AIRCRAFT SERIOUS INCIDENT REPORT AND EXECUTIVE SUMMARY

				Reference:		CA18/3/2/1394	
Aircraft Registration	**ZT-RZS**	**Date of Incident**		19 February 2022		**Time of Incident**	0100Z
Type of Aircraft	Agusta Westland AW119			**Type of Operation**		Air Ambulance Service (Part 138)	
Pilot-in-command Licence Type	Airline Transport Pilot Licence (Helicopter)			**Age**	37	**Licence Valid**	Yes
Pilot-in-command Flying Experience		**Total Flying Hours**		4972.5		**Hours on Type**	868.2
Last Point of Departure	Paarl Provincial Hospital Helistop, Western Cape Province						
Next Point of Intended Landing	Cape Town International Airport (FACT), Western Cape Province						
Damage to Aircraft	None						

Location of the incident site with reference to easily defined geographical points (GPS readings if possible)

Paarl Provincial Hospital rooftop (helistop), Western Cape province, at Global Positioning System (GPS) co-ordinates determined to be 33°43′33.06″ South 018°58′14.07″ East at an elevation of 439.54 feet (ft)

Meteorological Information	Wind direction: 340º; Wind speed: 9kts; Visibility: CAVOK; Temperature: 18ºC; Cloud cover: 0 OCTAS; Cloud Base: Clear; Dew point: 12ºC; QNH: 1008hPa

Number of People On-board	1+2	**Number of People Injured**	1	**Number of People Killed**	0	**Other (On Ground)**	0

Synopsis

On Saturday, 19 February 2022, a pilot and two paramedics on-board an Agusta 119 helicopter with registration ZT-RZS were preparing for a commercial flight from Paarl Provincial Hospital helistop to the Cape Town International Airport (FACT) when the serious incident occurred. This was a commercial flight, which was conducted at night in accordance with the provisions of Part 138 (Air Ambulance Operations) of the Civil Aviation Regulations (CAR) 2011 as amended.

The pilot reported that during start-up on the landing zone on the rooftop (helistop) of Paarl Provincial Hospital whilst the engine was spooling to 100% main rotor speed (NR), the helicopter experienced a 90° uncommanded violent yaw to the left-side, followed by two additional 360° yaws also to the left-side. During the uncommanded yaws, the pilot intervened by applying the full right pedal, but without success. The paramedics decided to disembark the helicopter when it came to a stop momentarily. A few moments later, another yaw ensued also to the left-side; the pilot then shut down the engine to cancel the torque effect when the helicopter stopped once more after the yaw. He then evacuated the helicopter.

One paramedic sustained minor injuries whilst the pilot and another paramedic were unharmed. There was no visible damage on the helicopter following the incident.

Probable Cause

During start-up, the helicopter yawed uncontrollably to the left-side, however, the cause of the yaw could not be determined.

SRP Date	14 February 2023	Publication Date	17 February 2023

Occurrence Details

Reference Number	**:** CA18/3/2/1394
Occurrence Category	**:** Serious Incident
Type of Operation	**:** Air Ambulance Services (Part 138)
Name of Operator	**:** Red Cross Air Mercy Services
Aircraft Registration	**:** ZT-RZS
Aircraft Make and Model	**:** Agusta 119
Nationality	**:** South African
Registration	**:** ZT-RZS
Place	**:** Paarl Hospital rooftop helipad, Western Cape province
Date and Time	**:** 19 February 2022 at 0100Z
Injuries	**:** Minor
Damage	**:** None

Purpose of the Investigation

In terms of Regulation 12.03.1 of the Civil Aviation Regulations (CAR) 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.

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.

Investigation Process

The Accident and Incident Investigations Division (AIID) of the South African Civil Aviation Authority (SACAA) was notified of the occurrence on 19 February 2022 at 0800Z. The occurrence was classified as a serious incident according to the CAR 2011 Part 12 and ICAO STD Annex 13 definitions. The notifications were sent to the State of Registry/Operator/Design/Manufacture in accordance with CAR 2011 Part 12 and ICAO Annex 13 Chapter 4. The Italian State (State of Manufacture) appointed a non-travelling accredited representative and advisor. Investigators were not dispatched to the incident site for this serious incident.

Notes:

1. *Whenever the following words are mentioned in this report, they shall mean the following:*
   Serious Incident — this investigated serious incident
   Aircraft — the Agusta 119 involved in this serious incident
   Investigation — the investigation into the circumstances of this serious incident
   Pilot — the pilot involved in this serious incident
   Report — this serious incident report

2. *Photos and figures used in this report were taken from different sources and may have been adjusted from the original for the sole purpose of improving clarity of the report. Modifications to images used in this report were limited to cropping, magnification, file compression; or enhancement of colour, brightness, contrast; or addition of text boxes, arrows, or lines.*

Disclaimer

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Abbreviation	Description
°	Degrees
°C	Degrees Celsius
AIID	Accident and Incident Investigations Division
A/C	Aircraft
ACCID	Accident
AMO	Aircraft Maintenance Organisation
ATPL	Airline Transport Pilot Licence
CAR	Civil Aviation Regulation
C of A	Certificate of Airworthiness
C of R	Certificate of Registration
CORS	Certificate of Release to Service
CVR	Cockpit Voice Recorder
E	East
FATO	Final Approach and Take Off
FDR	Flight Data Recorder
ft	Feet
GPS	Global Positioning System
hPa	Hectopascal
ICAO	International Civil Aviation Organisation
kt	Knots
LTE	Loss of Tail Rotor Effectiveness
m	Metres
METAR	Meteorological Routine Aerodrome Report
NR	Main Rotor Speed
QNH	Query Nautical Height
SACAA	South African Civil Aviation Authority
SACAR	South African Civil Aviation Regulations
SAWS	South African Weather Service
TLOF	Touchdown and Lift-Off Area
UTC	Co-ordinated Universal Time
VG	Vertical Gyro
Z	Zulu (Term for Universal Co-ordinated Time - Zero Hours Greenwich)

1. FACTUAL INFORMATION

1.1. History of Flight

1.1.1. On Saturday, 19 February 2022, a pilot and two paramedics on-board an Agusta 119 helicopter with registration ZT-RZS were preparing for lift-off from Paarl Provincial Hospital helistop (on the rooftop) with the intention to land at the Cape Town International Airport (FACT), both in the Western Cape province. This was a commercial flight which was conducted at night in accordance with the provisions of Part 138 (Air Ambulance Operations) of the Civil Aviation Regulations (CAR) 2011 as amended.

1.1.2. The pilot stated that he started up the helicopter engine. Thereafter, he advanced the throttle to reach 102% main rotor speed (NR) required for take-off whilst he simultaneously waited for the vertical gyro 1 and 2 (VG 1 & 2) caution lights to switch off, and stability augmentation system 1 and 2 (SAS 1 & 2) to engage. When the NR passed 100%, the helicopter abruptly experienced a violent yaw to the left-side of approximately 90 degrees; it then stopped for about a second. The pilot attempted to troubleshoot the problem, however, a second violent yaw to the left-side ensued in two full rotations (of 360 degrees) before the helicopter stopped again for approximately 2 seconds. The two paramedics decided to disembark (jump out) the helicopter voluntarily without alerting the pilot about their intention. Thereafter, a third rotation to the left-side ensued again.

1.1.3. Meanwhile, as the helicopter advanced through the third 360 degrees yaw to the left-side, the pilot rolled the throttle to the “close” position. This action slowly stopped the yaw rate. The pilot then managed to get the helicopter to ground idle. He then shut down the engine and switched off all power. The pilot then disembarked the helicopter whilst the rotor blades were still in motion, just in case the helicopter started to yaw uncontrollably again. Upon shut down and after exiting the helicopter, the pilot noticed that the right-side pedal was fully engaged to the right.

1.1.4. The pilot mentioned that the rate at which the helicopter was spinning could be compared to a full left pedal turn at maximum anti-torque pedal input. The pilot further stated that he had applied full right pedal whilst the helicopter was spinning, this action failed to stop the yaw rate. The pilot mentioned that it almost felt like the tail rotor was locked in a certain position.

1.1.5. One of the paramedics sustained minor injuries after being dragged by the helicopter skids whilst jumping off. The pilot and another paramedic were not injured. There was no visible damage to the helicopter post-incident.

1.1.6. The incident occurred at night time at Paarl Provincial Hospital rooftop (helistop), Western Cape province, and at Global Positioning System (GPS) co-ordinates determined to be 33°43′33.06″ South 018°58′14.07″ East, at an elevation of 439.54 feet (ft).

Figure 1: The rooftop helistop where the serious incident occurred. (Source: Google Earth)

1.2. Injuries to Persons

Injuries	Pilot	Crew	Pass.	Total On-board	Other
Fatal	-	-	-	-	-
Serious	-	-	-	-	-
Minor	-	1	-	1	-
None	1	1	-	2	-
Total	**1**	**2**	**-**	**3**	**-**

Note: Other means people on the ground.

1.2.1. One of the paramedics was dragged by the helicopter skids whilst disembarking from the helicopter; he sustained minor injuries during the incident.

1.3. Damage to Aircraft

1.3.1. None.

1.4. Other Damage

1.4.1. None.

1.5. Personnel Information

Nationality	South African	Gender	Male	Age	37
Licence Type	Airline Transport Pilot Licence (ATPL) Helicopter				
Licence Valid	Yes	Type Endorsed	Yes		
Ratings	Instrument rating				
Medical Expiry Date	30 June 2022				
Restrictions	None				
Previous Incidents	None				

Note: Previous serious incidents refer to past serious incidents the pilot was involved in, when relevant to this incident.

Flying Experience:

Total Hours	4972.5
Total Past 24 Hours	3.4
Total Past 7 Days	8.1
Total Past 90 Days	53.5
Total on Type Past 90 Days	53.5
Total on Type	868.2

1.5.1. The pilot was initially issued an Airline Transport Pilot Licence (ATPL) helicopter on 21 December 2011 in accordance with the South African Civil Aviation Regulations (CAR) 2011 Part 61. His last licence revalidation was carried out on 14 June 2021; the licence was reissued on the same day with an expiry date of 31 July 2022.

1.5.2. The pilot was issued a Class 1 medical certificate on 7 June 2021 in terms of the CAR 2011 Part 67 with an expiry date of 30 June 2022, with no medical waiver.

1.5.3. Aircraft Maintenance Engineer (AME)

Nationality	South African	Gender	Male	Age	45
Licence Type	Aircraft Maintenance Engineer				
Licence Valid	Yes	Type Endorsed	Yes		
Ratings	Agusta 109 series; Agusta A119; Robinson R22; Robinson R44; Cessna 550/551 series; Bell 206 series and Engines Fitted to Rotorcraft for which a CAT “A” is held.				
Restrictions	None				
Previous Incidents	None				

Note: Previous serious incidents refer to past serious incidents the pilot was involved in, when relevant to this incident.

1.6. Helicopter Information

1.6.1. Agusta Westland 119 Koala (Source: aerospace-technology.com/projects/a119/)

This single-turbine light helicopter, developed and manufactured by Agusta Westland of Italy, first flew in 1995 and entered service in 2000. The helicopter design work was carried out at Agusta's Cascina Costa di Samarate engineering centre in Italy. The AW119 Koala single turbine engine light helicopter has the capacity to transport seven passengers plus the pilot, or slung loads up to 1000 kilograms (kg). The maximum range with seven passengers and their luggage is more than 650 kilometres (km) (350 nautical miles).

The helicopter is primarily used for search and rescue (SAR), medical evacuation, surveillance, passenger and light cargo transport. The fuselage is made of high-strength aluminium alloy structure. The composite main rotor has a titanium hub with composite grips and elastomeric bearings. The four blades of 10.83m in diameter are fully articulated. The tail rotor is a two-bladed system.

Hydraulic system

The AW119 Hydraulic System Flight Controls has the purpose to service the pilot controls by acting on the main and tail rotor controls. The system is composed of two different sections completely separated, named System 1 and System 2. Each system provides hydraulic flow and pressure (15 l. max at 1500 psi) by self-adjusting hydraulic pump to the three Main Rotor Actuators installed on the Main Gearbox. Only System 1 provides hydraulic flow and pressure to the Tail Rotor Actuator installed on the luggage area located on the tail section. Both systems are also provided by a Solenoid Valve and Filter unit that maintain the oil as high level of cleanliness and permit the pilot to exclude the system in the event of malfunction.

Tail Rotor Actuator

The AW119 Tail Rotor Actuator P/N 109-0040-51-103 is a single body type actuator powered by Hydraulic System 1. It is directly connected to the fixed flight controls. During normal operations, the Distributor and the By-pass piston of the Servo Valve move together following the Control Lever movement. The new position of the valve allows the hydraulic pressure and flow to pressurise the relative Actuator chamber. Considering that only the Tail Rotor Actuator Cylinder is linked to the structure, both the Piston and the Main body moves according to the direction of the input manoeuvre. If during the functioning, a jamming of the distributor occurs, the functionality of the Servo Valve is still guarantee by the movement of the By-pass piston, directly linked to the input lever. In the described condition, the load necessary to move the piston is increased of 7 kg due to the presence of the spring allocated between the piston and the distributor. In Figure 4, the movement of the sole By-pass piston, in retraction

condition, in conjunction with the jamming of the Distributor is represented as an example to demonstrate the continuity of functioning of the component.

Solenoid valve and Filter unit

The AW119 Solenoid Valve and Filter unit P/N 109-0760-41-109 is a single component containing the following subcomponents, and installed on each Hydraulic System of the:

- *Pressure line filter*
- *Return line filter*
- *Pressure line clogged filter indicator*
- *Return line clogged filter indicator*
- *Relief valve*
- *Pressure switch*
- *Solenoid valve*

The Pressure and the Return Filters are installed into the main component with the aim to clean the oil from particles that could have impact on the life of the dynamic seals of each item installed on the Hydraulic System. In order to monitor the clogging of every Filter, a magnetic actuating type Filter Clogged indicator provides a visual signal on the main body when the filter cartridge needs to be checked/replaced.

In order to preserve the system from the hydraulic lock, a Relief valve is integrated on the Return line with the function to exclude the Return filter if completely clogged. In Figure 6 is represented the condition of Return filter clogged and Relief Valve open. This Relief valve is integrated on the main body of the Solenoid Valve and Filter unit. Its function is to automatically regulate the pressure value into the pressure lines when it increases over the allowable operating limit of 1640 psi. A pressure switch is located on the pressure line with the aim to generate a CAUTION message in case of low-pressure condition. A solenoid Valve unit is installed to give the pilot the possibility to exclude the system in case of malfunctioning.

Airframe:

Manufacturer/Model	Agusta 119	
Serial Number	14905	
Year of Manufacture	March 2015	
Total Airframe Hours (At Time of Serious Incident)	1 348.20	
Last Inspection (Date & Hours)	20 January 2022	1 300.20
Airframe Hours Since Last Inspection	48	
CRS Issue Date	20 January 2022	
C of A (Issue Date & Expiry Date)	5 April 2018	30 April 2022
C of R (Issue Date) (Present Owner)	1 February 2018	
Operating Category	Air Ambulance Services (Part 138)	

Type of Fuel Used	Jet A1
Previous Serious Incidents	None

Note: Previous serious incidents refer to past serious incidents the aircraft was involved in, when relevant to this incident.

Engine:

Manufacturer/Model	Pratt & Whitney PT6B-37A
Serial Number	PCE-PU0254
Part Number	3049755-01
Hours Since New	1348.2
Hours Since Overhaul	TBO not reached

Main rotor blades:

Manufacturer/ Model	Agusta Westland	Agusta Westland	Agusta Westland	Agusta Westland
Serial Number	1266	1260	1270	1268
Part Number	709-0104-01-111	709-0104-01-111	709-0104-01-111	709-0104-01-111
Hours Since New	1650.5	1650.5	1650.5	1647.7
Hours Since Overhaul	TBO not reached	TBO not reached	TBO not reached	TBO not reached

Tail rotor blades:

Manufacturer/Model	Agusta Westland	Agusta Westland
Serial Number	V13915	V13920
Part Number	709-0160-48-101	709-0160-48-101
Hours Since New	2058	2046
Hours Since Overhaul	TBO not reached	TBO not reached

Tail rotor servo actuator:

Manufacturer/Model	Microtecnica
Serial Number	2207
Part Number	109-0040-51-103
Hours Since New	1348.20
Hours Since Overhaul	TBO not reached

1.6.2. The last maintenance periodic inspection (MPI) prior to the incident flight was carried out on 20 January 2022 at 1 300.2 airframe hours. The aircraft was issued a Certificate of Release to Service (CRS) on 20 January 2022 with an expiry date of 20 January 2023 or at 1 400.00 hours, whichever occurs first. The aircraft had accumulated an additional 48 airframe hours in operation since the last inspection. There were no defects recorded in the flight folio since the last MPI.

1.6.3. The tail rotor servo actuator was fitted to the helicopter on 24 February 2016 at zero airframe hours. The tail rotor servo actuator accumulated 1348.2 hours; it was removed at 1348.2 airframe hours after the incident.

1.7. Meteorological Information

1.7.1. The weather information entered in the table below was obtained from the South African Weather Service (SAWS) report that was made available for Paarl Provincial Hospital area (Western Cape province) on 19 February 2021 at 0100Z.

Wind Direction	340°	Wind Speed	9kt	Visibility	9999m
Temperature	18°C	Cloud Cover	CAVOK	Cloud Base	CAVOK
Dew Point	12°C	QNH	1008hPa		

1.8. Aids to Navigation

1.8.1. The helicopter was equipped with standard navigational equipment as approved by the Regulator (SACAA). There were no recorded defects indicating that the navigation equipment was unserviceable prior to the incident.

1.9. Communication

1.9.1. The helicopter was equipped with a standard communication system as approved by the Regulator (SACAA). There were no recorded defects indicating that the communication system was unserviceable prior to the incident.

1.10. Aerodrome Information

1.10.1. The incident occurred at Paarl Provincial Hospital helistop.

Aerodrome Location	Paarl Provincial Hospital Helistop
Aerodrome Status	Registered
Aerodrome GPS coordinates	33°43’33” South, 18°58’14” East
Aerodrome Elevation	439.54 ft
Runway Headings	Helipad
Dimensions of Helistop Used	Touch down and Lift-off Area (TLOF) 15m x 15m Final Approach and Take-Off (FATO) 25m x 17.5m
Heading of Helistop Used	None
Surface of Helistop Used	Concrete
Approach Facilities	None
Radio Frequency	124.8 MHz

1.11. Flight Recorders

1.11.1. The helicopter was not equipped with a flight data recorder (FDR) or a cockpit voice recorder (CVR), nor was it required by regulation to be fitted to the helicopter type.

1.12. Wreckage and Impact Information

1.12.1. The helicopter was not damaged, however, scrape marks were evident on the surface of the helistop.

1.12.2. According to the pilot, the helicopter was positioned on the helistop facing north. During the start-up whilst the engine was passing 100% NR to get to 102% NR, the helicopter experienced a series of abrupt violent left-side yaw movements which could not be arrested by applying the right rudder pedal.

Figure 2: The scrape marks on the helistop made by the skids of the helicopter. (Source: Operator)

1.13. Medical and Pathological Information

1.13.1. None.

1.14. Fire

1.14.1. There was no evidence of a pre- or post-impact fire.

1.15. Survival Aspects

1.15.1. The serious incident was considered survivable because the pilot was able to shut down the engine and the cockpit area was not compromised.

1.16. Tests and Research

1.16.1 The hydraulic system on the aircraft was inspected and there were no leaks found; the teller pins were inspected and there were no warning indications on the instrument panel. The hydraulic fluid was inspected and found to be in good condition. The filters were found to be clear of particles.

1.16.2 The following tests were carried out on the helicopter to isolate the problem. The tests were taken from the Maintenance Manual section 22-11-5. They are the operational tests of the automatic stabilisation system:

1. Move LH (left-hand) pedal full forward

2. Supply the helicopter with external electrical power

Connect hydraulic test bench to the helicopter and adjust the pressure to 1500 pounds per square inch (psi)

4. Move the anti-torque pedals and release them. Verify that the anti-torque pedals return automatically in the LH pedal full forward position

5. Centre the anti-torque pedals and press the FORCE TRIM push button on Pilot's cyclic to centre the actuator position indicator (API) on the AFCS control panel.

6. Move the anti-torque pedals from the centre position and release them. Verify that the antitorque pedals return automatically to the centre position.

7. Disconnect the hydraulic test bench and the external electrical power.

8. Set the F-TRIM switch to OFF.

9. Move LH pedal full forward.

10. Supply the helicopter with external electrical power.

11. Connect hydraulic test bench to the helicopter and adjust the pressure to 1500 psi.

12. Move the anti-torque pedals to the centre position (do not press the FORCE TRIM). Verify that the anti-torque pedals remain centred

13. Set the F-TRIM switch to ON

14. Verify that the anti-torque pedals remain centred

1.16.3 Continuation of the tests:

1.Supply the helicopter with external power keeping the anti-torque pedals centred

2. Centre the anti-torque pedals and press the FORCE TRIM push button on Pilot's cyclic to centre the actuator position indicator (API) on the AFCS control panel (autopilot OFF)

3. Verify that Indicators of all three linear actuators are centred.

4. Start the engine in accordance with AW119Kx Section 2 Normal Procedures

5. Increase collective until light on skid and check if the aircraft starts to yaw to the left uncommanded:

a. If any abnormal movement is detected, interrupt the ground run (GR).

b. If no abnormal movement is detected, interrupt the GR and proceed with the following step after having shut down the engine.

6. Supply the helicopter with external power keeping the anti-torque pedals centred.

7. Centre the anti-torque pedals and press the FORCE TRIM push button on Pilot's cyclic to centre the actuator position indicator (API) on the AFCS control panel (autopilot #1 and #2 ON)

8. Verify that Indicators of all three linear actuators are centred.

9. Start the engine in accordance with AW119Kx Section 2 Normal Procedures

10. Increase collective until light on skid and check if the aircraft starts to yaw to the left uncommanded. If any abnormal movement is detected, interrupt the GR.

1.17. Organisational and Management Information

1.17.1. The flight was conducted in accordance with the provisions of the CAR 2011 Part 138 (Air Ambulance Operations).

1.17.2. The helicopter had a valid Certificate of Airworthiness (C of A) issued by the Regulator on 5 April 2018 with an expiry date of 30 April 2022.

1.17.3. The aircraft maintenance organisation (AMO) which carried out the last maintenance inspection prior to the accident flight had an approved AMO certificate that was issued by the Regulator on 29 October 2021 with an expiry date of 30 October 2022.

1.17.4 The aircraft maintenance engineer (AME) who performed the last MPI on the aircraft prior to the accident flight was in possession of an aircraft maintenance organisation (AMO) approval certificate. The AME was issued an Aircraft Maintenance Engineer Certificate on 14 October 2021 with an expiry date of 2 October 2023. According to the reviewed records, the aircraft type was endorsed on his certificate and he was rated on this aircraft type.

1.18. Additional Information

1.18.1 The following information is an extract from the operator's Flight Operating Manual.

The 24-hour operation roster will equate to the following Duty Hours:

Maximum standby duty time per at work over 28 days:	*168Hrs*
Maximum home standby per 28 days:	*84Hrs*
Cumulative Duty Time Planned per 28 days:	*252 Hrs*
Minimum time off per 28 days:	*420Hrs*
Total duty time off per week:	*48 Hrs*

1.18.2 According to the pilot's roster, the incident pilot was scheduled to fly for 10 days, of which eight were night shifts, before the incident flight. The shift hours for the pilot were from 07:00 to 15:00 for the day shift and 15:00 to 06:00 the next morning for the night shift. The pilot's logbook reflected 11.8 hours for day flying and 1.5 hours for night flying for the period 1 February 2022 until the incident flight. The shifts were relaxed without any strenuous flying. Prior to the flight, the pilot had flown 0.8 hours during the day, which was still part of his shift. The pilot was in the crew room before heading to the helipad for his flight.

1.18.3 The pilot flew a total of 13.3 hours in 19 days up to and including the incident date.

1.18.4.1 On the day of the incident, the helicopter was inspected and nothing out of the ordinary was found. The inspections and testing were carried out over a few days to get to the source of failure, which led to a decision to remove the incident servo actuator. A hydraulic rig was then placed on the rooftop of the hospital so that the systems could be further tested.

Management gave an instruction to remove the serviceable servo actuator and replace it with the incident servo actuator, and more checks were carried out. The incident servo actuator was removed and reinstalled at least two more times.

1.18.4.2 The incident servo actuator was then taken to the manufacturer's facility for inspection, and there was no abnormal external damage to the tail rotor servo.

1.18.4.3 The tail rotor servo actuator was prepared for testing and the tests were commenced according to the applicable Acceptance Test Procedure (ATP) NC 595. The tests yielded positive results (found serviceable). No deviations from the requirements were noted and the actuator was found to be functioning normally.

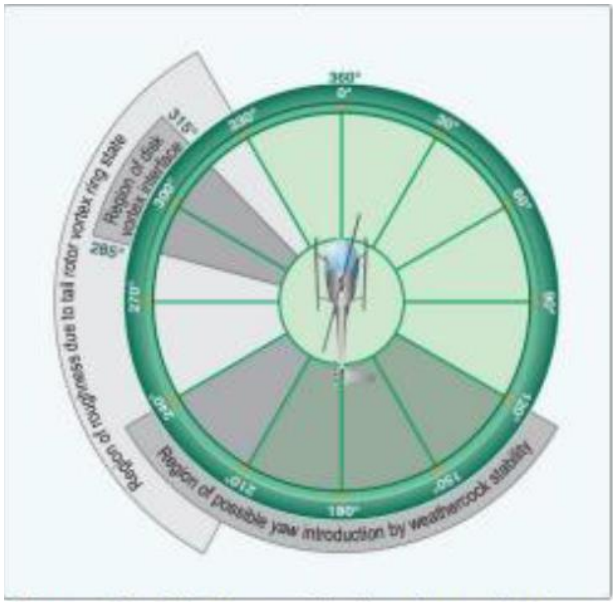
Further testing of the tail rotor servo actuator was conducted in July 2022 where the unit was disassembled. The tail rotor servo had no visual damage to the component parts except for a mark on the slider near the bracket, which was attributed to have been caused by the tool used to remove the tail rotor servo from the helicopter.

1.18.5. It was, therefore, determined that the tail rotor servo was functioning correctly. It would, therefore, be difficult to state the cause of the type of failure as the component was not tested immediately after the failure was reported because the component was removed and reinstalled into the system several times, and only later was it shipped for bench testing at the helicopter manufacturer's facility.

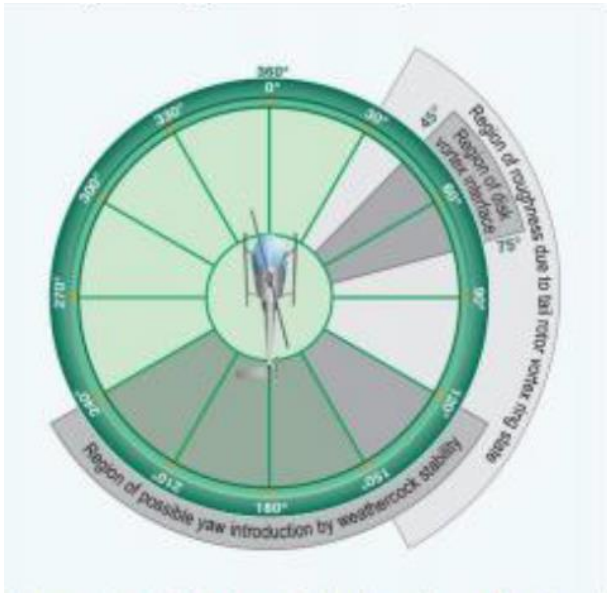
1.18.6 Loss of Tail Rotor Effectiveness (LTE) (Source: NTSB safety alert article)

In helicopters, loss of tail rotor effectiveness (LTE), or unanticipated yaw, is an uncommanded rapid yaw that does not subside of its own accord. The 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 3 and 4 below).

On US-manufactured single-rotor helicopters, the main rotor rotates counter-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 counter clockwise main rotor helicopters) or the 2 o'clock position (for clockwise 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 counter clockwise main rotor helicopters or from 30° to 150° on clockwise main rotor helicopters).



Relative wind directions that can contribute to LTE for counter-clockwise main rotor helicopters. (Source: NTSB safety alert article)



Relative wind directions that can contribute to LTE for clockwise main rotor helicopters. (Source: NTSB safety alert article)

1.19. Useful or Effective Investigation Techniques

1.19.1. None.

2. ANALYSIS

2.1. General

From the available evidence, the following analysis was made with respect to this incident. This shall not be read as apportioning blame or liability to any organisation or individual.

2.2. Analysis

2.2.1. Man

The pilot was initially issued an Airline Transport Pilot Licence (ATPL) on 21 December 2011 in accordance with the ICAO and the South African CAR 2011 Part 61. His licence revalidation was carried out on 14 June 2021 with an expiry date of 31 July 2022. The pilot was issued a Class 1 medical certificate on 7 June 2021 in terms of the CAR 2011 Part 67, with an expiry date of 30 June 2022 and with no waivers.

The pilot flew a total of 13.3 hours in 19 days up to and including the incident date. The operator's pilot rostering was evenly spaced, which gave the incident pilot adequate time to rest and the shifts had no strenuous flights.

Therefore, the pilot was well-rested prior to the incident flight and the pilot had no underlying medical issues which would have hampered his state of mind and reactions. There were no known stressors that the pilot was under at the time of the incident.

2.2.2. Machine

The flight was conducted in accordance with the provisions of the CAR 2011 Part 138 (Air Ambulance Operations). The aircraft had a valid C of A that was issued by the Regulator on 5 April 2018 with an expiry date of 30 April 2022.

The AMO which carried out the last maintenance inspection prior to the accident flight was in possession of an approved AMO certificate that was issued by the Regulator on 29 October 2021 with an expiry date of 30 October 2022.

The last maintenance inspection (MPI) prior to the incident flight was carried out on 20 January 2022 at 1 300.2 airframe hours. The aircraft was issued a Certificate of Release to Service (CRS) on 20 January 2022 with an expiry date of 20 January 2023 or at 1 400.00 hours, whichever occurs first. The aircraft had accumulated an additional 48 airframe hours in operation since the last inspection. There were no defects recorded in the flight folio since the last MPI.

The helicopter hydraulic system was systematically checked and inspected to determine the nature of the fault. The hydraulic system was found to be serviceable, and the filters were found to be clear of any blockages.

The helicopter had not been subjected to a loss of tail rotor effectiveness (LTE) test because it was on the ground during start-up.

2.2.3. Mission

During the start-up phase when the engine was advancing past 100% NR, the helicopter experienced a series of abrupt violent left-side yaw movements which the pilot could not stop when he applied the right rudder pedal. The pilot mentioned that it almost felt like the tail rotor was locked in a certain position. The paramedic disembarked the helicopter without alerting the pilot first. After shutting down and exiting the helicopter, the pilot noticed that the right-hand pedal was fully engaged to the right.

The AMO conducted tests on the tail rotor servo actuator, and the fault could not be simulated. The incident servo actuator was removed and reinstalled at least twice after the incident. The airframe hydraulic filters were inspected and found clear of any particles. The hydraulic indicator pins did not show any blockage. The results from the testing at the manufacturer's facility did not yield any errors with the servo actuator.

The AMO which performed the last MPI on the aircraft prior to the accident flight had an AMO approval certificate. The AME was issued an Aircraft Maintenance Engineer certificate on 14 October 2021 with an expiry date of 2 October 2023. According to the reviewed records, the aircraft type was endorsed on his certificate, and he was rated on the aircraft type.

2.2.4 Conclusion

There is a probability of a tail rotor servo hydraulic lock which caused the helicopter to yaw uncontrollably to the left. The cause of the hydraulic lock could not be determined because the incident servo actuator was removed and reinstalled into the helicopter several times before dismantling and bench-testing, and no anomalies were established. The human factor part was ruled out because the pilot was well-rested prior to the incident and there were no stressors that were affecting the pilot at the time. The pilot had also been in the crew room prior to the flight. The helicopter had not been subjected to the LTE test because it was on the ground during start-up.

3. CONCLUSION

3.1. General

From the available evidence, the following findings, causes and contributing factors were made with respect to this incident. These shall not be read as apportioning blame or liability to any organisation or individual.

To serve the objective of this investigation, the following sections are included in the conclusion heading:

- **Findings —** are statements of all significant conditions, events, or circumstances in this incident. The findings are significant steps in this incident sequence, but they are not always causal or indicate deficiencies.
- **Causes —** are actions, omissions, events, conditions, or a combination thereof, which led to this incident.
- **Contributing factors —** are actions, omissions, events, conditions, or a combination thereof, which, if eliminated, avoided or absent, would have reduced the probability of the incident occurring, or would have mitigated the severity of the consequences of the incident. The identification of contributing factors does not imply the assignment of fault or the determination of administrative, civil, or criminal liability.

3.2. Findings

3.2.1. The pilot was initially issued an Airline Transport Pilot Licence (ATPL) on 21 December 2011 in accordance with the ICAO and the South African CAR 2011 Part 61. His last licence revalidation was carried out on 14 June 2021 with an expiry date of 31 July 2022.

3.2.2. The pilot was issued a Class 1 medical certificate on 7 June 2021 in terms of the CAR 2011 Part 67, with an expiry date of 30 June 2022 and with no waivers.

3.2.3. The flight was conducted in accordance with the provisions of the CAR 2011 Part 138 (Air Ambulance Operations).

3.2.4. The aircraft had a valid C of A issued by the Regulator on 5 April 2018 with an expiry date of 30 April 2022.

3.2.5. The AMO which carried out the last maintenance inspection prior to the incident flight was in possession of an approved AMO certificate that was issued by the Regulator on 29 October 2021 with an expiry date of 30 October 2022.

3.2.6 The helicopter was not subjected to the LTE test because the incident occurred during start-up on the ground.

3.2.7 The pilot mentioned that it almost felt like the tail rotor was locked in a certain position.

3.2.8 The paramedic disembarked the helicopter without alerting the pilot of their intention.

3.2.9 During the start-up phase when the engine was advancing past 100% NR, the helicopter experienced a series of abrupt violent yaw movements which could not be arrested by the pilot when he applied the right rudder pedal.

3.2.10 The last MPI prior to the incident flight was carried out on 20 January 2022 at 1 300.2 airframe hours. The aircraft was issued a CRS on 20 January 2022 with an expiry date of 20 January 2023 or at 1 400.00 hours, whichever occurs first. The aircraft had accumulated an additional 48 airframe hours in operation since the last inspection. There were no defects recorded in the flight folio since the last MPI.

3.2.11 The AME who performed the last MPI on the helicopter prior to the incident flight was appropriately licensed.

3.2.12 Prior to the incident flight, it was found that the pilot had been rostered adequately and the pilot was well-rested. The pilot had flown 0.8 hours at the beginning of his shift on the day of the flight; and prior to the flight, he was resting in the crew room.

3.2.13 The pilot flew a total of 13.3 hours in 19 days up to and including the incident date. There were no known stressors that the pilot was under prior to the flight.

3.2.14 After shutting down the helicopter engine, the pilot noticed that the right-hand pedal was fully engaged to the right.

3.2.15 The incident servo actuator was removed and reinstalled at least twice after the incident.

3.2.16 The AMO tested the tail rotor servo actuator, but was unable to simulate the failure.

3.2.17 The airframe hydraulic system and filters were inspected and found clear of any particles. The hydraulic system was also found to be serviceable.

3.2.18 The indicator pins did not show any blockages.

3.2.19 During the various testing phases of the helicopter and the servo actuator, there was no indication of a hydraulic lock.

3.2.20 The results from testing at the manufacturer’s facility did not yield any errors with the servo actuator.

3.3. Probable Cause/s

3.3.1 During start-up, the helicopter yawed uncontrollably to the left-side, however, the cause of the yaw could not be determined.

3.4. Contributory Factor/s

3.4.1. None.

4. SAFETY RECOMMENDATIONS

4.1. General

The safety recommendations listed in this report are proposed according to paragraph 6.8 of Annex 13 to the Convention on International Civil Aviation and are based on the conclusions listed in heading 3 of this report. The AIID expects that all safety issues identified by the investigation are addressed by the receiving States and organisations.

4.2. Safety Recommendation/s

4.2.1. None.

5. APPENDICES

5.1. None.

This report is issued by:

Accident and Incident Investigations Division
South African Civil Aviation Authority
Republic of South Africa