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SOUTH AFRICAN CIVIL AVIATION AUTHORITY

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

AIRCRAFT ACCIDENT REPORT AND EXECUTIVE SUMMARY

				Reference:	CA18/2/3/9702		
Aircraft Registration	ZS-REG	**Date of Accident**	28 April 2018		**Time of Accident**	0547Z	
Type of Aircraft	Bell Helicopter Textron 206L-4		**Type of Operation**		Private (Part 91)		
Pilot-in-command Licence Type	PPL (Helicopter)		**Age**	43	**Licence Valid**	Yes	
Pilot-in-command Flying Experience	Total Flying Hours		176,6		Hours on Type	41,0	
Last point of departure	Farm Snymansdrift, East of Kuschke Nature Reserve (S24˚0'35,90" E029˚18'22,04"), Limpopo						
Next point of intended landing	Farm Snymansdrift, East of Kuschke Nature Reserve (S24˚0'35,90" E029˚18'22,04"), Limpopo						
Location of the accident site with reference to easily defined geographical points (GPS readings if possible)							
Farm Snymansdrift, East of Kuschke Nature Reserve (S24°01'26,5" E029°19'06,1") Elevation: 4800 ft							
Meteorological Information	Surface wind: Nil, Temperature: 13 °C, Pressure altitude: 1015 hPa, Dew point: 11 °C, visibility: 5000 m, Cloud: Overcast, and broken at 1000 ft AGL mist present						
Number of people on board	1+6	**No. of people injured**	1+6	**No. of people killed**	0		
Synopsis							

On 28 April 2018, a Bell 206L-4 with 6 passengers was flown on a scenic flight over a hilly terrain in the Kuschke Nature Reserve, Limpopo. The weather was fine, with no wind present and reported mist to the north-east. According to the pilot, after speed reduction for completion of sightseeing, a right turn was initiated by applying power and the right anti-torque pedal. As the helicopter turned right, it swung violently to the right and entered into a spiral dive. It was not possible to sustain normal flight. The helicopter, after completing 3 full revolutions, impacted the dense bushy terrain. The pilot further stated that he regained some control close to the ground, but a crash landing was unavoidable. The helicopter impacted the hilly terrain and broke into 3 pieces (fuselage, tail boom and tail rotor) and came to rest on its port side facing a magnetic heading of 300˚ by the cockpit magnetic compass. The helicopter sustained damage to the main rotor and tail rotor blades and severed the tail boom from the main fuselage. All occupants sustained minor injuries.

The investigation revealed that the helicopter was abruptly maneuvered to the right at low speed, resulting in the tail rotor system moving to the left at a high rate affecting the airflow on the tail rotor, which resulted in a Loss of Tail Rotor effectiveness (LTE).

Probable Cause

The helicopter was abruptly maneuvered to the right at low speed, resulting in the tail rotor system moving to the left at a high rate affecting the airflow on the tail rotor, which resulted in a Loss of Tail Rotor effectiveness (LTE).

Contributing factors were the following:

- The aircraft was operating very close to MAUW parameters
- The pilot's lack of experience (total flying hours in type: 41,0 hours)

SRP Date	13 November	Release Date	

Name of Owner	**:** Breaker Flight (Pty) Ltd
Name of Operator	**:** Private (Part 91)
Manufacturer	**:** Bell Helicopters
Model	**:** 206L-4
Nationality	**:** South African
Registration Marks	**:** ZS-REG
Place	**:** Kuschke Nature Reserve, 14 nm South West of Polokwane Airfield (FAPP)
Date	**:** 28 April 2018
Time	**:** 0547Z

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

Purpose of the Investigation:

In terms of Regulation 12.03.1 of the Civil Aviation Regulations (2011) this report was compiled in the interest of the promotion of aviation safety and the reduction of the risk of aviation accidents or incidents and ***not to apportion blame or liability.***

Disclaimer:

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 The pilot of a Bell Helicopter Textron Jet Ranger 206L-4, registration ZS-REG, took off from a private farm in Snymansdrift, east of Kuschke Nature Reserve at approximately 0530Z for a scenic flight with 6 passengers on board. On the day of the accident, the pilot took off with his passengers to route over the Kuschke Nature Reserve in the Limpopo province to view wildlife. According to the pilot, after approximately15 minutes of flying, the helicopter was in a low-level position and flying above a hill at low speed for sightseeing. The pilot concluded the sightseeing aspect of the flight and decided to route back to the farm they had departed from.

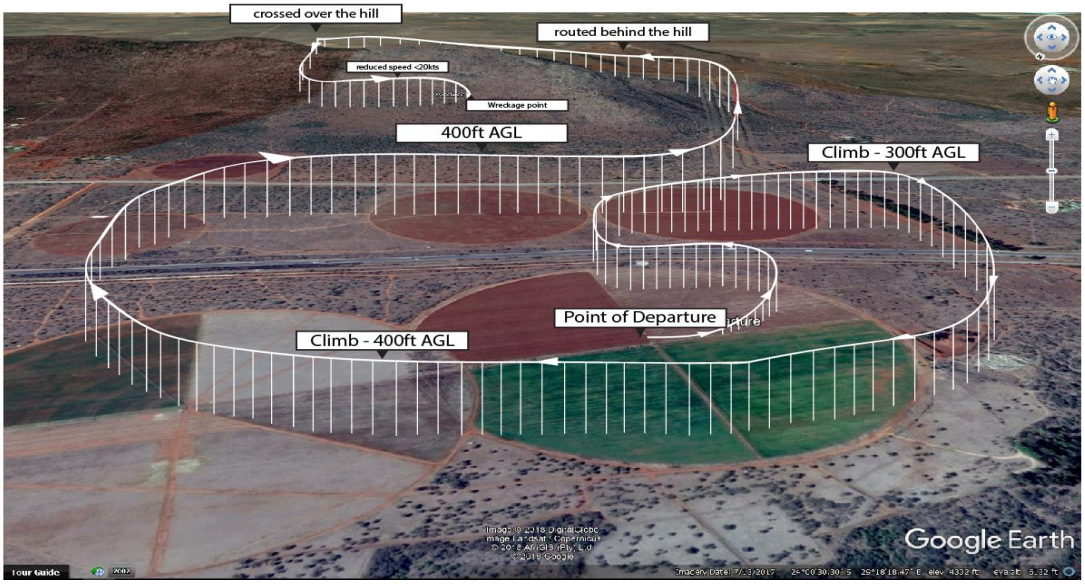


Figure 1: Google Earth location of the accident and flight path plotted for illustration purposes.

While flying at low speed, the pilot initiated a right turn by applying power and a right anti-torque pedal. As the helicopter turned right, it swung violently to the right and entered into a spiral dive. It was not possible to sustain normal flight. At 0547Z, the helicopter, after completing 3 full revolutions, impacted the dense bushy terrain and came to rest on its port side facing a magnetic heading of 300˚ by the cockpit magnetic compass. The helicopter sustained damage to the main rotor and tail rotor blades and severed the tail boom from the main fuselage. The pilot and passengers sustained minor cuts and bruises.

1.1.2 The accident occurred during daylight conditions at a geographical position determined to be South 24˚01'26,5" East 029˚19'06,1" 14 nm south-west of FAPP Airfield at an elevation of approximately 4800 ft.

1.2 Injuries to Persons

Injuries	Pilot	Crew	Pass.	Other
Fatal	-	-	-	-
Serious	-	-	-	-
Minor	1	-	6	-
None	-	-	-	-

1.3 Damage to Aircraft

The helicopter was substantially damaged during the impact sequence.

Figure 2

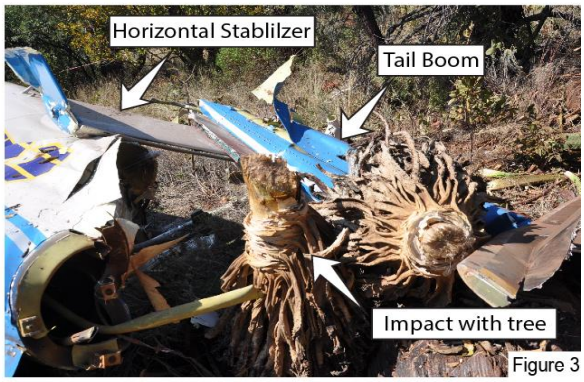


Figure 3


Figure 4

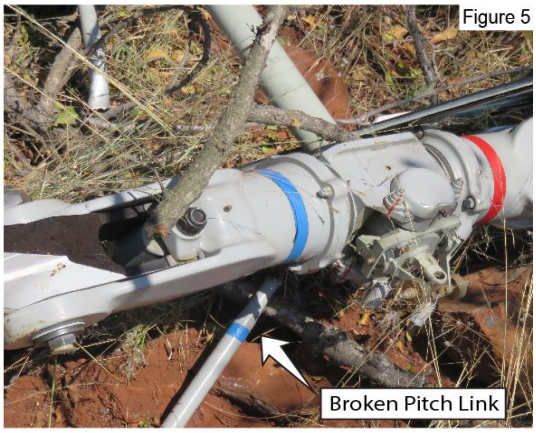


Figure 5

Figure 2: The wreckage as it lay on its port side on the broken left skid, **Figure 3:** Separation of the tail boom and fuselage resulting from impact with the tree., **Figure 4:** The separated tail rotor assembly. The tail rotor blades are still intact, but the strobe section impacted terrain and separated, .**Figure 5:** The main rotor hub showing one broken pitch link. The other pitch link was broken off.
(Figures 2, 3, 4 & 5 sourced from IIC)

1.4 Other Damage

1.4.1 There was no other damage.

1.5 Personnel Information

Nationality	South African	Gender	Male	Age	43
Licence Number	027 224 0573	Licence Type	Private Pilot Licence (H)		
Licence valid	Yes	Type Endorsed	Yes		
Ratings	SEH (LAND)				
Medical Expiry Date	30/11/2019				
Restrictions	None				
Previous Accidents	None				

Flying Experience:

Total Hours	171,6
Total Past 90 Days	76,5
Total on Type Past 90 Days	41,0
Total on Type	41,0

1.6 Aircraft Information

Airframe:

Type	206L-4	
Serial Number	52030	
Manufacturer	Bell Helicopter Textron	
Date of Manufacture	1993	
Total Airframe Hours (At time of Accident)	4235,5	
Last MPI (Date & Hours)	12/3/2018	4198,2
Hours since Last MPI	37,3	
C of A (Issue Date)	19/6/2001 (Expiry date: 2018/06/18)	
C of R (Issue Date) (Present owner)	08/6/2015	
Operating Categories	Standard Part 127	

Engine:

Type	ALLISON 250-C30P
Serial Number	CAE-85972
Hours since New	4235,5
Hours since Overhaul	Modular

Main Rotor:

Type	Semirigid

Serial Number	HR-440
Date installed	12/03/2018
Airframe Hours	4198,2
Component Total Time	1009,0
Lifespan of M/R Blades	4000,0

Tail Rotor:

Type	Semirigid
Serial Number	HB-329
Date installed	20/04/2009
Airframe Hours	2480,6
Component Total Time	0 (New)
Lifespan of M/R Blades	2500,0

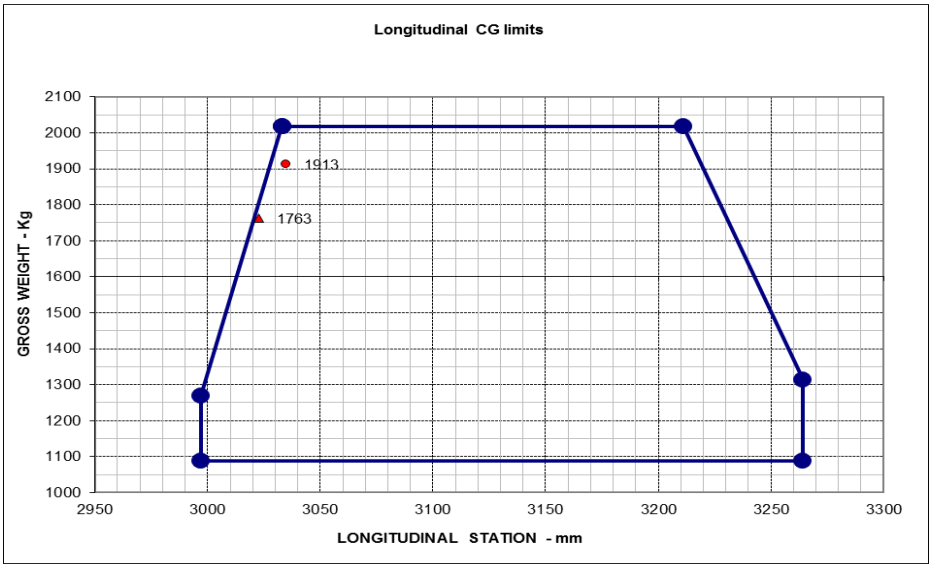
1.6.1 Weight and Balance:

The maximum certificated takeoff mass for the helicopter was 2018,5 kg according the pilot's operating handbook (POH), section 1, page 1-10. The helicopter was last reweighed on 12 March 2018, according to the mass & balance report.

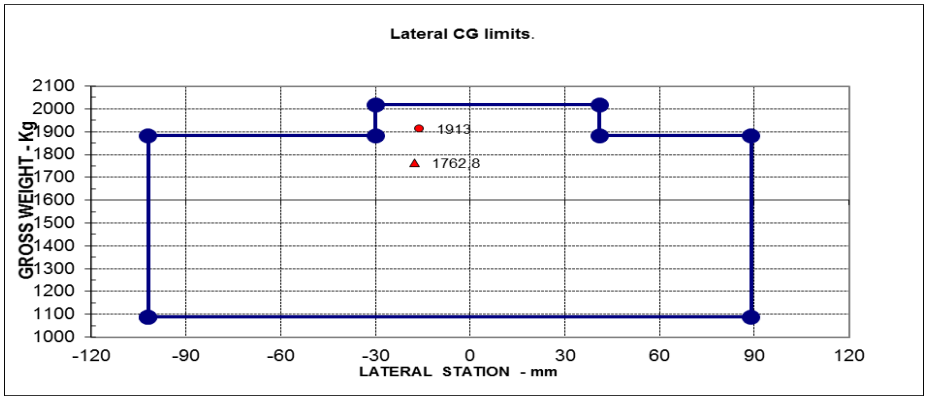
ITEM		MASS	ARM	MOMENT
A/C empty mass		1168,0	3269,0	3818169
Cargo hook	(5.67Kg)	0,0	2989,6	0
Zero fuel mass		**1168**	**3269,0**	**3818169**
Pilot		80	1651,0	132080
Co-pilot		115	1651,0	189865
Middle	M	60	2311,0	138660
Middle	M	65	2311,4	150241
Back	B	103	3276,6	337489,8
Back	B	88	3276,6	288340,8
Back	B	75	3276,6	245745
Litter		0	2743,2	0
Baggage		0	4419,6	0
Take-off fuel: Main		158,8	3175,0	504190
Total: Take-off		**1913**	**3034,7**	**5804780**
Total burn-off		**100**		
Landing fuel: Main		58,8	3175,0	27940
Total: Landing		**1763**	**3022,8**	**5328530**

Table 1: Mass & Balance table

The above calculation shows the helicopter was within its mass limitations.



Graph 1: Mass & balance longitudinal CG limits



Graph 2: Mass & balance lateral CG limits

The helicopter was operated within the allowable longitudinal and lateral CG limit.

1.6.2 Fuel:

The helicopter operated with Jet A-1 and had 300 lbs on board before impact.

1.7 Meteorological Information

1.7.1 An official weather report for the area where the accident occurred was obtained from South African Weather Services (SAWS) for the 28 April 2018, indicating the following conditions:

METAR FAPP 280600 00000KT 5000 BR OVC010 13/11 Q1015 TEMPO=

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Wind direction	Nil	Wind speed	Nil	Visibility	5000 m
Temperature	13 ˚C	Cloud cover	Overcast	Cloud base	1000 ft
Dew point	11 ˚C				

1.8 Aids to Navigation

1.8.1 The helicopter was equipped with standard navigational equipment as per the regulations. No defects were recorded.

1.9 Communications

1.9.1 The accident occurred outside of controlled airspace with the active VHF frequency at the time being 124,8MHz. There were no reported defects in the radio equipment on board the helicopter during the flight.

1.10 Aerodrome Information

1.9.1 The accident occurred in bushy terrain in a nature reserve and was not in close proximity to an aerodrome.

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 was it required by regulation to be fitted to this aircraft type

1.12 Wreckage and Impact Information

1.12.1 The helicopter impacted dense bushy terrain on its skids and the fuselage flipped over on its port side with a heading of 300 ˚M (magnetic). The helicopter was substantially damaged: the tail boom was broken off the main fuselage, the tail rotor section was severed from the tail boom, and the skids were torn off the belly of the fuselage and broke into 3 pieces.

Figure 6: The main wreckage as it came to rest.

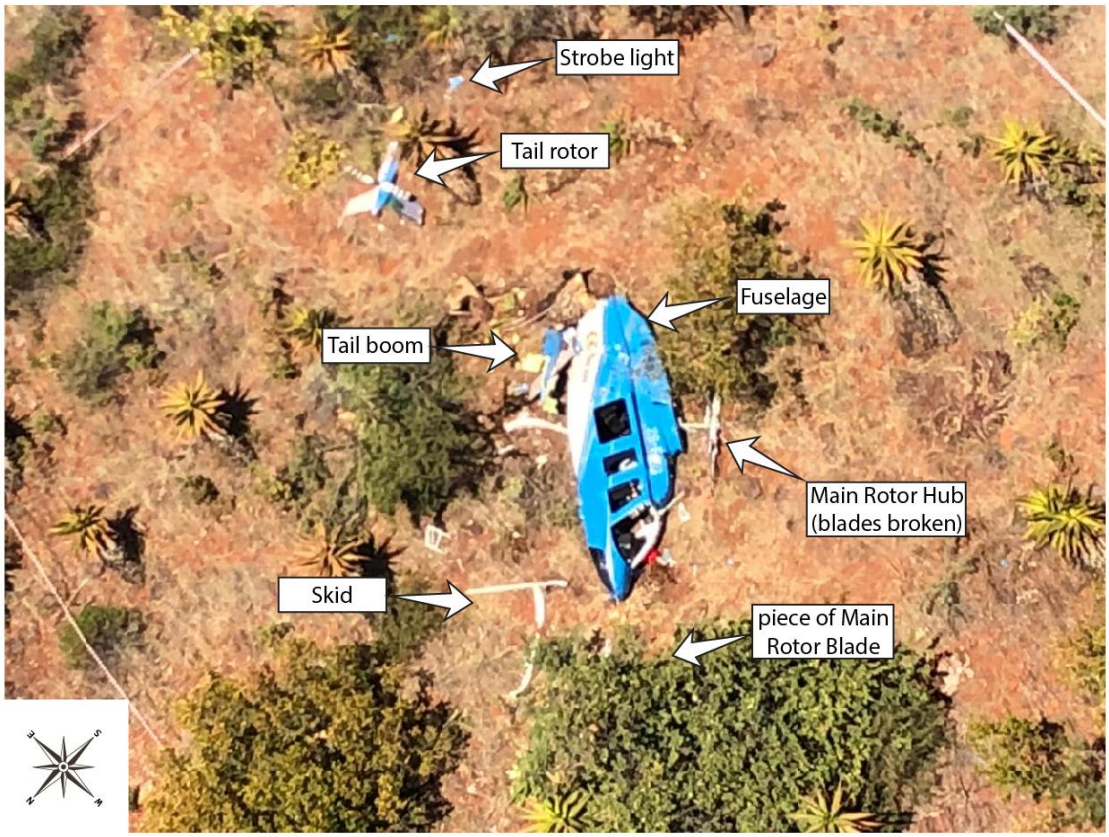

Figure 7: Aerial view of the wreckage showing the distribution of parts after impact.
(Image courtesy of first responder to crash site)

The safety harnesses of the pilot and passengers were found intact. The main rotor blades were found broken into different sections. The main rotor pitch links were both broken, with the collective pitch lever being in the 'down' position and the throttle in idle position. The collective pitch lever control panel was broken off the lever. The cyclic control stick was in the neutral position.

1.13 Medical and Pathological Information

1.13.1 None

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. The aircraft landed on the skids, which absorbed most of the impact forces. The safety belts were all found to be intact.

1.16 Tests and Research

1.16.1 An Advisory Circular 90-95 compiled by The Federal Aviation Administration, titled "Unanticipated right yaw in helicopters", examines this phenomenon.

1.17 Organisational and Management Information

1.17.1 None

1.18 Additional Information

1.18.1 UNANTICIPATED YAW / LOSS OF TAIL ROTOR EFFECTIVENESS (LTE)

The information was extracted from *Rotorcraft Flying Handbook FAA-H-8083-2IA and are used to explain the basic helicopter principles. Chapter 11, Page 12*

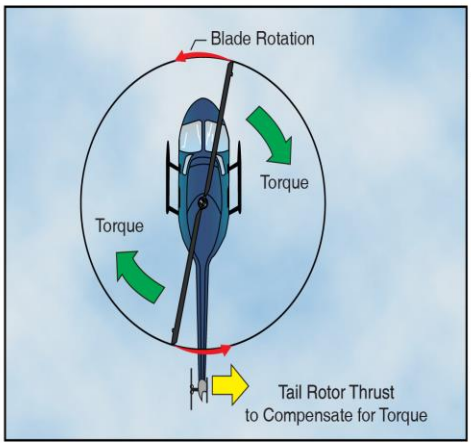

Figure 8. The anti-torque rotor produces thrust to oppose torque and helps prevent the helicopter from turning in the opposite direction of the main rotor.[2]

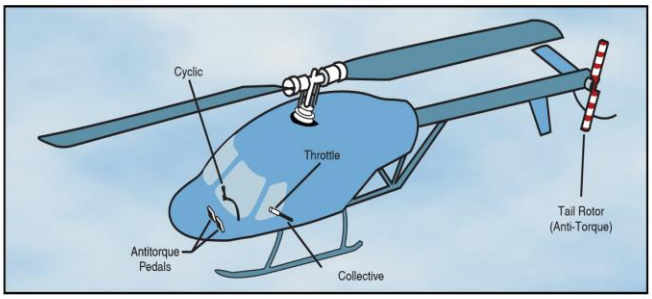

Figure 9. Location of flight controls.[2]

Figures: 8 and 9 respectively

Unanticipated yaw is the occurrence of an un-commanded yaw rate that does not subside of its own accord and, which, if not corrected, can result in the loss of helicopter control. This un-commanded yaw rate is referred to as loss of tail rotor effectiveness (LTE) and occurs to the right in helicopters with a counter-clockwise rotating main rotor and to the left in helicopters with a clockwise main rotor rotation. Again, this discussion covers a helicopter with a counter-clockwise rotor system and an anti-torque rotor. LTE is not related to an equipment or maintenance malfunction and may occur in all single-rotor helicopters at airspeeds less than 30 knots. It is the result of the tail rotor not providing adequate thrust to maintain directional control, and is usually caused by either certain wind azimuths (directions) while hovering, or by an insufficient tail rotor thrust for a given power setting at higher altitudes. For any given main rotor torque setting in perfectly steady air, there is an exact amount of tail rotor thrust required to prevent the helicopter from yawing either left or right. This is known as tail rotor trim thrust. In order to maintain a constant heading while hovering, you should maintain tail rotor thrust equal to trim thrust. The required tail rotor thrust is modified by the effects of the wind. The wind can cause an un-commanded yaw by changing tail rotor effective thrust. Certain relative wind directions are more likely to cause tail rotor thrust variations than others. Flight and wind tunnel tests have identified three relative wind azimuth regions that can either singularly, or in combination, create an LTE conducive environment. These regions can overlap, and thrust variations may be more pronounced. Also, flight testing has determined that the tail rotor does not actually stall during the period. When operating in these areas at less than 30 knots, pilot workload increases dramatically.

Other references of the similar occurrences are: ATSB Transport Safety Report – Aviation Occurrence Investigation – AO-2015-091 (Final – 4 November 2015)
ATSB Transport Safety Report – Aviation Occurrence Investigation – AO-2013-016 (Final – 1 August 2013)

1.19 Useful or Effective Investigation Techniques

1.19.1 None

2. ANALYSIS

2.1 The flight was uneventful until the pilot completed the scenic aspect of the flight and decided to route back to the landing zone (LZ). The pilot reduced the airspeed to +/-20 kts to view wildlife and game at the reserve. During this phase, borderline translational lift was experienced. The weight of the helicopter prior to the accident was very close to the MAUW (Maximum all up weight). Slow flying at this weight would require a higher than normal power setting with a much larger left pedal input.

2.2 The pilot stated that he increased the power and applied right pedal to direct the helicopter to the LZ. Increasing the power will produce a right yaw, due to the torque produced on an anti-clockwise main rotor hub (Newton's third law of motion). This would require a left anti-torque pedal input to maintain the aircraft heading. With no pedal input, the helicopter will yaw to the right.

2.3 The pilot applied right pedal to turn the helicopter towards the LZ. This input exposed the tail rotor to a crosswind from the left reaching a wind component value likely to induce loss of tail rotor effectiveness (LTE). What the pilot experienced next was an uncontrollable violent and rapid nose swing to the right. The pilot instinctively raised the collective to correct for the swing, which swung the aircraft further to the right. The pilot eventually applied corrective measures, lowering the collective and applying left pedal, but did not have enough height and time to accommodate the change.

2.4 The pilot's total amount of flying experience played a significant part in the outcome of the accident. He stated that he underwent numerous exercises with an MAUW scenario in the helicopter to familiarise himself with the flying configuration when heavy. The above calculations show that the helicopter was very close to its centre of gravity limitations. This would require the pilot to be extremely vigilant of the control inputs, especially with little forward airspeed. Pilots with more flying experience do cater for a change of the centre of gravity and fly the helicopter much more cautiously.

3. CONCLUSION

3.1 Findings

MAN

3.1.1 The pilot was the holder of a valid private pilot's licence and had the helicopter type endorsed in his logbook.

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

3.1.3 The pilot had a total of 176,6 flying hours.

3.1.4 The pilot had flown 41 hours on the Bell 206L- 4.

MACHINE

3.1.6 The helicopter was privately owned and operated under CARs, 2011 - Part 91.

3.1.7 The helicopter was issued with a certificate of airworthiness (C of A) in accordance with the regulatory requirements.

3.1.8 The helicopter had flown a total of 4235,5 hours up to the accident.

3.1.9 An MPI was performed on 12 March 2018 at 4198,2 hours.

3.1.10 The damage to the main rotor blades indicates that the engine was producing power on impact.

3.1.11 The helicopter sustained a substantial amount of damage. The skids were completely ripped off the belly of the helicopter (Figure 6) and broken into 3 pieces, the tail boom was broken off the main fuselage. The tail rotor section was severed from the tail boom and found 6 m from the main wreckage.

3.1.12 On-site investigation revealed that there was fuel in the tank.

3.1.13 The mass and balance calculation was determined by the pilot before the flight and was calculated to be 1913kg (4230 lbs). The MAUW (internal) is 2018,5 kgs (4450 lbs). The aircraft did not exceed its MAUW.

ENVIRONMENT

3.1.14 The weather report was obtained from the South African Weather Service. The meteorological aerodrome report (METAR) for 28 April 2018 at FAPP read as follows:

METAR FAPP 280600 00000KT 5000 BR OVC010 13/11 Q1015 TEMPO=

00000KT – No wind

5000 – 5000 m visibility

BR – Mist present

OVC010 – Overcast (8/8) cloud base 1000 ft

Temperature – 13 ˚C

Dew point – 11 ˚C

QNH – 1015 hPa

TEMPO – means a temporary fluctuation, less than an hour.

The misty conditions may have contributed by distracting and adding unnecessary pressure for the pilot to conduct a safe flight.

3.1.15 The accident occurred during daylight near the Kuschke Nature Reserve in Limpopo at a geographical position determined to be S24˚01'26.5" E029˚19'06.1", elevation 4800 ft AMSL, 14 nm to the south-west of FAPP (Polokwane Airport).

3.2 Probable Cause/s

The helicopter was abruptly maneuvered to the right at low speed and low level flight, resulting in the tail rotor system moving to the left at a high rate affecting the airflow on the tail rotor, which resulted in a Loss of Tail Rotor effectiveness (LTE).

Contributing factors were the following:

- The aircraft was operating very close to MAUW parameters
- The pilot's lack of experience on type (total hours on type: 41,0 hours)

4. SAFETY RECOMMENDATIONS

Safety Message:

Pilots should understand and avoid conditions that are conducive to loss of tail rotor effectiveness or uncontrolled yaw. The type rating should include the ground school aspect, focusing on the difference between turbine and piston engines, ensuring the pilot understands the power capabilities of a turbine-powered helicopter (especially the power-to-weight ratio and the torque production). The basic condition for LTE to occur is a wind component from the left that disrupts the tail rotor system. A very abrupt and sudden anti-torque pedal turn to the right produces a similar condition, basically pushing the tail rotor to the left at a high rate. However at this accident it was pilot induced due to mismanagement of flight controls and incorrect technique used during attempt for recover condition. Pilots need to be aware of the rate at which they turn the helicopter using anti-torque pedals. It is suggested that the regulator should review a minimum requirement for a pilot to obtain a PIC (pilot-in-command) endorsement for any turbine helicopter.

5. APPENDICES

5.1 None