduced the risk of unintended low rpm but like any mechanical component, a governor can fail and therefore pilots should know how to recover early from low rpm situations.

2.1.15 As a result of having no weather facilities available in the immediate area of the accident, Polokwane International Aerodrome (FAPP) (closest reporting station) METARs and TAFs issued on 9 September 2019 were considered. The wind reported by the pilot was north-easterly at 10kts, which was in contrast with the official weather of 280º at 04kts.

FACTUAL INFORMATION

3 FINDINGS

3.1 The pilot was issued a Commercial Pilot Licence (CPL) on 24 February 2010. His last skills test was carried out on 7 March 2019, and his renewal was issued on the same date with an expiry date of 31 March 2020. The helicopter type was endorsed on his licence.

3.2 The pilot was issued a Class 1 medical certificate on 25 February 2019 with an expiry date of 28 February 2020.

3.3 The pilot had a total of 3343.7 flying hours of which 3192.6 hours were on type.

3.4 The aircraft was issued a Certificate of Airworthiness on 26 February 2009 with an expiry date of 29 February 2020. The airframe hours at the time of the accident were 1868.3 hours.

3.5 The last Mandatory Periodic Inspection (MPI) was carried out on 18 July 2019 at 1798.1 hours and the Certificate of Release to Service (CSR) was issued on the same day with an expiry date of 17 July 2020 or at 1898.1 hours, whichever occurs first. The helicopter flew a further 70.2 hours after its last MPI and the airframe hours at the time of the accident were 1868.3 hours.

3.6 The weather did not contribute to the accident.

3.7 The helicopter's weight was calculated by the pilot to be at 2390lbs (which did not take into account the weather conditions of the day and the altitude at which the helicopter was being operated at, which would affect the performance of the helicopter). Investigators re-calculated the weight of the helicopter taking the weather conditions and altitude into account and they determined that the safe operating weight of the helicopter should have been at or below 2120lb.

3.8 The investigation revealed that the helicopter took off in a direction where there were high trees ahead and, as its performance was reduced by being above the required weight, the helicopter could not clear the obstacle; the pilot manoeuvred the helicopter to the left before reaching its flying speed (of 50kts). However, the helicopter lost lift, resulting in an impact with the water surface and severing its tail boom.

4 PROBABLE CAUSE

4.1 The helicopter took off in a direction where there were high trees ahead and, as its performance was reduced by being above the required weight, the helicopter could not clear the obstacle and the pilot manoeuvred the helicopter to left before reaching its flying speed (of 50kts). However, the helicopter lost lift, resulting in an impact with the water surface and severing its tail boom.

4.2 CONTRIBUTING FACTOR

4.2.1 Incorrect calculation of the helicopter's total weight whilst being operated in an area with a high elevation.

5. REFERENCES USED ON THE REPORT

5.1 Wagtendonk, W.J., 2006 – Principles of Flight, Pages.

6. SAFETY RECOMMENDATION

6.1 None.

7. ORGANISATION

7.1 The helicopter was operated privately in accordance with Part 127 of the Civil Aviation Regulations (CAR) 2011 as amended.

This report is issued by:

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