SOUTH AFRICAN CIVIL AVIATION AUTHORITY

Section/division **Occurrence Investigation** Form Number: CA 12-12a

AIRCRAFT ACCIDENT REPORT AND EXECUTIVE SUMMARY

					Reference:	CA18/2/3/9083	
Aircraft Registration	ZS-HGG	**Date of Accident**	19 September 2012		**Time of Accident**	0915Z	
Type of Aircraft	Robinson 44 Raven II (Helicopter)			**Type of Operation**	Charter flight		
Pilot-in-command Licence Type		Commercial (H)	**Age**	37	**Licence Valid**	Valid	
Pilot-in-command Flying Experience		Total Flying Hours	569.6		Hours on Type	232.7	
Last point of departure	Rand Airport FAGM - (Gauteng Province)						
Next point of intended landing	Rand Airport FAGM - (Gauteng Province)						
Location of the accident site with reference to easily defined geographical points (GPS readings if possible)							
Germiston area in bushy terrain. GPS co-ordinates: (S 26°13'41.28", E 028°7'43.23").							
Meteorological Information	Surface wind direction 240° at 07 knots, temperature 24℃, Cavok visibility						
Number of people on board	1+2	**No. of people injured**	1+2	**No. of people killed**	0		

Synopsis

The pilot, accompanied by two passengers, took off from Rand Airport (FAGM) on a scenic flight to the Johannesburg central business district (CBD). The pilot suddenly heard the engine revolutions per minute (RPM) increase with a high-pitched sound during a second left turn at a height of approximately 300 ft above ground level (AGL). The pilot then checked the engine RPM gauge and saw that the indicator was off-scale.

The pilot immediately closed (rolled off) the throttle, but the engine and main rotor RPM suddenly dropped dramatically and the low main rotor horn came on. The pilot then instinctively lowered the collective in order to attempt to restore the rotor RPM and put the helicopter into autorotation. The pilot attempted to flare the helicopter in order to reduce the rate of descent.

The pilot could not regain control and a hard landing followed, during which the skids broke off and the helicopter rolled over. The helicopter sustained substantial damage during the hard landing. The pilot and one passenger sustained minor injuries. The second passenger was admitted to hospital due to seriously injuries. The investigation found out that the aircraft engine over-speed condition was inconsistent with governor inoperative during flight.

Probable Cause

Unsuccessful forced landing following a decay in main rotor RPM in flight.

Contributory Factor/s

Poor handling technique

Engine over-speed condition in flight

IARC Date		Release Date	

AIRCRAFT ACCIDENT REPORT

Name of Owner/Operator	: HENLEY AIR (Pty) Ltd
Manufacturer	: Robinson Helicopter Company
Model	: R44 II
Nationality	: South African
Registration Marks	: ZS-HGG
Place	: Germiston at GPS: (S 26°13'41.28", E 028°7'43.23") .
Date	: 19 September 2012
Time	: 0915Z

All times given in this report is Co-ordinated Universal Time (UTC) and will be denoted by (Z). South African Standard Time is UTC plus 2 hours.

Purpose of the Investigation:

In terms of Regulation 12.03.1 of the Civil Aviation Regulations (1997) this report was compiled in the interest of the promotion of aviation safety and the reduction of the risk of aviation accidents or incidents and ***not to establish legal liability****.*

Disclaimer:

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

1. FACTUAL INFORMATION

1.1 History of Flight

1.1.1 On 19 September 2012 at approximately 0800Z two members of the South African Police Service (SAPS) from Germiston visited Rand Airport (FAGM). According to the officers, their visit to FAGM was to conduct a weapons (firearms) inspection at the security company. On completion of their task, the officers asked about the security measures for safeguarding the FAGM perimeter.

1.1.2 The security company then suggested that they organise one of the standby helicopters used for vehicle tracking for the officers, with the operator showing them the premises from the air. As they walked to the helicopter, the pilot showed the officers how he carried out a pre-flight inspection on the helicopter.

1.1.3 After the pre-flight inspection they boarded the helicopter and the pilot ensured that everyone was secured with the aircraft's safety harness.

1.1.4 At approximately 0913Z the pilot and the two passengers took off from FAGM Runway 17 on a scenic flight to the Johannesburg CBD. According to the pilot, he was cleared for lift-off by air traffic control (ATC) and was then instructed to remain east of Runway 35. ATC then cleared the pilot to cross Runway 35 heading to the north-western part of the aerodrome. The pilot was requested to report when outbound next. The pilot transitioned with an uneventful take-off profile and cleared all obstacles in his way.

1.1.5 According to the passengers, the pilot executed a 180-degree turn to the left over the golf course and the PPC cement factory while still climbing. On the second left turn, heading back to FAGM to show the passengers the premises, the helicopter suddenly lost height after they heard a strange noise coming from the engine compartment.

1.1.6 According to the pilot, at approximately 300 ft AGL he heard the engine RPM increasing. He immediately looked at the engine instrumentation (the tachometer) and noticed that the engine RPM indicator had moved off the scale and the main rotor RPM indicator was within the operating range on the scale (see figure 2).

1.1.7 The pilot's immediate reaction was to roll off the throttle. Suddenly both engine and main rotor RPM decayed. The low main rotor warning horn sounded, and the pilot instinctively lowered the collective control in order to regain rotor RPM and put the helicopter into autorotation. The pilot manoeuvred around to avoid colliding with obstacles in the area.

1.1.8 The pilot flared the helicopter in close proximity to the ground and a hard landing followed onto an old construction site. The skids broke off and helicopter rolled over onto its left side.

1.1.9 According to the air traffic controller (ATC), climb-out was normal and the helicopter headed towards the north-western side of the aerodrome, where it was observed losing altitude. The pilot later called the ATC and informed them that he had been involved in an accident, whereupon the ATC informed the aerodrome fire and rescue services, which immediately left for the location of the accident site.

1.1.10 The helicopter sustained substantial damage. The pilot and one the passenger sustained minor injuries. The second passenger was seriously injured in the accident and was later admitted to hospital.

1.2 Injuries to Persons

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

1.3 Damage to Aircraft

1.3.1 The helicopter sustained substantial damage during the impact sequence.

Figure 1: Main wreckage as it came to rest following impact

1.4 Other Damage

1.4.1 None.

1.5 Personnel Information

Nationality	South African	Gender	Male	Age	37
Licence Number	0272349291	Licence Type	Commercial		
Licence valid	Yes	Type Endorsed	Yes		
Ratings	Night Flying, Instructor Grade 3 and Test Pilot Single Piston Engine				
Medical Expiry Date	31 January 2013				
Restrictions	None				
Previous Accidents	None				

Flying Experience

Total Hours	569,6
Total Past 90 Days	52,5
Total on Type Past 90 Days	43,0
Total on Type	232,7

1.5.1 The pilot held an instructor rating on the helicopter type. According to the Robinson training procedure, it is a mandatory procedure for instructor pilots to conduct governor-off training during their training procedures.

1.6 Aircraft Information

Airframe:

Type	Robinson R44 Raven II	
Serial Number	13089	
Manufacturer	Robinson Helicopter Company	
Year of Manufacture	2011	
Total Airframe Hours (At time of Accident)	497	
Last MPI (Date & Hours)	2012/06/06	403,4
Hours since Last MPI	94,4	
C of A (Issue Date)	2011/02/17	
C of R (Issue Date) (Present owner)	2011/02/07	
Operating Categories	Standard Part 127	

Engine:

Type	Lycoming Engine IO-540-AE1A5
Serial Number	L-34153-48E
Hours since New	497
Hours since Overhaul	TBO not yet reached

Engine and main rotor RPM instrument (Tachometer)

1.6.1 The scale on the left (marked "E") represents engine RPM and the scale on the right (marked "R") represents main rotor RPM. The green shaded areas indicate the normal operating range for both engine and main rotor RPM.

1.6.2 The arrows indicate the over-speed conditions observed by the pilot prior to the accident. The engine speed needle was in the off-scale part of the scale. The rotor speed was in the green range, i.e. the normal operating ranges (see figure 2 below).

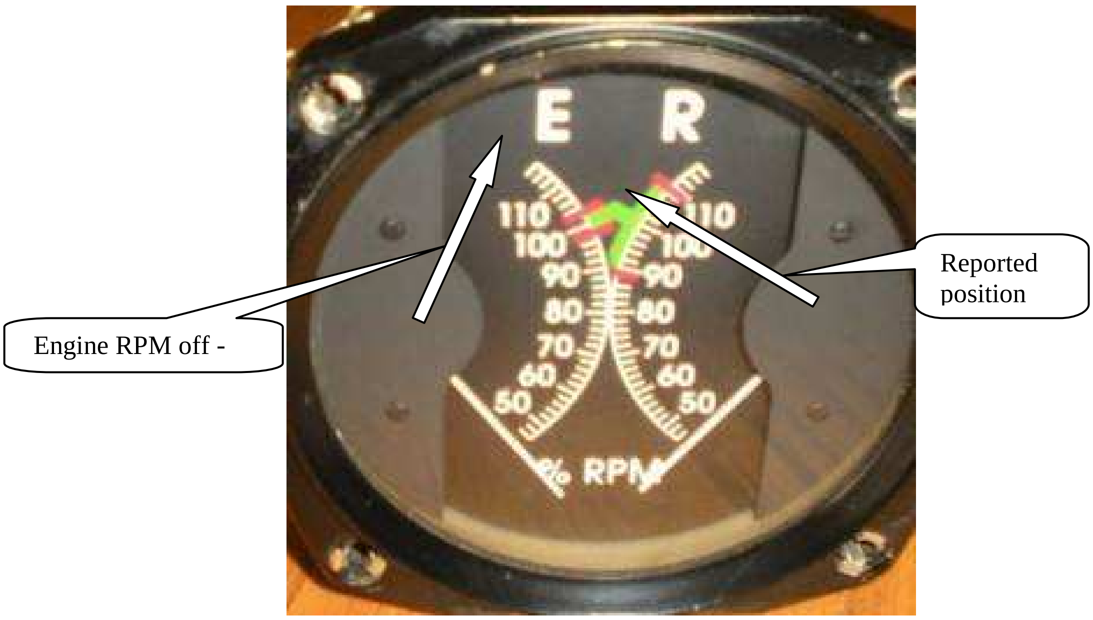

Figure 2: Tacho readings as reported by the pilot

Weight and balance

1.6.3 The weight and balance calculation were done and found to be within the limits, and fuel was sufficient for the flight.

- The maximum certified take-off mass for the helicopter as stated in Section2, pp 2 to 3 of the Pilot's Operating Handbook (POH) is 2500 lbs.

- For the purpose of the weight calculation, a 15-minute engine operation period was considered, and 27,65 lbs of fuel burn-off during that period was subtracted. This would include start, waiting for take-off clearance as well as the actual flight, which did not last more than 15 minutes. A fuel consumption of 110 lbs/ h was used for this calculation.

The helicopter weight at the time of the accident was calculated to be 2129,364 lbs, which was 370,636 lbs. below its maximum certified take-off weight.

	Weight (lbs)	Arm (inches)	Moment (in-lbs)
A/C mass empty	1552,7	106,9	165 983,63
Pilot	198	49,5	9 801
Forward passenger	165	49,5	8 167,5
R/H aft seat	165	79,5	13 117,5
Baggage	-	-	-
Fuel main tank (30.6L)	47,4	106,0	5 024,4
Fuel aux. tank (18.3)	28,914	102,0	2 949,23
Take-off Weight	2157,014		
-Fuel burn off	-27,65	106,0	-3 180
Weight at time of accident	2 129,364		

1.7 Meteorological Information

1.7.1 The weather information obtained from the South African Weather Service Meteorology in Johannesburg (METAR FAJS) showed that fine weather conditions prevailed.

Wind direction	240°(140V240)	Wind speed	7 knots	Visibility	CAVOK
Temperature	24°C	Cloud cover	Sky clear	Cloud base	-
Dew point	4°C				

1.8 Aids to Navigation

1.8.1 The helicopter was equipped with the standard navigational equipment as per the approved equipment list approved by the Regulator. There were no recorded defects to navigational equipment prior to the flight.

1.9 Communications

1.9.1 The helicopter was equipped with one VHF (Very High Frequency) radio which was approved by the Regulator. No defects of the communication equipment were reported prior to and during the flight. The pilot communicated with ATC FAGM on the frequency 118,7 MHz when receiving clearance for the take-off. After the accident the pilot phoned the ATC informing them about the accident.

1.9.2 The ATC then informed the aerodrome fire and rescue services, which immediately went to the accident site.

1.10 Aerodrome Information

1.10.1 The accident did not occur at the aerodrome. It occurred 3 kilometres from the aerodrome at the GPS coordinates determined as (S 26°13'41.28", E 028° 7'43.23").

1.11 Flight Recorders

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

1.12 Wreckage and Impact Information

Impact Information

1.12.1 The impact site was 3 km from the aerodrome. The accident occurred on an old demolished construction site which was 450 m from PPC cement factory. The terrain has bricks and old foundation structure on it and is surrounded by bush. The GPS reading for the accident site is (S 26°13'41.28 ",E 028°7'43.23").

Figure 3: View of the accident site

Wreckage

1.12.2 The observation was that the tail impacted the ground first and was severed from the tail boom.

1.12.3 The helicopter impacted the concrete surface heavily. The impact broke off the skids, which caused the helicopter to roll over.

1.12.4 The main rotor blades remained attached to the rotor hub assembly and displayed evidence of bending (upwards).

1.12.5 The cabin fuselage section, although deformed, was essentially intact. The nose section was damaged. The roof structure was damaged and it was noted that both front and rear doors were damaged as well.

1.12.6 The cyclic and collective levers in the cockpit displayed very little or no evidence of deformation; however, the governor switch located on the collective stick was found to be in the "OFF" position.

The picture below shows the position of the governor switch after the accident. The top switch is the governor switch, which is at this stage in the down position. The illustration of the position shows the operating range of the governor switch.

Figure 4: Governor Switch "ON" and "OFF" positions.

1.12.7 The final resting place of the main helicopter was 5 metres away from initial impact point. The helicopter was lying on its right side facing south-west.

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 All three occupants were making use of the helicopter's safety harness at the time of the accident.

1.15.2 After the accident the pilot was able to disembark from the wreckage unassisted and help the passengers.

1.15.3 The fire and rescue services found the pilot and passengers already evacuated from the aircraft wreckage when they arrived at the accident site.

1.15.4 They assisted by checking the aircraft pilot and passengers. The seriously injured passenger was admitted to hospital.

1.16 Tests and Research

1.16.1 For testing and research, the following components were taken into consideration, as they could have contributed to or have a direct influence on the change in both engine and main rotor RPM:

- Engine (inspection and function test).
- Airframe inspection (belt tensioner and fuel piping)
- Right-hand magneto
- Left-hand magneto
- Governor control system (inspection)

1.16.2 Engine inspection and function tests

1.16.2.1 Engine inspection

After the accident the engine was dismantled and components were checked for functionality and serviceability. The components were found serviceable.

1.16.3 Airframe Inspection

1.16.3.1 Belt tensioner inspection

An inspection was conducted on the engine belt drive grooves. There was no evidence of belt slip on either the drive grooves or the belt.

The belt tensioning mechanism was still engaged.

1.16.4 Governor control system

(Reference: Robinson R44 II Maintenance Manual, Chapter 8, pages 8 to 32)

The governor system senses engine RPM and apply corrective input forces to the throttle; when RPM are low, the governor increases throttle and vice versa. Throttle inputs are made through a friction clutch, which can be easily overridden by the pilot to regulate the engine RPM manually with the throttle and main rotor pitch control. The governor is active from 79% to 111% engine RPM and can be switched on or off by the pilot using the toggle switch on the end of the right-seat collective control.

The governor control system components were inspected (see 1.18.1 for components description). The components were found serviceable.

1.16.5 Right-hand and left-hand magnetos

(Reference: R44 maintenance manual p 14.5 and Pilot's Operating Handbook, Section 7, System Description, pp 7-6)

(i) The magneto on the right-hand side of the engine is the sensor that supplies a signal to the tachometer for the engine and main rotor gearbox RPM. The installation of electrical devices can affect the accuracy and reliability of the electronic tachometer; therefore, no electrical equipment may be installed in the R44 helicopter unless that particular installation is specifically approved by the factory.

(ii) The signal from the magneto can influence the governor functioning during flight. It helps the governor in regulating the engine RPM in response to the main rotor gearbox RPM as per throttle input during flight conditions. It also supplies a signal to the tachometer to show engine and main rotor RPM.

(iii) The left-hand magneto coordinates the starting sequence. If the lead is damaged and accidentally contacts the live conductor, starter re-activation can occur during flight. That will produce a high-pitched noise and affect the engine power by reducing the RPM. High engine RPM were in fact reported.

1.16.5.1 Tests

(i) Both left-hand and right-hand magnetos were inspected and tested for serviceability during the engine component check. The magnetos were overhauled and bench tested. No abnormalities were found during the tests. (See 5.2 Appendix B: Magneto test results).

1.17 Organisational and Management Information

1.17.1 The operator had a valid operating licence issued by SACAA with operation classification H1 & H2. The flight tickets were issued.

1.17.2 The last MPI was conducted and certified by an aircraft maintenance organisation (AMO) in possession of a valid CAA-approved maintenance organisation certificate which would expire on 31 January 2013.

1.17.3 The organisation uses a scheduled duty crew list for daily operational duties.

1.18 Additional Information

1.18.1 On 19 September 2012 the pilot was scheduled for 1230Z-1500Z flights to do aerial photography and fly between:

- FAGM to FALA for pick-up
- FALA to Royal Bafokeng
- Royal Bafokeng to FALA for drop-off
- FALA after drop-off back to FAGM

1.18.2 The governor system consists of the following major components:

The D278 governor controller, a solid-state analogue-circuit control unit mounted behind the left aft seat backrest. The controller senses engine RPM via tachometer points in the engine right magneto (helicopter left side) and provides a corrective signal to the governor assembly. All governor controllers operate on 14 V; 28 V ships use a 28 to 14 V converter to power the controller.

The 14V B247-5 governor assembly is attached to the collective stick assembly behind the left front seat. When activated by the governor controller, the governor gear motor and attached worm gear drive a friction clutch connected to the throttle.

1.18.3 Signal and power wiring:

(Reference: Pilot's Operating Handbook, Section7, System Description, pages 7-6)

The governor maintains engine RPM by sensing changes and applying corrective throttle inputs through a friction clutch that can be easily overridden by the pilot during governor failure and emergency conditions. The governor is only active above 79% engine RPM and can be switched on or off using the toggle switch on the end of the right-seat collective.

The governor is designed to assist in controlling RPM under normal conditions. It may not prevent over or under-speed conditions generated by aggressive flight manoeuvres.

CAUTION:

When operating at high-density altitudes, governor response rate may be too slow to prevent over-speeding during gusts, pull-ups or when lowering collective.

1.18.4 <u>Governor failure (emergency):</u>

(Reference: Pilot's Operating Handbook, Section 3, Emergency Procedures, pages 3 to 7)

If the engine RPM governor malfunctions, grip the throttle firmly to override the governor, and then switch the governor off. Complete the flight using manual throttle control. The governor off light is an amber warning light positioned on the instrument panel. The light will illuminate when the governor is switched off at the toggle switch on the collective control.

1.19 Useful or Effective Investigation Techniques

1.19.1 None

2 ANALYSIS

2.1 During a scenic flight from FAGM, Robinson R44 helicopter with 3 occupants on board experienced an increase in engine RPM with the main rotor RPM at normal operating range. The possibilities of an increase in engine RPM can be caused by either belt slip, wrong signalling of the right-hand magneto or failure of the governor during aggressive manoeuvring.

2.1.1 The belt tensioning mechanism was found to function normally, and although the belts were damaged as a result of the accident sequence, there was no evidence of friction marks caused by belt slip.

2.1.2 The right-hand magneto was found to functioning normally after the accident during bench tests.

2.1.3 Failure of the governor during a climbing turn.

2.1.3.1 A climbing turn is a simultaneous combination of various flight control settings involving coordination of the cyclic lever for turning, throttle for desired power, collective to maintain rate of climb and rudder pedals to reduce/ increase anti-torque demand. During the first turn the pilot might have realised that he was executing an unplanned turn in the desired direction. The pilot was then tempted to force another left turn following the 180 degree turn. At the time the governor may have been unable to respond (to regulate/ correct RMP) during the second left turn and allowed the engine RPM to exceed the operating range. This can be regarded as aggressive flight manoeuvring.

2.2 As the governor switch was found in the “OFF” position after the accident, the investigator is of the opinion that it either could have been accidentally switched off prior to the accident or it could have gone into the “OFF” position as a result of the impact. However, the pilot stated that the engine started over-speeding prior to the reduction of engine and rotor RPM. This indicates that the governor was inoperative prior to the accident.

2.2.1 Should the governor be accidentally switched off during a climbing turn, the possibility of the engine over-speeding is high due to the power demand. The condition is indicative of governor failure, where the pilot has to override the governor and regulate both the engine and main rotor rpm input manually using the throttle and collective controls. The throttle control settings to maintain a desired angle of bank in a new helicopter flight attitude will not be the same as when the governor is operating.

2.2.2 If the pilot was not aware that the governor was in “OFF” position, he would operate the throttle as if the governor were operating. With the governor not operating, the increase in power settings with the throttle would cause over-revving because the RPM would not be regulated.

2.2.3 The main rotor maintained its RPM within the normal operating range during engine over-speed conditions because of the rapid change of pitch (angle at which the blade is set to produce the desired lift) control during turning regulated by the resistance force (drag force).

2.3 The pilot attempted to execute an emergency recovery procedure by first correcting the engine high speed condition by rolling off (closing) the throttle. He then lowered the collective after seeing on the tachometer that both engine and main rotor RPM were dropping rapidly and the low main rotor RPM horn sounding.

2.3.1 By closing (rolling off) the throttle the pilot reduced the engine power to idle. By lowering the collective the pilot reduced the pitch of the main rotor. That would allow the pilot to put the helicopter into autorotation.

2.3.2 The reason why both the engine and the main rotor RPMs decayed dramatically was that when the engine power is reduced in flight, there will be more resistance on the main rotor blades caused by drag forces (depending on the pitch). The main rotor RPM dropped when the pilot was lowering the collective control stick to reduce pitch to autorotation.

2.4 The pilot executed two manoeuvres over the golf course prior to the over-speed condition: while climbing, he executed a 180-degree turn to the left followed shortly after by another left turn; this led to the engine over-speeding at the minimum allowable height of approximately 300 ft AGL.

2.4.1 It is the investigator's opinion that the pilot's decision to execute the two consecutive left turns at the height of approximately 300 ft resulted from overconfidence. The pilot is an instructor on the helicopter type. It is stated clearly that at this height it was not safe to execute the two consecutive turns. Although the pilot attempted to recover the aircraft, the height was not enough to recover flight.

2.5 On 19 September 2012 the pilot was scheduled to do aerial photography at 1230Z-1500Z comprising four legs flight between FAGM-FALA-Royal Bafokeng-FALA-FAGM.

2.5.1 It is with the investigator's opinion that the pilot was not prepared for the scenic flight. The pilot was operating out of his schedule and he had his own scheduled flight to prepare. The purpose of the flight was to quickly show the officers the FAGM premises from the air.

2.6 The helicopter mass and balance were within the limits. The fuel was of correct grade, containing no contaminants sufficient for the flight.

2.7 Fine weather conditions prevailed, and the weather was not considered a factor in the accident.

2.8 The accident site surface was not suitable for landing or for executing an emergency landing.

2.9 According to the passengers their purpose at FAGM was to inspect weapons at the security company. The flight was organised for the officers as a courtesy after they had shown concern about the security measures at the FAGM premises.

2.9.1 The helicopter was scheduled for vehicle tracking operation. The organisation agreed to operate outside their routine procedures and deployed a pilot who was already scheduled for a later flight operation.

3 CONCLUSION

3.1 Findings

3.1.1 The pilot was properly licensed and had the helicopter type endorsed in his logbook.

3.1.2 The pilot's medical was properly issued by an approved SACAA medical examiner and was valid.

3.1.3 The maintenance records indicate that the aircraft was equipped and maintained in accordance with existing regulation and approved procedures.

3.1.4 The mass and the centre of gravity of the aircraft were within the prescribed limits.

3.1.5 There was no evidence of airframe failure prior to flight.

3.1.6 There was no evidence of any defect or malfunction of the engine components inspected that could have contributed to the accident.

3.1.7 The engine function test bench runs were successful and acceptable.

3.1.8 The flight was an unplanned flight.

3.1.9 The passengers were not briefed on emergency safety procedures prior to the flight.

3.1.10 The governor switch was found in "OFF" position and the governor control system was found serviceable during functional tests.

3.2 Probable Cause/s

3.2.1 Unsuccessful forced landing following decay of main rotor RPM in flight.

3.3 Contributory Factor/s

3.3.1 Poor handling technique

3.3.2 Engine over-speed condition in flight.

4. SAFETY RECOMMENDATIONS

4.1 None

5. APPENDICES

5.1 Appendix A : Weight and Balance

5.2 Appendix B : Engine dismantling, repairs and function results

5.3 Appendix C : Magneto Overhaul and Bench Test results

5.1 Appendix A

R44 II Weight and Balance

	WEIGHT	LONG. ARM	LONG. MOM.	LAT. ARM	LAT. MOM.
Empty Weight	1552.70	103.57	160815.00	0.00	0.00
Pilot	198	49.5	9801.00	+12.2	2415.60
Pilot Baggage	0	44.0	0.00	+11.5	0.00
Fore Passsenger	165	49.5	8167.50	-10.4	-1716.00
Fore Passenger Baggage	0	44.0	0.00	-11.5	0.00
Right Aft Passenger	165	79.5	13117.50	+12.2	2013.00
Right Aft Baggage	0	79.5	0.00	+12.2	0.00
Left Aft Passenger	0	79.5	0.00	-12.2	0.00
Left Aft Baggage	0	79.5	0.00	-12.2	0.00
Total Weight & Balance w/Zero Usable Fuel	No Fuel Weight	No Fuel Long. C.G.	Long. Empty Moment	No Fuel Lat. C.G.	Lat. Empty Moment
	2080.70	92.23	191901.00	1.30	2712.60
Main Tank	47.40	106.0	5024.4	-13.5	-639.9
Aux Tank	28.91	102.0	2949.228	+13.0	375.882
Total Weight & Balance w/Take Off Fuel	Take Off Weight	Long. Full CG	Long. Full Moment	Lat. Full CG	Lat. Full Moment
	2157.01	92.66	199874.63	1.14	2448.58

Fuel Availability @ Weight		Fuel Conversion Calculator			
Max. Gross Weight	2500	Main Tank Pounds	0.00	0.00	Gallons
Payload	528	Main Tank Gallons	30.60	183.60	Pounds
Max. Fuel (Pounds)	217.09	Aux. Tank Pounds	0.00	0.00	Gallons
Max. Fuel (Gallons)	36.18	Aux. Tank Gallons	18.30	109.80	Pounds
			Total 48.90	**Total** 293.40	

5.2 Appendix B

Engine components dismandling and functional check results.

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AERO ENGINEERING AND POWERPLANT (PTY.) LTD. G	AMO 227 Doc No:227/ED/002 Revision:1 Date:21-02-2013 WORK PACK NO.: 4520

PART 1: GENERAL			
Job Opened (Date):	01-03-2013		
Customer Name:	T.A.M.		
Aircraft Registration:	ZS-HGG		
Job Closed (Date):			
Work Required (Mark with X):	Inspection X	Repair	Overhaul

PART 2: ENGINE PARTICULARS	
Make:	LYCOMING
Model:	IO-540-AE1A5
Serial Number:	L-34153-48E

PART 3: AIRWORTHINESS DATA			
Description:	Publication Number:	Publication Issue/ Revision Number:	Publication Issue/ Revision Data:
Overhaul Manual:			
AD's			
SB's/SL's/SI's			

Document Description: Work Pack Index	Checked by:
Job Card	
Engine Inspection Report	
Engine Assembly Report	
Engine Test Report	
Spares List	
SB/SL/SI and FAA AD List	
NDT Report	
Component Work	
Measurement Sheet	

PART 4: COMPONENTS (REMOVED)

Description:	Part Number:	Serial Number:
Dual Magneto	N/A	—
Left Magneto S6LSC - 200	10 - 600616 - 9	E09KA017
Right Magneto S6LSC - 204T	10 - 600646 - 201	E09LA056
Fuel Injector RSA-10AD1	2576630-4	70DH9604
Fuel Pump AC TYPE	L - 15473	0210
Flow Divider	2576526 -1	A0G6506
Carburettor	N/A	—
Alternator	ALU - 8521LS	J110671
Generator	N/A	—
Starter	BC315 -100-4	0310260325
Vacuum Pump	N/A	—
Turbo Charger	N/A	—
Density Controller	N/A	—
Differential Pressure Controller	N/A	—
Variable Pressure Controller	N/A	—
Waste Gate Controller	N/A	—
Constant Speed Unit (C.S.U.)	N/A	—
Hydraulic Pump	N/A	—
Over Boost Pump	N/A	—
Tacho Generator	N/A	—
Pressure Pump	55073	0157603080
Oil Cooler	10886A / 10962A	5271 / 2139
Fuel Control Unit (F.C.U.)		

Additional items fitted: OIL TEMP PROBE / RING GEAR + BELT

Items missing from engine: CHT PROBE / RH EXH / EXH TAIL PIPE

Notable damage to engine: LH EXH

INSPECTION REPORT

CAMSHAFT

Camshaft S/N:			
Cam lobes	S	Cam journals	S
Cam gear	S	C.S.U. drive gear	—
Key	—	Circlips	—

Remarks: —

Mechanic: (Signature) [signature]

VACUUM PUMP DRIVE

Housing	S	Gear	S
Spacer	S	Seal surface	S

Remarks: —

Mechanic: (Signature) [signature]

OIL PUMP

Housing	S	Drive shaft	S
Drive impeller	S	Idler impeller	S

Remarks: —

Mechanic: (Signature) [signature]

CRANKCASE			
Crankcase S/N:	K1797		
Finished surfaces	S	Studs	S
Oil passages	S	Thrust faces	S
Main bearing surface	S	Cam bearing surface	S
Main bearing parting surface	S	Dowels	S
Oil seal surface	S		
Remarks:	/	**Mechanic:** (Signature)	[signature]

Aero Engineering & Powerplant

ACCESSORY HOUSING			
Finished surface	S	Studs	S
Oil passages	S	Suction tube	S
Oil filter housing	S	Oil filter screen	S
Oil filter cartridge	—	Oil filter bolt	—
By pass valve	S	By pass spring	S
Thermo valve	S	Thermo valve seat	S
Remarks:	/	**Mechanic:** (Signature)	[signature]

CRANKSHAFT			
Crankshaft S/N:	V537975 1459		
Thrust bearing journal	S	Main bearing journal	S
Conrod bearing journal	S	Oil tubes	S
Splines	S	Flange bushes	S
Pilot	S	Counterweights	S
Rollers	S	C.W. plates	u/s
C.W. Circlips	u/s	Welch plug	u/s
Remarks:	/	**Mechanic:** (Signature)	[signature]

OIL RELIEF VALVE			
Housing	S	Spring	S
Ball / ~~Plunger~~	S	Seat	S
Remarks:	/	**Mechanic:** (Signature)	[signature]

MAGNETO DRIVERS			
Gears	S	Shaft	S
Bearing	S	Coupling	S
Cushion	u/s	Bearing surface (c/case)	S
Remarks:	/	**Mechanic:** (Signature)	[signature]

FUEL PUMP DRIVE			
Housing	A/C pump	Gear & shaft	
Seal surface		Idler shaft	
Idler gear		Spacer	
Circlip			
Remarks:		**Mechanic:** (Signature)	[signature]

CAM FOLLOWERS			
Tappet bodies	u/s	Hydraulic units	S
Sockets	S		
Remarks:	/	**Mechanic:** (Signature)	[signature]

BELT TENSIONER SYSTEM			
Bracket	N/A	Jockey pulley	
Jockey bearing		Alternator/generator belt	
Remarks:	/	**Mechanic:** (Signature)	[signature]

5.3 Appendix C

Engine Run Results

Aero Engineering and Powerplant
Engine Test Report

Doc No:227-T
Revision:1
Date: 01-03-2012

Reg: ZS-HGG **Job Card: 4520**

Make: LYCOMING **Model: IO-540-AEIA5** **Serial No: L-34153-48E** **Date: 25-03-2013**

Time	RPM	Oil Temp	CHT	Oil Press psi	Fuel Press	Manifold Press	OAT	
13.15	1200	60°C	190°C	90	28	12	25	
13.20	1500	60°C	220°C	88	28	14	25	
13.25	1800	60°C	250°C	89	28	16	25	
13.30	2200	70°C	290°C	88	28	20	25	
13.35	2500	80°C	310°C	88	28	25	25	
15.35	2200	75°C	280°C	85	28	20	25	
15.40	1800	60°C	250°C	80	28	16	25	
15.45	1500	60°C	230°C	78	28	14	25	
15.50	1200	60°C	200°C	70	28	12	25	

Mag Drop @1800 RPM **Left 50** **Right 50**

Remarks: None

Engine Tested By: GP Jacobs **Signature:**

Engine Accepted: YES **Engine Rejected: NO**

AME Inspector: Name: A Nel **Signature:**

AE&P INSPECTOR NO.: 1 AMO NO.: 227

Appendix B

5.2 Magneto Overhaul and Bench Test

TAM
Transvaal Aircraft Maintenance

Transvaal Aircraft Maintenance (PTY) Ltd.
Reg nr. 81/10145/07
P O Box 82159
Doornpoort,
0017
Tel. (012) 567 1191
Fax. (012) 543 1246
email: tamaircraft@mweb.co.za

17 May 2013

SACAA
Ikhaya Lokundiza
Treur Close
Waterfall Park
Bekker Street
Midrand

Accident Investigations
Attention: Mr. Aubrey Nkoana

Ref: Robinson R44, ZS-HGG: Magneto's Report

Dear Mr. Nkoana,

Both Magneto's (from ZS-HGG) P/N: S6LSC-204T/10-600646-201, S/N: E09LA056 and S/N: E09KA017 were Bench Checked as per Manual P/N: X42001-2, Rev: Aug 2011, and were found satisfactory.

Magneto's were subsequently Overhauled as per attached CRMA Numbers: 6110/1 and 6110/2.

Yours Truly,

W.J. Jordaan
Workshop Manager

SOUTH AFRICAN CIVIL AVIATION AUTHORITY

1.	2. AUTHORISED RELEASE CERTIFICATE CA 21-19 AIRWORTHINESS APPROVAL TAG				3. Form Tracking Number: 6110/1	
4. Organization Name and Address: TRANSVAAL AIRCRAFT MAINTENANCE. Hangar No. 3 Wonderboom Airport Pretoria.					5. Work order / contract / Invoice Number: ZS-HGG	
6. Item:	7. Description:	8. Part No:	9. Eligibility: *	10. Quantity:	11. Serial / Batch No:	12. Status / Work:
1	MAGNETO	S6LSC-204T/10-600646-201	N/A	1	E09LA056	OVERHAUL

13. Remarks: MAGNETO OVERHAULED AND TESTED IAW T.C.M. MANUAL X42001-2 AUGUST 2011.

SB'S COMPLIED WITH: SB631,MSB644,MSB645.

14. Certifies the items identified above were manufactured in conformity to: ☐ Approved design data and are in condition for safe operation. ☐ Non-approved data specified in block 13.		19. ☒ Part 43 Release to Service. ☐ Other regulation specified in block 13. Certifies that unless otherwise specified in Block 13, and the work identified in block 12 and described in Block 13 was accomplished in accordance with Civil aviation Regulations, part 43 and in respect to that work, the items are approved for return to service.	
15. Authorised Signature	16. Approval/Authorization No.	20. Authorised Signature	21. Certificate/Approval Ref No. 85 TRANSVAAL AIRCRAFT MAINTENANCE AMO 85 INSP. No. 6
17. Name	18. Date (YY/MM/DD)	22. Name B.KNOPJES	Date (YY/MM/DD) 2013-04-02

SOUTH AFRICAN CIVIL AVIATION AUTHORITY

1.	2. AUTHORISED RELEASE CERTIFICATE CA 21-19 AIRWORTHINESS APPROVAL TAG				3. Form Tracking Number: 6110/1	
4. Organization Name and Address: TRANSVAAL AIRCRAFT MAINTENANCE. Hangar No. 3 Wonderboom Airport Pretoria.					5. Work order / contract / Invoice Number: ZS-HGG	
6. Item:	7. Description:	8. Part No:	9. Eligibility: *	10. Quantity:	11. Serial / Batch No:	12. Status / Work:
1	MAGNETO	S6LSC-204T/10-600646-201	N/A	1	E09LA056	OVERHAUL

13. Remarks: MAGNETO OVERHAULED AND TESTED IAW T.C.M. MANUAL X42001-2 AUGUST 2011.

SB'S COMPLIED WITH: SB631,MSB644,MSB645.

14. Certifies the items identified above were manufactured in conformity to: ☐ Approved design data and are in condition for safe operation. ☐ Non-approved data specified in block 13.		19. ☒ Part 43 Release to Service. ☐ Other regulation specified in block 13. Certifies that unless otherwise specified in Block 13, and the work identified in block 12 and described in Block 13 was accomplished in accordance with Civil aviation Regulations, part 43 and in respect to that work, the items are approved for return to service.	
15. Authorised Signature	16. Approval/Authorization No.	20. Authorised Signature	21. Certificate/Approval Ref No. 85 TRANSVAAL AIRCRAFT MAINTENANCE AMO 85 INSP. No. 6
17. Name	18. Date (YY/MM/DD)	22. Name B.KNOPJES	Date (YY/MM/DD) 2013-04-02