AIRCRAFT ACCIDENT REPORT AND EXECUTIVE SUMMARY

				Reference:	CA18/2/3/9699		
Aircraft registration	**ZS-HHI**	**Date of accident**	9 April 2018		**Time of accident**	1115Z	
Type of aircraft	AS350B3 (Helicopter)		**Type of operation**		Private (Part 91)		
Pilot-in-command licence type		Private	**Age**	47	**Licence valid**	Yes	
Pilot-in-command flying experience		Total flying hours	546.3		Hours on type	18.2	
Last point of departure	Private helipad near Nigel, Mpumalanga Province						
Next point of intended landing	Private helipad near Nigel, Mpumalanga Province						
Location of the accident site with reference to easily defined geographical points (GPS readings if possible)							
Transnet railway service road near Frutuna (GPS position; 26°36’42.10” South 028°32’39.70” East)							
Meteorological information	Surface wind: variable 20–25 kt, Temperature: 20°C, Visibility: CAVOK						
Number of people on board	1 + 4	**No. of people injured**	1 + 1	**No. of people killed**	0		
Synopsis							

On Monday 9 April 2018 at approximately 1115Z daylight time, a Eurocopter (Airbus Helicopters) AS350B3, with registration ZS-HHI, was substantially damaged when it crashed onto a service road next to a railroad line in the Balfour district. The pilot reported that he was circling anti-clockwise overhead a farmstead, which was in close proximity to the railroad, at a height of between 50 and 100 ft above ground level (AGL). The pilot reported that he was flying sideways (a manoeuvre referred to as a ‘pedal turn’) at approximately 30 kt when the helicopter began to yaw and spin uncontrollably in an anti-clockwise direction. The pilot was unable to recover from the inadvertent yaw and lost control of the helicopter. He attempted to cushion the landing by applying maximum collective pitch before the helicopter impacted with the ground. There were four passengers on-board, three seated in the back and one seated next to the pilot in the left front seat. The front-seated passenger and the pilot were injured. The passenger was attended to by paramedics on the scene before being admitted to a private hospital in Alberton. This was a private flight conducted under the provisions of Part 91, with visual meteorological conditions (VMC) prevailing. The flight originated from a private helipad near Nigel (Vosterkroon) with the intention to land back at the same helipad.

The investigation determined that the pilot lost control of the helicopter while performing a ‘pedal turn’ manoeuvre in strong wing conditions, which resulted in a loss of tail rotor effectiveness and subsequent loss of control of the helicopter before impacting with the ground.

Probable cause

The pilot executed a non-standard manoeuvre (referred to as a pedal turn) in strong wind conditions, which resulted in a loss of tail rotor effectiveness and subsequent loss of control.

SRP date	12 February 2019	Release date	

Name of owner	**:** Mesiglo (Pty) Ltd
Name of operator	**:** Private (Part 91)
Manufacturer	**:** Eurocopter
Model	**:** AS350B3
Nationality	**:** South African
Registration markings	**:** ZS-HHI
Place	**:** Transnet service road near the town of Balfour
Date	**:** 9 April 2018
Time	**:** 1115Z

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 interests 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 recently purchased the helicopter in Cape Town and had conducted several flights over the period 5 to 7 April 2018. On Sunday, 8 April 2018, he ferried the helicopter from Cape Town International Aerodrome (FACT) to Heidelberg Aerodrome (FAHG), where he had a hangar. En route he landed at Beaufort West Aerodrome (FABW) and then New Tempe Aerodrome (FATP) near Bloemfontein to uplift fuel. The next morning he refuelled the helicopter to its maximum capacity. He then flew 8 nm from FAHG to a private helipad near Nigel (Vosterkroon), where he landed and shut down the helicopter. At the helipad he was met by four of his employees, and he intended to take them on a local pleasure flight of the area.

1.1.2 Before they commenced with the flight, the pilot gave the four passengers a safety briefing and explained to them how the safety harnesses worked, as some of them had never flown before. All the occupants were issued with a headset and they were able to communicate with one another. Three of the passengers were seated in the aft row of seats and one was seated in the left front seat next to the pilot. (Dual flight controls were installed in the helicopter.) The doors were closed for the flight, and after they took off, they flew in south-easterly direction towards the pilot's farm, which was located near the town of Balfour.

1.1.3 The pilot stated that, upon reaching his farm, he began an orbit to the left. A quarter way into the turn he initiated an orbiting pedal turn while overhead the farmstead at a height of approximately 150 ft above ground level (AGL). The helicopter was stable and he was halfway through the second orbit, near the railway line, when the helicopter started yawing to the left (in an anti-clockwise direction). The pilot reported that he was flying sideways at approximately 30 kt when the helicopter began to yaw and spin uncontrollably in an anti-clockwise direction. He applied full right pedal but it had no effect, and the yaw rate increased; the helicopter spun out of control at least twice. He saw that they were heading towards the transmission lines over the railway line and was able to guide the helicopter over them, missing them but striking two smaller wires on the other side. The main rotor blades struck a transmission line stanchion as the helicopter descended towards the service road, next to the railway line. Just before ground impact, the pilot attempted to cushion the landing by applying maximum collective pitch lever, but it had very little effect on the rate of descent and the helicopter impacted heavily with the ground in an upright position. The pilot then secured the helicopter by shutting down the engine and he and the passengers exited once the main rotor blades were stationary.

1.1.4 Emergency services in the town of Balfour were contacted and they responded to the accident scene. The three passengers that were seated in the back of the helicopter were not injured, but were traumatised/shocked. The passenger in the left front seat was unconscious as her head had impacted with the overhead rotor brake and throttle quadrant. She was attended to by paramedics on-scene and according to her statement she only regained consciousness when she was loaded into the ambulance by the paramedics. She was admitted to a private hospital in Alberton via road ambulance. She suffered from concussion and was discharged the following day. The pilot also suffered from a blow to his head and sustained a laceration to his right upper arm when the front section of the right skid gear deformed and bent upwards at almost 90°, penetrating the cabin/cockpit area during the impact sequence. The pilot and the other three passengers went for a medical check-up to a medical practitioner in the town of Balfour, approximately 8 km from the accident site.

1.1.5 The helicopter was substantially damaged in the accident sequence. Additional damage was caused to the overhead power supply cables as well as one of the support pylons from the Transnet railway service. The two railroad lines were taken out of commission until the pylon could be replaced, and a train in close proximity to the accident was stopped until the infrastructure was repaired.

1.1.6 The accident occurred during daylight conditions at a geographical position determined to be 26°36’42.10” South 028°32’39.70” East at an elevation of 5 210 ft above mean sea level (AMSL). The accident site was approximately 14 nm to the south of their point of departure.

1.2 Injuries to persons:

Injuries	Pilot	Crew	Pass.	Other
Fatal	-	-	-	-
Serious	-	-	1	-
Minor	1	-	-	-
None	-	-	3	-

1.3 Damage to aircraft:

1.3.1 The helicopter was substantially damaged (beyond economical repair) during the accident sequence.

1.4 Other damage:

1.4.1 An electrical conductor support pole from the railroad service was damaged during the accident sequence and needed to be replaced (Figures 1 and 2). One of the electrical conductors was also severed. The railroad line was taken out of commission as repairs had to be effected before the line was declared safe and normal services could resume. During the on-site investigation, a train had to be stopped some distance from the accident scene as it was unable to proceed due to damage to the infrastructure.

Figure 1: The railroad electrical support pylon that fractured and needed to be replaced

Figure 2: A close-up view of the pylon that fractured

1.5 Personnel information:

1.5.1 Pilot-in-command (PIC):

Nationality	South African	Gender	Male	Age	47
Licence number	0272410176	Licence type	Private		
Licence valid	Yes	Type endorsed	Yes		
Ratings	Night, Game / Livestock				
Medical expiry date	30 November 2019 (Class 2)				
Restrictions	None				
Previous accidents	None				

The pilot commenced his pilot training in June 2015, flying Robinson R22 and R44 helicopters. He then bought a Robinson R66 and completed his conversion onto it. He also completed conversion onto the Bell 206B and Bell 407 type of helicopters. All these helicopters are equipped with anti-clockwise rotating main rotor systems.

On 16 November 2017, the pilot completed his game/cull rating successfully after he had flown three flights on the day with a flight instructor with a total flight time of 5.1 hours. The game rating was obtained while flying a Robinson R44 helicopter.

According to available information, the pilot conducted his conversion onto the AS350B3 helicopter on 1 July 2016. On the day he flew one flight with a flight instructor for a total flight time of 1.4 hours, whereafter the type rating was endorsed in his logbook as well as his licence. During the period 1 July 2016 until 4 April 2018, the pilot flew a total of 6.8 hours with the AS350B3 type of helicopter.

On 5 April 2018, the pilot flew for 1.4 hours with a flight instructor, practising take-offs and landings and working through various other in-flight scenarios. The flight instructor also flew with the pilot the following day on a private flight around the Cape Peninsula; the flight time was 2.3 hours. After the two sessions with the flight instructor, the instructor had recommended to the pilot that he needed to take it slow as this was a new helicopter that was completely different to a Robinson R66. According to the pilot's logbook, most of his flying was conducted on the Robinson R66. According to available information, he was also the owner of a Robinson R66 helicopter with registration markings ZS-HNU when this accident occurred.

The flying hours entered in the table below were obtained from the pilot questionnaire.

Flying experience:

Total hours	546.3
Total past 90 days	50.4
Total on type past 90 days	11.4
Total on type	18.2

A summary of the pilot's flying experience during the period 5 to 9 April 2018 on the AS350B3 according to his logbook can be found tabled below. Over the 5-day period, he accumulated 63% of his total flying experience on this helicopter type.

Date	Duration	Comments
5 April 2018	1.4	Pilot flew with a flight instructor in Cape Town
6 April 2018	2.3	Pilot conduct a local flight of the Cape Peninsula
7 April 2018	0.5	Pilot conduct a local flight in the Cape Town area
7 April 2018	0.4	Pilot conduct a local flight in the Cape Town area
8 April 2018	2.2	Pilot flew from FACT to FABW, landed and refuelled
8 April 2018	2.5	Pilot flew from FABW to FATP, landed and refuelled
8 April 2018	1.9	Pilot flew from FATP to FAHG (his private hangar), and landed
9 April 2018	0.2	Pilot flew from FAHG to a private helipad near Nigel
9 April 2018		Accident flight in the Balfour area (flying time was not known as the vehicle engine monitoring display (VEMD) could not be powered-up for a flight report page)
Total hours	**11.4**	

1.6 Aircraft information:

1.6.1 The AS350B3 helicopter:

The AS350B3 is a single-engine helicopter, with a cabin that can accommodate up to seven occupants depending on the configuration/cabin layout. It is versatile, low maintenance, and has low acquisition costs, while it excels in high and hot, and extreme environments.

Figure 3: The helicopter ZS-HHI

1.6.2 Airframe:

Type	AS350B3	
Serial number	4442	
Manufacturer	Eurocopter	
Year of manufacture	2008	
Total airframe hours (at time of accident)	2 209.4	
Last MPI (hours & date)	2 197.2	22 March 2018
Hours since last inspection	12.2	
C of A (issue date)	14 October 2017	
C of A (expiry date)	13 October 2018	
C of R (issue date) (Present owner)	22 January 2018	
Operating categories	Standard Normal (Rotorcraft)	

1.6.3 Engine:

Type	Turbomeca Arriel 2B1
Serial number	46037
Hours since new	2 209.4
Hours since overhaul	TBO not yet reached

1.6.4 Weight and balance:

Item description	Weight (kg)	Arm (m)	Moment
Helicopter empty weight	1 274.7	3.54	4 515
Pilot + passenger (front seats)	164.0	2.71	444
Three passengers (rear seats)	218.0	3.81	831
Rear cargo hold	10.0	2.30	23
Cargo swing	16.8	3.45	58
Zero fuel weight	**1 683.5**	**3.48**	**5 859**
Fuel	380.0	3.48	1 322
Total weight on take-off	**2 063.5**	**3.48**	**7 181**

The take-off weight as calculated was the weight of the helicopter after the four passengers boarded the helicopter at Vosterkroon helipad in Nigel. This was after the pilot flew from FAHG to the helipad. The maximum fuel weight of the helicopter when fuelled to capacity is 427 L. The fuel used for start and the flight to the helipad was approximately 47 L. The fuel consumption of the helicopter used for calculation purposes was 200 L per hour, which accounts to 3.3 L per minute; however, it should be noted that the fuel consumption might vary.

The maximum take-off weight (MTOW) for this helicopter as stipulated in the flight manual, section 2, page 2-2 is 2 250 kg (4 961 lb). The helicopter was operated within the MTOW limitations and well as within the centre of gravity (CG) limitations as contained in the flight manual.

1.7 Meteorological information:

1.7.1 The weather information entered in the table below was obtained from the pilot questionnaire:

Wind direction	Variable	Wind speed	20–25 kt	Visibility	Clear
Temperature	25°C	Cloud cover	3/8	Cloud base	2 000 ft
Dew point	Unknow n				

1.7.2 There was no meteorological aerodrome report (METAR) available for FAHG for the date and time of the accident. The METAR information below was for OR Tambo International Aerodrome (FAOR) on Monday 9 April 2018 at 1100Z, which was 15 minutes before the accident occurred. The METAR was issued by the South African Weather Service (SAWS). The accident site was 33 nm south-east of FAOR. According to the satellite image, which was obtained from an official weather report that was recorded at 1115Z on the day, there were low-level clouds at the accident site.

FAOR 091100Z 01012KT 9999 SCT031 BKN042 20/13 Q1027 NOSIG=

Wind	-	010° at 12 kt
Visibility	-	9999 m
Cloud cover	-	Scattered at 3 100 ft and broken at 4 200 ft
Temperature	-	20°C
Dew point	-	13°C
Pressure altitude	-	1027 hPa
NOSIG=	-	No significant weather

The following was the METAR for Rand Aerodrome (FAGM) on 9 April 2018 at 1100Z (the accident site was 30 nm south-east of FAGM):

FAGM 091100Z 02014KT 9999 OVC030 20/14 Q////=

Wind	-	020° at 14 kt
Visibility	-	9999 m
Cloud cover	-	Overcast at 3 000 ft
Temperature	-	20°C
Dew point	-	14°C

1.7.3 The density altitude was calculated to be 6 731 ft by making use of a web-based application: http://www.pilotfriend.com/pilot_resources/density.htm, whereby the elevation, the air temperature, the dew point and altimeter setting were used.

1.7.4 There was no wind and it was overcast at the accident site when the investigating team arrived there, approximately 2.5 hours after the accident occurred.

1.8 Aids to navigation:

1.8.1 The helicopter was equipped with standard navigational equipment as required by the regulator for the helicopter type. No defects that rendered the navigation system unserviceable were recorded prior to or during the flight.

1.9 Communication:

1.9.1 The pilot was flying outside of controlled airspace below the terminal control area (TMA) and was communicating on very high frequency (VHF) frequency 124.8 MHz.

1.9.2 The helicopter was equipped with standard communication equipment as required by the regulator. No defects that rendered the communication system unserviceable were recorded prior to or during the flight.

1.10 Aerodrome information:

1.10.1 The accident did not occur at or close to an aerodrome.

1.11 Flight recorders:

1.11.1 The helicopter was not fitted with a flight data recorder (FDR) or a cockpit voice recorder (CVR), neither was either required by regulations to be fitted to this type of helicopter.

1.12 Wreckage and impact information:

1.12.1 The helicopter impacted with a gravel road in a vertical attitude on a heading of 162°M. Very little to no lateral movement was observed on the ground. The forward fuselage was lying in a right nose-down attitude, with the cockpit/cabin area remaining intact although some distortion to the roof structure had occurred. No damage was caused to the instrument panel, and the helicopter had dual controls fitted. The skid gear collapsed, and the right forward skid was found bent upwards at an angle of almost 90°, penetrating the cabin area on the pilot’s side. All three main rotor blades displayed evidence of rotation, with one of the blades failing at mid-span. The main rotor gearbox assembly was found tilted towards the right (when viewed from behind). The control rods were still secured to the non-rotating swash plate. The tail boom was found to be severely distorted and only partially connected to the main fuselage. The lower vertical fin was bent towards the left with some damage evident on the tail rotor blades as well as the horizontal stabilisers. The tail boom as well as the tail rotor drive shaft were twisted forward of the horizontal stabilisers, which is associated with a main rotor blade strike. As the main rotor blades turn in a clockwise direction, the deformation of the tail rotor drive shaft and the tail boom structure is in line with this observation. The deformation of the entire fuselage and associated damage was that of a helicopter that was turning in an anti-clockwise direction before it impacted with the ground.

Figure 4: Google Earth overlay of where the accident occurred

Figure 5: The helicopter as it came to rest next to the railway line

Figure 6: A view of the cabin of the helicopter with the farmstead visible in the background

Figure 7: A side view from the left of the cockpit with the collective pitch levers in the full up position

Figure 8: The engine nacelle with evidence of fire extinguisher contents having been discharged

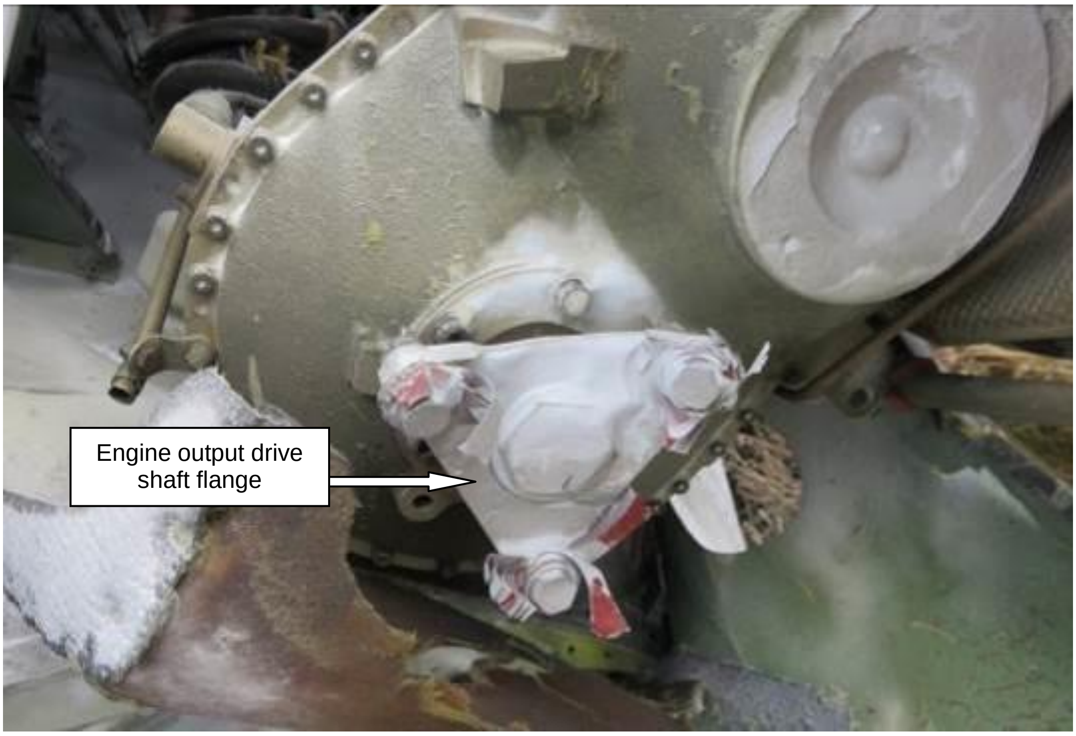

Figure 9: Output drive shaft flange from the engine to the tail rotor drive, displaying evidence of power

Figure 10: The tail rotor drive shaft and tail boom, having been struck by the main rotor blades

1.13 Medical and pathological information:

1.13.1 Not applicable.

1.14 Fire:

1.14.1 Following impact, people at the farmstead rushed to the scene of the accident with portable fire extinguishers. One of the people observed smoke emanating from the engine nacelle and activated one of the portable fire extinguishers into the engine nacelle area to contain any possible fire that might have erupted (Figure 8).

1.14.2 During the on-site investigation, no evidence of any fire from the engine or any other part of the helicopter was evident.

1.15 Survival aspects:

1.15.1 The accident was survivable. The cockpit cabin area remained intact. Three of the passengers were seated in the aft row of seats, and were making use of the helicopter-equipped safety harnesses, which included a shoulder harness. Apart from shock, none of them were injured in the accident. The pilot was seated in the right front seat, and was secured by the helicopter-equipped four-point safety harness. He suffered from a laceration to his head as well as his right upper arm, the latter caused by the forward right skid gear bending upwards at an angle of almost 90° and penetrating the cabin during the impact sequence. The passenger seated next to the pilot was also secured by means of the four-point safety harness. She suffered from a serious laceration to her head. Available evidence indicates that she and the pilot impacted the overhead throttle quadrant when the roof structure partially collapsed due to impact damage. The front-seated passenger was attended to on-scene by paramedics and was taken to a private hospital where she underwent further medical tests. She was discharged from hospital the following day. According to a letter from a medical practitioner, she suffered from concussion and multiple soft tissue injuries.

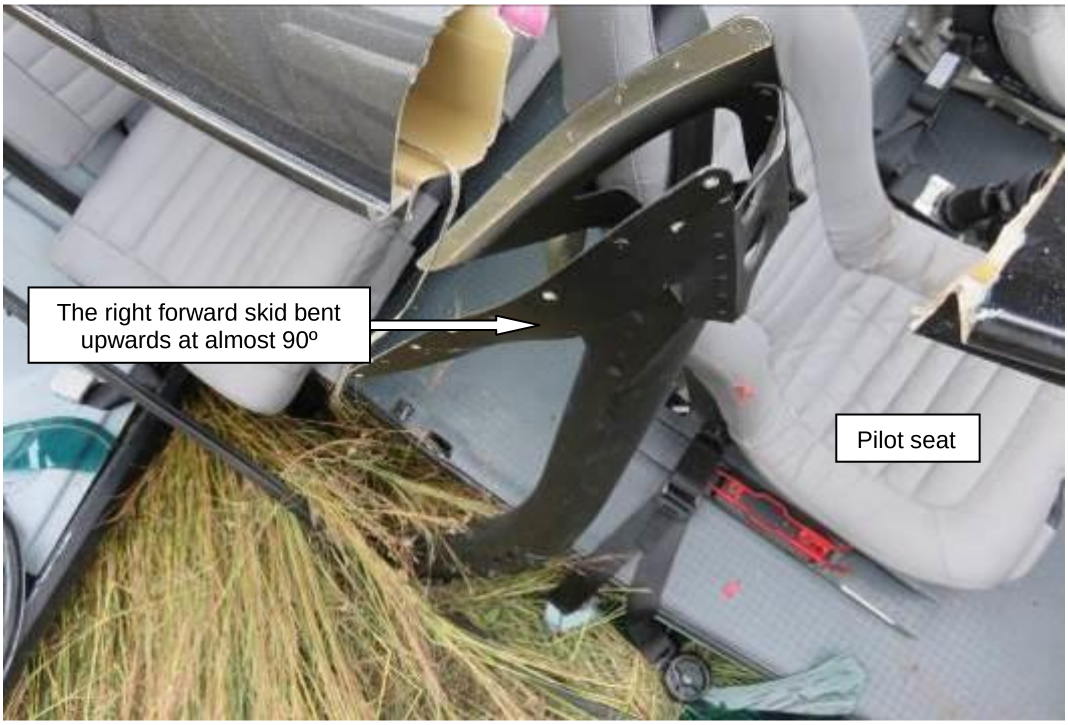

Figure 11: The right forward skid gear that penetrated the cabin

Figure 12: The four aft cabin seats, with the cabin structure that remained intact

Figure 13: Failure of the roof structure

Figure 14: Inside view of the damaged roof structure, with the rotor brake/fuel shut-off quadrant visible

1.16 Tests and research:

1.16.1 The State of Design and Manufacture of the helicopter and engine were notified of the accident as per international protocol, i.e. International Civil Aviation Organization (ICAO) Annex 13, Chapter 5. The helicopter and engine were designed and manufactured in France; the Bureau d'Enquêtes et d'Analyses Pour La Sécurité de L'Aviation Civile (BEA) appointed a non-travelling Accredited Representative. The BEA informed both the helicopter and the engine manufacturers of the accident and they offered their assistance to the investigating team.

1.16.2 The helicopter manufacturer has a maintenance facility as well as a flight training centre in South Africa. They also have a simulator for this helicopter type and with their assistance and oversight, a senior flight instructor was made available on Tuesday 29 May 2018 to simulate the flight profile as described by the pilot. The manoeuvre was repeated several times, at different wind speeds, and during each simulation the flight instructor lost control of the helicopter as soon as the helicopter experienced a certain wind azimuth on the tail rotor, which resulted in a loss of tail rotor effectiveness (LTE), and which was followed by a subsequent loss of control.

1.17 Organizational and management information:

1.17.1 This was a private flight, with the pilot also being the owner of the helicopter. The four passengers on-board the helicopter were employees of the helicopter owner.

1.17.2 The last maintenance inspection (12-year inspection) that was carried out on the helicopter prior to the accident flight had been certified on 22 March 2018 at 2 197.2 airframe hours. Since the inspection, a further 12.2 hours had been flown with the helicopter. The pilot stated during an interview that took place the day after the accident that there was no technical malfunction with the helicopter prior to or during the flight.

1.18 Additional information:

1.18.1 Loss of tail rotor effectiveness (LTE)

LTE is a critical, low-speed aerodynamic flight characteristic that can result in an uncommanded rapid yaw rate that does not subside of its own accord and, if not corrected, can result in the loss of helicopter control. Pilots need to be alert to certain wind conditions when operating at low airspeeds, generally below effective translational lift. LTE is not a mechanical failure of the tail rotor system, although the potential for encountering LTE is increased (and the ability to escape from LTE is reduced) if the tail rotor has not been rigged properly. The pilot must therefore always comply with the procedures listed in the pilot's operating handbook (POH).

Factors that increase the likelihood of encountering LTE include:

(i) Poor pilot technique
(ii) High wind conditions
(iii) High density altitude
(iv) High gross weight
(v) Low airspeed
(vi) Low rotor revolutions per minute (RPM)
(vii) Poor performance planning

The following is an extract from https://en.wikipedia.org/wiki/Loss_of_tail-rotor_effectiveness:

1. *Main-rotor vortexes pushed into the tail rotor by wind. This can occur with wind coming from 10 o'clock on North American (*anti-*clockwise) rotors and from 2 o'clock on clockwise rotors. The wind pushes the dirty air and generates vortexes from the main rotor into the tail rotor, preventing the tail rotor from having clean air to propel.*
2. *Wind from the tail (6 o'clock position) can cause the helicopter to attempt to weathervane into the wind. Wind passes on both sides of the tail rotor, make it teeter between being effective (providing thrust) and ineffective (not providing thrust). This creates a lot of pedal work for the pilot to eliminate unintended yaw.*

   Wind moving in the same direction as the tail rotor moves air. With pusher tail rotors, that is wind from the opposite side of the tail-rotor. With puller tail-rotors, that is wind from the same side as the tail rotor. For main rotors with clockwise rotation (European), that is wind from 9 o'clock. For main rotors with anti-clockwise rotation, that is wind from the 3 o'clock position. The wind going through the tail rotor causes an actual stall condition *as it decreases the effective airspeed of the air through the tail rotor. This condition will cause an unintended yaw that may develop into a spin. Recovery from this condition may be difficult if no airspeed is available, and will require entry into an* autorotation *(thus removing the torque of the engine and transmission)."*

The National Transportation Safety Board (NTSB) in the United States has issued a Safety Alert on LTE, which is attached to this report as Annexure A. The writer hereby acknowledges the source. From the attached document the critical wind azimuth areas are illustrated in a diagram.

1.18.2 The following is an extract from the Helicopter Flight Manual, Section 3, Emergency Procedures (section 3.3):

The procedure from the flight manual stipulates the following with respect to the procedure that the pilot must comply with in the case of a complete loss of tail rotor effectiveness:

3.3 TAIL ROTOR FAILURES

3.3.1 COMPLETE LOSS OF TAIL ROTOR EFFECTIVENESS

Symptom : the helicopter will yaw to the left with a rotational speed depending on the amount of power and the forward speed set at the time of the failure.

WARNING

SAFE AUTOROTATIVE LANDING CAN NOT BE WARRANTED IN CASE OF A FAILURE IN HOGE BELOW THE TOP POINT OF THE HV DIAGRAM (REFER TO SECTION 5) OR IN CONFINED AREA.

3.3.1.1 HOVER-IGE (or OGE in HV diagram)

LAND IMMEDIATELY

1. **Twist Grip.................... IDLE detent**
2. **Collective .... INCREASE** to cushion touch-down

3.3.1.2 HOVER-OGE (Clear area, out of HV diagram)

Simultaneously,

1. **Collective .... REDUCE** depending on available height
2. **Cyclic .... FORWARD** to gain speed
3. Cyclic .... ADJUST to set IAS to Vy and control yaw

LAND AS SOON AS POSSIBLE

If a go-around has been performed, carry out an autorotative landing on a suitable area for landing procedure.

3.3.1.3 IN CRUISE FLIGHT

1. Cyclic .... ADJUST to set IAS to Vy and control yaw
2. Collective...................... REDUCE to avoid sideslip

LAND AS SOON AS POSSIBLE

APPROACH AND LANDING

On a suitable area for autorotative landing :

1. Twist grip .... IDLE detent.
2. Carry out an autorotative landing as landing procedure.

3.3.2 TAIL ROTOR CONTROL FAILURE

Symptom : jamming of pedals or pedals effectiveness loss. These conditions induce an inability to change tail rotor thrust with the pedals.

WARNING

LANDING IS MADE EASIER BY LANDING WITH A RH WIND COMPONENT.

WHEN AIRSPEED IS LOWER THAN 20 kt (37 km/h), GO-AROUND IS IMPOSSIBLE DUE TO LOSS OF VERTICAL FIN EFFICIENCY.

1. Cyclic and collective................ ADJUST to set IAS to 70 kt (130 km/h) in level flight.

On a suitable area for a running landing procedure:

Make a shallow approach with a slight left sideslip. Perform a running landing, the sideslip will be reduced progressively as airspeed is reduced and collective is applied to cushion the landing.

1.19 Useful or effective investigation techniques:

1.19.1 No new methods were used.

2. ANALYSIS

2.1 Man (Pilot):

The pilot was the holder of a valid private pilot licence on helicopters. Most of his flying (97%) had been conducted on helicopters with anti-clockwise rotating main rotor systems.

During a 5-day period between 5 and 9 April 2018, the pilot had flown 11.4 hours on the helicopter type, accounting for 63% of his total flight time on the type. Following his conversion onto the type on 1 July 2016, up until 4 April 2018, he had flown 6.8 hours on the type.

The pilot referred to the manoeuvre he had flown over the farmstead as a ‘pedal turn’ manoeuvre. This is not an approved manoeuvre by the helicopter manufacturer and nor does it form part of the flight training syllabus. This might be a manoeuvre used during game capture operations and a manoeuvre the pilot had most probably conducted numerous times before while flying helicopters with anti-clockwise rotating main rotor systems.

The pilot was warned by his flight instructor in Cape Town, in the period over 5 and 6 April 2018, that he should take it slow, as this was a new helicopter that was completely different helicopter to the Robinson R66.

The loss of helicopter control came about following a pilot-induced manoeuvre during strong wind conditions whereby tail rotor effectiveness was compromised, resulting in the accident. An additional contributing factor was the pilot’s limited flying experience on the helicopter type.

The manoeuvre was subsequently flown in an approved simulator for this helicopter type by a qualified pilot employed by the helicopter manufacturer. During each simulation, the pilot lost control of the helicopter.

2.2 Machine (Helicopter):

The helicopter had been subjected to a 12-year maintenance inspection and subsequently had flown several hours, including a ferry flight from Cape Town to Heidelberg in Gauteng. No defects were entered in the flight folio prior to the accident flight. The pilot indicated in an interview that there was no mechanical malfunction with the helicopter prior to or during the flight.

2.3 Environment:

It was evident from the METARs that were issued for FAOR and FAGM at 1100Z on the day of the accident that the surface wind at these two aerodromes was from a northerly to a north-easterly direction between 12 and 14 kt. The writer is aware that these two weather stations were approximately 30 nm away from the accident site, but they are the closest aerodromes that had active METARs issued. In the pilot questionnaire, the pilot stated that the prevailing wind was variable between 20 to 25 kt at the accident site. Winds with speeds of between 20 and 30 kt (between 36 and 56 km/h) are categorised as a strong wind according to the document 'Terms used in Forecasts' by the SAWS (reference: Public Document CLS-CI-PDD-001.4). Performing a manoeuvre during strong wind conditions such as the pilot did on the day of the accident had a definite effect on tail rotor effectiveness, which ultimately lead to a total loss of tail rotor effectiveness and loss of control of the helicopter.

3. CONCLUSION

3.1 Findings:

<u>Pilot</u>

3.1.1 The pilot was the holder of a valid private pilot's licence and he had the helicopter type endorsed on it. He had renewed his licence on 10 November 2017 and it was valid until 30 November 2018.

3.1.2 The pilot had conducted his type conversion training onto the AS350B3 helicopter on 1 July 2016. He had accumulated a total of 18.2 flying hours on type when the accident occurred.

3.1.3 The pilot was the holder of a valid aviation medical certificate, which had been renewed on 2 November 2017 and which was valid until 30 November 2019.

3.1.4 According to available records, the pilot had flown 11.4 hours on the helicopter type in the last 90 days, including the ferry flight from FACT to FAHG, which accounted for a flight time of 6.6 hours.

3.1.5 Most of the pilot's flying experience (97%) was on helicopters with anti-clockwise rotating main rotor systems.

3.1.6 The pilot did not follow the emergency procedure for loss of tail rotor effectiveness as stipulated in section 3 of the flight manual. Their location at the time might have influenced his actions.

3.1.7 This was a private flight with the pilot also being the owner of the helicopter.

<u>Helicopter</u>

3.1.8 The helicopter was in possession of a valid Certificate of Airworthiness, which was issued on 14 October 2017 and expired on 13 October 2018.

3.1.9 The helicopter was issued with a Certificate of Release to Service on 22 March 2018, which will lapse on 21 March 2019 or at 2 297.2 airframe hours, whichever comes first.

3.1.10 The helicopter was subjected to a 12-year maintenance inspection, which was certified on 22 March 2018 at 2 197.2 airframe hours by an approved maintenance organisation.

3.1.11 The skid gear was substantially deformed, with the right front skid penetrating the cabin/cockpit area on the right-hand side of the aircraft and injuring the pilot.

3.1.12 Apart from the roof structure, the cockpit/cabin area remained intact. The pilot and front-seated passenger were each secured by a four-point safety harness and the passengers in the aft seats were secured by the helicopter-equipped safety harnesses.

3.1.13 The main rotor blades displayed evidence of severe deformation due to the accident, with one of the blades partially fractured at approximately mid-way along the blade.

3.1.14 The helicopter was operated within its MTOW and CG limitations as specified in the flight manual.

Environment

3.1.15 Overcast conditions prevailed and the pilot indicated the wind to be variable at 20–25 kt at the time of the accident.

3.1.16 The density altitude was calculated to be 6 731 ft at the time of the accident.

3.1.17 METARs at FAOR and FAGM recorded the surface wind to be northerly to north-easterly with speeds of between 12 and 14 kt.

3.1.18 By the time the accident investigation team arrived at the scene, overcast conditions prevailed and there was no wind.

Crash survivability

3.1.19 The accident was survivable as the cockpit/cabin area remained intact and all the occupants were properly restrained by helicopter manufacturer safety harness.

3.1.20 Emergency medical services responded to the scene and one of the passengers was admitted to a private hospital. The pilot sustained minor injuries and was treated by a medical practitioner in Balfour.

3.2 Probable cause:

3.2.1 The pilot executed a non-standard manoeuvre (referred to as a pedal turn) in strong wind conditions, which resulted in a loss of tail rotor effectiveness and subsequent loss of control.

3.3 Contributory factors:

3.3.1 The pilot conducted the pedal turn manoeuvre during strong wind conditions, which had an exaggerated effect on tail rotor effectiveness.

3.3.2 The pilot had limited flying experience on the AS350B3 helicopter type when he executed the pedal turn manoeuvre.

3.3.3 The pedal turn manoeuvre was not demonstrated to the pilot during training as it was not an approved manoeuvre for certification purposes, nor did it form part of the helicopter type manufacturer conversion training syllabus.

3.3.4 Most of the pilot's flying experience (97%) was on helicopters with anti-clockwise rotating main rotor systems. The helicopter in question had a clockwise main rotor system.

3.3.5 The pilot had accumulated 63% of his flying time on this helicopter type in the five days prior to the accident flight, which included the ferry flight from FACT to FAHG.

3.3.6 The pilot was warned by his flight instructor in Cape Town, over the period 5 and 6 April 2018, that he should take it slow, as this helicopter was completely different to the Robinson R66.

4. SAFETY RECOMMENDATIONS

4.1 Over the years, several helicopter accidents have occurred in South Africa where a pilot converts from one main rotor system to another without the pilot attending the manufacturer conversion course. Many pilots opt for non-approved manufacturer's conversion training which doesn't cover essential aspects such as emergency procedures.

4.1.1 It is therefore recommended to the Director of Civil Aviation that the Director should review the current requirements for pilot conversion from anti-clockwise to clockwise rotating main rotor systems or vice versa. The review should ensure that minimum manufacturer's requirements for conversion training are complied with prior to the issuance of conversion rating or approval.

5. APPENDICES

5.1 Annexure A (NTSB Safety Alert on Loss of Tail Rotor Effectiveness in Helicopters)

NTSB

SAFETY ALERT

National Transportation Safety Board

Loss of Tail Rotor Effectiveness in Helicopters

Be alert for uncommanded yaw so you don’t get caught off guard!

The problem

In helicopters, loss of tail rotor effectiveness (LTE), or unanticipated yaw, is an uncommanded rapid yaw that does not subside of its own accord. LTE can occur in all single-engine, tail rotor-equipped helicopters at airspeeds lower than 30 knots and, if uncorrected, can cause the pilot to lose helicopter control, potentially resulting in serious injuries or death.

Various factors can contribute to LTE, including: varying airflow from the main rotor blades (particularly at high power settings) or from the environment, which can affect the airflow entering the tail rotor; operating at airspeeds below translational lift; operating at high altitudes and high gross weights; operating near large buildings or ridgelines, which can cause turbulence; and the relative wind direction (see Figures 1 and 2).

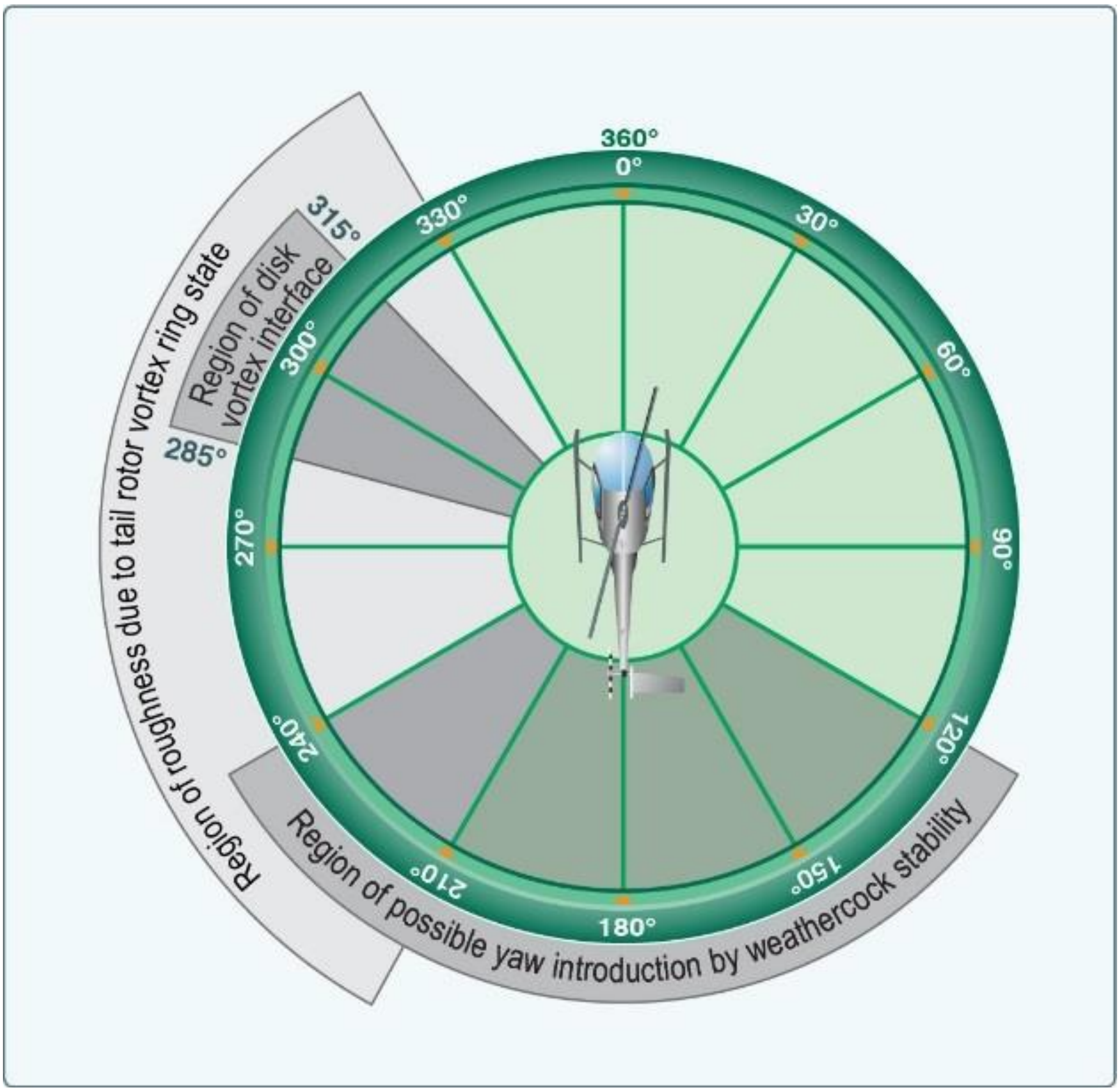

Figure 1. Relative wind directions that can contribute to LTE for anti-clockwise main rotor helicopters

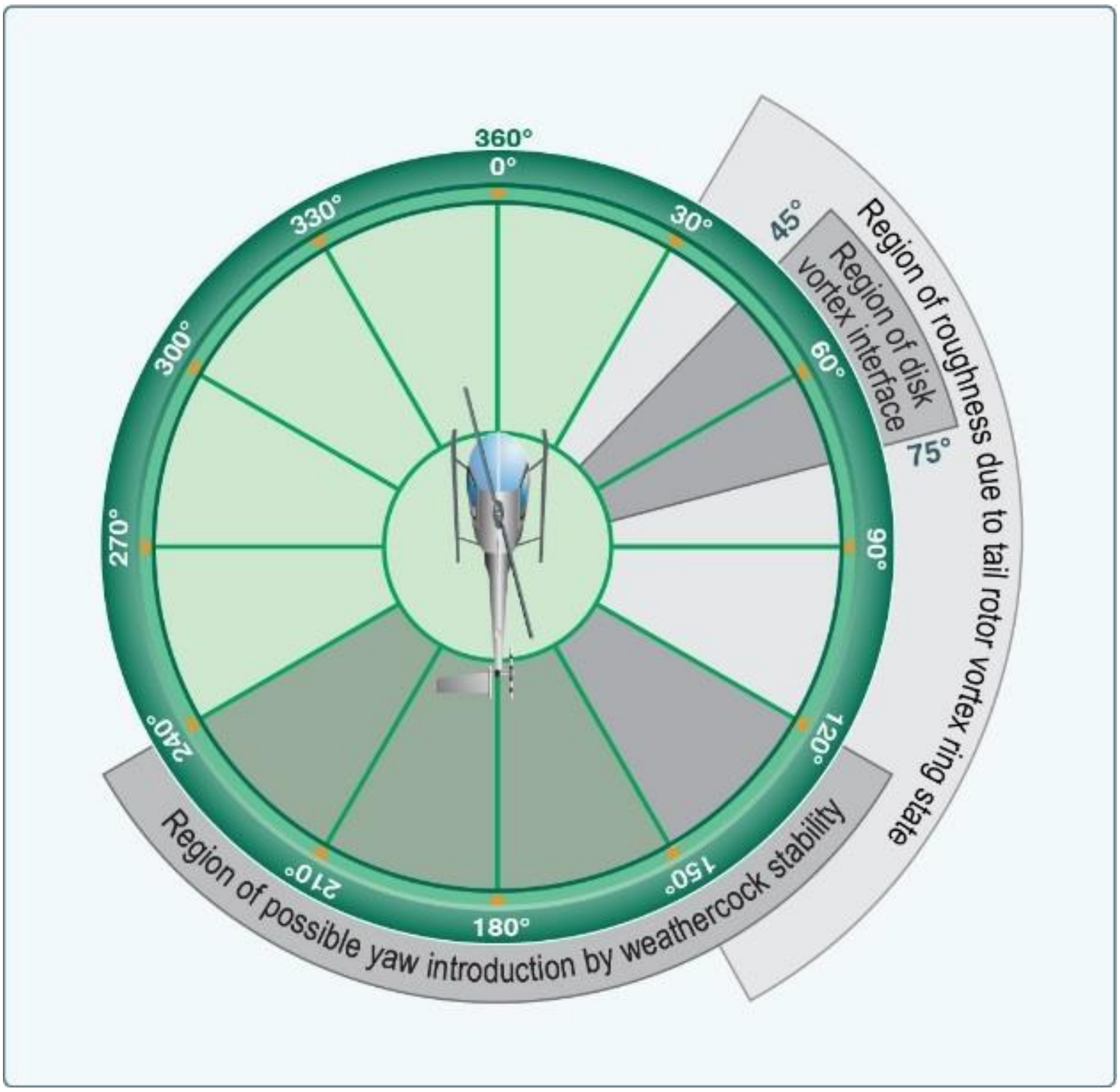

Figure 2. Relative wind directions that can contribute to LTE for clockwise rotating main rotor helicopters

On US-manufactured single-rotor helicopters, the main rotor rotates anti-clockwise as viewed from above. The torque produced by the main rotor causes the fuselage of the helicopter to rotate in the opposite direction (nose right). On some European- and Russian-manufactured helicopters, the main rotor rotates clockwise as viewed from above. In those helicopters, the torque produced by the main rotor causes the fuselage to rotate nose left. Operating with the relative wind direction within ±15° of the 10-o'clock position (for anti-clockwise main rotor helicopters) or the 2-o'clock position (for clockwise rotating main rotor helicopters) generates vortices that directly blow into the tail rotor. Also, tailwinds from 120° to 240° can cause high workloads. Finally, crosswinds can create roughness due to tail rotor vortex ring state (wind from 210° to 330° on anti-clockwise rotating main rotor helicopters or from 30° to 150° on clockwise rotating main rotor helicopters).

Due to safety concerns, training for LTE is rarely done in an actual helicopter. Simulators allow pilots to practise recovery; however, the element of surprise – and the rapid yaw that pilots may experience when the helicopter encounters LTE in flight – is difficult to realistically achieve in some simulators.

Related accidents

During the 10-year period from 2004 to 2014, the National Transportation Safety Board (NTSB) investigated 55 accidents involving LTE. In the following cases, the pilots were unable to recover when the helicopters encountered unanticipated yaw. All three cases involved helicopters with anti-clockwise rotating main rotor blades.

1. The pilot was making an approach to a hospital helipad into light wind at night when he chose to go around. The pilot lowered the helicopter's nose, added power, and raised the collective. The helicopter then entered into a rapid ‘violent’ right spin. The pilot applied left anti-torque pedal and cyclic but was unable to recover. The helicopter spun several times before impacting power lines and terrain. Just before the pilot added power to go around, the helicopter was travelling at about 5 kt groundspeed. At such a low groundspeed, the tail rotor is required to produce nearly 100% of the directional control. The pilot likely did not adequately account for the helicopter’s low airspeed when he applied power to go around, which resulted in a sudden, uncommanded right yaw due to LTE. (CEN15FA003)

2. The pilot and two passengers were surveying deer, with the helicopter about 50 to 100 ft above ground level with a 5- to 10-kt left crosswind and an indicated groundspeed of 30 to 35 kt. As terrain began to rise, the pilot added power to clear a ridge. The pilot reported that when the helicopter was about 100 ft from the top of the ridge, the helicopter began to yaw to the right. He added power to clear the ridgeline, which greatly increased the right yawing motion. The helicopter began spinning, crossed over the ridgeline backwards, and continued spinning before it contacted the ground and rolled over onto its left side. One passenger reported that although the wind was about 10 kt when they started the survey, the wind speed had increased when the helicopter reached the top of the ridge, and the pilot had to correct for it twice before the helicopter began spinning to the right. The helicopter was operating with wind coming from the left and at a high power setting; the unanticipated right yaw and subsequent spinning of the helicopter are consistent with LTE. (CEN13TA165)

3. The pilot had planned a Part 91 sightseeing flight around New York City with two passengers; however, four passengers arrived for the flight. The pilot did not complete performance calculations before the accident flight, and the helicopter was in excess of its maximum allowable gross weight at take-off. Shortly after departure, while the helicopter was climbing to 60 ft above the water, the pilot failed to anticipate and correct for conditions (high gross weight, low indicated airspeed, and a right downwind turn) conducive to LTE, which resulted in LTE and an uncontrolled spin. (ERA12MA005)

What can you do?

1. Include wind speed and direction in your pre-flight planning, because it can greatly affect your helicopter’s susceptibility to LTE.

2. Know your helicopter’s performance limitations, as outlined by the manufacturer, and adhere to them.

3. Be aware of your helicopter’s flight control characteristics, particularly tail rotor pedal forces, so that you can quickly recognise and resolve the onset of unanticipated yaw.

4. Review the Federal Aviation Administration's (FAA's) *Helicopter Flying Handbook* for specific tips on avoiding LTE. Here are a few tips to get you started:

- Conduct a thorough pre-flight planning assessment with particular attention to the helicopter's maximum allowable gross weight.
- Maintain awareness of the wind direction and speed in flight, especially in high workload areas, when flying along ridgelines and around buildings, and when hovering in wind of about 8 to 12 kt when a loss of translational lift can occur.
- Avoid tailwinds or crosswinds (the direction depends on the type of helicopter you are flying) when operating below an airspeed of 30 kt.
- Avoid out-of-ground-effect operations and high-power-demand situations below 30 kt.
- Monitor the amount of anti-torque pedal being used. If insufficient pedal is available, you may not be able to counteract an unanticipated right yaw.

Train for and know how to recover immediately from LTE so that you are prepared. Remember that LTE can be sudden, and pilots have described the onset of yaw as 'violent'.