AIRCRAFT ACCIDENT SHORT REPORT

CA18/2/3/9895: Dynamic roll-over during a training flight at FACT.

Date and time	: 17 July 2020, 0820Z
Aircraft registration	: ZS-ROP
Aircraft manufacturer and model	: Airbus Helicopters, H120
Last point of departure	: Cape Town International Aerodrome (FACT)
Next point of intended landing	: Cape Town International Aerodrome (FACT)
Location of accident site with reference to easily defined geographical points (GPS readings if possible)	: On the edge of the threshold of Runway 34, FACT GPS position: 33°58'20.10" South 018°36'37.56" East
Meteorological information	: Surface wind: 020°/6kt, temperature: 19°C, CAVOK
Type of operation	: Training (Part 141)
Persons on-board	: 2 + 2
Injuries	: None
Damage to aircraft	: Substantial

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

Purpose of the Investigation:

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

Ministerial Order regarding Aircraft Accident and Incident Investigations dated 26 May 2016 issued by Minister Dipuo Peters in terms of section 100 (1)(b) of the Civil Aviation Act, 2009 (Act No. 13 of 2009): "The Aircraft Accident and Incident Investigation unit shall report functionally to the Minister of Transport through the Deputy Director-General: Civil Aviation in so far as it relates to accident and incident investigations and reports. The South African Civil Aviation Authority (SACAA) shall be responsible for managing operational resources (technical, human, financial) to conduct investigations without hindrance".

Disclaimer:

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SRP Date: 1 December 2020 Publication Date: 1 December 2020

1. SYNOPSIS

1.1 The accident occurred during a turbine helicopter conversion training flight. On-board the helicopter were a flight instructor and a private pilot (who was the pilot flying and was seated on the right front seat), as well as two other passengers (also private pilots) who were seated at the back seats. After the helicopter had been airborne for approximately 40 minutes and during the pilot flying's (PF's) last exercise, which involved a steep approach and which they had entered into from a height of 1 000 feet (ft) above ground level (AGL), the PF's intention was to come into a low hover (approximately 6 feet AGL) at the threshold of Runway 34. As the helicopter approached the ground, the PF was too late in his recovery technique. The helicopter yawed to the left and the right skid gear made contact with the ground, followed by a dynamic roll to the right. This was a training flight conducted under the provisions of Part 141 of the Civil Aviation Regulations (CAR) 2011 as amended.

1.2 The PF had applied the incorrect technique to recover the helicopter during the steep approach.

2. FACTUAL INFORMATION

2.1 History of flight

2.1.1 On Friday morning 17 July 2020, a helicopter with registration ZS-ROP took off from Cape Town International Aerodrome (FACT) at 0740Z on a turbine helicopter conversion training flight. On-board the helicopter were a flight instructor and a private pilot, who was the pilot flying (PF) and who was seated on the right front seat. There were also two other passengers seated at the back seats of the helicopter who were also private pilots. The intention of this turbine helicopter conversion training flight was that each of the three private pilots would have a turn to fly the helicopter. During the take-off clearance, the air traffic control (ATC) provided the crew with the prevailing wind condition, which was 330° less than 5 knots.

2.1.2 After the helicopter had been airborne for approximately 40 minutes and during the PF's last exercise, which comprised a steep approach and which the helicopter entered into from a height of 1 000 feet (ft) above ground level (AGL), the PF's intention was to come into a low hover (approximately 6 feet AGL) at the threshold of Runway 34. As they approached the ground, the PF initiated the recovery technique too close to the ground; thus, the helicopter yawed to the left and the right skid gear made contact with the ground, followed by a dynamic roll-over to the right.

2.1.3 The helicopter was equipped with an emergency locator transmitter (ELT) which automatically activated during the impact sequence. The unit transmitted a 406-megahertz

(MHz) signal, which was detected by the Cospas Sarsat System. The unit was deactivated by a qualified person at the scene of the accident. The helicopter sustained substantial damage during the impact sequence, particularly the main rotor drive train and the tail boom section. The skid gear had remained intact, but the aft gross tube assembly had separated from the fuselage mounting point.

2.1.4 The video footage of the flight was captured on close circuit television (CCTV) security cameras that were positioned facing east on the terminal building overlooking the apron and the aerodrome. Although the accident occurred within the aerodrome perimeter, the scene of the accident was further from the closest CCTV cameras. The video footage that was obtained from the accident helicopter was assessed, and it confirmed the correctness of the statements that were obtained from the flight instructor, the PF and the two other pilots who were on-board the helicopter.

2.1.5 The accident occurred during daylight at a geographical position determined to be: 33°58'20.10" South 018°36'37.56" East at an elevation of 150ft above mean sea level (AMSL).

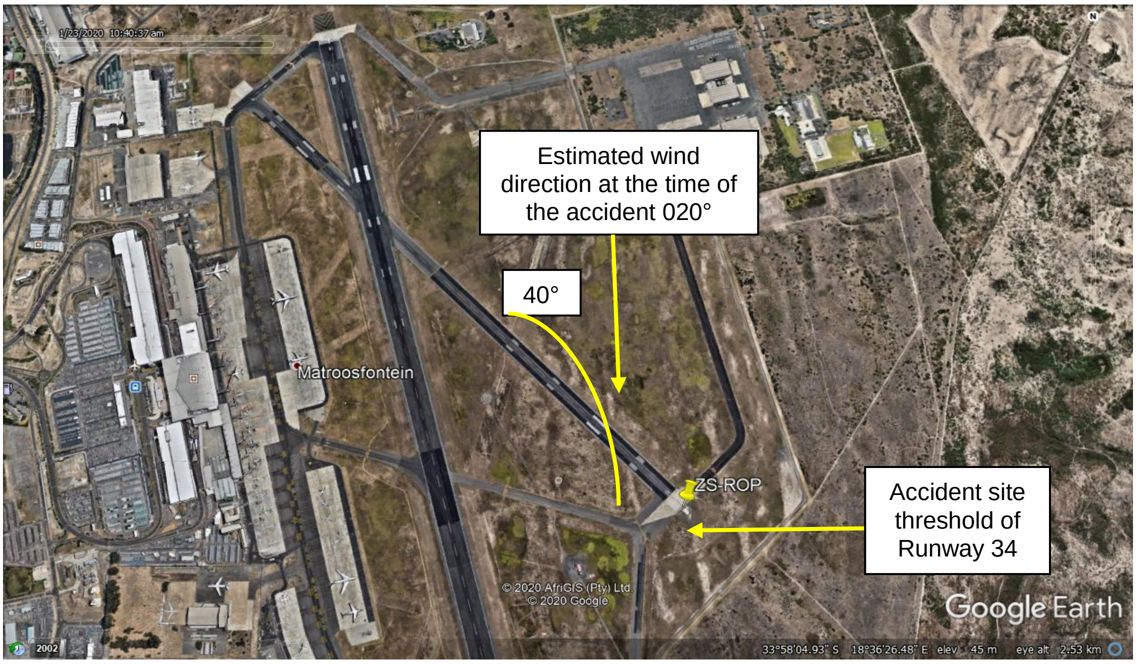


Figure 1: Google Earth overlay indicating the location of the accident site (yellow pin shows where ZS-ROP helicopter was positioned).

2.1.6 Summary of the Crews' Flying Hours

Pilot-in-command (PIC) / Flight Instructor

Total hours	3 882.5
Total past 90 days	46.9
Total on type past 90 days	23.7
Total on type	1 084.3

Pilot Flying (Private Pilot)

Total hours	164.7
Total past 90 days	25.2
Total on type past 90 days	5.2
Total on type	5.2

Breakdown of flying hours for the PF on helicopters

Robinson R22	133.5
Robinson R44	8.6
EC-120	5.2
Simulator (FNTP II)	17.4
Total flying hours	**164.7**

2.1.7 Helicopter Information

The helicopter, an Airbus H120, with serial number 1332 was manufactured in 2003. It had a total time of 5 387.9 airframe hours at the time of the accident. The last maintenance inspection prior to the accident flight was performed on 14 July 2020 and the helicopter had flown a further 45.8 hours since the inspection.

2.1.8 Weight and Balance

HELICOPTER (A)	MASS (Kg)	ARM (m)	MOMENT
BASIC EMPTY WEIGHT (incl. Oils)	1109	4,28	4746,5
FUEL	310	4,09	1267,9
CREW (1 x pilot)	65	2,35	152,8
BASIC OPERATING WEIGHT (A)	1484		6167,2
MAUW	1715		
AVAILABLE PAYLOAD	-8		0

PAYLOAD (B)	MASS (Kg)	ARM (m)	MOMENT
Co-pilot / Front Pax	80	2,35	188
Rear Pax (RH)	68	3,25	221
Rear Pax (Mid)	0	3,25	0
Rear Pax (LH)	75	3,25	243,8
Cargo Side	0	4,1	0
Cargo Rear	0	4,75	0

PAYLOAD (B)	223		652,8
BASIC OPERATING WEIGHT (A)	1484		6167,2
GROSS WEIGHT (A+B)	1707		6820
C of G (Take Off)		4,0	
Calculated Fuel Burn off (C)	66	4,09	269,94
TOTAL (A+B-C)	1641		6550,06
C of G (Landing)		3,99	

The maximum all-up weight (MAUW) for this helicopter is 1 715 kilograms (kg) (3 780 lbs).

The maximum fuel capacity of the helicopter is 416 litres (L) (110 US gallons, 92 imperial gallons).

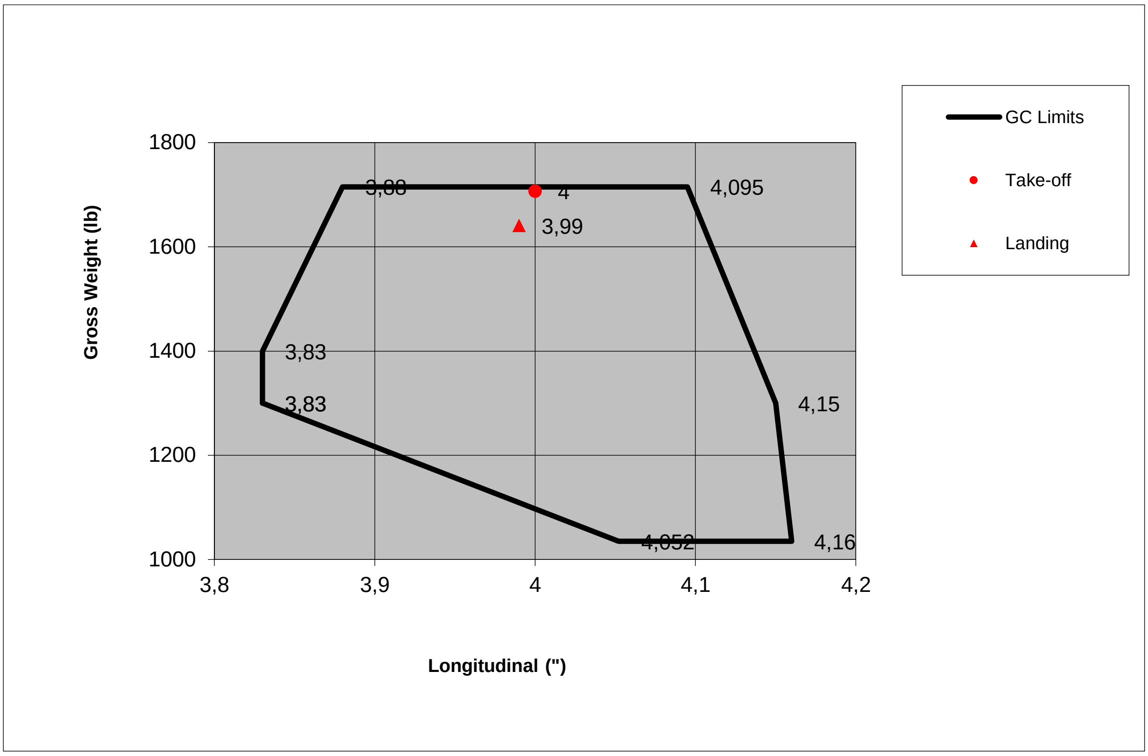
The crew stated that there was 100 US gallons (310kg) of fuel on-board at the start of the flight.

The average fuel consumption at sea level is approximately 98kg per hour.

The weight information (on the table above) of each of the four crew members was obtained from their respective last aviation medical examinations prior to the accident flight.

The PF as well as the two pilots who were seated at the back seats completed their aviation medical examinations on the same day on 23 January 2020. The flight instructor completed hers on 27 May 2020.

On the initial take-off, the centre of gravity (CG) was calculated to be at the forward limit. At the time of the accident, the forward CG was just within limit, but still very close to the forward CG limit.



2.1.9 Meteorological Information

According to available information from ATC, the helicopter took off at 0740Z; the prevailing surface wind information that the ATC had given the crew as part of their take-off clearance was: wind 330° at less than 5 knots.

The weather information in the table (below) was obtained from the 0800Z (Packtime: 0756Z) Meteorological Aeronautical Report (METAR) that was issued by the South African Weather Service (SAWS) for FACT: 170800Z 03007KT CAVOK 17/02 Q1025 NOSIG=.

Wind Direction	030°	Wind Speed	7 kt	Visibility	+ 10km
Temperature	17°C	Cloud Cover	N/A	Cloud Base	N/A
Dew Point	2°C	QNH	1025 hPa		

The weather information in the table (below) was obtained from the 0830Z (Packtime: 0826Z) METAR that was issued by the SAWS for FACT: 170830Z 02006KT 340V040 CAVOK 19/02 Q1025 NOSIG=.

Wind Direction	020°	Wind Speed	6 kt	Visibility	+ 10km
Temperature	19°C	Cloud Cover	N/A	Cloud Base	N/A
Dew Point	2°C	QNH	1025 hPa		

2.1.10 Wreckage and Impact Information

The right skid gear first made contact with the ground (grass covered area) near the threshold of Runway 34 (see Figure 2). The helicopter then came to rest on the edge of the threshold facing east. Debris (mostly consisting of carbon fibre) was spread over a large area because the three main rotor blades impacted the ground and broke into smaller pieces as the rotor system was still turning at normal operating speed on impact. The tail boom (also constructed from carbon fibre) was damaged on the front part of the fenestron tail rotor assembly (see Figure 4).

Figure 2: The helicopter as it came to rest. (Photograph courtesy of FACT ARFF)

Figure 3: Debris on the runway threshold after the accident. (Photograph courtesy of FACT ARFF)

Figure 4: The broken tail boom structure on the front part of the fenestron. (Photograph courtesy of FACT ARFF)

2.1.11 Steep Approach to a Hover

Source: Helicopter Flying Handbook (FAA-H-8083-21B), Chapter 10

A steep approach is used primarily when there are obstacles in the approach path that are too high to allow a normal approach. A steep approach permits entry into most confined areas and is sometimes used to avoid areas of turbulence around a pinnacle. An approach angle of approximately 13° to 15° is considered a steep approach. Caution must be exercised to avoid the parameters for vortex ring state (20% to 100% of available power applied, airspeed is less than 10 knots, and rate of descent greater than 300 feet per minute (fpm)).

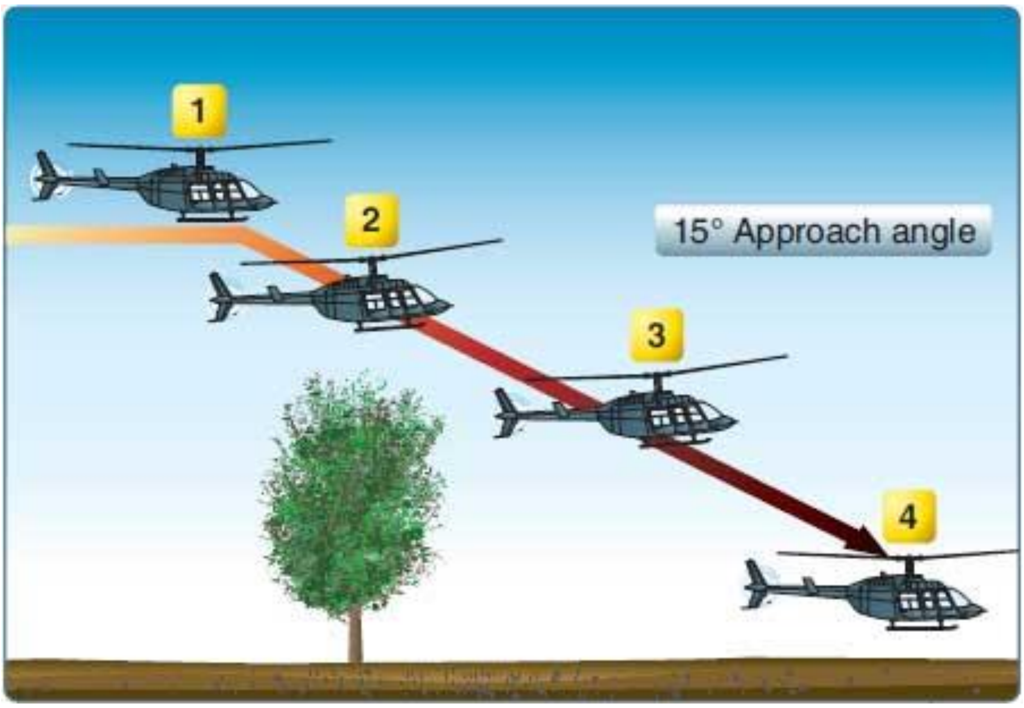


Figure 5: Steep approach to a hover.

Technique

On final approach, maintain track with the intended touchdown point and into the wind as much as possible at the recommended approach airspeed (Figure 5 position 1). When intercepting an approach angle of 13° to 15°, begin the approach by lowering the collective sufficiently to start the helicopter descending down the approach path and decelerating (position 2). Use the proper antitorque pedal for trim. Since this angle is steeper than a normal approach angle, reduce the collective more than that required for a normal approach. Continue to decelerate with slight aft cyclic and smoothly lower the collective to maintain the approach angle.

The intended touchdown point may not always be visible throughout the approach, especially when landing to a hover. Pilots must learn to cue in to other references that are parallel to the intended landing area that will help them maintain ground track and position.

Constant management of approach angle and airspeed is essential to any approach. Aft cyclic is required to decelerate sooner than a normal approach, and the rate of closure becomes apparent at a higher altitude. Maintain the approach angle and rate of descent with the collective, rate of closure with the cyclic, and trim with antitorque pedals.

The helicopter should be kept in trim just prior to loss of effective translational lift (approximately 25 knots). Below 100' AGL, the antitorque pedals should be adjusted to *align the helicopter with the intended touchdown point. Visualize the location of the tail rotor behind the helicopter and fly the landing gear to 3 feet above the intended landing point. In small confined areas, the pilot must precisely position the helicopter over the intended landing area. Therefore, the approach must stop at that point.*

Loss of effective translational lift occurs higher in a steep approach (position 3), requiring an increase in the collective to prevent settling, and more forward cyclic to achieve the proper rate of closure. Once the intended landing area is reached, terminate the approach to a hover with zero groundspeed (position 4). If the approach has been executed properly, the helicopter will come to a halt at a hover altitude of 3 feet over the intended landing point with very little additional power required to hold the hover.

The pilot must be aware that any wind effect is lost once the aircraft has descended below the barriers surrounding a confined area, causing the aircraft to settle more quickly. Additional power may be needed on a strong wind condition as the helicopter descends below the barriers.

Common Errors

1. *Failing to maintain proper rpm during the entire approach.*
2. *Using collective improperly in maintaining the selected angle of descent.*
3. *Failing to make antitorque pedal corrections to compensate for collective pitch changes during the approach.*
4. *Slowing airspeed excessively in order to remain on the proper angle of descent.*
5. *Failing to determine when effective translational lift is being lost.*
6. *Failing to arrive at hovering altitude and attitude, and zero groundspeed almost simultaneously.*
7. *Utilizing low rpm in transition to the hover at the end of the approach.*
8. *Using too much aft cyclic close to the surface, which may result in the tail rotor striking the surface.*
9. *Failure to align landing gear with direction of travel no later than beginning of loss of translational lift.*

3. FINDINGS

3.1 The PIC (flight instructor) was issued a Commercial Pilot Licence on 20 June 2011. She held the necessary ratings to operate the helicopter and had accumulated a total of 3 882.5 flight hours of which 1 084.3 were on the helicopter type.

3.2 The PIC was issued a Class 1 aviation medical certificate on 27 May 2020 with an expiry date of 31 May 2021, without any restrictions.

3.3 The PF was initially issued a Private Pilot Licence on 14 October 2019. He had accumulated a total of 164.7 flight hours of which 5.2 hours were on the accident helicopter type. These 5.2 hours were dual flying hours while under instruction.

3.4 The PF was issued a Class 1 aviation medical certificate on 23 January 2020 with an expiry date of 25 January 2021, without any restrictions.

3.5 This was a training flight conducted under the provisions of Part 141 of the CAR 2011 as amended. The aviation training organisation (ATO) was issued an ATO certificate by the South African Civil Aviation Authority (SACAA).

3.6 The helicopter was issued a Certificate of Airworthiness on 13 August 2016 with an expiry date of 31 August 2020.

3.7 The helicopter was issued a Certificate of Release to Service on 14 July 2020 with an expiry date of 23 June 2021 or at 5 442.1 airframe hours, whichever comes first.

3.8 The helicopter was issued a Certificate of Registration on 2 March 2020.

3.9 The last scheduled Mandatory Periodic Inspection (MPI) that was carried out on the helicopter prior to the accident flight was certified on 24 June 2020 at 5 342.1 airframe hours. The helicopter had accumulated an additional 45.8 airframe hours since its last inspection.

3.10 At the time of the accident, the helicopter was operated 74kg (163 lbs) below its maximum all-up weight. At the time of the accident, the forward CG was just within limits, but still very close to the forward CG limit.

3.11 The crew did not report any malfunction with regards to the helicopter during the flight which could have contributed or have caused the accident.

3.12 The flight was conducted under visual flight rules (VFR) by day.

3.13 The wind direction and intensity had changed from the time the helicopter took off at 0740Z to the time the accident occurred at 0820Z.

3.14 The PF stated that he initiated the recovery technique too close to the ground and the helicopter yawed to the left; the right skid gear contacted the ground, followed by a dynamic roll-over.

3.15 The helicopter sustained extensive damage beyond repair.

3.16 Neither of the four occupants on-board the helicopter was injured during the accident sequence.

3.17 The accident occurred on a licensed aerodrome and the Aerodrome Rescue and Fire-fighting (ARFF) personnel responded swiftly to the accident scene after the crash alarm was activated by ATC.

4. PROBABLE CAUSE

4.1 As a result of an incorrect recovery technique for a steep approach, the helicopter's right skid gear touched the ground whilst rotating to the left; this resulted in a dynamic roll-over.

5. CONTRIBUTING FACTOR

5.1 The flight instructor's delay to intervene timeously, and as a result, the rate of descent continued all the way to the ground, which resulted in the right skid gear making contact with the ground while the helicopter continued to yaw towards the left.

5.2 The lack of experience by the PF on the helicopter type as the major part of his flying experience (97%) at the time was on helicopters with counter rotating main rotor systems when viewed from above, which was the opposite (rotating clockwise) of the helicopter he was flying during the accident flight. The accident helicopter was equipped with a fenestron tail rotor which behaved slightly different to the conventional tail rotor the PF was used to.

6. REFERENCES USED IN THE REPORT

6.1 Pilot questionnaires (form CA 12-03)
6.2 Operator questionnaire (form CA 12-04)
6.3 Helicopter maintenance documentation
6.4 Cape Town International Aerodrome ARFF personnel
6.5 Helicopter Flying Handbook (FAA-H-8083-21B), Chapter 10
6.6 Airbus Helicopters
6.7 Eurocopter Service Letter No. 1673-67-04

7. SAFETY RECOMMENDATION

7.1 None.

8. ORGANISATION

8.1 This was a training flight, which was conducted under the provisions of Part 141 of the Civil Aviation Regulations 2011 as amended.

8.2 The ATO was issued an ATO certificate No. CAA/0306 by the SACAA on 15 August 2018 with an expiry date of 31 August 2022.

8.3 The last MPI that was carried out on the helicopter prior to the accident flight was certified on 24 June 2020 at 5 342.1 airframe hours. The aircraft maintenance organisation (AMO) was issued an AMO-approval certificate No. 1388 by the SACAA on 1 October 2019 with an expiry date of 31 August 2020.

9. APPENDICES

9.1 Annexure A (Eurocopter Service Letter No. 1673-67-04)

9.2 Annexure B (FACT Aerodrome chart)

This report is issued by:
Accident and Incident Investigations Division (AIID)
South African Civil Aviation Authority
Republic of South Africa

ANNEXURE A

eurocopter
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Lettre-Service
No. 1673-67-04

Marignane, 04.02.05

To **all Pilots**,
for **all types of helicopters** fitted with a tail rotor.

Main rotor rotating clockwise

SUBJECT: **Reminder** concerning the **YAW axis control for all helicopters** in some flight conditions

The technical comments in this Service-Letter apply to **main rotors rotating clockwise when seen from above**. For rotors rotating anticlockwise, see Service-Letter No. 1692-67-04.

Ref.: First reminder = S.L. No. 1518-67 dated 26.04.2001

Dear Customer,

The analysis of the causes of severe helicopter incidents or accidents leads EUROCOPTER to issue a few reminders as regards YAW axis control in some flight situations.

1 - **BACKGROUND**:

Various events which occurred during flight near the ground and at very low speed in light wind conditions on aircraft fitted either with conventional tail rotors or with Fenestrons, took place as follows:

From hover flight at take-off at very low speed, the Pilot initiates a left turn a few meters above the ground by applying yaw pedals towards the neutral position: the aircraft starts its rotation which increases until the Pilot attempts to stop it by applying the RH yaw pedal.

In the various cases which resulted in the loss of yaw axis control, the action applied to the RH yaw pedal was not enough (amplitude/duration) to stop rotation as quickly as the Pilot wished.

As the aircraft continues its rotation, the Pilot generally suspects a (total or partial) tail rotor failure and decides either to climb to gain speed or to get closer to the ground.

In the first case, increasing the collective pitch results in increasing the main rotor torque and consequently further speeds up leftward rotation. This results in the loss of aircraft control.

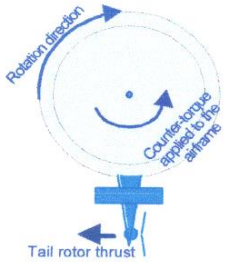
In the second case, sharp decrease in collective pitch can make the aircraft tilt to the side whilst rotating and cause it to touch the ground.

The investigations carried out following such events have never revealed any defect as regards flight controls and tail rotor assembly.

Furthermore, given their altitude and weight conditions the tail rotors were far from their maximum performance limits.

2 – IMPORTANT REMINDERS

AIRCRAFT SEEN FROM ABOVE

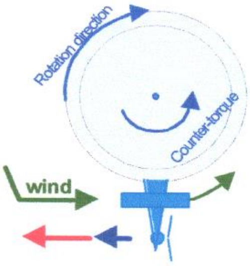


In hover flight or in very low speed flight:

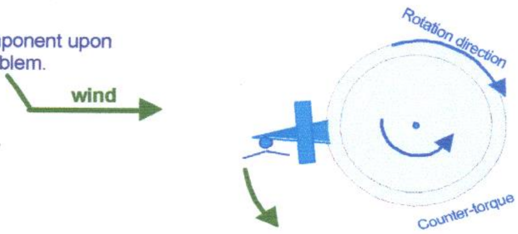
The Pilot counteracts the leftward aircraft rotation by applying RH yaw pedal.

When adding a light unfavourable wind,

never forget that a leftward **rotation** departure can result in the aircraft's initiating a high rotation rate, if no adequate and additional action is immediately applied to the yaw pedals.



Remember that a **tail wind** component upon departure would worsen the problem.



In a quick leftward rotation, if the Pilot attempts to counteract this rotation by applying the RH yaw pedal up to a position corresponding to that of hover flight, the aircraft will not decelerate significantly!

In this situation, **immediate action of significant amplitude** applied to the RH yaw pedal must be initiated and **maintained to stop** leftward **rotation**. **Never hesitate to go up to the RH stop**.

Any delay when applying this correction will result in an increase in rotation speed.

Intentional or accidental initiation of this **rotation phenomenon** can therefore be **physically explained** and is in no way connected to the tail rotor performance; **in all cases, when adequate correction is applied, rotation will stop**!

Finally, it **should also be remembered** that any intentional manoeuvre to **initiate leftward rotation** in hover flight conditions or at very low speed, must be performed through a **moderate action** on the LH yaw pedal!

3 – **ADDITIONAL TECHNICAL INFORMATION** relative to various tail rotor types

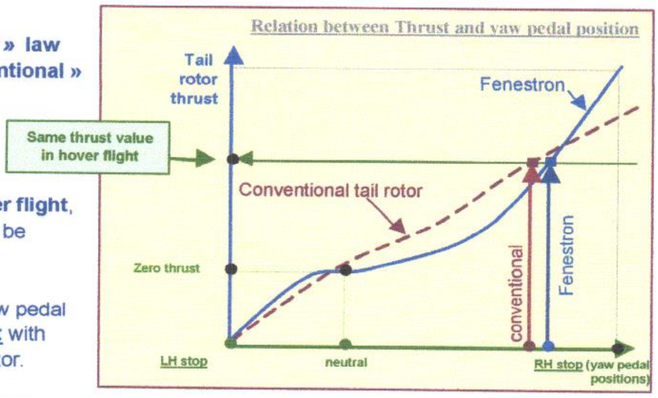
Yaw pedal positions around the hover flight

The « *yaw pedal position / tail rotor thrust* » law curve shape is not the same for a « conventional » rotor and a « Fenestron ».

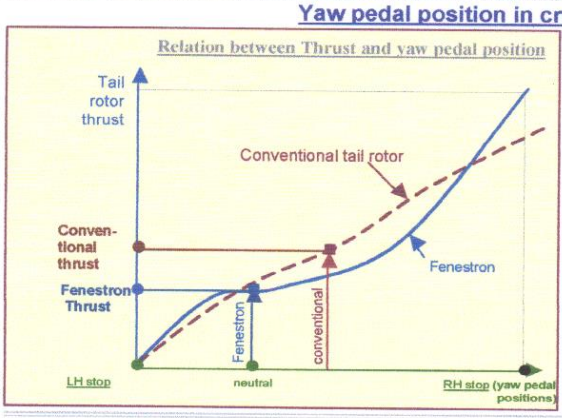
Consequently:

For the same thrust value needed for **hover flight**, the Fenestron requires a little more action to be applied to the RH yaw pedal.

But in hover flight, **the same variation** of yaw pedal position will result in **more significant effect** with the **Fenestron** than with the conventional rotor.



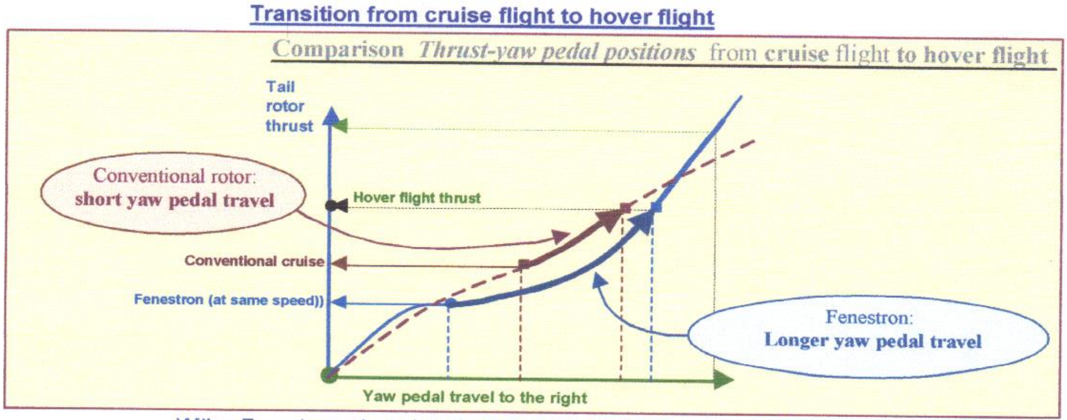
Yaw pedal position in cruise flight



In cruise flight, the **conventional rotor** delivers a thrust which comes in addition to its vertical stabilizer profile effect, so as to maintain zero sideslip.

As regards the **Fenestron**, since the fairing effect is higher due to its large surface, the thrust to be applied by the tail rotor is lower.

Transition from cruise flight to hover flight



With a Fenestron, when changing from **cruise flight to hover flight**, be prepared for a **significant movement of the foot to the right**.

Insufficient application of pedal would result in a leftward rotation of the aircraft during the transition to hover.

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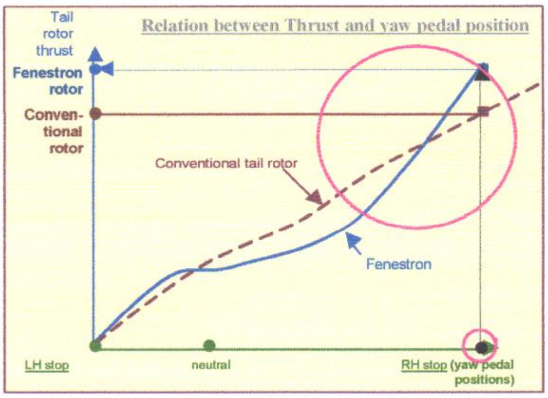
Using maximum thrust

To stop rotation to the left, whether it is intentional or not, never hesitate to go up to the yaw pedal RH stop!

It can be noticed that near the RH stop, the Fenestron efficiency is very high (curve slope).



Conclusion

1 – In hover flight or at very low forward flight speed, stopping a quick rotation to the left must be performed by **immediately applying** the RH yaw pedal with a significant and maintained amplitude, regardless of the tail rotor type.

2 – In hover flight or at very low speed, intentional initiation of a turn to the left shall always be made by moderate action on the yaw pedals.

3 – Wind coming from the left or tail wind increases the aircraft rotation speed.

Yours sincerely,

Technical Support Operations Department
Customer Service

M. SOULHIARD

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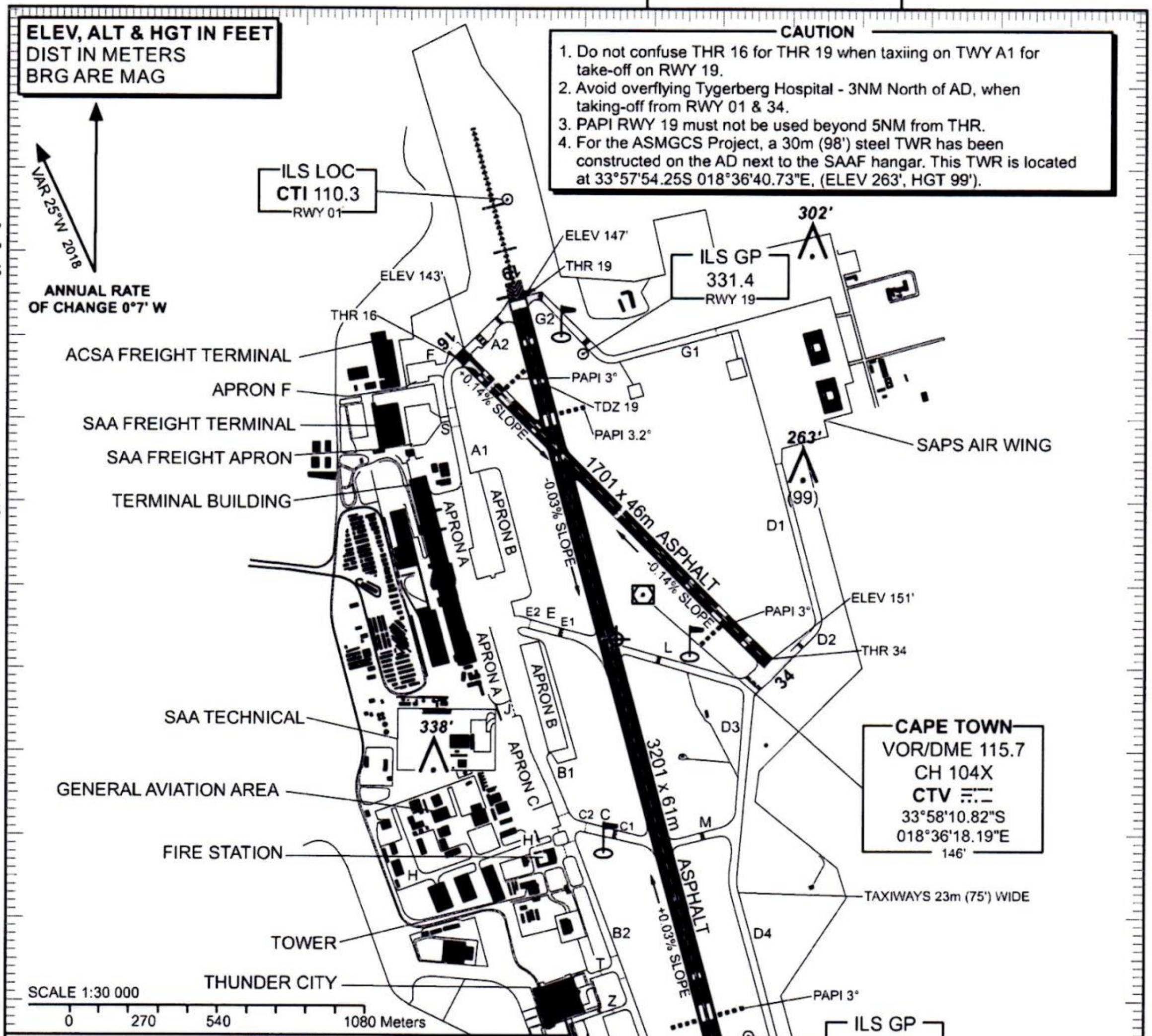
ANNEXURE B

AERODROME/ HELIPORT CHART - ICAO | 33°58'16.93"S 018°36'15.45"E | **ELEV 151'** **GUND 102.3'** | CAPE TOWN ATIS 127.00 APN 122.65 SMC 121.90 TWR 118.10 | **CAPE TOWN INTL** FACT



RWY LIGHTING

RWY	ALS	PAPI	RTHL	REDL	RENL
01	PALS CAT II	3°	GREEN	WHITE	RED
19	PALS CAT II	3.2°	GREEN	WHTIE	RED
16	NIL	3° L/H	GREEN	WHITE	RED
34	NIL	3° L/H	GREEN	WHITE	RED

OTHER: TWY, OBST, WDI & MAST

PHYSICAL CHARACTERISTICS

RWY	DIRECTION	THR COORDINATES	THR ELEVATION	TORA (m)	TODA (m)	ASDA (m)	LDA (m)	SWY (m)	CWY (m)	SLOPE	SURFACE	BEARING STRENGTH	CIRCUIT
01	345°(T)	33°59'15.864"S 018°36'32.013"E	144'	3201	4172	3201	3201	NIL	971	0.0003U	ASPH	PCN 66/F/A/X/T	L/H
19	165°(T)	33°57'35.429"S 018°36'00.181"E	147'	3201	3544	3201	3201	NIL	343	0.0003D			L/H
16	135°(T)	33°57'40.957"S 018°35'50.890"E	143'	1701	1701	1701	1701	NIL	NIL	0.0014U	ASPH	PCN 32/F/A/X/U	UNK
34	315°(T)	33°58'20.144"S 018°36'37.564"E	151'	1701	1701	1701	1701	NIL	NIL	0.0014D			UNK

CHANGE: RWY 01/19 Lighting System

EFF: 20 JUN 19 | SOUTH AFRICAN CIVIL AVIATION AUTHORITY | **AD-01**