REPUBLIC OF KENYA

MINISTRY OF ROADS AND TRANSPORT

STATE DEPARTMENT FOR TRANSPORT

AIRCRAFT ACCIDENT INVESTIGATION DEPARTMENT

INVESTIGATION REPORT 09/2021

REPORT ON THE ACCIDENT TO THE ROBINSON R44 HELICOPTER, 5Y-MEP ON 17.10.2020

AT ELDAMAT-MELILI, NAROK COUNTY

OBJECTIVE

This report contains factual information that has been determined up to the time of publication. The information in this report is published to inform the aviation industry and the public of the general circumstances of accidents, serious incidents, and incidents.

This investigation has been carried out in accordance with ***The Kenya Civil Aviation (Aircraft Accident and Incident Investigation) Regulations, 2013, and Annex 13 to the ICAO Convention on International Civil Aviation.***

The objective of the investigation of an accident or incident under these Regulations shall be the prevention of accidents and incidents. It shall not be the purpose of such an investigation to apportion blame or liability.

The information contained in this report is derived from the data collected during the Investigation of the Accident.

AIRCRAFT ACCIDENT INVESTIGATION

OPERATOR	:	Karen Blixen Camp Trust (KBCT)
AIRCRAFT TYPE	:	Robinson Helicopter R44, Raven II
AIRCRAFT MANUFACTURER	:	Robinson Helicopter Company.
YEAR OF MANUFACTURE	:	May 2019
AIRCRAFT REGISTRATION	:	5Y-MEP
AIRCRAFT SERIAL NUMBER	:	14327
DATE OF REGISTRATION	:	20 June 2019
NUMBER AND TYPE OF ENGINE	:	One, Lycoming IO-540-AE1A5
DATE OF OCCURRENCE	:	17 October 2020
LAST POINT OF DEPARTURE	:	Eldamat-Melili, Narok County (0°55′38.96″N, 36°05′20.18″E)
POINT OF INTENDED LANDING	:	Olenkipejus Village
TIME OF OCCURRENCE	:	1315 (1615)
LOCATION OF OCCURRENCE	:	Eldamat-Melili, Narok County
TYPE OF FLIGHT	:	Commercial (Passenger)
PHASE OF FLIGHT	:	Take-off
NUMBER OF PERSONS ON BOARD	:	Three (3)
INJURIES	:	0
NATURE OF DAMAGE	:	Substantial
CLASS OF OCCURRENCE	:	Accident
PILOT IN COMMAND	:	YK-9740-PL (H)
PIC’s FLYING EXPERIENCE	:	1471 Hours

All times given in this report is Coordinated Universal Time (UTC), with East African Local Time in Parenthesis

INVESTIGATION PROCESS

The occurrence involved a Robinson Helicopter R44 Raven II passenger helicopter, registration 5Y-MEP was notified to the Aircraft Accident Investigation Department (AAID), State Department for Transport (SDT), Ministry of Transport, Infrastructure, Housing, Urban development, and Public Works through a phone call by the Chief Executive Officer, Karen Blixen Camp Trust.

Under the provisions of Annex 13 to the Convention on International Civil Aviation and Kenya laws and regulations, a team of AAID investigators was dispatched to the site on 17 October 2020 for initial onsite investigation and witness interviews.

After the initial on-site investigation phase, the occurrence was classified as an ‘Accident’ owing to the substantial damage to the Aircraft.

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LIST OF ABBREVIATIONS/GLOSSARY OF TERMS

AAID	-	Aircraft Accident Investigation Department
AGL	-	Above Ground Level
AMSL	-	Above Mean Sea Level
CG	-	Centre of Gravity
FAA	-	Federal Aviation Authority
PPL	-	Private Pilot License
ELT	-	Emergency Locator Transmitter
FT	-	Feet
GPS	-	Global Positioning System
ICAO	-	International Civil Aviation Organization
KCAA	-	Kenya Civil Aviation Authority
KBCT	-	Karen Blixen Camp Trust
KTS	-	Knots
LBS	-	Pounds
LH	-	Left Hand
LT	-	Local Time
LTE	-	Loss of Tail Rotor Effectiveness
OGE	-	Out of Ground Effect
POH	-	Pilots Operating Handbook
RH	-	Right Hand
TBN	-	To Be Notified
VFR	-	Visual Flight Rules

SYNOPSIS

The report describes the events of a helicopter accident that took place on 17 October 2020 involving a Robinson R44 Raven II registration 5Y-MEP operated by the Karen Blixen Camp Trust (KBCT). The helicopter took off at 1315 (1615) on a private Visual Flight Rules flight to Olenkipejus Village, on board were the pilot and two passengers who were on a private VFR Flight after attending a burial ceremony before the accident occurred at Melili Village in Narok County.

In strict adherence to requirements by ICAO, AAID notified the State of manufacture of the Robinson R44 helicopter which is also the state of manufacture of the engine.
ICAO was also notified of the occurrence.

1.0 FACTUAL INFORMATION

1.1 History of the Flight

On 17 October 2020 at 1330(1630), Aircraft Accident Investigation Department (AAID) was notified of an accident at Melili, Narok County by the Chief Executive Officer of the Karen Blixen Camp Trust (KBCT). The accident involved a Robison R44 Raven II helicopter registration 5Y-MEP operated by KBCT. The pilot reported that before the fateful flight he had conducted three flights that day each with two passengers on board. The three flights were uneventful. His client for the day was the Governor of Narok County.

On that day, the governor had graced a burial ceremony at Melili and after the function, the pilot planned to fly him to the southeastern side of the Mau forest to inspect the extent of deforestation en route to Olenkipejus village. The plan was aborted due to unfavourable weather conditions at the destination.

The helicopter lifted off at 1315 (1615) from a wheat-filled area at Melili for Olenkipejus village (see Figure 1). Onboard were the pilot, the governor, and his security guard. The Governor occupied the left front seat while his guard occupied the left rear seat.

The pilot reported that whilst the helicopter was in a hover on a northerly heading (at approximately 15 meters above ground), with 15knots indicated airspeed, he got a low RPM warning and slightly lowered the collective control descending into a wheat field. The pilot made left yaw turn with the intention that the spot turn would stop at 180° (half a revolution) so that the helicopter could be stabilized in a hover facing the terrain of the Melili area before transitioning to forward flight over the wheat field. This maneuver subsequently developed into a continuous uncontrolled forward movement. The helicopter then impacted the terrain with a nose-down orientation on a southerly heading at approximately 100 m to the southwest of the lift-off position.

The helicopter eventually came to rest on its left side after the nose tipped over with the tail boom section detached from the main body. The tail boom was severely fractured, locally twisted, and bent to the starboard near the damper bearing of the tail rotor drive shaft. The left skid was substantially damaged. The main rotor blades remained attached to the helicopter but were significantly bent and twisted. Both blades of the tail rotor were severed.

The pilot and his passengers, were able to vacate the helicopter by climbing through the left doors, although the passengers on the left (upper) side needed some assistance in undoing their seatbelts. The occupants, though shaken, were unhurt. The pilot made the helicopter safe, by turning off the fuel and electric power. Upon exit from the helicopter, the pilot was then able to see ground marks which indicated to him that it had probably rolled onto its side when one of the skids struck the ground.

There was no post-impact fire

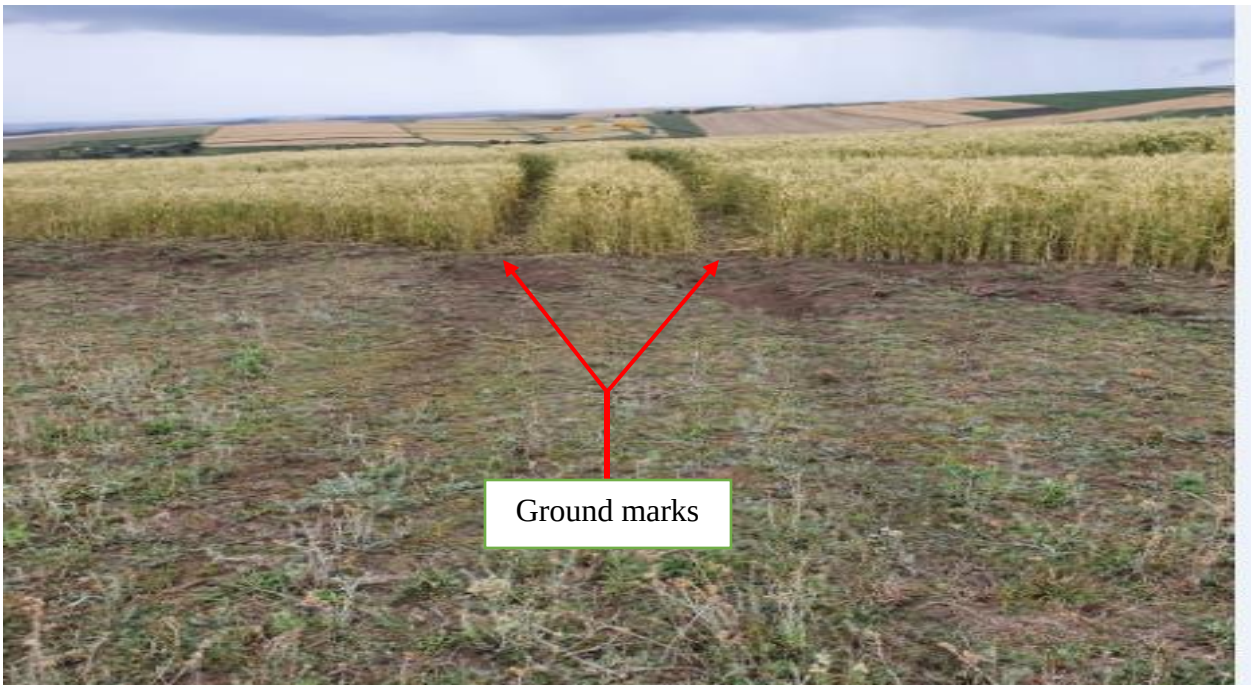

Figure 1: The Wheatfield area

1.2 Injuries to Persons

Table 1: Injury chart

Injuries	Crew	Passenger	Others
Fatal	0	0	0
Serious	0	0	0
Minor/none	1	2	0
Total	1	2	

1.3 Damage to Aircraft

The helicopter was substantially damaged.

Figure 2: The wreckage of the helicopter

1.4 Other Damage

The destruction of the Wheat-field area spread across a diameter of approximately 38metres.

1.5 Personnel Information

1.5.1 Pilot's Information

Records available showed that at the time of the crash, the pilot of 5Y-MEP was a 35-year old Kenyan male. He held a valid Private Pilot License (Helicopters) granted by the KCAA on the 02 November 2015 on the strength of his FAA license PPL Number 3736156 dated 14 December 2013. The pilot had a single aircraft type rating endorsed on his license under Group II.

On 7 August 2019, the pilot underwent a medical examination and was declared fit and issued with a class two certificate valid for 24 months.

He held a Flight Radio Telephony Operator's License number YK-9740-RL. It was issued by the KCAA on 16 August 2019 with a validity of up to 21 August 2021.

Table 2: Summary of the pilot's relevant information

D.o.B/Age	1 March 1985 (35 years)
Sex	Male
Nationality	Kenyan
Type of License	Private Pilot License (Helicopters)
Issuing Authority	KCAA
Date of issue	2 November 2015
Last Issue	16 August 2019
Validity of License	Expires on 21 August 2021
Ratings	Robinson R44
Total Flying hours	≃1471
Total hours on type	≃1399
Total last 90 days (hours)	101
Total last 30 days (hours)	55
Total last 14 days (hours)	27
Total last 24 Hours (hours)	04
Medical Certificate (Class/Validity)	Class two medical Examined on 7 August 2019 Valid for 24 months

1.6 Aircraft Information

1.6.1. General

The Robinson R44 Raven II is a four seater, single main rotor, single-engine helicopter constructed primarily of metal and equipped with skid-type landing gear (Figure 3).

There are two front and two rear seats; the pilot normally occupies the front right seat. It is equipped with dual controls and certified for single-pilot operations on the right front seat.

The primary fuselage structure is welded steel tubing and riveted aluminum sheet. The tail cone is a monocoque structure in which aluminum skins carry most primary loads.

Fiberglass and thermoplastic are used in secondary cabin structure, engine cooling shrouds, and various other ducts and fairings. The cabin doors are also constructed of fiberglass 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 dipstick. Additional access to controls and other components for maintenance is provided by removable panels and cowlings.

Stainless steel firewalls are located of and above the engine. The four-cabin doors are removable.

As of November 2018, the manufacturer had constructed approximately 12,000 R44s.

1.6.2 Powerplant and Transmission System

R44 Raven II is powered by a Lycoming IO-540-AE1A5 six-cylinder, horizontally-opposed, overhead-valve, air-cooled, fuel-injected engine with a wet sump oil system. The engine is equipped with a starter, alternator, shielded ignition, two magnetos, muffler, two oil coolers, oil filter, and induction air filter. A direct drive, squirrel cage cooling fan mounted to the engine output shaft supplies cooling air to the cylinders and oil coolers via a fiberglass and aluminum shroud.

1.6.3 Rotor Systems (Main and Tail Rotors)

The main rotor has two all-metal blades mounted to the hub by coning hinges. The hub is mounted to the shaft by a teeter hinge. The coning and teeter hinges use self-lubricated bearings. Droop stops for the main rotor blades provide a teeter hinge friction restraint which normally prevents the rotor from teetering while starting or stopping. Pitch change bearings for each blade are enclosed in a housing at the blade root. The housing is filled with oil and sealed with an elastomeric boot. Each blade has a thick stainless steel spar at the leading edge which is resistant to corrosion and erosion. The skins are bonded to the spar approximately one inch aft of the leading edge.

The tail rotor has two all-metal blades and a teetering hub with a fixed coning angle. The pitch change bearings have self-lubricated liners. The teeter hinge bearings are elastomeric. The rotor blades are constructed with aluminum skins and root fittings

1.6.4 Flight Controls

R44 has dual controls which are standard equipment and all primary controls are actuated through push-pull tubes and bell-cranks. Bearings used throughout the control system are either sealed ball bearings which do not require lubrication or have self-lubricated liners.

Flight control operation is conventional. The cyclic is center-mounted with the left and right control grips mounted to a cross tube that pivots on the center cyclic post. The pilot’s cyclic grip

angle can be adjusted fore and aft relative to the cross tube by a mechanic to achieve the most comfortable hand position. The most forward position provides the most control clearance at aft cyclic for larger pilots. Pilots should always verify the ability to apply full control travel before the flight.

A collective operation is also conventional. The engine throttle is correlated to collective inputs through a mechanical linkage. When the collective is raised, the throttle is opened and when the collective is lowered, the throttle is closed. The collective stick also incorporates a twist grip throttle control.

1.6.5 5Y-MEP

Figure 3: 5Y-MEP before the accident

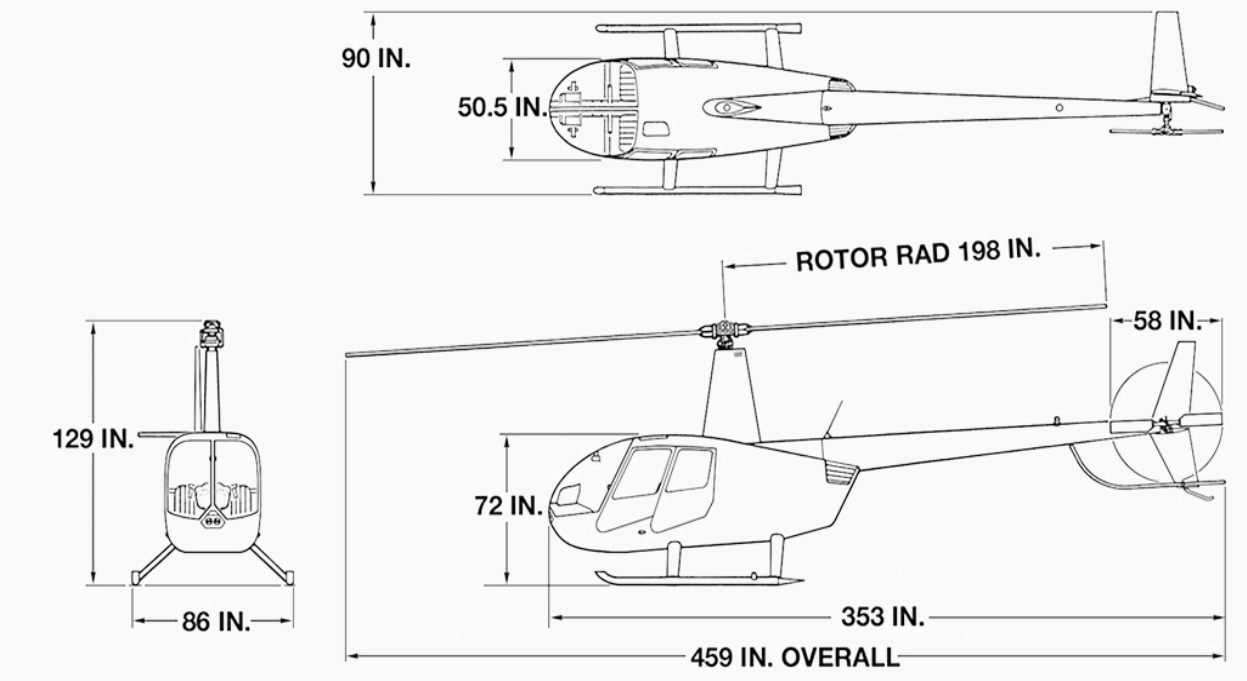

Figure 4: The Helicopter Dimensions

Table 3: Aircraft data at the time of the accident

Aircraft data at the time of the Accident	
Manufacturer:	Robinson Helicopter Company
Model:	Robinson Helicopter R44 RAVEN II
MSN:	14327
Date of manufacture:	May 2019
Nationality and registration mark:	Kenyan, 5Y-MEP
Certificate of airworthiness	
Number: Issue date: Valid to:	S/No 0742 12 August 2020 11 August 2020
Certificate of registration	
Number: Issue date:	S/No 0138 20 June 2010
Date of delivery	TBN
Engine	Lycoming IO-540-AE1A5
Engine Serial Number	L-37217-48E
Total hours since new	405.7
Total cycles since new	TBN
Last major inspection and date:	TBN
Total hours since the last inspection:	TBN
Total cycles since the last inspection:	TBN
Maximum take-off Weight	1134 Kgs (2500LBS)
Maximum Landing Weight	1092 Kgs (2400LBS)
Maximum Operating Altitude	14,000ft

The Aircraft technical records indicated that the helicopter had been maintained per Maintenance Schedule AMP/HCEA/02/2019, Work order No 20200080016 and there had not been any significant airworthiness problems. The most recent scheduled maintenance check was a 50-hour Inspection carried out on 14 August 2020. At the time of that inspection, the airframe had accumulated 405.7 flight hours since new.

A review of the Aircraft logbook indicated that the helicopter had no known defects before the accident flight. The helicopter was therefore deemed to be serviceable in all respects.

1.6.6 Fuel

The fuel used was AVGAS 100 and the quantity on board was reported to be sufficient for the flight.

1.7 Meteorological Information

The METAR from Narok Meteorological station is the nearest representative station to the area under consideration at Latitude 0.84°S, Longitude 36.14°E, and altitude 2737.00 meters. The prevailing fine weather conditions between 1300 (1600) and 1830 (2130) over Melili experienced comprised of no rainfall, light to moderate winds at 5 to 10 knots accompanied by less turbulence, and broken clouds with fairly good visibility.

1.7.1 Meteorological Information Obtained by the Pilot

The pilot mentioned during the initial interview after the accident that he had carried out a self-briefing in the morning before the series of flights by checking through the internet website for weather information that consisted of the actual and forecast weather for aviators, sunrise and sunset, high and low tide times.

From the self-briefing, the pilot gathered that the weather conditions, in general, were fine with light and variable winds, mainly southwesterly; and the temperature was 30°C with good visibility.

1.8 Aids to Navigation

The flight was conducted in the daytime under VFR and the helicopter was appropriately equipped with navigation aids for such a flight.

1.9 Communication

The helicopter was fitted with VHF radio communication equipment and the radio was serviceable on the day of the accident.

1.10 Aerodrome information

The accident took place at an open wheat field area in Melili village.
Aerodrome information is not relevant.

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1.11 Flight Recorders

The helicopter was not fitted with flight recorders and there was not a requirement by the KCAA regulations.

1.12 Wreckage and Impact Information

The on-scene examination of the accident site and wreckage revealed that the helicopter and separated components came to rest approximately 100m to the south of the lift-off position. The accident site was 45 kilometers west of Narok town.
The wreckage rested on a slightly sloping open Wheatfield surface with the fuselage toppled to the left.
The main wreckage, consisting of the fuselage, transmission, cockpit, most of the right skid tube, a portion of the left skid tube, and the majority of both main rotor blades, came to rest within a perimeter of 20metres.
The engine remained attached to the airframe with no deformation. The fuel tanks were intact.

Damage to the helicopter as a result of the impact was as follows (see Figure 6,7,8,9 and 10).

(a) The left skid was substantially damaged.

(b) The main rotor blades remained attached to the helicopter but were significantly bent and twisted.

(c) Both blades of the tail rotor were intact although detached from the tail boom.

(d) The tail boom was severely fractured and detached from the main wreckage.

(e) The main rotor blades remained attached to the helicopter but were significantly bent and twisted.

(f) The perspex canopy was extensively damaged.

Figure 5: Helicopter Wreckage

Figure 6: Helicopter Wreckage after it was tilted with the detached tail rotor on the side.

Figure 7: The side view of wreckage after it was tilted.

Figure 8: Damaged tail rotor assembly

Figure 9: Helicopter damaged components

1.12.2 Emergency locator transmitter

5Y-MEP aircraft was equipped with an emergency locator transmitter (ELT). There was no ELT signal recorded at the time of the accident.

1.13 Medical and Pathological Information

1.13.1The Pilot

The pilot had a valid Class 2 Medical Certificate. There was no evidence to suggest that he suffered from any pre-existing illness that might have contributed to the accident.

According to the pilot's statement, he was not taking any medicines prescribed by a doctor or purchased over the counter.

1.13.2The Left Front Seat Passenger

This passenger was not injured in the accident and was not admitted to the hospital. At the time of helicopter impact with the ground, he was momentarily leaning forward off his seat in an attempt to comfort the left front seat passenger. He was not entrapped in the accident and managed to vacate the wreckage with the assistance of the accident pilot.

1.13.3Left Rear Seat Passenger

This passenger was unhurt and decided to remain inside the wreckage until the Governor was evacuated.

1.14 Fire

There was no post-crash fire

1.14.1 Aircraft Survivability

Crashworthiness survivability analyses were conducted which included an assessment of the container, restraints, environment, energy absorption features, and post-crash factors.

1.15 Survival Aspects

The accident was survivable.

1.16 Tests and Research

Not applicable.

1.17 Organizational and Management Information

Karen Blixen Camp Trust is a Kenyan non-profit organization located in the Maasai Mara in Kenya.

The organization supports the conservation of wildlife and wilderness, community empowerment, and childhood and vocational education.

It is registered under the address; PO Box 9913-00100 GPO NBO, Marula Lane no. 40C Karen, Nairobi, Kenya

1.17.1 Search and rescue.

There was no search and rescue carried out.

According to the accident pilot, all the occupants were evacuated shortly after the accident.

1.18 Additional Information

Not applicable

1.19 Useful or effective investigation techniques

Not applicable

Robinson Safety Tips

The Robinson R44 POH has a section containing safety tips and the following were considered relevant to this accident.

> *10. Never make takeoffs or landings downwind, especially at high altitude. The resulting loss of translational lift can cause the aircraft to settle into the ground or obstacles.*
> *13. When operating at higher altitudes (above 3000 or 4000feet), the throttle is frequently wide open and RPM must be controlled with the collective. Throttle/collective correlation is not effective under these conditions and the governor response rate is fairly slow. It may be necessary to roll the throttle off as the collective is lowered to prevent overspeed.*

2.0 ANALYSIS

2.1 Serviceability of the Helicopter

The helicopter and its engine were being maintained as per the Approved maintenance program (AMP) approved by KCAA. Aircraft technical records indicated that the helicopter had been maintained per Maintenance Schedule AMP/HCEA/02/2019, Work order No 20200080016 which was a 50-hour Inspection carried out on 14 August 2020 at Wilson airport. At the time of that inspection, the airframe had accumulated 405.7 flight hours since new.

On the event day, the helicopter had carried out uneventful 01:13 hrs of flight & 02 landings before the accident flight. Further scrutiny of the maintenance records revealed that there had not been any significant airworthiness problems reported before the accident.

In view of the above, the maintenance or serviceability of the helicopter did not contribute to the accident.

2.2 Pilot

The PIC was not qualified to operate the subject flight. Although he held a valid Private Pilot license and was qualified to operate the helicopter, he was not qualified to perform commercial flight operations. He was current in all the other trainings and ratings as per KCAA regulations. He had a total flying experience of about 1471 hours with 1399 hours on type and about 101 hours in the last 90 days. He underwent a Class II medical examination on 07 August 2019 and was still valid on the day of the accident. He had flown the same helicopter on the previous day of the accident i.e. on 16.10.2020 and carried out a total flying of 03:05 hours which was uneventful. He was quite familiar with the route as he had been flying on this route for over 3 years, since joining the Karen Blixen Camp Trust company.

2.4 Engine

The accident flight was the third flight of the day and during the first and the second flight, the flight crew did not report any abnormalities. During the onsite visit, the engine was externally examined and no external anomalies were noted that would have contributed to the accident. To rule out any possibility (to the extent possible), of the engine misbehaving, the engine was transported to the base of the operator and re-examined in detail. All the attachments (of accessories) were found intact. All the electrical harness attachments to various points on the firewall were found satisfactory. Exhaust and induction lines were also found secured to the respective locations. The base mountings were found intact in place.

2.5 Helicopter Turning into the Wind

Whilst the helicopter is in a turn, the tail rotor would be subjected to vortex ring effect due to the meeting of the Induced Flow and the Rate of Turn Flow causing vortices to form on the periphery of the tail rotor disc, spreading inboard as a result of the increasing Rate of Turn Flow. The vortices disturb the airflow around the tail rotor, leading to the loss of Tail Rotor Thrust. Furthermore, as the helicopter was turning into the wind, the tail rotor would also be affected by the vortices created by the main rotor downwash. This would result in the further loss of Tail Rotor Thrust available to the tail rotor, aggravating the uncontrolled yaw turn situation and further accelerating the turn.

As soon as the helicopter entered into the initial state of LTE, it would be important for the pilot to arrest the increasing rate of turn by the timely application of the left yaw pedal. Hovering tailwind would make it more difficult to control the helicopter and involve a relatively higher level of pilot workload. While the pilot intended to make a slow spot turn as he reported, the left rear seat passenger noted a rapidly increasing rate of turn as described in the following recollection: "… *It was an abrupt spot turn to the left. It started quickly and kept accelerating.* …". There was no evidence to indicate that the pilot had taken effective action to control the unanticipated increasing rate of turn during the initial 180° spot turn.

Just before the impact, as the helicopter was yawing to the left, it got into further effect of the left yaw and rolled towards the left. It made contact with the ground and tilted to the left, which led to impact loads on the left passenger side.

2.6 Weight and Balance

The helicopter's empty weight is 1522lbs/690.36kg and the maximum all-up weight is 2500lbs/1134kg.The amount of fuel the helicopter is certified to carry is 47.7gallons/180lbs/81.64liters.The main fuel tank is 30.5gallons/115lbs/52.16liters and the auxiliary tank is 17.2gallons/65lbs/29.48liters.

On the day of the accident, the helicopter was refueled with 18.4gallons in the main tank and 8,6gallons in the auxiliary tank. The two passengers and the pilot had a combined weight of 772lbs/350.17kg. The elevation above the mean sea level (AMSL) is 8979feet which is ±1400 above the manufacturer's performance for hoover in ground effect and the temperature during the takeoff was 19^0c/66.2^0F. The position of the center of gravity is estimated to have been longitudinally at 100.8 inches the aft of the datum and laterally 1.1inches into the right of the airframe symmetry plane, both of which are estimated to have been out of the allowable limits (i.e., maximum gross weight of 2,400 lbs, minimum gross weight of 1,550 lbs, center-of-gravity range for the weight at the time of the accident: longitudinally 92 – 102.5 inches the aft of the datum and laterally within 3inches into the left and 3inches into the right of the airframe symmetry plane).

The above figures made it impossible for the helicopter to take off safely.

R44 WEIGHT AND BALANCE CALCULATIONS

	WEIGHT	LOCATION		MOMENT	
	(lbs)	STA	B.L.	LONG	LAT
DATE WEIGHED			12-Apr-19		
SER NO 14327	1522.2	107.09	-0.10	163008	-148
EQUIPMENT ADDED/REMOVED					
			0.0	0	0
			0.0	0	0
				0	0
				0	0
				0	0
				0	0
				0	0
				0	0
				0	0
				0	0
				0	0
CORRECTED EMPTY WEIGHT	1522.2	107.09	-0.10	163008	-148
BALLAST ADDED					
Nose battery	0.0	11.3	0.0	0.0	0.0
Fwd floor left	0.0	30.0	-12.2	0	0
Fwd floor right	0.0	30.0	12.2	0	0
Fwd baggage left	0.0	42.0	-11.1	0	0
Fwd baggage right	0.0	42.0	12.2	0	0
Rear floor left	0.0	62.0	-13.0	0	0
Rear floor right	0.0	62.0	13.0	0	0
Rear floor right	0.0	62.0	13.0	0	0
Rear baggage left	0.0	82.0	-12.2	0	0
Rear baggage right	0.0	82.0	12.2	0	0
Fwd tail	0.0	220.5	0.0	0	0
Aft tail	0.0	244.5	0.0	0	0
Miscellaneous	11.0	66.0	-32.6	726	-359
Pilot	231.0	49.5	12.2	11435	2818
Passenger	298.0	49.5	-10.4	14751	-3099
Left rear seat	243.0	79.5	-12.2	19319	-2965
Right rear seat	0.0	79.5	12.2	0	0
Takeoff fuel				GAL	
Aux	51.5	102.0	13.0	5257	670
Total	162.0	104.7	-5.1	16966	-821
Takeoff	2467.2	91.68	-1.85	226204	-4573

TAKEOFF FUEL:

ENTER 1, 2, OR 3

1=MAIN, 2=AUX, 3=TOTAL:

ENTER # OF GALLONS:

The calculations above use the aircraft's weight and balance sheet dated 12 April 2019 fueling records, three occupants along with a rucksack captured as miscellaneous. The total weight at the time of the accident is calculated using a fuel consumption rate of 15.5 gallons per hour during the takeoff period. From the weights and information obtained, the gross weight and CG at takeoff were 2467 pounds at a fuselage station of 91.68 inches. The maximum allowable gross weight for the Raven II is 2500 pounds. The maximum forward CG is 92 inches, the aircraft, therefore, took off with the longitudinal CG out past the forward limit. In addition, due to the location of the fuel in the aircraft, as fuel is burned, the CG moves forward. Therefore the out-of-limit CG condition would have gotten more out of limit, or worse, as the flight went on.

2.7 Performance and Centre of Gravity

The helicopter took off out of both longitudinal and lateral center of gravity limits. The Maximum Approved Gross Weight of the helicopter is 2,500 lbs/1134kg; the take-off weight of the helicopter was calculated to be approximately 2,467 lbs/1119kg at the time of the accident. With takeoff at close to its maximum weight, downwind to an out of ground effect (OGE) hover, in hilly terrain with full carburetor heat applied and considering the inexperience of the pilot, the performance figures in the POH and evidence gathered during the investigation shows this was outside the declared flight envelope of the helicopter. Having reached the hover, it, therefore, started to descend, and probably entered a vortex ring state (settling with power) before landing heavily.

2.8 Damage to the Aircraft

The analysis of the damage to the Aircraft listed is as detailed below.
It is considered highly probable that external forces applied during the accident caused all of the damage and that the airframe did not have any abnormalities before the occurrence of the accident.

Deformation of the left-hand lower frame of the fuselage. Because the left-hand lower frame of the fuselage is attached to the skids, it is considered highly probable that the upward force applied to the skid during the touchdown caused compressive deformation in the frame.

3. CONCLUSION

3.1 Findings, Probable Causes, and/or Contributing Factors

3.1.1 Findings

-The helicopter had a valid Certificate of Airworthiness and was maintained in accordance with the approved maintenance schedule.

-The pilot held a Private Pilot's License (Helicopters) with a Robinson R22 helicopter rating and a valid Class 2 Medical Certificate. However, the license did not bear the signature of the pilot.

-The flight was conducted in daylight under VFR and the helicopter was appropriately equipped with a navigation instrument for such a flight.

-Based on weather information and observation after the accident, it was concluded that the pilot had misinterpreted the wind direction.

-The helicopter had no outstanding defects before the accident flight and was fully serviceable in all respects.

-The main rotor blades remained attached to the helicopter but were significantly bent and twisted as a result of impact with the ground.

-The fuel tanks of the helicopter were intact in the accident and there was no fuel leakage.

-There was no evidence to suggest that the performance of the pilot had been affected by tiredness, alcohol, drugs, physiological factors, or incapacitation.

- The aircraft, therefore, took off with the longitudinal CG out past the forward limit

-The pilot conducted a self-briefing on the weather conditions of the Narok area before the series of flights and was aware of the altitude of Melili area.

-Immediate initial rescue was carried out by the local people working in the field and was followed by the local police authorities.

-The accident was survivable.

3.2 Probable Cause

Loss of control due to the helicopter operated outside the manufacturer's specifications leading to the helicopter toppling to its front during final impact with the ground.

The pilot’s inadequate preparation including loading and assessment of the helicopters expected performance on take-off at high altitude area

3.3 Contributing factors

Inadequate flying qualifications, experience, and knowledge of the helicopter's performance requirements.

The pilot’s failure to perform weight and balance calculations before departing on the flight, which resulted in his operation of the helicopter outside of its published weight and balance limitations and a subsequent loss of control shortly after takeoff.

The pilots lack of understanding of commercial operations of the aircraft

4.0 SAFETY RECOMMENDATIONS

AAID recommends that the Kenya Civil aviation Authority to exercise its oversight role by ensuring that the Air Operator Certificate (AOC) holders, pilots and other licensed personnel to exercise the privileges granted on the type of license within the prescribed limitation.

Martyn Lunani
CHIEF INVESTIGATOR OF ACCIDENTS
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