SOUTH AFRICAN CIVIL AVIATION AUTHORITY

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

AIRCRAFT ACCIDENT REPORT AND EXECUTIVE SUMMARY

Reference:	CA18/2/3/9535

Aircraft Registration	**ZS-REW**	**Date of Accident**	27 Feb 2016	**Time of Accident**	0402Z
Type of Aircraft	Robinson R22 Beta II		**Type of Operation**	Agriculture (Part 137)	

Pilot-in-command Licence Type	Commercial Pilot -Helicopter	**Age**	48	**Licence Valid**	Yes
Pilot-in-command Flying Experience	Total Flying Hours	1 559.9		Hours on Type	1 012.3

Last point of departure	Killer Krankie, Margate: KwaZulu-Natal
Next point of intended landing	Killer Krankie, Margate: KwaZulu-Natal

Location of the accident site with reference to easily defined geographical points (GPS readings if possible)

Killer Krankie, Margate, KwaZulu-Natal. (GPS co-ordinates 29°25'59.36"S 30°42'30.64"E) elevation 3 166 feet (FT) AMSL.

Meteorological Information	Wind: light and variable; Visibility: Good; Temperature: 12 °C; sky clear				
Number of people on board	1+0	**No. of people injured**	1	**No. of people killed**	0

Synopsis

The pilot took off from a private farm at Killer Krankie in Margate, KwaZulu-Natal, on a crop spraying operation with the intention of landing back at Killer Krankie. The pilot stated that during the lift-off whilst transitioning at approximately 50 FT above ground level (AGL), the low rotor RPM warning light illuminated on the instrument panel. The pilot was unable to restore the rotor rpm because the helicopter was at a low altitude. The pilot executed a forced landing in sugar cane field due to low rotor RPM. On touchdown the ground was uneven and the helicopter left skid was caught in a furrow. The helicopter entered a dynamic roll over and came to rest on its left-hand side.

The pilot sustained minor injuries. The helicopter sustained damage to the main rotor blades, tail boom, mast, and the left skid broke off.

Investigation revealed that the pilot failed to monitor main rotor RPM and lost control of the helicopter.

Probable Cause

Unsuccessful forced landing after take-off due to low rotor RPM.

SRP Date	12 September 2017	Release Date	19 September 2017

AIRCRAFT ACCIDENT REPORT

Name of Owner	: ZS-REW CC
Name of Operator	: Triple R Aviation
Manufacturer	: Robinson Helicopter Company
Model	: Robinson R22 Beta II
Nationality	: South Africa
Registration Marks	: ZS-REW
Place	: Killer Krankie, Margate, KwaZulu-Natal.
Date	: 27 February 2016
Time	: 0402Z

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 establish blame or liability****.*

Disclaimer:

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

1. FACTUAL INFORMATION

1.1 History of Flight

1.1.1 On Saturday 27 February 2016, the pilot of ZS-REW took off from Killer Krankie farm on a crop spraying operation. The pilot indicated that as part of his pre-flight inspection, he filled up the aircraft with 5 gallons of Avgas LL 100 fuel and took on-board 121.3 pounds of spraying chemical. The weather was fine and the wind was light and variable.

1.1.2 The pilot stated that during the lift-off whilst transitioning at approximately 50 FT AGL, he noticed that the low rotor RPM warning light had illuminated on the instrument panel. The pilot was unable to restore the rotor rpm because the helicopter was at a low altitude. The pilot decided to execute a forced landing on the sugar cane field. On touchdown, the ground was uneven and the helicopter's left skid was caught in a furrow. The helicopter entered a dynamic roll-over and came to rest on its left side.

1.1.3 The pilot sustained minor injuries and the helicopter sustained damage to the main rotor blades, tail boom, mast and the left skid gear broke off.

1.1.4 The accident occurred during daylight conditions at a geographical position determined to be 29°25'59.36" South 030°42'30.64" East, at an elevation of 700 feet above mean sea level (AMSL). verify the evelation (See the ynopsis as well)

Figure 1: Google Earth map showing the accident site

1.2 Injuries to Persons

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

1.3 Damage to Aircraft

1.3.1 The helicopter sustained substantial damage.

Figure 2: The helicopter after the accident

1.4 Other Damage

1.4.1 Damage was caused to the sugar cane plantations at the crash site.

1.5 Personnel Information

Nationality	South African	Gender	Male	Age	48
Licence Number	0272320656	Licence Type	Commercial Pilot-Helicopter		
Licence valid	Yes	Type Endorsed	Yes		
Ratings	Flight Instructor Grade 2, Agricultural, test pilot & Night				
Medical Expiry Date	30 November 2016				
Restrictions	Wear suitable corrective lenses				
Previous Accidents	None.				

*Note: Crop spraying training was carried out in accordance with South African Civil Aviation Regulations Part 61, subpart 25. The pilot completed his crop spraying training on 07 February 2014 and was found competent.

Flying Experience:

Total Hours	1 559.9
Total Past 90 Days	57.5
Total on Type Past 90 Days	55.4
Total on Type	1 012.3

1.6 Aircraft Information

Aircraft description:

1.6.1 The R22 is a two-blade, single-engine helicopter constructed primarily of metal and equipped with skid type landing gear. The primary structure of the fuselage is welded steel tubing and riveted aluminium. The tail cone is a monocoque structure in which the aluminium skins carry the primary loads. Fiberglass and thermoplastics are used in the secondary structure of the cabin, engine cooling system, and in various other ducts and fairings. The doors are also constructed of fiberglass and thermoplastics.

Figure 3: The helicopter picture taken from the internet

Type	Robinson Helicopter R22 Beta II	
Serial Number	3469	
Manufacturer	Robinson Helicopter Company	
Date of Manufacture	July 2003	
Total Airframe Hours (At time of Accident)	3 835.9	
Last MPI (Hours & Date)	3 798.3	23/01/2016
Hours since Last MPI	37.6	
C of A (Issue Date)	23/01/2016	
C of R (Issue Date) (Present owner)	13/09/2011	
Operating Categories	Conditions – Part 137 Operations.	

Engine:

Type	Lycoming
Serial Number	L-39106-36A
Hours since New	3 798.3
Hours since Overhaul	1 598.2

Main Rotor Blades:

Type	A016-4
Serial Number	7623/6202C
Hours since New	1 636/1 480.3
Hours since Overhaul	Not yet reached

Tail Rotor Blades:

Type	A029-1
Serial Number	13641/13318
Hours since New	1 636
Hours since Overhaul	Not yet reached

WEIGHT AND BALANCE CALCULATION

Item	Weight (lbs)	Arm (inches)	Moment (lbs-inches)
Helicopter empty weight	881.0	102.7	90461.1
Pilot (102 kg)	224.9	78.0	17540
Removable controls	-2.7	66.8	-180
Right front door	-5.2	77.50	-403
Left front door	-5.2	77.50	-403
Apollo Spray	68.0	75,4	5127
Left rear door	121.3	87.70	10634
Zero fuel weight	**1282.0**	**95.77**	**122776**
Main fuel tank(5.0 US gal)	30	108.60	3263
Aux fuel tank	0	103.80	0
Take-off weight	**1312.1**	**96.06**	**126039**

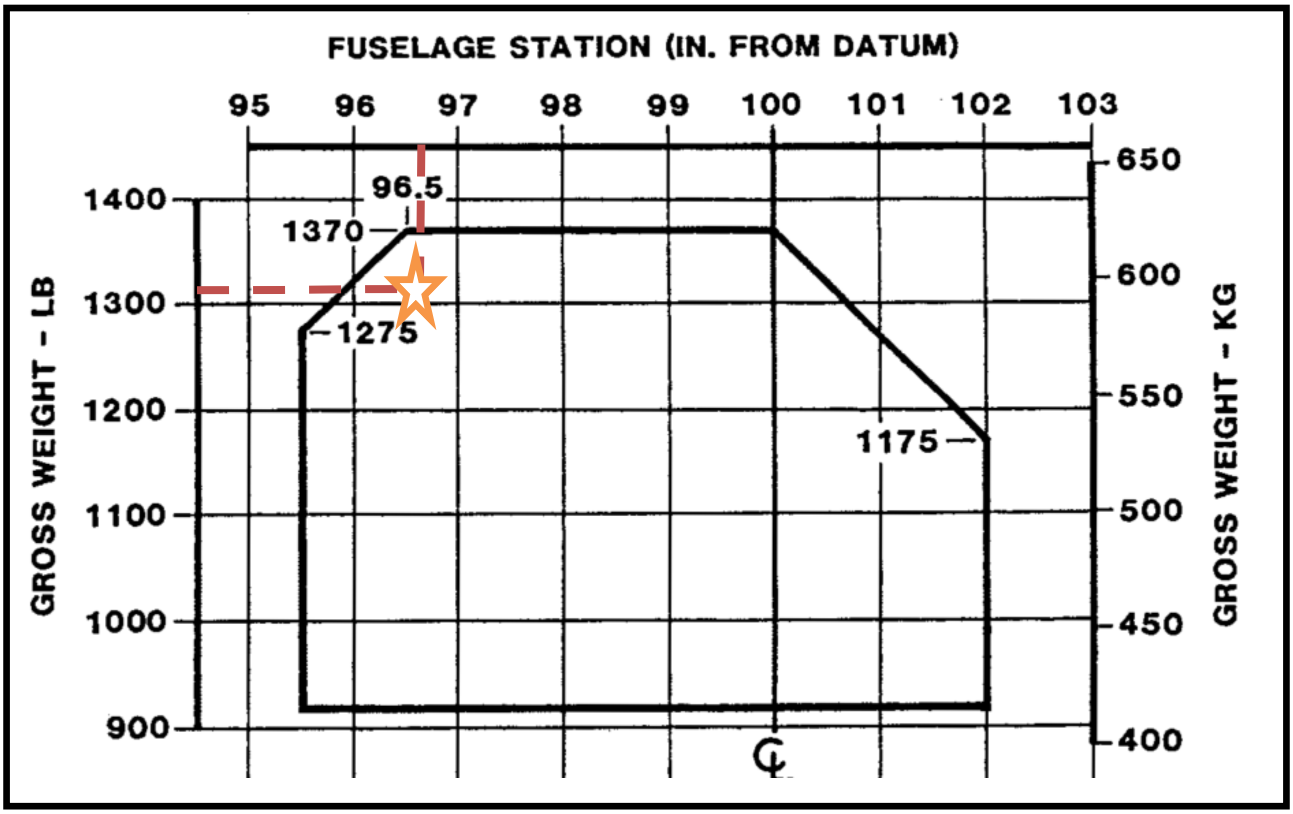
Figure 4: Weight and balance table

The helicopter empty weight data used in the weight and balance calculation was obtained from the last weighing report that was conducted on 29 February 2016.

Maximum longitudinal CG limits according to Section 2 of the POH:

Forward CG-95.5 inches aft of datum
Aft CG -101.0 inches aft of datum

1.6.2 According to the pilot's operating handbook (POH), the maximum (certificated) take-off weight for the helicopter type in question was within allowed operating limits of 1370 pounds. The helicopter was being operated in close proximity to the forward CG limit as can be seen on the CG graph below.



1.7 Meteorological Information

1.7.1 The following weather information was obtained from the pilot's questionnaire.

Wind direction	South-west	Wind speed	3 kts	Visibility	CAVOK
Temperature	12 °C	Cloud cover	Scattered	Cloud base	N/A
Dew point	N/A				

1.8 Aids to Navigation

1.8.1 The helicopter was equipped with approved navigational aids. No defects to the navigational equipment were reported or recorded prior to the accident flight.

1.9 Communications.

1.9.1 The helicopter was equipped with approved communication equipment. No defects to the communication equipment were reported or recorded prior to the accident flight.

1.10 Aerodrome Information

1.10.1 The accident did not occur at an aerodrome. It happened on a sugar cane farm in Margate, KwaZulu Natal at a geographical position determined to be 29°25'59.36" South 30°42'30.64" East, at 0402Z, elevation 700 ft above mean sea level (AMSL).

1.11 Flight Recorders

1.11.1 The helicopter was not fitted with a Cockpit Voice Recorder (CVR) or a flight data recorder (FDR), nor was this required by regulations.

1.12 Wreckage and Impact Information

1.12.1 The helicopter's left skid was caught in a furrow and the helicopter entered a dynamic rollover before coming to rest on its left side. The left skid broke off at the front.

Figure 5: The position of the helicopter after the accident with broken skid

1.12.2 The engine indications instrument panel dislodged from the pedestal. The engine remained retained inside the engine-mounting support and displayed only minor impact damage to the surrounding engine cowlings.

Figure 6: Damage to instrument panel

Figure 7: Condition of engine and cowlings

1.12.3 Both main rotor blades were destroyed after hitting the tail boom and the surrounding vegetation during the sequence of the accident. The rest of the tail boom remained attached to the fuselage of the helicopter, but was significantly crushed.

Figure 8: Damage to main rotor blades

1.13 Medical and Pathological Information

1.13.1 None.

1.14 Fire

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

1.15 Survival Aspects

1.15.1 The pilot was properly restrained by the safety harnesses. The accident was considered survivable due to the associated low kinetic forces and there was minimal damage to the cabin area.

1.16 Tests and Research

1.16.1 None.

1.17 Organizational and Management Information

1.17.1 The flight was conducted under the provisions of Part 137 of the Civil Aviation Regulations of 2011 as amended. The operator was in possession of a valid air operating certificate (AOC) with reference No's. N1194D and G1095D at the time of the accident. The AOC was issued on 02 October 2015 and the helicopter ZS-REW was duly authorised to operate under the AOC.

1.17.2 The last mandatory periodic inspection that was carried out on the helicopter prior to the accident flight was certified on 23 January 2016 at 3798.3 airframe hours. The aircraft maintenance organisation (AMO) that performed the last maintenance on the helicopter was in possession of a valid AMO Approval certificate.

1.18 Additional Information

*NOTE: The main rotor blade system of the Robinson R22 helicopter is considered a low inertia rotor system. The term refers to the tendency for the rotor to deplete its stored energy quickly, leading to the decay of main rotor rpm and therefore an aerodynamic stall of the rotor system. The Robinson helicopter company issued safety notices S/n 24 "Low rpm rotor stall can be fatal", in September 1986 (See attachment A). The notice states that a very high percentage of accidents are caused by rotor stall due to low main-rotor rpm. The Robinson R22 pilot operating handbook (POH) states that a warning horn and an illuminated amber caution light indicate that rotor rpm is below safe limits. The horn stops and the amber caution light extinguishes when rotor rpm is increased to safe limits or the collective control is full down. The "green arc" for safe operation of main-rotor rpm is between 97% and 104%. The warning horn and the amber light activate at 97% rpm. The "danger" area on the rpm gauge is 90% rpm and is indicated by a red line. The danger of low rotor rpm leading to a main-rotor aerodynamic stall during autorotation is covered during ground school but is not required as a review item during pre-flight briefing. Rotor stall due to low rpm has resulted in many helicopter accidents. At the stalling angle, usually around 15°, the airflow over the rotor blades would abruptly separate, causing a sudden loss of lift and a large increase in drag. A rotor stall occurs because of low rotor rpm. As the rotor rpm decreases, the angle of attack of the rotor blades must be increased "by the pilot flying" to generate the lift required to support the helicopter, else the helicopter will descend. Once the rotor blades reach the stalling angle of attack, lift suddenly decreases and drag greatly increases. This increased drag acts like a huge rotor brake, causing the rotor rpm to decrease further, accentuating the effect of the rotor stall. Once the rotor rpm has decayed significantly, recovery is unlikely because, as the helicopter begins to descend, the upward rushing air further increases the angle of attack of the slowly rotating blades. A tail boom cut often accompanies a low rotor rpm stall because of asymmetrical rotor stall, that is, the tendency for the helicopter to pitch nose down due to the upward airflow under the tail surfaces and the application of aft cyclic by the pilot in an attempt to keep the nose from dropping.

1.18.2 Section 10, Safety Tips (Safety Notice SN-10)
Source: Pilot's Operating Handbook

"Fatal Accidents caused by low RPM rotor stall

A primary cause of fatal accidents in light helicopters is failure to maintain rotor RPM. To avoid this, every pilot must have reflexes conditioned so he will instantly add throttle and lower collective to maintain RPM in any emergency.

The R22 and R44 have demonstrated excellent crashworthiness as long as the pilot flies the aircraft all the way to the ground and executes a flare at the bottom to reduce his airspeed and rate of descent. Even when you going down into rough terrain, trees, wires or water, he must force himself to lower the collective to maintain RPM until just before impact. The ship may roll over and be severely damaged, but the occupants have an excellent chance of walking away from it without injury.

Power available from the engine is directly proportional to RPM. If the RPM drops 10%, there is 10% less power. With less power, the helicopter will start to settle, and if the collective is raised to stop it from settling, the RPM will be pulled down even lower, causing the ship to settle even faster. If the pilot not only fails to lower the collective, but instead pulls up on the collective to keep the ship from going down, the rotor will stall almost immediately. When it stalls, the blades will either "blow back" and cut off the tail cone or it will just stop flying, allowing the helicopter to fall at an extreme rate. In either case, the resulting crash is likely to be fatal.

No matter what causes the low rotor RPM, the pilot must first roll on the throttle and lower the collective simultaneously to recover RPM ***before*** *investigating the problem. It must be a conditioned reflex. In forward flight, applying aft cyclic to bleed off airspeed will also help recover lost RPM."*

1.18.2 *Low Rotor RPM and Blade Stall*

Source: FAA Helicopter Flying Handbook, Chapter 11, Helicopter Emergencies

As mentioned earlier, low rotor rpm during an autorotation might result in a less than successful maneuver. However, if rotor rpm decays to the point at which all the rotor blades stall, the result is usually fatal, especially when it occurs at altitude. It can occur in a number of ways, such as simply rolling the throttle the wrong way, pulling more collective pitch than power available, or when operating at a high density altitude. When the rotor rpm decreases, the blades produce less lift so the pilot feels it necessary to increase collective pitch to stop the descent or increase the climb. As the pitch increases, drag increases, which requires more power to keep the blades turning at the proper rpm. When power is no longer available to maintain rpm and, therefore, lift, the helicopter begins to descend. This changes the relative wind and further increases the AOA. At some point, the blades stall unless rpm is restored. As main rotor RPM decays, centrifugal force continues to lessen until the lift force overcomes the centrifugal forces and folds or breaks the blades. At this point, airflow will provide no any lift or driving force for the system, and the result is disastrous. Even though there is a safety factor built into most helicopters, any time rotor rpm falls below the green arc and there is power, simultaneously add throttle and lower the collective. If in forward flight, gently applying aft cyclic causes more air flow through the rotor system and helps increase rotor rpm. If without power, immediately lower the collective and apply aft cyclic.

1.18.3 Recovery from Low Rotor RPM
Source: FAA Helicopter Flying Handbook, Chapter 11, Helicopter Emergencies

Under certain conditions of high weight, high temperature, or high density altitude, a pilot may get into a low rotor rpm situation. Although the pilot is using maximum throttle, the rotor rpm is low and the lifting power of the main rotor blades is greatly diminished. In this situation, the main rotor blades have an AOA that has created so much drag that engine power is not sufficient to maintain or attain normal operating rpm. When rotor rpm begins to decrease, it is essential to recover and maintain it. As soon as a low rotor rpm condition is detected, apply additional throttle if it is available. If there is no throttle available, lower the collective. The amount the collective can be lowered depends on altitude. Rotor rpm is life! If the engine rpm is too low, it cannot produce its rated power for the conditions because power generation is defined at a qualified rpm value. An rpm that is too low, equals low power. Main rotor rpm must be maintained. When operating at altitude, the collective may need to be lowered only once to regain rotor speed. If power is available, throttle can be added and the collective raised. Once helicopter rotor blades cone excessively due to low rotor rpm, return the helicopter to the surface to allow the main rotor rpm to recover. Maintain precise landing gear alignment with the direction of travel in case a landing is necessary. Low inertia rotor systems can become unrecoverable in 2 seconds or less if the rpm is not regained immediately. Since the tail rotor is geared to the main rotor, low main rotor rpm may prevent the tail rotor from producing enough thrust to maintain directional control. If pedal control is lost and the altitude is low enough that a landing can be accomplished before the turning rate increases dangerously, slowly decrease collective pitch, maintain a level attitude with cyclic control, and land.

1.18.5 Dynamic Rollover

Source: FAA Helicopter Flying Handbook, Chapter 11, Helicopter Emergencies

Dynamic rollover begins when the helicopter starts to pivot laterally around its skid or wheel. This can occur for a variety of reasons, including the failure to remove a tie down or skid-securing device, or if the skid or wheel contacts a fixed object while hovering sideward, or if the gear is stuck in ice, soft asphalt, or mud. Dynamic rollover may also occur if you use an improper landing or take-off technique or while performing slope operations. Whatever the cause, if the gear or skid becomes a pivot point, dynamic rollover is possible if not using the proper corrective technique. Once started, dynamic rollover cannot be stopped by application of opposite cyclic control alone.

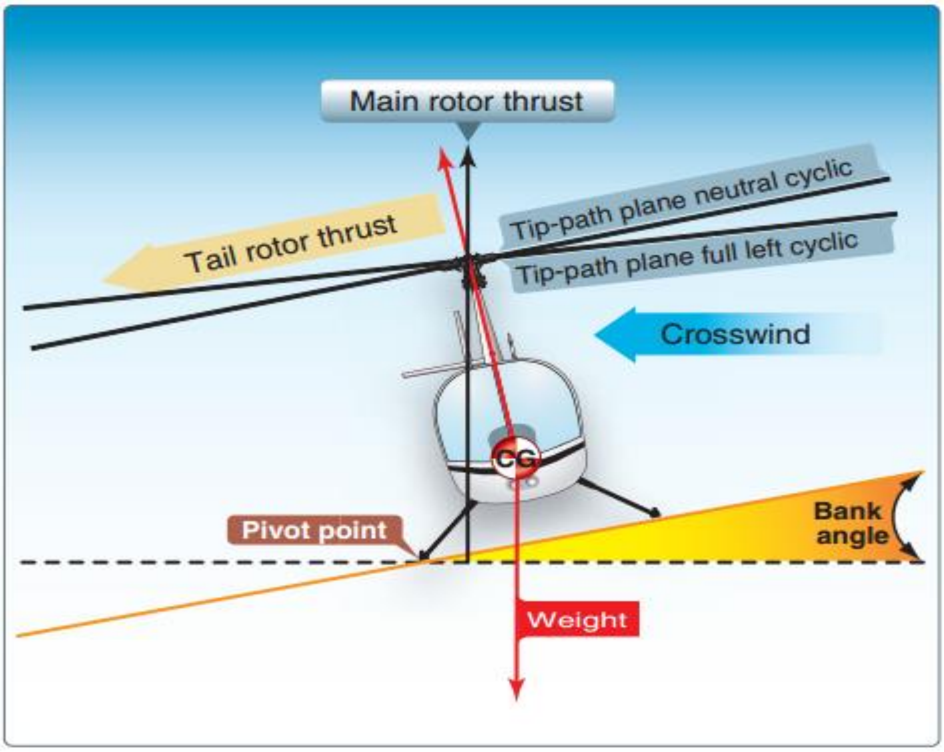


Figure 11-7. *Forces acting on a helicopter with right skid on the ground.*

Reference all the figures

1.19 Useful or Effective Investigation Techniques

1.19.1 None.

2. ANALYSIS

2.1 The pilot held a valid helicopter commercial licence with the type rating endorsed on it, as well as a valid aviation medical certificate with suitable corrective lenses restriction. He had no medical condition which might have prevented him from performing the flight on the day.

2.2 The pilot was flying the helicopter from Killer Krankie for a crop spraying operation with the intention to land back at Killer Krankie. The helicopter experienced a decay in rotor RPM shortly after the lift-off transition. The investigation concluded that the pilot did not monitor and maintain the rotor RPM.

2.3 The pilot was unable to restore the rotor rpm because the helicopter was at a low altitude. The pilot attempted an emergency landing, but the ground ~~ground~~ was uneven and the helicopter skid got caught in the furrow. The helicopter entered a dynamic roll-over and came to rest on its left side.

3. CONCLUSION

3.1 Findings

3.1.1 The pilot had a valid helicopter commercial licence and a valid aviation medical certificate.

3.1.2 The helicopter was in possession of a valid certificate of airworthiness at the time of the accident and had flown 36.7 hours since the last MPI.

3.1.3 The helicopter operator was in possession of a valid air operating certificate (AOC) at the time of the accident.

3.1.4 The pilot did not monitor and maintain the rotor RPM.

3.1.5 The helicopter main rotor RPM decayed at low altitude and the pilot was unable to restore it.

3.2 Probable Cause/s6.13 and 7.41

3.2 1 Unsuccessful forced landing after take-off due to low rotor RPM.

4. SAFETY RECOMMENDATIONS

4.1 Safety Massage: Pilots needs to adhere to the procedures issued by the manufacturer, organisation and the regulation as they are issued as a prevention measure for possible accident and accidents.

5. APPENDICES

5.1 None.