CA18/2/3/8855

SOUTH AFRICAN CIVIL AVIATION AUTHORITY

ACCIDENT REPORT – EXECUTIVE SUMMARY

Aircraft Registration	**ZU-DCI**	**Date of Accident**	18 October 2010	**Time of Accident**	0615Z
Type of Aircraft	Rotorway Executive 162		**Type of Operation**	Training	
Pilot-in-Command Licence Type	Commercial Pilot	**Age**	38	**Licence Valid**	Yes
Pilot-in-Command Flying Experience	Total Flying Hours	1 280.6		Hours on Type	50.7
Last Point of Departure	Morning Star Aerodrome, Western Cape				
Next Point of Intended Landing	Morning Star Aerodrome, Western Cape				

Location of the Accident Site with Reference to Easily Defined Geographical points (GPS readings if possible)

In a wheat field, approximately 3 nm east of Morning Star Aerodrome

Meteorological Information	Wind 090° at 5 kts; temperature 18°C, visibility +10 km				
Number of People on Board	1 + 1	**No. of People Injured**	0	**No. of People Killed**	0

Synopsis

An instructor and a student pilot took off from Morning Star Aerodrome on a training flight to Fisantekraal airfield (FAFK). At a height of approximately 1 500 ft above mean sea level (AMSL) during a climb, the instructor demonstrated to the student a simulated engine failure by rolling off the throttle.

The instructor stated that the entry was good and a safe autorotation was established. However, upon approaching the briefed recovery altitude, a recovery was attempted by rolling the power back on. The engine then appeared to splutter and the engine failed to regain power.

The instructor made several attempts to restore engine power without success. At approximately 200 ft above ground level, the instructor committed to carrying out a full autorotation landing in an open field. The instructor touched down on the left-hand skid, causing the helicopter to roll over onto its right-hand side.

The helicopter was substantially damaged, with damage to the main rotor blades, tail rotor, tail boom, skids and fuselage.

Probable Cause

Incorrect co ordination of the throttle and collective pitch resulted in the loss of revolutions per minute (RPM) during a simulated autorotation, resulting in a hard landing followed by a dynamic rollover.

AIRCRAFT ACCIDENT REPORT

Name of Owner/Operator	**:** Druid's Castle Investments 10 CC
Manufacturer	**:** Rotorway
Model	**:** Executive 162 F
Nationality	**:** South African
Registration Marks	**:** ZU-DCI
Place	**:** Approximately 3nm east of Morning Star Aerodrome
Date	**:** 18 October 2010
Time	**:** 0615Z

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 two hours.

Purpose of the Investigation:

In terms of Regulation 12.03.1 of the Civil Aviation Regulations (1997), this report was compiled in the interests 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 An instructor and a student pilot took off from Morning Star Aerodrome on a training flight to Fisantekraal airfield (FAFK). The instructor stated that at a height of approximately 1 500 ft above mean sea level during a climb, he demonstrated to the student a simulated engine failure by rolling off the throttle.

1.1.2 The instructor stated that the entry was good and a safe autorotation was established. However, upon approaching the briefed recovery altitude, a recovery was attempted by rolling the power back on. The engine then appeared to splutter and the engine failed to regain power.

1.1.3 The instructor made several attempts to restore engine power without success. At approximately 200 ft above ground level, the instructor committed to carry out a full autorotation landing in an open field. The instructor touched down on the left-hand skid, causing the helicopter to roll over onto its right-hand side.

1.1.4 The instructor stated that the slope of the ground on which he touched down resulted in the helicopter rolling over.

1.2 Injuries to Persons

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

1.3 Damage to Aircraft

1.3.1 The helicopter sustained substantial damage to the main rotor blades, tail rotor, tail boom, skids and fuselage.

1.4 Other Damage

1.4.1 No other damage was caused.

1.5 Personnel Information

1.5.1 Instructor

Nationality		South African			
Licence No.	**********	Gender	Male	Age	38
Licence Valid		Yes	Type Endorsed	Yes	
Ratings		Instrument rating, Instructor Grade 2 rating, Night rating			
Medical Expiry Date		31 December 2010			
Restrictions		None			
Previous Accidents		None			

1.5.2 Flying Experience:

Total Hours	1 280.6
Total Past 90 Days	73.4
Total on Type Past 90 Days	8.6
Total on Type	50.7

1.6 Aircraft Information

1.6.1 Airframe:

Type	Executive 162 F	
Manufacturer	Rotorway	
Year of Manufacture	2002	
Total Airframe Hours (At Time of Accident)	132	
Last Annual inspection (Hours & Date)	125.9	17 July 2010
Hours Since Last Annual Inspection	6.1	
C of A (Issue Date)	20 July 2007	
Authority to Fly (Expiry Date) (Present Owner)	17 July 2011	
Operating Categories	Private operation and owner training	

1.6.2 Engine**:**

Type	Rotorway RI 162F
Hours Since New	132
Hours Since Overhaul	Not Applicable

1.7 Meteorological Information

1.7.1 Weather information was obtained from the pilot's questionnaire:

Wind Direction	090°	Wind Speed	5 kts	Visibility	10 km+
Temperature	18°C	Cloud Cover	Partly cloudy	Cloud Base	3 000 ft
Dew Point	10°C				

1.8 Aids to Navigation

1.8.1 The helicopter was equipped with standard navigation equipment and no defects were recorded before the flight.

1.9 Communications

1.9.1 The pilot transmitted his intentions on VHF frequency 124.8 MHz.

1.9.2 There was no communication with air traffic control (ATC) as the aircraft was operated outside of controlled space.

1.9.3 The helicopter was equipped with standard communication equipment and no defects were recorded before the flight.

1.10 Aerodrome Information

1.10.1 The accident did not occur at an aerodrome, but in a wheat field approximately 3 nm east of Morning Star Aerodrome, at an elevation of 250 ft AMSL.

1.11 Flight Recorders

1.11.1 The helicopter was not equipped with a flight data recorder (FDR) or a cockpit voice recorder (CVR), nor were these required in terms of the regulations to be fitted to this type of helicopter.

1.12 Wreckage and Impact Information

1.12.1 The pilot was performing an autorotation when the helicopter made contact with the ground and rolled over onto to its right-hand side.

1.12.2 Impact with the ground occurred approximately 28 seconds after entering into the autorotation. This can be seen by the impact damage occurring on the front of the right-hand skid (i.e. no flare at touchdown) as well as the short forward distance the helicopter travelled after first impact (approx. 5 m), indicating a high decent angle.

Figure 1: The helicopter on its right-hand side

Figure 2: Damage to and position of the helicopter

1.13 Medical and Pathological Information

1.13.1 Not applicable.

1.14 Fire

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

1.15 Survival Aspects

1.15.1 The accident was considered survivable. Both occupants onboard the helicopter were properly restrained at the time by their helicopter equipped safety harnesses.

1.16 Tests and Research

1.16.1 Rotorway International was contacted in order to assist with the Full Authority Digital Engine Control (FADEC) engine download taken off the engine's Electronic Control Units (ECUs). Their findings as follows:

i. Autorotation started at 3.29.01 when the throttle was closed during a climbing autorotation demonstration. This was the second performed during this flight; the first was done just prior to the second.

ii. Impact with the ground occurred at 3.29.31, 28 seconds after the autorotation was entered. Impact is indicated by the CPU errors and ignition errors occurring on impact. The ECU enclosures were damaged by ground impact at

iii. this time, and rapid engine RPM deceleration occurred as well causing the CPUs to fail. No error codes were seen for the intial part of the flight or previous flights. Code errors were only seen during FADEC cycling during take-off checks, where the FADEC's are cycled on and off – this is normal.

iv. From the high MAP, seconds before the impact with full throttle percentage applied but drooping engine RPM, it can be deduced that over-pitching of collective occurred, and that the high resultant load on the engine would not allow the engine RPM to increase or regulate.

v. Rotor RPM and engine RPM achieved 95% 23 seconds before impact, but the pilot did not roll on full throttle until seconds later – this allowed the RPM to droop with the high load.

vi. It is probable that insufficient height remained for a normal recovery to be made, and over-pitching resulted in the pilot trying to arrest the rate of descent. This can be seen by the impact damage occurring on the front undercarriage (i.e. no flare at touchdown) as well as the short forward distance the helicopter travelled after first impact (approx. 5 m), indicating a high descent angle and only 58% rotor and engine RPM available.

vii. Two autorotations were performed within 38 seconds. According to the pilot, the first was commenced at about 1 500 ft AMSL. It is suspected that the second autorotation was performed too close to the ground and, as a result, RPM recovery was never made in time and power was applied too late, which resulted in the over-pitching.

1.16.2 An examination on the wreckage was carried out at the Rotorway South Africa Factory and the following was observed:

i. A fuel sample was taken from the drain point and no water or contamination was found.

ii. No wiring or damage to any electrical plugs was found. No plugs were found pulled out despite the high impact at landing.

iii. All engine drive belts were checked and found to be within spec. No slippage was indicated by pilot or FADEC records.

iv. The FADEC records (for the last 30 minutes of flight) were then downloaded from the primary ECU and engine oil was added to the sump as it had leaked from the breather pipe during the 90º side angle for 4 hrs before the helicopter was righted.

v. The engine was started with the tail boom and main rotor blades removed. The start was easily achieved with all engine parameters indicating normal.

vi. Thick blue smoke and oil deposits emitted after start-up. This was due to engine oil flowing into the valve cover for 4 hrs while the engine lay on its side. The engine was stopped after about 30 seconds when the water temperature started to climb due to air in the system. Coolant had to be added when the new u/c was fitted, followed by a coolant bleed thereafter as normal operating procedure. The coolant was bled and the engine restarted easily with much less smoke emitting.

vii. No mechanical noises or loads could be heard or felt during the engine runs.

viii. The engine was then given a leak-down test and the cylinder values were found as follows:

- CYL 1 77 /80
- CYL 2 75 /80
- CYL 3 70 /80
- CYL 4 77 /80

These values are considered normal and within the acceptable factory limits. From these, it can be deduced that no internal damage occurred to the engine and no defect on the engine or the engine management could be found that could have caused the accident.

1.17 Organisational and Management Information

1.17.1 This was a training flight.

1.17.2 The flying school under which the training was conducted was in possession of a valid Aviation Training Organisation Accreditation and Approval Certificate.

1.17.3 According to available records, the approved person (AP) that certified the last annual inspection on the aircraft prior to the accident was in possession of a valid MISASA Approved Person Approval.

1.18 Additional Information

1.18.1 None.

1.19 Useful or Effective Investigation Techniques

1.19.1 None.

2. ANALYSIS

2.1 The helicopter was serviceable prior to the accident and no record of any malfunction or defect was recorded that could have contributed to or caused the accident.

2.2 The instructor and student pilot were properly licensed and medically fit to operate the helicopter.

2.3 Available information indicated that fine weather prevailed in the area at the time of the accident. Therefore, the prevailing weather conditions were not considered to have had any bearing on the accident.

2.4 The engine fitted to this helicopter was fitted with an engine monitoring system (FADEC), which was downloaded after the accident occurred. This assisted in determining if the engine operated as designed. It was established during the investigation that the engine indeed operated as designed.

2.5 This was a training flight. The instructor demonstrated an engine failure simulation to the student, followed by an autorotation to the ground, at which point the engine did not respond to inputs as it should have. He further stated that he managed to put the helicopter safely on the ground, but due to the slope of the ground the helicopter rolled over onto to its side.

2.6 The slope of the ground was not a contributory factor in causing the helicopter to roll over onto its side. The information gathered during the investigation indicates that the helicopter impacted the ground with the front of the right-hand skid, indicating no flare at touchdown and a high descent angle.

2.7 The second autorotation was performed too close to ground, the rotor RPM recovery was not made in time, and power was applied too late, which resulted in the helicopter rotor blades over-pitching to arrest the rate of descent. This can be seen by the impact damage occurring on the front undercarriage (i.e. no flare at touchdown) as well as the short forward distance the helicopter travelled after first impact (approx. 5 m), indicating a high descent angle and only 58% rotor and engine RPM available.

3. CONCLUSION

3.1 Findings

3.1.1 The instructor was the holder of a valid commercial pilot's license and had the helicopter type endorsed in his license.

3.1.2 The instructor was the holder of a valid medical certificate that was issued by an approved CAA medical examiner.

3.1.3 The helicopter was maintained in accordance with the approved maintenance schedule and was in possession of a valid Authority to Fly at the time of the accident.

3.1.4 The helicopter had flown 6.1 hours since the last maintenance inspection was done.

3.1.5 The training was conducted at an approved Aviation Training Organisation.

3.1.6 Weather did not contribute to the accident.

3.1.7 No defect on the engine or the engine management could be found that could have contributed to the accident.

3.1.8 The second autorotation was performed too close to the ground, the rotor RPM recovery was not made in time, and power was applied too late, resulting in the pilot over-pitching the helicopter blades to arrest the rate of descent.

3.2 Probable Cause/s

3.2.1 Incorrect co-ordination of the throttle and collective pitch resulted in the loss of RPM during a practised autorotation, which resulted in a hard landing followed by a dynamic roll over.

4. SAFETY RECOMMENDATIONS

4.1 None.

5. APPENDICES

5.1 Appendix A: Report from Rotorway International South Africa.

Compiled by:

Ahmed Motala Date: ……..

For: Director of Civil Aviation

Investigator-in-charge: ……. Date: ……..

Co-Investigator: ……..…… Date: ……

Appendix A

Report from Rotorway International South Africa on
Engine Information Downloaded from FADEC

46 MILNER ROAD, METRO INDUSTRIA
Paarden Eiland, 7405
Cape Town, South Africa

21 Oct 2010

Attention: SACAA Accident Investigations Dept.

Summary of Findings On ZU- DCI Rotorway Exec 62F Acis Accident, 18/10/2010

The following report was made by Rotorway SA and Rotorway International USA staff based on data from the accident investigation performed in conjunction with the CAA, wreckage onsite and later at the SA factory, the pilot's report and discussion, and the FADEC engine download taken off the engine ECUs after the crash and after the post-crash engine start-up.

From the FADEC download, 19 slots of engine data were obtained, which had been stored every second by the engine control units. (The last four fours of engine run time is stored by the ECUs.) The last two autorotations performed by the pilot are tabulated for reference. The full flight data log is provided as a separate document.

The first line of the log below indicates the last second of the accident sequence, when the pilot turns off the FADEC after the crash – the rest of the log should be read as moving back into the flight time. Items shown in red are added notes for explanation.

Engine RPM at 4250 rpm is 100% Rotor RPM (520 RRPM)
For the day,100 -102KPA equates to Baro of 29.9 Inches Hg at site of accident

ECU DATA LOG Recorded: 19 Oct 2010 11:59:22 AM

Each count 1.000 second
HH:MM:SS hours:minutes:seconds that the RPM > 0
Adjust when the log rate not equal to 1 second
MRPM The maximum RPM reading, 25 RPM resolution
MECT The maximum engine coolant temperature in ºC
RPM The current RPM reading, 25 RPM resolution
ECT The current engine coolant temperature in ºC
DUTY The current injector duty cycle
ADV The current ignition advance degrees
ACT The current air charge temperature in ºC
BARO The current barometric pressure in KPa
TP The current throttle position percent
MAP The current intake pressure in KPa
BAT The current battery voltage
R The red lamp status, 1 = on 0 = off
Y The yellow lamp status, 1 = on 0 = off
C Crank sensor error, 1 = on 0 = off
I Ignition error, 1 = on 0 = off
E ECU CPU error, 1 = on 0 = off
T ECU self test error, 1 = on 0 = off
S ECU primary/secondary, 1 = secondary 0 = primary

HH:MM:SS	MRPM	MECT	RPM	ECT	DUTY	ADV	ACT	BARO	TP	MAP	BAT	RYCIETS	
3:29:37	4700	75	0	18	0	14	20	100	0	102	12.0	0000000	FADEC turned off
3:29:36	4700	75	175	18	9	14	20	100	0	102	12.0	0000000	
3:29:35	4700	75	0	68	0	14	29	100	45	101	13.2	0100100	Heli rolled over RPM low/0
3:29:34	4700	75	150	69	8	14	29	100	42	101	12.9	0100100	
3:29:33	4700	75	150	69	8	14	29	100	43	102	13.2	0100100	Throttle closing, MAP reducing
3:29:32	4700	75	2425	69	28	35	29	115	91	115	13.9	0100100	
3:29:31	4700	75	2650	69	30	34	29	110	87	114	13.9	0100100	Impact Gnd, CPU errors
3:29:30	4700	75	2425	69	28	34	29	111	96	115	13.7	0000000	58% eng RPM or 297 RRPM
3:29:29	4700	75	2475	69	28	34	29	111	100	114	13.8	0000000	
3:29:28	4700	75	1875	70	20	35	29	107	95	108	13.8	0000000	
3:29:27	4700	75	2425	70	28	34	29	112	97	115	13.7	0000000	
3:29:26	4700	75	2450	70	29	34	29	111	100	115	13.7	0000000	Full throttle on
3:29:25	4700	75	1725	70	17	35	29	104	99	106	13.7	0000000	with high MAP values
3:29:24	4700	75	2625	70	29	35	29	110	82	115	13.7	0000000	Eng RPM drooping due to
3:29:23	4700	75	2025	70	22	35	29	110	98	108	13.7	0000000	high loads / collective up.
3:29:22	4700	75	1750	70	27	35	30	104	95	106	13.7	0000000	
3:29:21	4700	75	3125	70	51	30	30	110	96	113	12.4	0000000	10 sec to impact
3:29:20	4700	75	3425	71	38	28	30	111	95	111	13.6	0000000	
3:29:19	4700	75	3425	71	39	28	31	111	99	111	13.7	0000000	
3:29:18	4700	75	3550	71	40	28	31	114	97	110	13.7	0000000	

HH:MM:SS	MRPM	MECT	RPM	ECT	DUTY	ADV	ACT	BARO	TP	MAP	BAT

RYCIETS

3:29:17	4700	75	3625	71	41	28	31	115	99	110	13.7	0000000 Full throttle on + high MAP
3:29:16	4700	75	3600	71	40	29	31	115	83	112	13.5	0000000
3:29:15	4700	75	3900	72	45	29	30	121	78	113	13.7	0000000
3:29:14	4700	75	3350	72	51	30	30	111	67	111	12.5	0000000 Throt 2/3 open, hi-load eng RPM low
3:29:13	4700	75	3775	72	32	30	32	117	44	104	13.6	0000000 Hi MAP but drooping eng RPM
3:29:12	4700	75	3500	72	25	31	34	114	27	86	13.8	0000000 due to high load / collective up
3:29:11	4700	75	3850	73	29	30	38	115	32	93	13.6	0000000
3:29:10	4700	75	3800	73	26	30	40	115	24	80	13.7	0000000
3:29:09	4700	75	4025	73	23	30	41	114	18	68	13.7	0000000 Eng RPM up to 95%
3:29:08	4700	75	3150	73	20	32	43	116	14	68	13.8	0000000 Slow throttle rolled on
3:29:07	4700	75	2600	73	16	35	46	115	10	69	13.8	0000000
3:29:06	4700	75	2875	73	11	33	46	118	2	38	13.8	0000000
3:29:05	4700	75	2200	73	7	38	46	110	0	37	13.8	0000000 Engine at idle + no load
3:29:04	4700	75	2275	73	7	37	47	110	0	36	13.8	0000000
3:29:03	4700	75	2250	73	7	37	47	110	0	36	13.8	0000000 MAP low 36 KPa, no load on eng
3:29:02	4700	75	2900	73	10	33	47	116	0	29	13.8	0000000 Throttle fully closed
3:29:01	4700	75	4150	73	24	30	46	119	19	70	13.8	0000000 Start of 2nd climbing autorotation
3:29:00	4700	75	4200	72	46	30	46	117	49	104	13.7	0000000
3:28:59	4700	75	4175	72	46	30	46	117	51	104	13.7	0000000
3:28:58	4700	75	4200	72	47	30	46	118	49	105	13.8	0000000

HH:MM:SS MRPM MECT RPM ECT DUTY ADV ACT BARO TP MAP BAT
RYCIETS

3:28:57	4700	75	4225	72	45	30	46	117	47	102	13.8	0000000
3:28:56	4700	75	4225	72	46	30	47	118	47	103	13.0	0000000
3:28:55	4700	75	4275	72	46	30	47	119	47	103	13.0	0000000
3:28:54	4700	75	4300	72	46	30	47	118	46	104	13.7	0000000
3:28:53	4700	75	4350	72	45	30	47	119	45	101	13.0	0000000
3:28:52	4700	75	4400	72	45	30	47	118	44	102	13.1	0000000
3:28:51	4700	75	4400	72	44	30	47	118	43	100	13.7	0000000
3:28:50	4700	75	4425	72	47	30	47	117	43	100	13.8	0000000
3:28:49	4700	75	4400	72	44	30	48	119	43	100	13.1	0000000 30 inches MAP, heli climbing
3:28:48	4700	75	4375	72	44	30	48	118	44	102	13.8	0000000
3:28:47	4700	75	4275	72	42	30	48	116	43	99	13.7	0000000
3:28:46	4700	75	4175	72	45	30	48	118	49	104	13.2	0000000 High MAP, heli climbing power
3:28:45	4700	75	4150	72	35	30	49	117	39	98	13.6	0000000
3:28:44	4700	75	4200	71	37	30	49	117	39	96	13.5	0000000 First auto-recovery complete
3:28:43	4700	75	4250	72	36	30	49	115	38	94	13.8	0000000
3:28:42	4700	75	4300	71	44	30	49	117	37	92	13.6	0000000
3:28:41	4700	75	4275	72	35	30	50	116	35	93	13.8	0000000
3:28:40	4700	75	4275	71	35	30	50	117	35	91	13.6	0000000
3:28:39	4700	75	4200	72	32	30	50	115	33	88	13.7	0000000
3:28:38	4700	75	4175	72	32	30	50	117	33	91	13.6	0000000

HH:MM:SS MRPM MECT RPM ECT DUTY ADV ACT BARO TP MAP BAT
RYCIETS

3:28:37	4700	75	4175	72	31	30	50	115	31	87	13.6	0000000
3:28:36	4700	75	4225	72	35	30	51	113	31	85	13.7	0000000
3:28:35	4700	75	4225	72	31	30	51	116	31	87	13.7	0000000
3:28:34	4700	75	4225	72	31	30	51	116	31	85	13.7	0000000
3:28:33	4700	75	4225	72	31	30	51	115	30	87	13.7	0000000
3:28:32	4700	75	4250	72	29	30	51	114	27	81	13.7	0000000
3:28:31	4700	75	4300	72	28	30	51	115	26	80	13.8	0000000
3:28:30	4700	75	4325	72	26	30	51	113	25	78	13.7	0000000
3:28:29	4700	75	4300	73	25	30	50	113	23	72	13.7	0000000
3:28:28	4700	75	4225	73	24	30	49	118	21	72	13.7	0000000 100% eng RPM +RRPM
3:28:27	4700	75	4075	73	27	30	49	117	18	64	13.7	0000000
3:28:26	4700	75	3925	73	20	30	48	117	14	56	13.8	0000000
3:28:25	4700	75	3900	73	18	30	46	118	10	49	13.8	0000000 Throt on. MAP low .Eng RPM
3:28:24	4700	75	3325	73	13	31	46	119	3	35	13.8	0000000 recovering to normal
3:28:23	4700	75	2225	73	7	38	45	110	0	37	13.8	0000000
3:28:22	4700	75	2175	73	7	38	45	109	0	37	13.8	0000000
3:28:21	4700	75	2150	73	7	38	45	108	0	37	13.8	0000000
3:28:20	4700	75	2175	73	7	38	46	109	0	37	13.8	0000000
3:28:19	4700	75	2200	73	7	38	46	109	0	37	13.7	0000000
3:28:18	4700	75	2200	73	7	38	46	109	0	37	13.8	0000000

HH:MM:SS	MRPM	MECT	RPM	ECT	DUTY	ADV	ACT	BARO	TP	MAP	BAT	RYCIETS
3:28:17	4700	75	2250	73	7	38	46	109	0	35	13.8	0000000 Throt closed, eng Idle RPM
3:28:16	4700	75	2000	73	6	38	46	107	0	40	13.8	0000000
3:28:15	4700	75	4325	73	20	30	46	122	11	61	13.7	0000000 Start of first climb autorotation
3:28:14	4700	75	4400	73	49	30	46	119	48	105	13.7	0000000
3:28:13	4700	75	4425	73	49	30	46	119	48	105	13.7	0000000
3:28:12	4700	75	4400	72	49	30	46	119	48	104	12.6	0000000
3:28:11	4700	75	4375	73	49	30	46	117	48	103	13.7	0000000
3:28:10	4700	75	4375	72	49	30	46	119	49	105	13.8	0000000
3:28:09	4700	75	4350	73	49	30	46	118	49	104	13.7	0000000
3:28:08	4700	75	4300	72	49	30	46	118	50	104	12.5	0000000
3:28:07	4700	75	4275	72	50	30	46	118	51	105	13.7	0000000
3:28:06	4700	75	4275	72	49	30	46	119	51	105	12.5	0000000
3:28:05	4700	75	4250	72	49	30	46	119	51	106	13.8	0000000
3:28:04	4700	75	4250	72	49	30	47	118	52	105	13.7	0000000
3:28:03	4700	75	4250	72	48	30	47	119	52	106	13.8	0000000
3:28:02	4700	75	4225	72	48	30	47	118	51	105	13.7	0000000
3:28:01	4700	75	4150	72	37	30	47	117	42	99	13.5	0000000
3:28:00	4700	75	4175	72	38	30	48	117	41	100	13.8	0000000

The following can be accurately deduced from the above log:

1. Autorotation started at 3.29.01 when the throttle was closed during a climbing autorotation demonstration. This was the second performed during this flight – the first was completed just prior to the second. See above notes in red.
2. Impact with the ground occurred at 3.29.31, 28 seconds after the autorotation was commenced. Impact is indicated by the CPU errors and ignition errors. The ECU enclosures were damaged by ground impact at this time and rapid engine RPM deceleration occurred. No error codes were seen for the rest of the flight duration or in

previous flights. Error codes were only seen during FADEC cycling during take-off checks where the FADECS are cycled on and off, and this is normal.

3. From the high MAP, seconds before the impact, with full throttle percentage applied but drooping engine RPM, it can be deduced that over-pitching of collective occurred and the high resultant load on the engine would not allow the engine RPM to increase or regulate.
4. A 95% RRPM and engine RPM was achieved 23 seconds before impact, but the pilot then did not roll on full throttle until seconds later, and this allowed the RPM to droop with the high load.
5. It is probable that insufficient height remained for a normal recovery to be made and over-pitching resulted in an attempt to arrest the rate of descent. This can be seen by the impact damage occurring on the front undercarriage (i.e. no flare at touchdown) as well as the short forward distance the helicopter travelled after first impact (approx. 5 m), indicating a high descent angle and only 58% rotor and engine RPM available.
6. Two autorotations were performed within 38 seconds. According to the pilot, the first was started at about 1 500 ft AMSL. It is suspected that the second was performed too close to the ground, RPM recovery was never made in time and power was applied too late, which resulted in the over-pitching.

The above log was sent to RWI USA and the same outcome was determined by the engine technician and flight staff.

Post-crash, the helicopter had its tail boom removed and was moved from the accident site to the RWSA factory.

1. A new undercarriage and skids were fitted.
2. A fuel sample taken from the drain point and no water or contamination was found. The sample was given to the CAA investigator. A sample of the fuel from the fuel bowzer was also taken and given to the CAA.
3. No wiring or damage to any electrical plugs was found. No plugs were found pulled out despite the high impact at landing.
4. All engine drive belts were checked and found to be with in spec, with no slippage indicated by the pilot or FADEC records.
5. The FADEC records (last 30 mins of flight) were then downloaded from the primary ECU.
6. Engine oil was added to the sump as it had leaked from the breather pipe during the four hours it lay at a 90º side angle before it was righted.
7. With the CAA investigator present, the engine was started with the tail boom and main rotor blades removed. The start was easily achieved with all engine parameters indicating normal. Thick blue smoke and oil deposits were emitted after start-up due to engine oil flowing into the valve cover while the engine lay on its side. The engine was stopped after about 30 sec as the water temperature started to climb and also due to air in the system. Coolant had to be added when the new u/c was fitted and a coolant bleed was required thereafter, as normal operating procedure. The coolant was bled and the engine restarted easily with much less smoke. No mechanical noises or loads could be heard or felt during the engine runs.

8. The engine was then given a leak down test and the cylinder values were found as follows:

CYL 1 77 /80
CYL 2 75 /80
CYL 3 70 /80
CYL 4 77 /80

These values are considered normal and within the acceptable factory limits.

From these points above, it can be deduced that no internal damage had occurred to the engine – no defect on the engine or the engine management could be found that could have caused the accident.

Due to the shock load, the engine will still have to have a mandatory stripdown and inspection. Any findings will be reported to the CAA that may be found contrary to the above findings.

Further findings were based on evidence seen at the crash site:

1. The fuel pump inertia switches had both deployed as designed to on impact, turning off the HP fuel pumps to reduce fuel spreading should any pipes rupture. No pipes, hoses or lines failed on impact, and no leaks in the fuel lines resulted.
2. The fuel cap tops sheared off where body panels contacted them on impact. The inner screw and valve remained in the tank, holding the integrity of the fuel tanks. Only minimal fuel was lost: about 2–5 l during the four hours the helicopter lay in its side.
3. The landing gear absorbed a huge amount of energy and collapsed. No part entered the cockpit area, which remained sterile of any external objects during the crash and ensuing rollover.
4. The main rotor blades bent extensively but remained fully intact, without any delamination to the blades.
5. The seatbelts (four-point hooker) held the two occupants well, with no seatbelt injuries or damage to the seatsbelts themselves. The occupants did not suffer any back or spine injuries, nor any muscle strains despite the heavy landing. The underseat energy-absorbing foam helped in this regard.
6. The fuel tanks did not move at all, nor weer any fuel lines stressed. The polypropylene molded tanks did not bend, crack or deform in any way despite the loads applied.

The above items were noted to validated to the CAA that the design criteria were achieved in this instance, and should be recorded by the CAA and passed on to the RWI design department for their evaluation.

This report has been written based on my best ability to independently review all the data available and give the best factual summary possible. The FADEC data findings were separately evaluated at RWI USA and the exact same results were found.

Should you require any further input please feel free to contact me.

Yours sincerely

RICHARD CHASE

Managing Director
RotorWay South Africa (Pty) Ltd
Tel: +27 (0)21 511 7700
Fax: +27 (0)21 511 7704
Cell: +27-82 577 7735
richardc@rotorway.com