AIRCRAFT ACCIDENT FINAL REPORT

A 03/21

Air Accidents Investigation Bureau (AAIB)

Ministry of Transport

Accident Involving an Airbus Helicopters H125
Registration 9M-LEO
at Sultan Abdul Aziz Shah Airport (WMSA), Malaysia
on the 24 March 2021

Air Accidents Investigation Bureau
Ministry of Transport
No. 26, Jalan Tun Hussein, Precinct 4
Federal Government Administrative Centre
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E-mail: aaib@mot.gov.my
Website: http://www.mot.gov.my/en

Issued on 24 March 2022

AIR ACCIDENTS INVESTIGATION BUREAU (AAIB)
MALAYSIA

ACCIDENT REPORT NO. : A 03/21

OWNER	**:**	**CHAILEASE INT FINANCIAL SVC CO LTD**
OPERATOR	**:**	**LEOPAD AVIATION SDN BHD**
AIRCRAFT TYPE	**:**	**AIRBUS HELICOPTERS H125**
NATIONALITY	**:**	**MALAYSIA**
REGISTRATION	**:**	**9M-LEO**
PLACE OF OCCURRENCE:		**SULTAN ABDUL AZIZ SHAH AIRPORT (WMSA)**
DATE AND TIME	**:**	**24 MARCH 2021 AT 0915LT**

This investigation is carried out to determine the circumstances and causes of the accident with the sole objective for the preservation of life and the avoidance of accidents in the future. It is not for the purpose of apportioning blame or liability (Annex 13 to the Chicago Convention).

All times in this report are Local Time (LT) unless stated otherwise. LT is UTC +8 hours.

INTRODUCTION

The Air Accidents Investigation Bureau Malaysia

The Air Accidents Investigation Bureau (AAIB) is the air accident and serious incident investigation authority in Malaysia and is accountable to the Minister of Transport. Its mission is to promote aviation safety through the conduct of independent and objective investigations into air accidents and serious incidents.

The AAIB conducts the investigations in accordance with Annex 13 to the Chicago Convention, the Civil Aviation Act of Malaysia 1969 and the Civil Aviation Regulations of Malaysia 2016.

It is inappropriate that AAIB reports should be used to assign fault or blame or determine liability, since neither the investigation nor the reporting processes has been undertaken for that purpose.

In accordance with ICAO Annex 13 paragraph 4.1, notification of the accident was sent out on 29 March 2021 to the French Accident Investigation Authority, the *Bureau d'Enquêtes et d'Analyses pour la Sécurité de l'Aviation Civile (BEA)*, France as the State of Design and Manufacturer **(APPENDIX A)**.

Unless otherwise indicated, recommendations in this report are addressed to the investigating or regulatory authorities of the State having responsibility for the matters with which the recommendations are concerned. It is for those authorities to decide what action is to be taken.

TABLE OF CONTENTS

APPENDICES

ABBREVIATIONS

AAIB	Air Accidents Investigation Bureau
CAAM	Civil Aviation Authority of Malaysia
ICAO	International Civil Aviation Organisation
LT	Local Time
METAR	Meteorological Aerodrome Report
MRO	Maintenance Repair Overhaul / Operations
POB	Persons on Board
RT	Radio Telephony
UTC	Coordinated Universal Time
WMSA	ICAO Code for Sultan Abdul Aziz Shah Airport

DEFINITIONS

LTE Loss of Tail-rotor Effectiveness (LTE) occurs when the tail rotor of a helicopter is exposed to wind forces that prevent it from carrying out its function which is that of cancelling the torque of the engine and transmission. Any low-airspeed high-power environment provides an opportunity for it to occur.

SYNOPSIS

On 24 March 2021, an Airbus Helicopters H125 bearing the registration 9M-LEO was involved in an accident at Sultan Abdul Aziz Shah Airport (WMSA), Malaysia. The aircraft had 5 POB.

9M-LEO had just approached to a high hover and was repositioning itself to taxy back to the Helicentre at WMSA when it experienced an uncommanded yaw to the left. The aircraft subsequently impacted the tarmac and broke apart.

The AAIB Chief Inspector was notified within the hour and an investigation team was dispatched immediately.

1.0 FACTUAL INFORMATION

1.1 History of the Flight

On Wednesday, 24 March 2021, the ill-fated helicopter took-off from Sungai Lembing for Sultan Abdul Aziz Shah Airport, Subang (WMSA). The intended route as per the Flight Plan **(APPENDIX B)** was Sungai Lembing – Maran – Temerloh – Karak – Batu Caves – WMSA. The purpose of the flight was to return to Subang after night stopping the previous day due to inclement weather.

Upon reaching Subang, the aircraft approached to a high hover over Taxiway Sierra before repositioning itself to air taxy back to the Helicentre. During this time the aircraft entered into an uncommanded left yaw before impacting the ground whilst continuing to spin and disintegrate before finally coming to a rest on its right side.

During this time the right-hand seat pilot and the passenger seated at the back to the extreme right were ejected from the aircraft. The pilot was thrown clear of the aircraft but the passenger unfortunately ended up being pinned down by the aircraft.

The ground personnel acted quickly to extinguish a small post-impact fire from the aircraft's exhaust before rescuing the passenger

under the aircraft and helping the others egress from the aircraft safely. Emergency response crews arrived shortly thereafter and sent the injured to a nearby hospital.

On-site investigations were then carried out by both the Police and AAIB and by afternoon the on-site investigations were completed and the wreckage was then cleared and transported back to the facilities of the responsible MRO service provider.

1.2 Injuries to Persons

The left-hand seat pilot and the passenger who was seated to the extreme right at the back of the aircraft had serious leg injuries. This is in addition to some burns this passenger suffered as a result of being pinned down by the aircraft. The three other occupants however escaped with only minor cuts and bruises.

	9M-LEO	
Injuries	**Crew**	**Pax**
Fatal	-	-
Serious	1	1
Minor / None	1	2

1.3 Damage to Aircraft

For images of damage to the aircraft on-site please refer to **APPENDIX C**. The aircraft was deemed as a total write-off.

Additionally, a Damage Assessment Report prepared by the responsible MRO is available as **APPENDIX D**.

1.4 Other Damages

The tarmac onto which 9M-LEO crashed was part of Taxiway Sierra leading to the Helicentre at WMSA. Apart from impact and scuff marks on the ground, no damage to other property was noticed.

1.5 Personnel Information

Both pilots of the helicopter were properly qualified and working for the same company.

1.6 Aircraft Information

The helicopter in question was leased and operated by Leopad Aviation Sdn Bhd, a subsidiary of the Leopad Group, a local leading Integrated Industrial Services, Manufacturing and Fabrication company.

Aircraft Type	H125
Manufacturer	Airbus Helicopters
Registration	9M-LEO
Serial No.	8568

1.7 Meteorological Information

The weather on that fateful day was clear with nil wind conditions **(APPENDIX E)**.

1.8 Aids to Navigation

Not applicable.

1.9 Communications

No distress calls were made that day over the RT. Information about the accident was relayed to the tower by another aircraft nearby.

1.10 Aerodrome Information

Not applicable.

1.11 Flight Recorders

The Airbus Helicopters H125 is not equipped with the traditional flight recorders (FDR & CVR) nor is it mandated by law to do so. Nonetheless, the aircraft is equipped with Appareo's flagship Airborne Image Recording System (AIRS), the Vision 1000.

The Vision 1000 camera was initially designed for light aircraft and intended to give operators the possibility to perform basic Helicopter Flight Data Monitoring (HFDM) to improve their operations, maintenance and flight safety.

The video analysis from the aircraft's Vision 1000 recording will be discussed at length later in this report.

1.12 Wreckage and Impact Information

A visual assessment of ground markings at the crash site revealed that 9M-LEO had impacted the ground hard and continued to rotate a few times before rolling onto its side. During that time the tail boom of the aircraft separated and both main and tail rotors disintegrated. As stated earlier there were numerous impact and scuff marks on the tarmac. See **APPENDIX C & D**.

1.13 Medical and Pathological Information

The seriously injured pilot and passenger were sent to a nearby hospital immediately after the accident. They both suffered injuries to their legs whilst the passenger also sustained some burns. The other pilot and passengers only had light injuries (cuts and bruises).

1.14 Fire

There was only a minor post-impact fire emanating from the aircraft's exhaust which was quickly extinguished by the ground personnel.

1.15 Survival Aspects

As the helicopter had come to a rest on its right side, the left-hand seat pilot and the two passengers seated at the back towards the left side of the aircraft managed to egress through the port cockpit door and the port aft sliding door assisted by the ground personnel.

It must be noted that the right-hand seat pilot and passenger seated at the back to the extreme right were ejected from the aircraft during the crash sequence. This although both were adamant that they were wearing their seat-belts at the time.

How the right-hand seat pilot avoided being hit by the rotors is indeed a miracle. However the ejected passenger was less fortunate as he was pinned under the aircraft and suffered some burns from coming in contact with some hot surfaces. He was rescued almost immediately by the ground personnel.

1.16 **Tests and Research**

Forensic tests on the seat belts by the OEM did not indicate any abnormalities of malfunction of the equipment.

1.17 **Organisational and Management Information**

All organisation and management aspects of the operator were found to be in order throughout the investigation.

1.18 **Additional Information**

An Accident Notification Form was transmitted by AAIB Malaysia to the relevant stakeholders. A copy of the form can be found at **APPENDIX A**.

1.19 **Useful or Effective Investigation Techniques**

Nil.

2.0 ANALYSIS

2.1 During the investigation, Airbus Helicopters in France were so kind as to come out with a readout and analysis of the video recording obtained from the Vision 1000 fitted to the aircraft **(APPENDIX F)**.

2.2 As can be seen from the readout, at timestamp 01:19:17, the left-hand seat pilot who is having control has just established a high hover from his approach to Taxiway Sierra and begins an in-place left-hand turn to face the Helicentre and proceed to hover taxy back to the intended landing point.

2.3 At 01:19:24, the left-hand seat pilot completes his 180º left-hand turn but is now to beginning to experience difficulty in arresting the left yaw. The right-hand seat pilot can be seen about to take over control to assist his colleague.

2.4 Unfortunately, for reasons unknown, the right-hand seat pilot in his effort to stop the aircraft from yawing further to the left applies full left pedal. This exacerbates the situation and the aircraft begins to yaw left at an ever increasing rate of turn.

2.5 This leads to a loss of control of the aircraft and impact with the ground occurs at 01:19:29. The aircraft continues to initially spin upright on the ground whilst ejecting the right-hand seat pilot in the process before finally rolling over and coming to a rest on its right side.

2.6 The most plausible explanation for the accident above would be an incidence of an Unanticipated Left Yaw (for helicopters with a clockwise rotating main rotor). This phenomena is also commonly referred to as a Loss of Tail-Rotor Effectiveness (LTE).

2.7 An explanation of Unanticipated Left Yaw can be found in **APPENDIX G**. This Safety Information Notice produced by Airbus Helicopters in 2019 explains in detail this unusual flight characteristic which affects all types of single rotor helicopters regardless of their peculiar anti-torque design.

3.0 CONCLUSION

This incident is an unfortunate classic occurrence of an Unanticipated Left Yaw.

4.0 SAFETY RECOMMENDATIONS

CAAM is to ensure all helicopter operators are reminded of the dangers of Unanticipated Left Yaw which is also commonly referred to as a Loss of Tail-Rotor Effectiveness (LTE) in their everyday operations.

The Safety Information Notice produced by Airbus Helicopters **(APPENDIX G)** should be distributed to all helicopter operators.

INVESTIGATOR-IN-CHARGE
Air Accidents Investigation Bureau
Ministry of Transport
24 March 2022

AAIB MALAYSIA
ACCIDENT / SERIOUS INCIDENT
NOTIFICATION FORM

Air Accident Investigation Bureau
Ministry of Transport
No 26, Jalan Tun Hussein, Presint 4,
62100 PUTRAJAYA,
Malaysia

Ref. No. : A 03/21
Telephone : +60 3 8892 1071
Facsimile: : +60 3 8888 0163
Website: : www.mot.gov.my
Email : aaib@mot.gov.my

A. Classification Accident / Serious Incident	**ACCIDENT**
B. Details of Aircraft / Flight	**Manufacturer : Airbus Helicopters** **State of Manufacture : France** **Model : H125** **Registration : 9M-LEO** **State of Registration : Malaysia** **Serial Number : 8568** **Flight Number/Call Sign : 9M-LEO**
C. Details of Owner / Operator / Lessee (If applicable)	**Owner : Chailease Int. Financial Services Co. Ltd.** **Operator : Leopad Aviation Sdn. Bhd.** **Lessee (If Applicable) : Leopad Aviation Sdn. Bhd.**
D. Date and Time (Local / UTC) of the event	**Date : 24/03/2021** **Time : 0915 LT**
E. Last point of departure and point of intended landing of the aircraft	**Last point of departure : Sungai Lembing, Pahang** **Point of intended landing : Helicentre, WMSA**
F. Last known position	**Latitude : 3 07 34.02 N** **Longitude : 101 33 39.26 E**
	Description **Taxiway Sierra, WMSA**

<table>
<tr><td>G. No of crew and passengers; aboard, killed and seriously injured</td><td>Total occupant on board: 5
<table>
<tr><th>Injuries</th><th>Crew</th><th>Passengers</th><th>Others</th></tr>
<tr><td>Fatal</td><td>Click here</td><td>Click here</td><td>Click here</td></tr>
<tr><td>Serious</td><td>Click here</td><td>1</td><td>Click here</td></tr>
<tr><td>Minor / None</td><td>2</td><td>2</td><td>Click here</td></tr>
</table>
<u>Condition</u> (Example: Pilot managed to vacate during fire)
One passenger was initially pinned under the aircraft but was quickly rescued by ground personnel.</td></tr>
<tr><td>H. Qualification of the pilot in command and nationality of the crew and passengers</td><td>Pilot in Command qualification : PPL
Pilot in Command nationality : Malaysia
First Officer nationality : Malaysia
Passengers nationality : Malaysia</td></tr>
<tr><td>I. Description of the accident or serious incident and the extent of damage to the aircraft so far as is known:</td><td>The aircraft had just approached to a high hover and was repositioning itself when it experienced an uncommanded yaw to the left. It subsequently impacted the tarmac and broke apart. A minor fire from the exhaust was quickly put out by ground personnel. The helicopter was deemed a total write-off.</td></tr>
<tr><td>J. An indication to what extent the investigation will be conducted or is proposed to be delegated by the State of Occurrence</td><td>The Air Accident Investigation Bureau (Malaysia) has classified this as Accident (A) and has conducted an investigation in accordance with the provision of Annex 13 to the Convention of International Civil Aviation.

Occurrence category: LOC-I (Loss of control - inflight)</td></tr>
<tr><td>K. Presence and description of dangerous goods on board the aircraft</td><td>No

If Yes, please describe: Click here to enter text</td></tr>
<tr><td>L. Operation Type</td><td>General Aviation</td><td>Non-Scheduled</td><td>Passenger</td></tr>
<tr><td>M. Level of damage to aircraft (If information is available)</td><td>Substantial</td></tr>
<tr><td>N. Designated IIC and contact details</td><td>Name : Brigadier General Izani bin Ismail RMAF
Email : izani@mot.gov.my
Mobile : +60 12 779 6056
24hrs : +60 3 8892 1071</td></tr>
<tr><td colspan="4">The State of Occurrence shall forward a notification of an accident or serious incident with a minimum of delay and by the most suitable and quickest means available to: a) the State of Registry b) the State of the Operator c) the State of Design d) the State of Manufacture and e) the International Civil Aviation Organisation, when the aircraft involved is of a maximum mass of over 2250 kg.</td></tr>
</table>

AAIB of Malaysia welcomes representatives from the States with an interest to participate in the investigation in accordance with the provisions of Annex 13 to the Convention on International Civil Aviation.

Form Approved: OMB NO. 2120-0026

U.S. Department of Transportation
Federal Aviation Administration

International Flight Plan

PRIORITY: FF

ADDRESSEE(S):

FILING TIME:

ORIGINATOR:

SPECIFIC IDENTIFICATION OF ADDRESSEE(S) AND / OR ORIGINATOR

3 MESSAGE: (FPL

7 AIRCRAFT IDENTIFICATION: 9MLEO

8 FLIGHT RULES: V

TYPE OF FLIGHT: G

9 NUMBER: 1

TYPE OF: H125

WAKE TURBULENCE CAT.: /L

10 EQUIPMENT: SD /C

13 DEPARTURE AERODROME: ZZZZ

TIME: 0000030

15 CRUISING SPEED: N120

LEVEL: A035

ROUTE:

SG LEMBING /MAARAN 010/TERERLOH 015/KARAK 010/BT CAVE 010/WMSA010//

16 DESTINATION: WMSA

TOTAL EET HR MIN: 0100

ALTN AERODROME: WMKD

2ND ALTN AERODROME:

18 OTHER INFORMATION

DOF :24/03/21

OPS : LEOPAD AVIATION SDN 2121

19 SUPPLEMENTARY INFORMATION (NOT TO BE TRANSMITTED IN FPL MESSAGES)

E/ HR MIN: 0140

PERSONS ON BOARD: P/ 05

EMERGENCY: R/ UHF: X VHF: V ELBA: E

SURVIVAL EQUIPMENT: S/ POLAR: X DESER: X MARITIM: M JUNGLE: X

JACKETS: J/ X LIGHT: L FLUORE: F UHF: X VHF: X

DINGHIES: D/ NUMBER: CAPACITY: COVER: C: X COLOUR:

AIRCRAFT COLOR AND MARKINGS: A / WHITE/ BLACK

REMARKS: N/ X

PILOT-IN-COMMAND: C / Capt Jega 0196668644)

FILED BY	ACCEPTED BY	ADDITIONAL INFORMATION
Jega		

FAA Form 7233-4 (7-93)

APPENDIX C

DAMAGE ASSESSMENT (IMAGES ON-SITE)

9M-LEO

9M-LEO (Cont…)

9M-LEO (Cont…)


Sapura
Aero
AeroHandlers
AeroManager
AeroDynamic
AERO FREE


Sapura
Aero
AeroHandlers
AeroManager
AeroDynamic
AERO FREE

9M-LEO (Cont…)

9M-LEO DAMAGE REPORT

APPENDIX D

AIRCRAFT DETAILS:

Manufacturer	Airbus Helicopters
Model	AS 350B3
Registration	9M-LEO
State of Registration	Malaysia
Serial Number	8568
Operator	Leopad Aviation Sdn Bhd

CIRCUMSTANCES:

The helicopter departed from Pahang and was reported crash at runaway Sierra 1, SZB. During a private flight with 5 persons on board the aircraft crashed during landing. The main wreckage was damaged and 3 persons on board were seriously injured and the other 2 suffered minor injuries.

All the observed damages on the main dynamic components recovered (Main Rotor Head, Main Gearbox and its suspension, Tail Rotor Transmission Shafts, Tail Gearbox, etc…),

General condition of the recovered parts:

Most of the parts are damaged and destroyed.

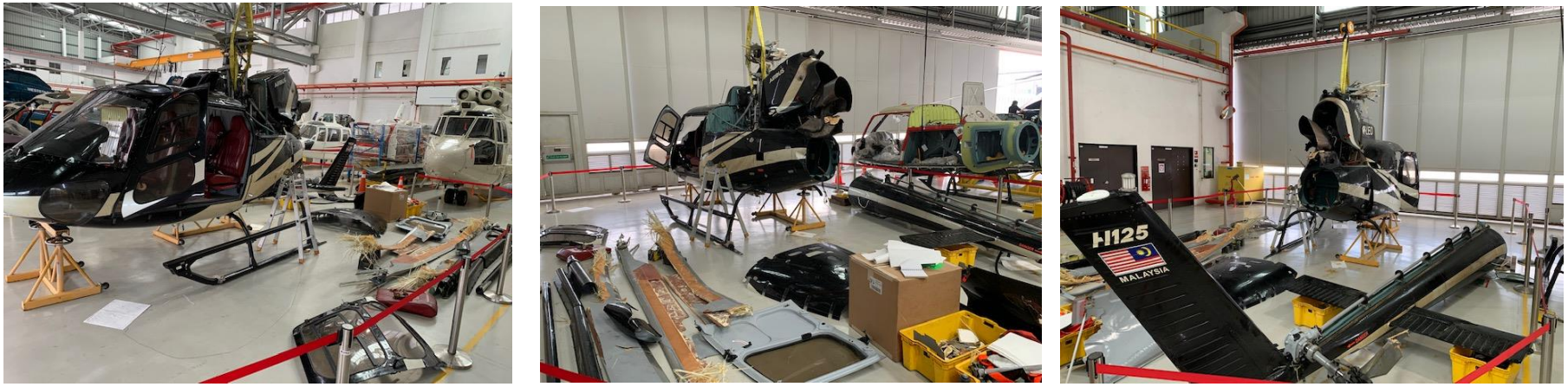


Figure 1. Parts recovered after the accident

General conditions of the main Rotor Blades:

The 3 Main Rotor Blades are seriously damaged (leading and trailing edges) and exhibit impact damages.

- Blade split

Figure 2. Damage on all the 3 Main Rotor Blades

General conditions of the Dynamic Components (Main Gear Box):

Figure 3 - Swashplate Guide – dislocated and sheared

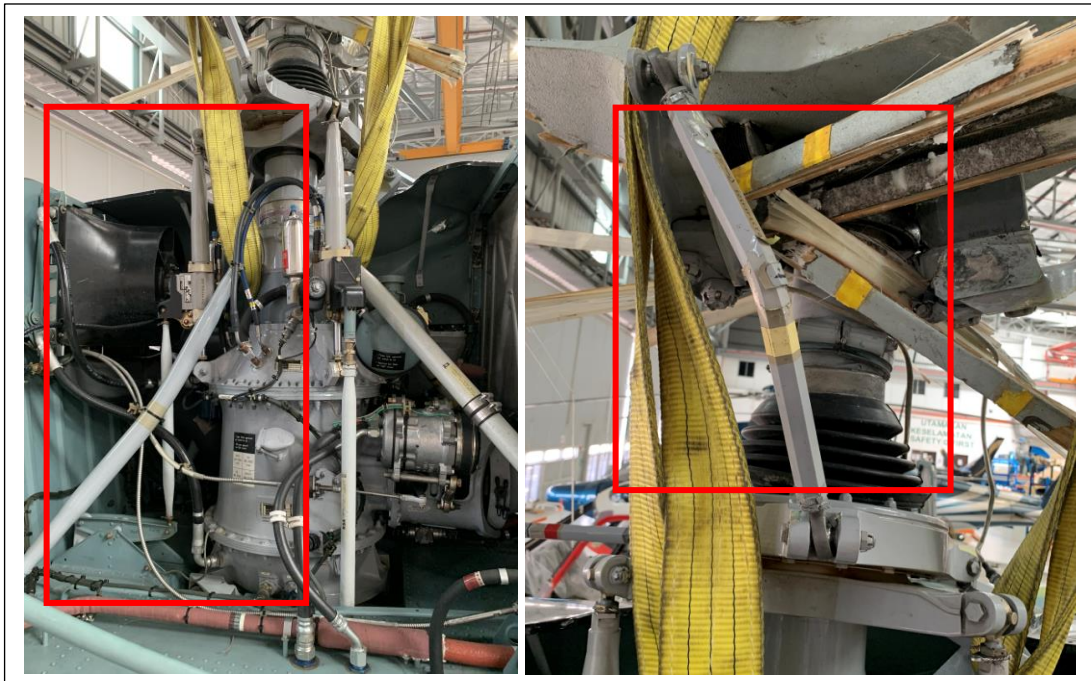


Figure 4 – Main Rotor Assembly

- LH forward MGB suspension bar bend
- Pitch link broken
- Starflex broken
- Sleeve Assembly missing

General conditions of the Tail Rotor and Transmission components

Figure 5 - Intermediate Tail Rotor Drive Shaft broken on engine side but all the attachment bolts are available

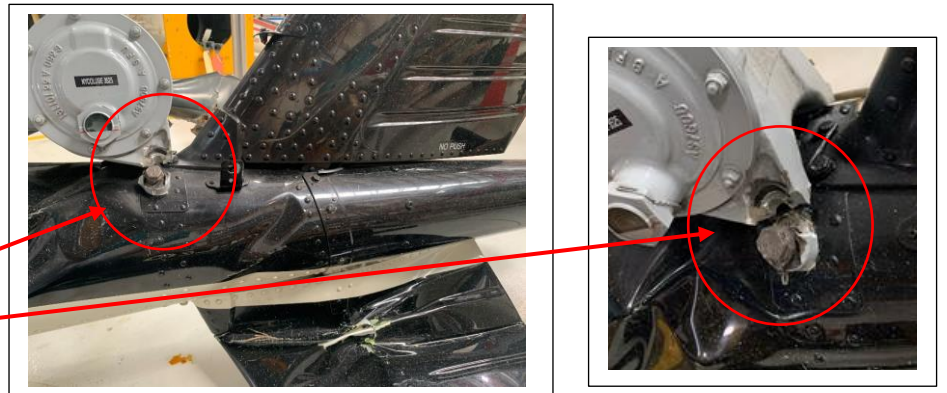


Figure 6 - Tail gear Box attachment base broken

General conditions of the Tail Rotor and Transmission components (Cont)

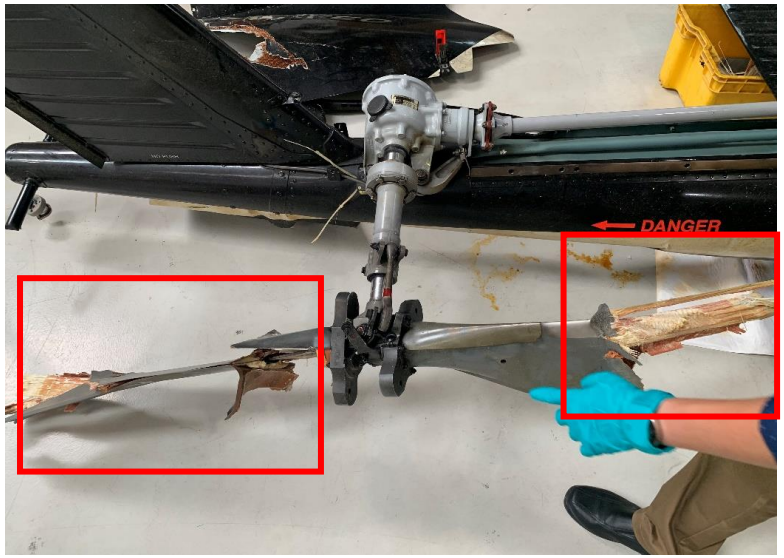


Figure 7 - The 2 Tail Rotor Blades were broken.

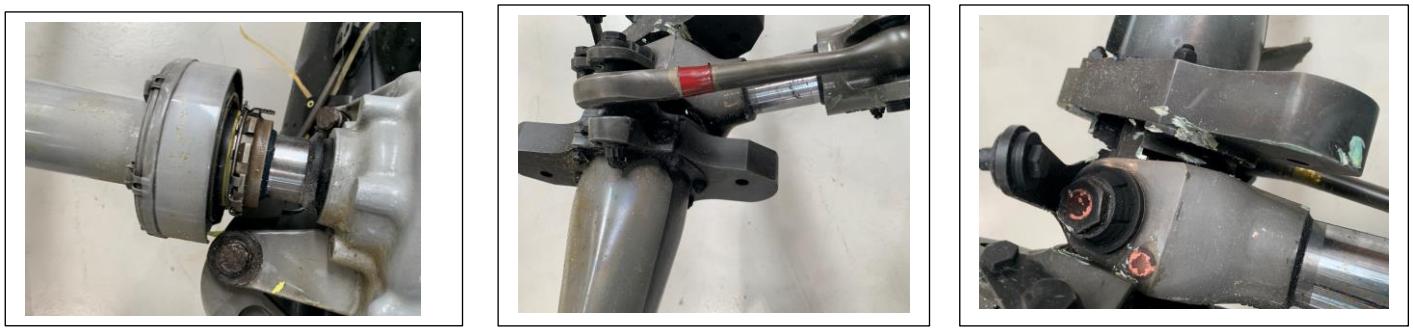
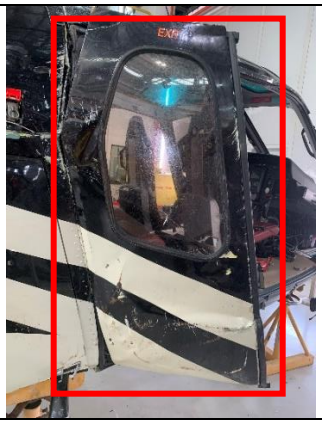
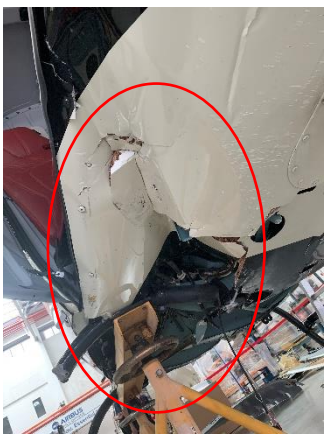
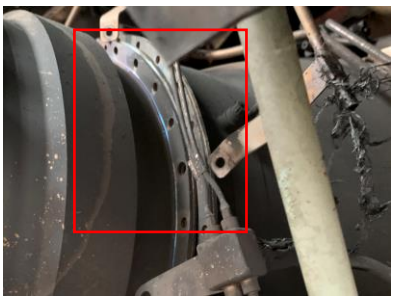
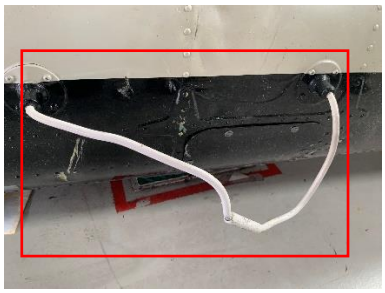
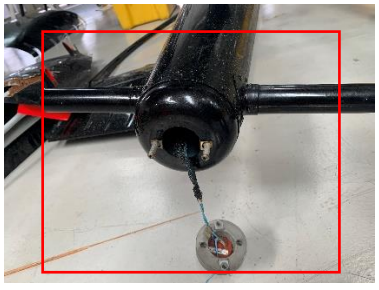


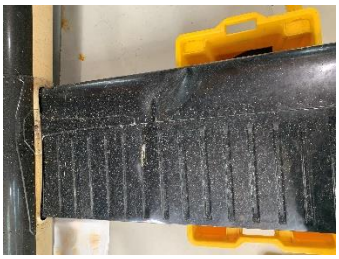
Figure 8 - Pitch Change Spider, Pitch Link Elastomer, Tail Rotor Hub not damage and all attachments are intact.

Other damages

No	Damage Description	Picture
1	RH Windshield crack and punctured.	
2	Nose Canopy was badly ruptured	

No	Damage Description	Picture
3	Air Intake cowling was punctured.	
4	Landing Light missing and surrounding cowling broken	
5	RH Flap Door exhibit multiple damage (scratches, bend, window pane cracked and punctured)	
6	RH Aircraft Structure (cabin floor) bent and cowling ruptured	

No	Damage Description	Picture
7	• Split Engine module 3 and 4 (most bolts sheared) • Exhibit burn damage • Engine Exhaust bent	 
8	Tailboom Junction circumference structure badly damage and Tailboom Assembly detached.	
9	LH and RH Main Gear Box Cowling badly broken	 
10	VOR Antenna damaged	
11	Tail Position Light detached	

No	Damage Description	Picture
12	Horizontal Stabilizer exhibit big dent and severe scratches.	 
13	RH Landing gear: • Cross Tube broken • Landing Skid broken • Side step broken	 

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SBA0143 240108
GG WMSAZTZX
240108 WMKKYMYX
SAMS32 WMKK 240100
METAR WBGG 240100Z 12003KT 080V170 9999 SCT020 24/24 Q1010 NOSIG=
METAR WBKK 240100Z VRB03KT 9999 FEW014 30/25 Q1009 NOSIG=
METAR WMKJ 240100Z VRB03KT 9999 FEW017CB 26/25 Q1009=
METAR WMKK 240100Z VRB01KT 9999 FEW017CB 26/24 Q1009 NOSIG=
METAR WMKP 240100Z VRB01KT 9000 FEW020 28/25 Q1009 NOSIG=
METAR WMSA 240100Z 00000KT 9999 FEW017CB 26/24 Q1010=
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9M-LEO Investigation

Vision 1000 readout

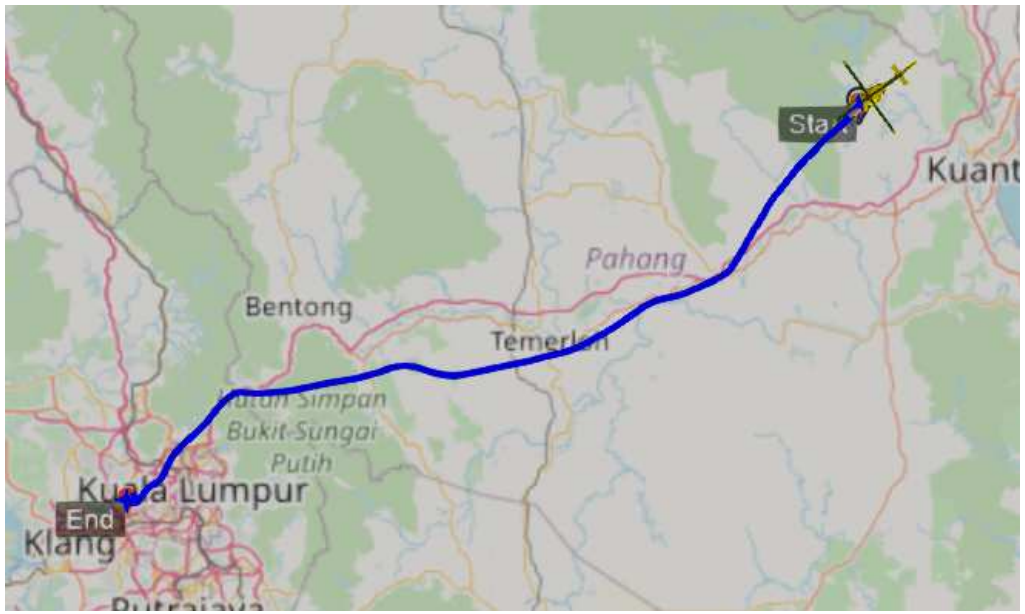
HELICOPTERS

EQAI
27 April 2021

AIRBUS

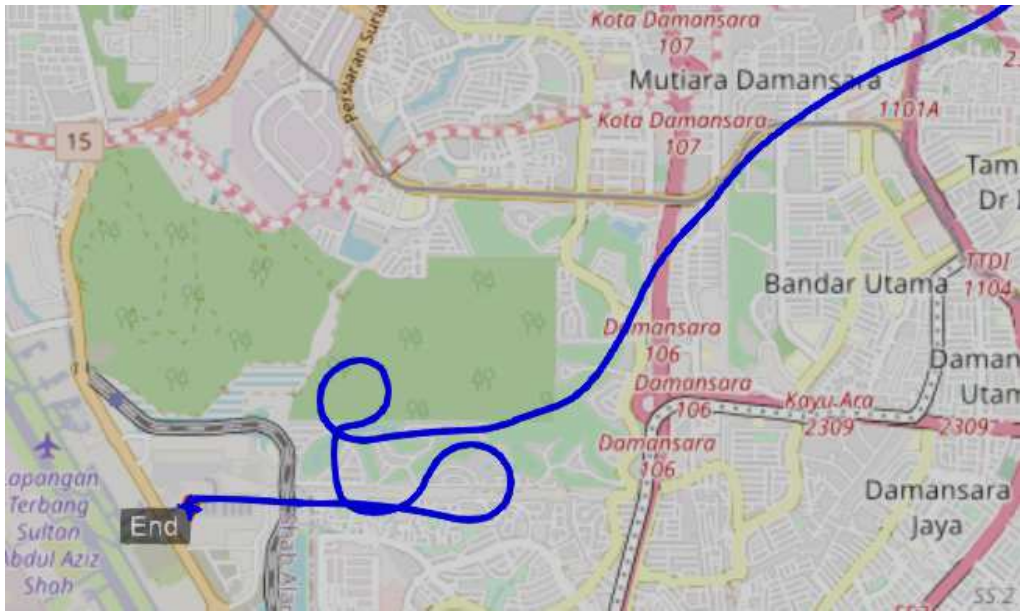
Vision 1000 _ Trajectory analysis by BEA

- Complete flight



Vision 1000 _ Trajectory analysis by BEA

- End of the flight



AIRBUS

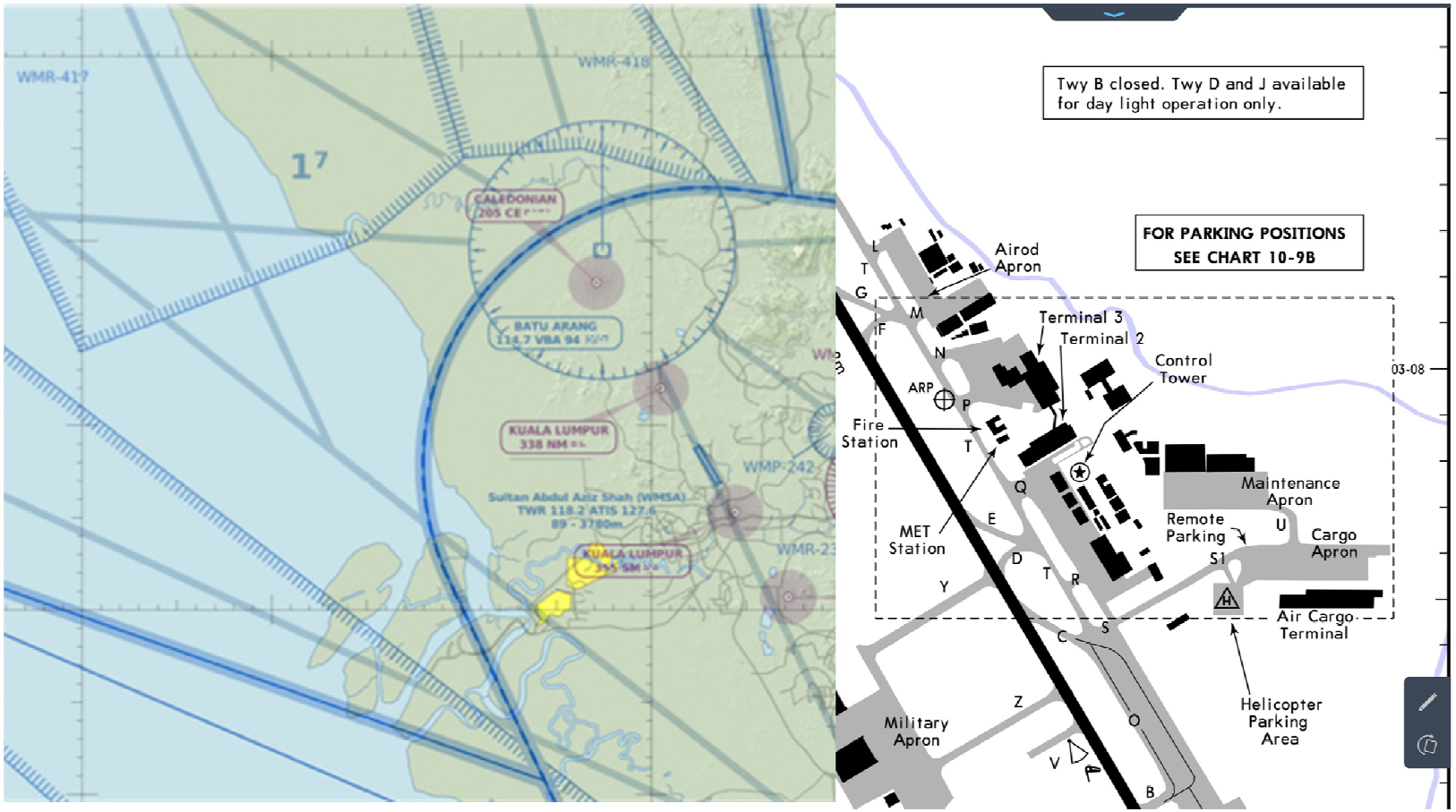
METAR

- Sultan Abdul Aziz Shah Airport (UTC +8)

```
WMSA    2021-03-24 01:00          78.80   75.20   88.75   0.00    0.00    0.00    29.83   M
M       M       M       M       M       M       WMSA 240100Z 00000KT 9999 FEW017CB 26/24 Q1010
```

- → No wind

Sultan Abdul Aziz Shah Airport



Sultan Abdul Aziz Shah Airport

Vision 1000 extracts

- Vision 1000 power-On

VIS-FHVS-01268-0046014

→T0 = 00:19:35,249

AIRBUS

Vision 1000 extracts

- Take-off

VIS-FHVS-01268-0262010
→00:23:11
→T0 + 03min35s

Comments:

- PIC on the RH side
- Take-off and then cruise flight (no hand on the collective)

Vision 1000 extracts

- Cruise flight _ Pilot change

VIS-FHVS-01268-0681758
→00:30:11
→T0 + 10min35s

Comment:

- PIC on the RH side gives the controls to the pilot on the LH side

Vision 1000 extracts

- Cruise flight (first buildings)_ LH side pilot in control

VIS-FHVS-01268-3001259
→01:08:50
→T0 + 49min14s

Comment:
- RH pilot action on the VHF ?

Vision 1000 extracts

- Right turn over buildings/golf terrain_ LH side pilot in control

VIS-FHVS-01268-3409260

→01:15:38

→T0 + 56min02s

Vision 1000 extracts

- Right turn over buildings/golf terrain_ RH side pilot in control

VIS-FHVS-01268-3436759

→01:16:06

→T0 + 56min30s

Comment:

- RH turn with bank angle increase

Vision 1000 extracts

- Right turn with nose down attitude over golf terrain_ RH side pilot in control

VIS-FHVS-01268-3468508

→01:16:37

→T0 + 57min01s

Comment:

- Manoeuvre close to the ground

Vision 1000 extracts

- Left turn over golf terrain_ RH side pilot in control

VIS-FHVS-01268-3473009
→01:16:42
→T0 + 57min06s

Comment:

- Manoeuvre close to the ground with a bank angle increase

Vision 1000 extracts

- Left turn _ Pilot change

VIS-FHVS-01268-3510758
→01:17:20
→T0 + 57min44s

Comment:

- PIC on the RH side gives the controls to the pilot on the LH side

Vision 1000 extracts

- Right turn _ LH side pilot in control

VIS-FHVS-01268-3513758

→01:17:23

→T0 + 57min47s

Vision 1000 extracts

- Approach _ LH side pilot in control

VIS-FHVS-01268-3581510

→01:18:30

→T0 + 58min54s

Comments:

- Approach at IAS approx. 60kt heading 280°
- Crossing the metro line

Vision 1000 extracts

- Runway axis _ LH side pilot in control

VIS-FHVS-01268-3599260
→01:18:48
→T0 + 59min12s

Comments:

- IAS approx. 40kt heading 280°
- Low FLI

Vision 1000 extracts

- Runway axis _ LH side pilot in control

VIS-FHVS-01268-3622010

→01:19:11

→T0 + 59min35s

Comments:

- Low speed heading 280°
- FLI increase
- RH pilot switches on the light (switch on the collective lever)
- RH pilot seat belt fastened

Vision 1000 extracts

- LH turn start_ LH side pilot in control

VIS-FHVS-01268-3628009

→01:19:17

→T0 + 59min41s

Comments:

- Low speed
- FLI increase

AIRBUS

Vision 1000 extracts

- LH turn _ LH side pilot in control

VIS-FHVS-01268-3635508
→01:19:24
→T0 + 59min48s

Comments:

- LH turn +180° (U turn)
- No action on rudder pedals to stop the aircraft rotation

Vision 1000 extracts

- LH turn _ LH side pilot in control + RH pilot reaction

VIS-FHVS-01268-3635758
→01:19:24
→T0 + 59min48s

Comments:

- LH turn +180° (U turn)
- No action on rudder pedals to stop the aircraft rotation

Vision 1000 extracts

- LH turn _ LH side pilot in control + RH pilot in control

VIS-FHVS-01268-3636008
→01:19:24
→T0 + 59min48s

Comments:

- LH turn +180° (U turn)
- Rudder pedal pushed in the LH side position (instead of RH to stop the aircraft left rotation)
- Aircraft rotation speed increase
- Loss of aircraft control
- No warning on CWP

Vision 1000 extracts

- Impact on ground

VIS-FHVS-01268-3640010
→01:19:29
→T0 + 59min53s

Vision 1000 extracts

- Impact on ground _ Crash sequence

VIS-FHVS-01268-3640260

→01:19:29

→T0 + 59min53s

Comments:

- RH pilot ejected
- ELT activated
- Aircraft spinning on ground
- Warnings on CWP

Vision 1000 extracts

- Impact on ground _ Crash sequence

VIS-FHVS-01268-3640512

→01:19:29

T0 + 59min53s

Comments:

- RH pilot ejected
- ELT activated
- Seat belt buckle visible
- Aircraft spinning on ground
- Warnings on CWP

Vision 1000 extracts

- Impact on ground _Crash sequence

VIS-FHVS-01268-3642510

→01:19:31

→T0 + 59min55s

Comments:

- RH pilot ejected
- ELT activated
- Very high FLI
- Aircraft rollover on its RH side
- Aircraft spinning on ground
- Warnings on CWP

Vision 1000 extracts

- Impact on ground _Crash sequence

VIS-FHVS-01268-3643759

→01:19:32

→T0 + 59min56s

Comments:

- RH pilot ejected
- ELT activated
- FLI to the max
- Aircraft rollover on its RH side
- Aircraft spinning on ground
- Warnings on CWP

Vision 1000 extracts

- Impact on ground _Crash sequence

VIS-FHVS-01268-3656511
→01:19:45
→T0 + 1h00min09s

Comments:

- RH pilot ejected
- ELT activated
- FLI to the max → Switch to 3 info indication
- Aircraft rollover on its RH side
- Aircraft spinning on ground
- Warnings on CWP

Vision 1000 extracts

- Last image recorded

VIS-FHVS-01268-4023258

→01:25:52

→T0 + 1h06min16s

HELICOPTERS

Thank you

AIRBUS

AIRBUS HELICOPTERS

No. 3297-S-00

SAFETY INFORMATION NOTICE

SUBJECT: GENERAL

Unanticipated left yaw (main rotor rotating clockwise), commonly referred to as LTE

For the attention of	
	

AIRCRAFT CONCERNED	Version(s)	
	Civil	Military
EC120	B	
AS350	B, BA, BB, B1, B2, B3, D	L1
AS550		A2, C2, C3, U2
AS355	E, F, F1, F2, N, NP	
AS555		AF, AN, SN, UF, UN, AP
EC130	B4, T2	
SA365 / AS365	C1, C2, C3, N, N1, N2, N3	F, Fs, Fi, K, K2
AS565		MA, MB, SA, SB, UB, MBe
SA366		GA
EC155	B, B1	
SA330	J	Ba, L, Jm, S1, Sm
SA341	G	B, C, D, E, F, H
SA342	J	L, L1, M, M1, Ma
ALOUETTE II	313B, 3130, 318B, 318C, 3180	
ALOUETTE III	316B, 316C, 3160, 319B	
LAMA	315B	
EC225	LP	
EC725		AP
AS332	C, C1, L, L1, L2	B, B1, F1, M, M1
AS532		A2, U2, AC, AL, SC, UE, UL
EC175	B	
EC339		KUH/Surion

Background

Unanticipated yaw is a flight characteristic to which all types of single rotor helicopter (regardless of anti-torque design) can be susceptible at low speed, dependent usually on the direction and strength of the wind relative to the helicopter.

This characteristic was first identified and analyzed in relation to OH-58 helicopters by the US Army, who coined the description "loss of tail rotor effectiveness (LTE)" even though the tail rotor always remained fully serviceable. It is not linked to any failure and has nothing to do with the full loss of tail rotor thrust.

Where this type of unanticipated yaw situation is encountered, it may be rapid and most often will be in the opposite direction of the rotation of the main rotor blades (i.e. left yaw where the blades rotate clockwise). Swift corrective action is needed in response otherwise loss of control and possible accident may result.

However, use of the rudder pedal in the first instance may not cause the yaw to immediately subside, thus causing the pilot to make inadequate use of the pedal to correct the situation because he suspects that it is ineffective when, in fact, thrust capability of the tail rotor available to him remains undiminished. "Loss of tail rotor effectiveness" is not, therefore, a most efficient description as it wrongly implies that tail rotor efficiency is reduced in certain conditions.

Understanding unanticipated yaw is important to avoiding it, particularly as it appears to continue to be a contributing factor to some accidents. Therefore, this notice gives detailed information on when the situation may arise, why the tail rotor may wrongly appear to be ineffective, and how to respond in order to maintain full control / recover.

How does Unanticipated Left Yaw occur?

The explanation can be found in a diagram/curve which charts pedal position according to helicopter heading relative to true wind direction (while at trim and in hover). Such a curve exists for each combination of weight, altitude, temperature and wind speed.

An example is provided in **Figure 1**. The well-known critical azimuth, which gives the smallest pedal margin, corresponds in this Figure to about +90° heading (wind coming from the left hand side with respect to the helicopter).

The blue curve corresponds to hover trim conditions. From there, when right pedal is added (i.e. the pedal position moves above the blue curve) the helicopter yaws to the right, and when left pedal is added it yaws to the left (the pedal position moves below the curve).

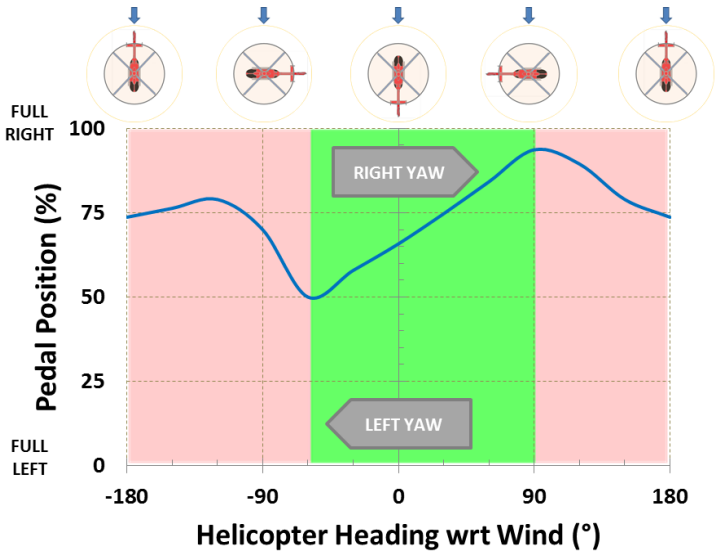


Figure 1: Example of hover pedal curve

Where a headwind is present (green area in **Figure 1**) the helicopter is stable in yaw. If a gust alters the heading of the helicopter, from 0° to -10° for example, the pedal position is now above the curve (the heading was brought to -10° with the pedal position that existed at 0°). The helicopter yaws right until it crosses the trim curve, which happens at the initial 0° heading. Shifted away from the trim position, it comes back to it.

On the opposite side of Figure 1 the red area represents an area of a yaw instability. When the helicopter is shifted from its trim position, it moves further away until a stable headwind condition is found. This tailwind instability is well known by helicopter pilots who are aware that yaw must be very carefully controlled when the wind approaches from behind (tailwind).

Stabilizing surfaces are installed downstream of the center of gravity. The tail rotor and the fin have this role and are well located for forward flight conditions. In a tailwind, however, their position on the helicopter is not ideal. As a result, they cause yaw instability.

This can be managed as long as the pilot is aware of the wind direction relative to the helicopter. It becomes more difficult when information about wind direction and strength is not available, especially when yaw maneuvering is required. The pilot can reach the lower limit of the stable range (about -60° heading in **Figure 1**) without much advance warning and, as a result, switch from experiencing stable yaw behavior to fully unstable yaw behavior. This can give the pilot the feeling that the helicopter rotates of its own accord - even if though it is the result of his control inputs and the consequence of the change of wind heading on tail rotor thrust.

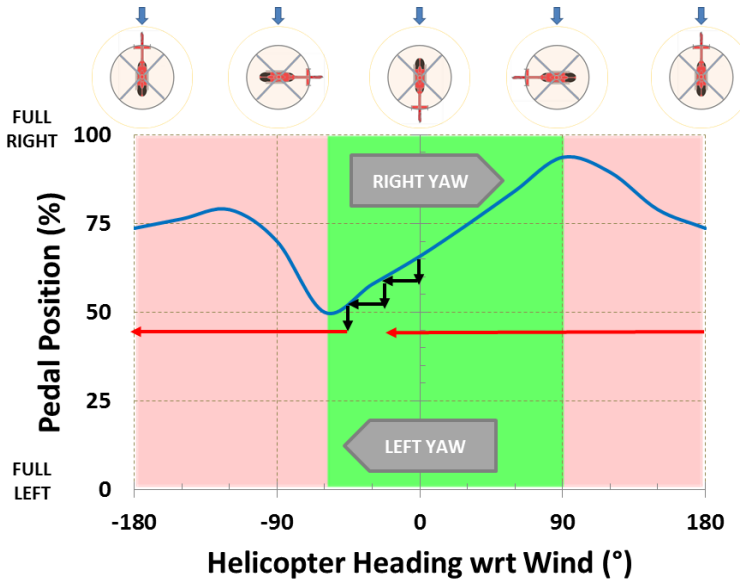


Figure 2: Starting an Unanticipated Left Yaw

This is illustrated in the graph in **Figure 2**. Starting from 0° wind heading, a left pedal step is made (indicated by a vertical black arrow). This brings the control position below the trim curve and the helicopter therefore rotates to the left until it crosses the trim curve, where it stops. In headwind conditions, pedal provides an attitude command : a control step mainly produces a heading step.

A second left pedal step is included in **Figure 2**. It has a similar effect to the first pedal step, leading to a second heading step.

When a third left pedal step is made with the same amplitude, the same heading change in the order of -20° can be anticipated, but unexpectedly this third step brings the pedal position below the lowest point of the pedal curve. This means a nose-left rotation will occur, as indicated by a red arrow. As the trim curve is never reached, however, rotation of the helicopter (i.e. spinning) will not stop unless right pedal is added. On the basis of the previous behavior of the helicopter, a -20° heading step with a limited yaw rate was expected. On the third pedal step, however, spinning is reached, with strong yaw acceleration. This is the "*uncommanded rapid yaw rate which does not subside of its own accord*" which defines unanticipated yaw.

The gap between the current pedal position (red arrow) and the blue trim curve gives an indication of the encountered yaw rate. In the **Figure 2** example, after passing the minimum of the blue curve (about -60° heading), that gap increases drastically. It is not due to a pedal input, but to a trim position that is moving away. The pilot has no indication of this changing trim position and the resulting yaw acceleration is therefore wrongly perceived as being uncommanded, attributable to some external factor.

This is not the only way unanticipated yaw can start. Under-monitoring of the helicopter's yaw axis behavior while at low speed in tailwind conditions can lead to the same result. It would depend on the direction of the initial wind disturbance and should be equally distributed between right and left rotations. The same problem demonstrated in **Figure 2** can also appear on the other side of the stability range (circa +90° heading). The unanticipated yaw developing there can only be to the right.

Most instances of unanticipated yaw which lead to accidents are to the left when the main rotor rotates clockwise. This shows that the main problem is not a tailwind or wind in the vicinity of the critical azimuth, where the pedal coming close to the 100% stop gives a clear warning. The main problem area for unanticipated left yaw is on the other side of the stability range, when the pedal position is much more benign.

Why does the tail rotor appear to be ineffective?

Following unanticipated left yaw occurrence depicted in **Figure 2**, three recovery strategies have been plotted in **Figure 3**. Here, the pilot is assumed to have been caught unaware by the helicopter's behavior and reacted late in the vicinity of a -90° heading.

No control input (as shown by the red line), or a very small control input based on the tail rotor efficiency as perceived prior to the event, is not an option for the pilot. It cannot stop the yawing.

A large and slow input (as shown by the yellow line) can zero the yaw rate, but halting it will occur quite late. The trim curve is only crossed 270° after the step input. This can appear to be a very long time to any pilot who does not appreciate what is happening. This is why the tail rotor can seem ineffective: large but slow inputs make a clearly visible effect only at the end of a 360° rotation.

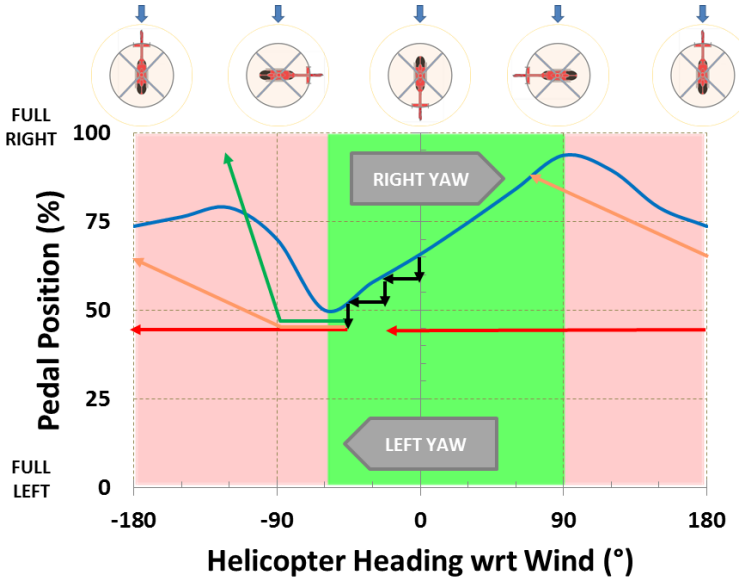


Figure 3: Recovering from an Unanticipated Left Yaw

A large and rapid input is represented by the green line. The yaw stops much more quickly, but the trim is found in the unstable tailwind range. The heading must be closely monitored and headwind conditions recovered as soon as practicable. For example, in one accident recorded by video, a decreasing yaw rate could be seen, followed by further acceleration, indicating that the pilot seemed to have been unknowingly affected twice by unanticipated yaw.

The key feature of an unanticipated left yaw recovery is large amplitude right pedal input. Recovery may not be immediate, but will occur if the pilot persists in maintaining right pedal. In some instances, the pilot re-centered the pedal before entering again a right pedal input. This cannot help and only delays recovery from the yaw. If the yaw deceleration is not enough, more right pedal must be added, reaching the pedal end-stop if necessary.

The most probable reason for accidents following unanticipated yaw events is a late and too limited pedal input. The pedal curve shows that this cannot stop the yaw in the short term. During an unanticipated yaw event, the tail rotor remains fully effective and provides the best chance to recover. Yaw rate and wind conditions reduce its thrust if it is at a constant pitch. There must be counterbalance by a huge pitch increase. The only warning the pilot may get of potential loss of control is the onset of unanticipated yaw.

The apparent lack of efficiency of a limited pedal input can lead to misinterpretation of an unanticipated yaw as a full loss of tail rotor thrust (for example, as would be the case after rupture of the tail rotor drive). The symptom (unexpected intense left yaw) is similar and the short term response to a small and late pedal input is almost zero for both. Only full right pedal input will make the required difference and enable the pilot to identify whether he is experiencing unanticipated yaw or full loss of tail rotor thrust (due to malfunction) and, as a result, enable him to take the most appropriate action. If full right pedal has no effect on the yaw, it is clear that there has been a definite full loss of thrust, necessitating an immediate landing. If, however, full right pedal decelerates the yaw, it becomes clear that the issue is unanticipated yaw in character, which necessitates staying well clear of the ground and obstacles until a full recovery has been achieved.

Unanticipated yaw when performance limited

In pure hover, about 10% of the total power is spent on the tail rotor. Applying full right pedal can more than triple the tail rotor power consumption. When the helicopter is power-limited (engine or MGB torque limit), it is possible that full pedal cannot be reached while staying inside the helicopter's performance limitations. If the power is available, applying full right pedal means an over-torque resulting in only maintenance actions rather than loss of control and possible accident. If a hard power limitation exists (MGB torque limit or engine limit monitored by the engine FADEC), the additional power required on the tail rotor can be unavailable. This will result in RPM droop, which further increases the need for anti-torque while impairing the tail rotor thrust capability.

Most unanticipated yaw accidents do not occur in performance-limited conditions and, therefore, allow using full right pedal to secure a straightforward recovery. Be aware, however, that when performance is limited, prevention of unanticipated yaw occurrence becomes even more important (3 first points in the next paragraph).

What to do?

- Take particular care when wind comes from the right side or forward-right quadrant. Do not fly unnecessarily in those conditions.
- Prefer, as much as possible, yaw maneuvers to the right, especially in performance-limited conditions. It is easier to monitor the torque demand at the start of the maneuver than when responding to an abrupt unanticipated yaw.
- To make a yaw maneuver, apply a low angular rate of turn and closely monitor it. Yaw acceleration will be more obvious than during an aggressive maneuver.
- If unanticipated yaw occurs, react immediately and with large amplitude opposite pedal input. Be ready to use full pedal, if necessary. Do not limit yourself to what you feel sufficient, your feeling can be wrong. Never bring the pedal back to neutral before the yaw is stopped.