Air Accidents Investigation Branch

AAIB Bulletin 6/2026

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The sole objective of the investigation of an accident or incident under these Regulations is the prevention of future accidents and incidents. It is not the purpose of such an investigation to apportion blame or liability.

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CONTENTS

SPECIAL BULLETINS / INTERIM REPORTS

SUMMARIES OF AIRCRAFT ACCIDENT ('FORMAL') REPORTS

AAIB FIELD INVESTIGATIONS

AAIB CORRESPONDENCE INVESTIGATIONS

CONTENTS Cont

AAIB CORRESPONDENCE INVESTIGATIONS Cont

UNMANNED AIRCRAFT SYSTEMS

RECORD-ONLY INVESTIGATIONS

MISCELLANEOUS

ADDENDA and CORRECTIONS

(ALL TIMES IN THIS BULLETIN ARE UTC)

AAIB Field Investigation Reports

A Field Investigation is an independent investigation in which AAIB investigators collect, record and analyse evidence.

The process may include, attending the scene of the accident or serious incident; interviewing witnesses; reviewing documents, procedures and practices; examining aircraft wreckage or components; and analysing recorded data.

The investigation, which can take a number of months to complete, will conclude with a published report.

Serious Incident

Aircraft Type and Registration:	Leonardo AW139, G-CIMU
No & Type of Engines:	2 Pratt & Whitney Canada PT6C-67C turboshaft engines
Year of Manufacture:	2015 (Serial no: 31583)
Date & Time (UTC):	13 June 2022 at 1801 hrs
Location:	Norwich Airport
Type of Flight:	N/A found during maintenance inspection
Persons on Board:	Crew - None Passengers - None
Injuries:	Crew - N/A Passengers - N/A
Nature of Damage:	Bearing failure
Commander's Licence:	N/A
Commander's Age:	N/A
Commander's Flying Experience:	N/A
Information Source:	AAIB Field Investigation

Synopsis

The failure of an AW139 tail rotor duplex bearing was identified during a post-flight maintenance check from wear damage on the bearing/actuator cover. The extent of the damage to the bearing confirmed that a loss of tail rotor control event would likely have occurred had the helicopter continued to operate with the bearing fitted. The bearing is defined as a critical part and failure of a similar design of bearing fitted to an AW169 helicopter resulted in a fatal accident in 2018. Despite a full forensic assessment, the bearing was too badly damaged to determine the cause of failure. Three Safety Recommendations have been made to address safety concerns relating to the failure of tail rotor duplex bearings on the AW139.

Initial report of a bearing failure

The helicopter had operated a passenger flight to North Sea oil rigs during the day. On its return it was moved into the hangar to perform a daily maintenance inspection. During the walkaround check, the maintenance team noticed that a hole had been worn in the cover mounted over the tail rotor duplex bearing and the end of the tail rotor control actuator. Removal of the cover confirmed the presence of a large amount of carbon dust on the inside. The actuator was protruding further than normal; the bearing race was badly damaged and the ball bearings in the outboard race of the bearing were visible (Figure 1).

Figure 1

Bearing cover, and damaged tail rotor bearing in situ

The maintenance team tried to remove the bearing, but the damage was so severe that the bearing disintegrated into its component parts during this process.

The AAIB was informed of the incident by the operator and, given its possible relevance to another ongoing bearing failure investigation[1] on the AW169 and AW189 helicopter types, an investigation was launched. The AAIB attended the operator's maintenance facility to review the removed bearing and actuator, which were then recovered for independent analysis.

Aircraft description

The Leonardo AW139 was the first of three models from the same family type to be introduced, the others being the AW169 and AW189. Each model varies in size but shares similar design features and components. The AW139 formally started development in March 1999 and was granted a type design by ENAC[2] in June 2003. The subsequent European Union Aviation Safety Agency (EASA) type certification approval date was September 2003. The AW139 has a certified MTOW of 6,400 kg, which can be increased to either 6,800 or 7,000 kg when the helicopter is operated in accordance with the relevant Rotorcraft Flight Manual (RFM) supplement, and the appropriate mod kit is embodied. It has an operating ceiling of 20,000 ft.

Description of helicopter yaw control system

Helicopters can manoeuvre in three axes: pitch, roll and yaw. Yaw is rotation around the vertical axis and changes the heading of the helicopter. Movement about this axis is controlled by a set of opposing foot pedals, which change the tail rotor blade pitch. Pressing the right pedal forward pushes the left pedal back and rotates the nose to the right, pressing the left pedal forward, pushes the right pedal back and rotates the nose to the left, (Figure 2).

Footnote

1 See report section 'Other information'.
2 Ente Nazionale per l'Aviazione Civile – Italian national airworthiness authority.

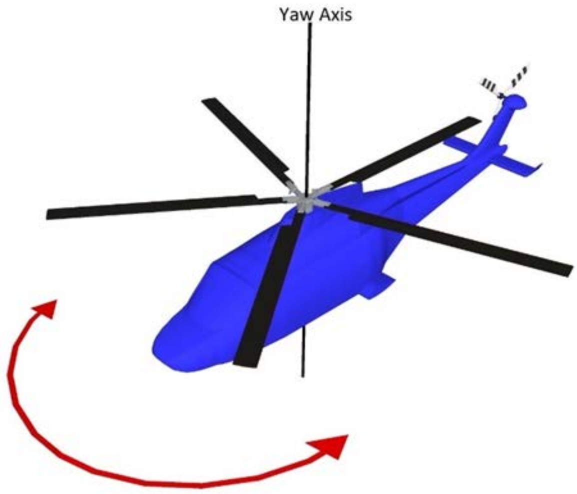

Figure 2
Helicopter yaw axis

In helicopters such as the AW139, with a single main rotor system that turns anti-clockwise (looking down from above), a torque couple is created when the rotor blades rotate under power from the engines, this causes the nose of the helicopter to yaw to the right. To resist this tendency, for example when the pilot wishes to keep the helicopter straight or to yaw to the left, a smaller rotor system is fitted to the tail of the helicopter.

This tail rotor generates a torque around the yaw axis which can match the torque couple from the main rotor, thus keeping the helicopter pointing forward or if required exceed it, resulting in the helicopter yawing to the left. The tail rotor blades rotate at a relatively constant speed. To increase or decrease the force generated by the tail rotor system, the angle at which the rotor blades travel through the air relative to their path of rotation (pitch), is adjusted on all the blades at the same time. Increasing the angle increases the force, reducing the angle reduces the force. The control input load required to change the angle of the blades on large helicopters such as the AW139, is too large for a pilot to achieve by moving a simple direct mechanical linkage. A hydraulic system is therefore used to translate the pilot's control inputs on the pedals into changes in the tail rotor blade pitch angle.

Adjustment of the tail rotor blade pitch is achieved by a tail rotor control actuator. The control shaft of the actuator extends and retracts in response to the movement of hydraulic fluid on either side of a set of pistons, in response to the pilot's pedal inputs. The input from the pedals is via an input lever which is attached to the end of the actuator shaft by a castellated locking nut. On the AW139 this nut has a left-hand thread. This ensures that if the actuator shaft rotates due to a failure of the system, the nut will tighten, and the input lever will remain connected to the actuator.

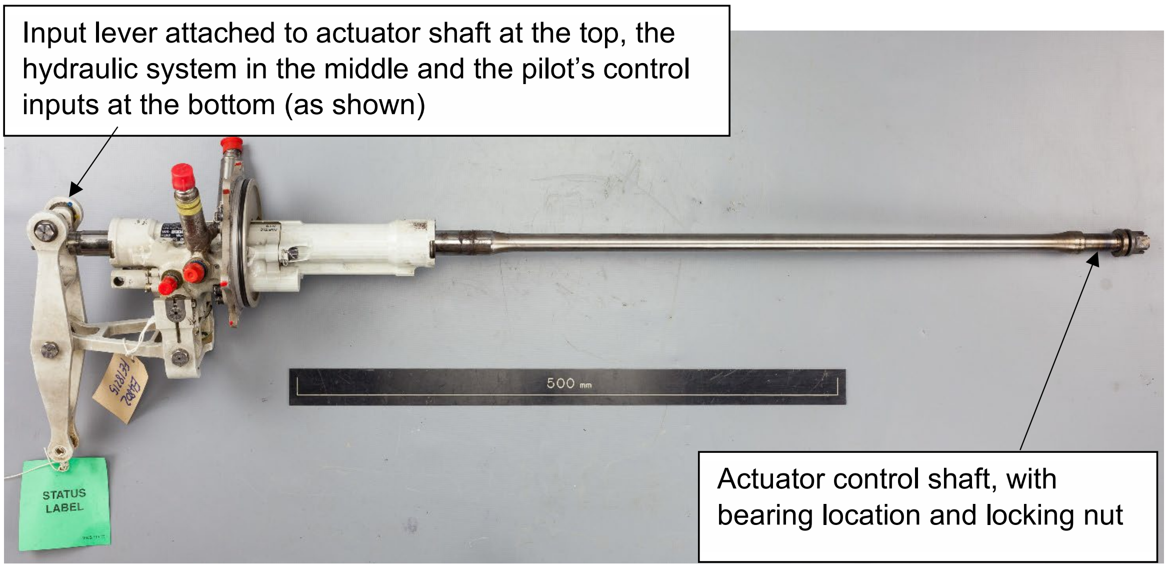

Figure 3
AW139 Tail rotor control actuator

The actuator is attached to the tail rotor gearbox and the control shaft passes through the gearbox located within a hollow drive shaft. The tail rotor head is attached to and is driven by this gearbox drive shaft. The static actuator control shaft connects to the rotating components of the tail rotor by means of a duplex bearing. Figure 3 shows the pilot input mechanism on the left side of the actuator and the location of the duplex bearing and securing nut on the right-hand end of the control shaft (as orientated in the image).

The inner race of the bearing is fitted to the control shaft and is locked in place by a securing nut, while the outer race rotates with the tail rotor hub. A smaller hub called the spider is attached to the tail rotor hub by scissor links and locates a slider which supports the outer race of the duplex bearing. The slider guides the movement of the spider as it is extended and retracted by the action of the control shaft. Each of the arms of the spider is connected by a rod (pitch link) to the rear of a tail rotor blade (Figure 4).

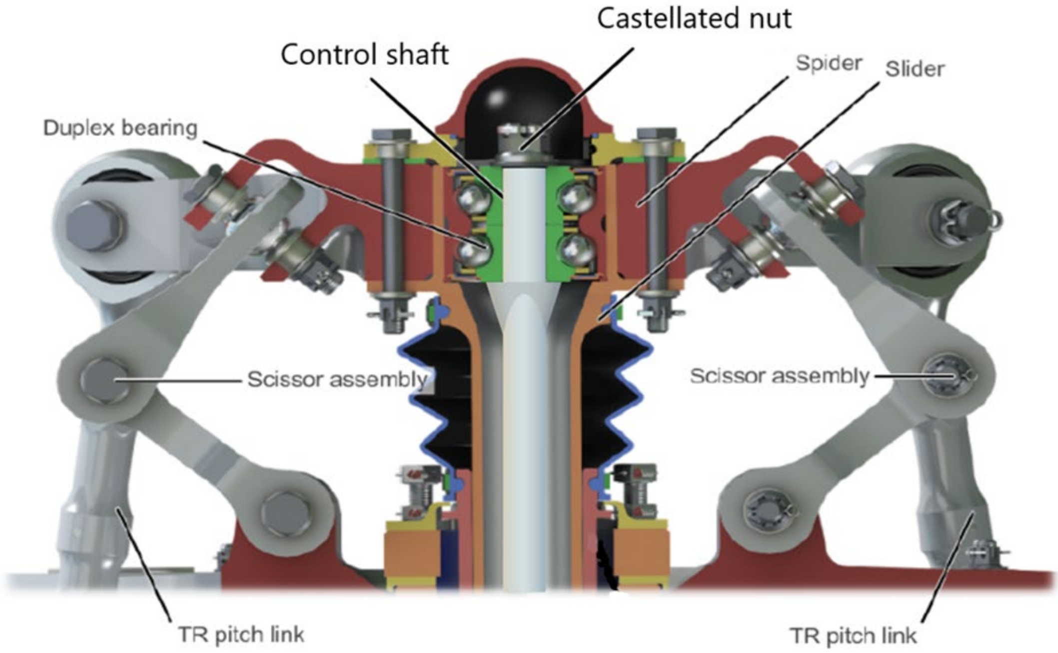

Figure 4

Tail rotor spider and pitch link assembly
(Original image courtesy of the manufacturer)

As the control shaft moves in two directions (extend/retract), the bearing is required to have two rows positioned back-to-back to support the axial load in each direction. In order to support loads in both the axial (F_Z) and radial (F_Y) directions, the running surfaces of each row are angled at approximately 30°. The control shaft also experiences a bending moment (M) which is transferred to the bearing (Figure 5).

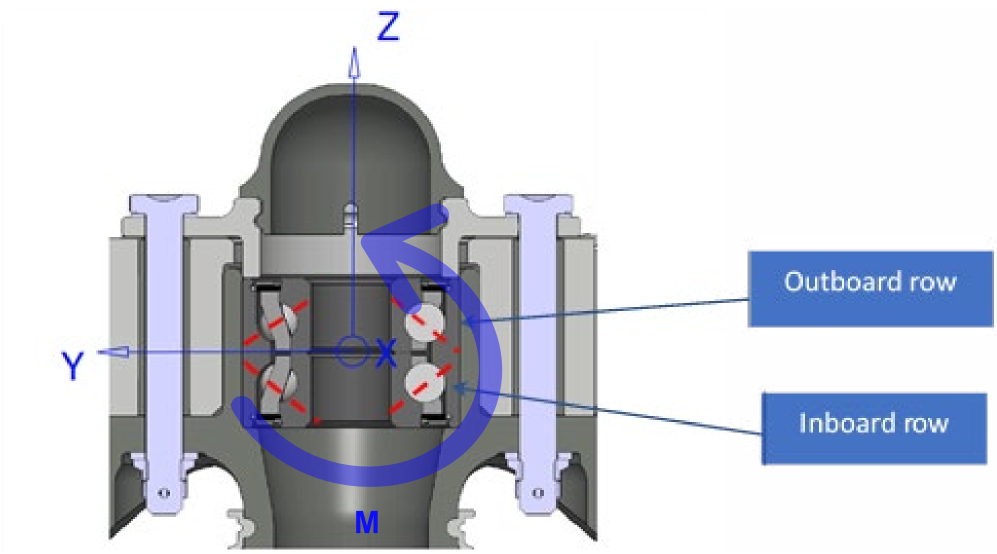

Figure 5

Diagram (with control shaft removed) showing two halves of the bearing (inboard and outboard) and the 30° orientation
(Original image courtesy of the manufacturer)

The two halves of the bearing are referred to as the inboard and outboard rows based on their relative position to the helicopter centreline. The inner races are clamped together on the control shaft by the castellated nut. The internal design of the bearing in combination with the torque setting on the nut ensures the correct preload is applied to the bearing. The correct preload gives a consistent baseline contact pressure which is necessary so that the ball bearings roll rather than skid along the running surfaces. By applying a constant installed load, it also reduces the amount of deflection within the bearing when external operational loads are applied.

The bearing consists of a steel one-piece outer housing, which forms the two outer races (running surfaces) of each half of the bearing, two steel inner races, two sets of nine silicon nitride ceramic ball bearings and two bronze alloy cages. The cages sit between the inner and outer races of the bearing to locate the ball bearings, ensuring the balls are in contact with the races in the correct position. An elastomeric seal on each end of the bearing prevents entry of contaminants and debris.

The bearing drawing was amended in 2021 from requiring 100% grease fill to specifying a minimum 33% fill, which equates to 2 g of grease in total.

Figure 6

Bearing in new condition - (A) Housing and outer race, (B) inner race, cage and balls assembled, (C) cage, seal and inner race disassembled

Figure 6 shows the housing and the outboard row, outer race in image A. Image B shows the inner race, cage and balls as they have been removed from the housing in image A and turned over (the top surface in view is normally located in the middle of the bearing). Image C shows the inner race, cage and seal after they have been disassembled and the balls removed. The other row of the bearing is identical but is installed the opposite way around (mirror image).

The combination of steel races with ceramic ball bearings is referred to as a hybrid bearing. Use of ceramic ball bearings provides several benefits over traditional all steel bearings. These include weight reduction, a wider operating temperature range, allowing higher rotational speeds, better resistance to corrosion and they are electrically isolating. However, as the silicon nitride material is exceptionally hard, it is also more brittle and can be susceptible to shock loads. The relative hardness of the ceramic ball compared to a steel ball bearing also reduces the contact area with the races, resulting in approximately 12% higher contact pressure[3] applied to the race material under the same load.

The tail rotor duplex bearing is classed as a critical part. Critical parts are defined by EASA Certification Specification (CS) 29.602 as:

> *'A critical part is a part, the failure of which could have a catastrophic effect upon the rotorcraft, and for which critical characteristics have been identified which must be controlled to ensure the required level of integrity.'*

Tail rotor duplex bearing development history

Hybrid bearings have been used in various industry applications for around 40 years but are less common in aerospace applications, particularly in critical safety functions.

The helicopter manufacturer first introduced a hybrid duplex bearing design on the AW139 tail rotor control system as part number (p/n) 3G6430V00151. This was subsequently modified in 2006 by a minor modification to facilitate assembly, which changed the p/n to 3G6430V00153. The bearing is manufactured and delivered as a sealed unit by the bearing manufacturer and is then assembled onto the tail rotor actuator control shaft by the helicopter manufacturer. The AW139 bearing has accumulated 4,690,742[4] hours in-service across both part numbers.

Dimensionally and functionally, the p/n 3G6430V00153 bearing is identical to the bearing which was subsequently used in the AW169 and AW189 tail rotor system. The steel specification for the race material is 100C6. This was changed to CHROMEX 40 on the AW189/AW169 bearing to address corrosion issues experienced in-service on the AW139 bearing. 100C6 is approximately double the hardness of CHROMEX 40.

Original certification of the bearing on the AW139 considered it to be an 'on condition' part. This meant it had no scheduled removal time and remained operating in-service until it required replacement due to deterioration of its performance.

There were originally two Approved Maintenance Planning Information (AMPI) Manual maintenance tasks required which affected the bearing. The condition of the bearing is assessed by a tactile check of the bearing's rotational smoothness, achieved by

Footnote

[3] The figure of 12% is quoted by a number of research papers including: Lorösch, H.K., Vay, J., Weigand, R., Gugel, E., Kessel, H., (1980). Fatigue Strength of silicon nitride for high-speed rolling bearings, Transactions of ASME, J. of Engineering for Power, vol. 102, 128-131.), A figure of 12.8% is also quoted by NASA paper NASA/TM-2005-213061.

[4] As of October 2025.

disconnecting the spider from the rotor blades and rotating it by hand. This check was scheduled every 600 flying hours or one calendar year, whichever came first. At 2,400 flying hours or four calendar years the bearing was removed from the slider, and the spider/slider assembly visually inspected, before the bearing was refitted. If bearings were rejected due to roughness during these routine maintenance checks, they were disposed of by the operator and a new bearing fitted. Data provided to the investigation from a retrospective assessment of UK and Italian AW139 operators' records by the UK and EU airworthiness authorities confirmed that a number of bearings were rejected across a range of operating hours for roughness, axial play and grease leakage, as a result of these inspections.

2012 AW139 bearing serious incident

In 2012, an operator based in Qatar suffered a loss of yaw control incident on an AW139. This was found to have been caused by a failure of the duplex bearing (p/n 3G6430V00151) at 4,117 flight hours since new. Evidence of rotation of the tail rotor actuator control shaft confirmed that the bearing had seized at some point. However, as the control shaft had a left-hand thread, the pin carrier had tightened onto the actuator shaft, rather than unscrewing[5]. This transferred the torque load back into the bearing, forcing rotation until the bearing components became so heavily worn that the bearing failed completely, to the extent that it no longer provided any resistance to the movement of the hydraulic actuator. Effectively no longer attached to the control system, the tail rotor blades moved to, and remained at, a positive blade pitch angle of approximately 10° with no means of changing the blade position possible by pilot action. The helicopter started to turn under the influence of the main rotor torque couple, but the loss of tail rotor control occurred while the helicopter was in forward flight. The reduced engine torque demand, the vertical tail surface aerodynamically contributing to the yaw control and the force generated by the default blade position, were sufficient to allow the pilot to maintain forward flight and perform a 'run on' landing without any additional damage occurring to the helicopter.

The 2012 AW139 loss of yaw control event wasn't subject to an independent Annex 13 investigation, and the operator, helicopter manufacturer and local airworthiness authority assessed that the bearing was too badly damaged to conduct a meaningful failure analysis.

As a precautionary response to the bearing failure, the manufacturer applied two new requirements to the AW139 bearing. The first was an amendment to the Approved Maintenance Manual (AMM) stating bearings shall not be refitted after removal from the spider/slider assembly. The second was to apply a discard life of 3,000 hours. Once a bearing reached this life in-service it was discarded by the operator and a new bearing fitted. This change was introduced in August 2012 by a Mandatory Service Bulletin (SB) 139-288 from the manufacturer. For bearings over 3,000 hours this required a check for roughness in rotation of the bearing every 200 hours, until the bearings were replaced within a maximum period of six months. The airworthiness authority did not issue an Airworthiness Directive to mandate this action, as such the discard life was only controlled by an amendment to Chapter Five of the AMPI.

Footnote

5 See report section '*AW169 bearing failure investigation'* for further information.

A selection of seven bearings across a range of service lives from 98 to 7,000 hours were removed and sent back to the bearing manufacturer for assessment of their condition. No abnormal wear was identified. The bearing manufacturer's stated conclusion from this assessment was that they supported a discard life of 2,400 hours (rather than 3,000 hours), in addition to the 600 hour rotational inspections.

Initial investigation of the G-CIMU failed bearing

The operator reviewed their maintenance records for the failed bearing from this event. The bearing was installed new in 2018. The records confirmed that the spider/slider assembly had been replaced in 2020, following a 2,400 hour required inspection, but the duplex bearing had been refitted to the replacement spider/slider rather than being disposed of, which was contrary to the AMM instructions. The bearing had accumulated 1,007 flight hours since new, when it was refitted. When the bearing's failure was identified its total operating hours were 2,750, indicating it had operated a further 1,743 hours since being refitted. Review of the operator's fleet identified seven other bearings which had also been refitted contrary to the AMM instructions. These bearings were also removed from service and retained by the investigation. The additional bearings were disassembled and inspected, but no damage was identified.

The duplex bearing is fitted in the slider/spider assembly and held in place by means of an interference fit. Removal of the bearing to facilitate a maintenance inspection of the slider, requires the use of an Arbor press applying force to a tool in contact with the inner race to push the bearing out of the slider housing. This results in the force applied by the press being transferred through the balls to the outer race. The manufacturer considered that this would result in brinelling[6] damage on the bearing races, leading to the failure of the bearing if it was then refitted and returned to service. However, prior to the prohibition on refitting bearings after the 2012 incident, this extraction technique had been used for more than seven years to remove bearings on a routine basis, prior to the refitting and return to service of these bearings, without significant numbers of in-service failures.

Both the investigation and an audit by the UK regulator of the operator's maintenance procedures, identified that the maintenance process used to refit all the tail rotor duplex bearings at the operator's facility didn't comply with the AMM procedure. Due to the interference fit between the bearing outer race and the slider in which it was located, the AMM procedure required the bearing to be cooled prior to it being refitted to the slider. The operator was using an unapproved technique to cool the bearings which resulted in them being cooled to a significantly lower temperature than stated by the AMM. The grease manufacturer was consulted by the investigation to determine whether this may have been a factor in the deterioration of the failed bearing in-service. They confirmed that the temperature achieved by the incorrect process used was likely still within the specification of the grease and once the bearing had returned to ambient temperature, there would be no ongoing adverse effect. This assessment was validated by the lack of damage identified on the other bearings which had been subject to this technique and had also been refitted and returned to service.

Footnote

6 A type of plastic deformation caused by repeated, localized impacts or static overload, brinelling causes surface damage to a bearing raceway in the form of regularly spaced indentions.

Manufacturer and Airworthiness Authority's immediate response

A Technical Information Letter (22-004) was issued in June 2022 reminding operators that the tail rotor duplex bearings fitted to AW169, AW139 and AW189 should not be refitted after removal, in accordance with the AMM. This was immediately followed by Temporary Maintenance Instruction 139-559 to amend the applicable AMM task to further clarify this requirement. The helicopter manufacturer then issued an Emergency Alert SB 139-725 in July 2022. This reduced the bearing discard life to 2,400 hours to bring it in line with the maintenance inspection requirement that required the bearing to be removed, addressing any ambiguity about whether it could be refitted. A short interval repetitive inspection programme was introduced on bearings with a life greater than 2,400 hours or that had been refitted, until those bearing were removed from service in accordance with the SB requirements. It also required a slippage mark to be applied to the actuator to identify any rotation of the control shaft, which would be indicative of the duplex bearing seizing. While not the stated reason for the change, this also aligned the AW139 bearing life with the bearing manufacturer's recommended discard life for the AW169/AW189 bearings.

EASA then issued Airworthiness Directive (AD) No. 2022-0182-E, which mandated the removal from service of bearings over 2,390[7] hours.

While the SB and AD were necessary to correct an airworthiness discrepancy across the global fleet, it was also based on the helicopter manufacturer and EASA's assessment that refitting of the bearing was likely to be the cause of the bearing failure.

G-CIMU bearing failure investigation

The failed bearing removed from G-CIMU was sent by the investigation to an independent, specialist forensic metallurgy organisation who conducted a detailed analysis of the component parts of the bearing.

Inner races

Both inner races were heavily worn and distorted (Figure 7). Some damage had also occurred when the operator was removing the damaged bearing from the control shaft using pliers (Figure 7). The race surfaces showed evidence of cracking and material deposition, notably copper from the cages. This layer of deposited material was approximately 10 µm thick on the inner race, but areas up to 25 µm were also observed.

Hardness testing of the inboard inner race material, resulted in hardness measurements approximately half to a third of the specified value for a new race. Etching of cross-sectional samples of the race material showed evidence of microstructural change due to heating.

Footnote

7 The AD allows 10 hours for implementation, giving a total limit of 2,400 hours.

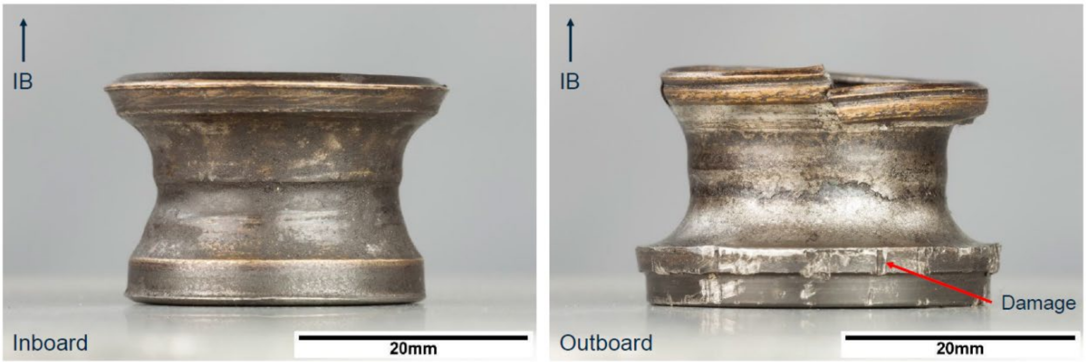

Figure 7
Inboard and outboard inner races

Outer race

This was also heavily distorted compared to the standard race profile for the bearing.

Cross sections of both inner races and the outer race in Figure 8 show the severe level of damage and distortion.

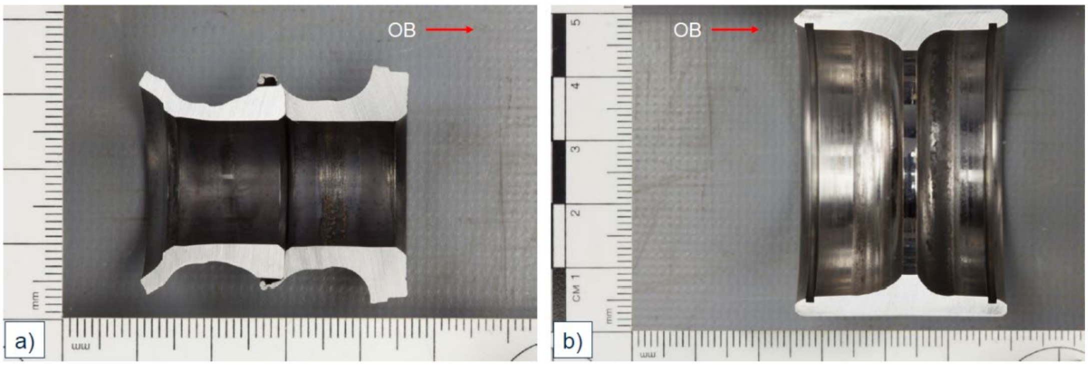

Figure 8
Cross section of the inner and outer races

These damaged cross sections were superimposed on the original design cross section to highlight the changes (Figure 9). The yellow hatched sections are the damaged bearing races; the teal coloured sections are the intended design cross section, showing the extent of the missing and deformed material.

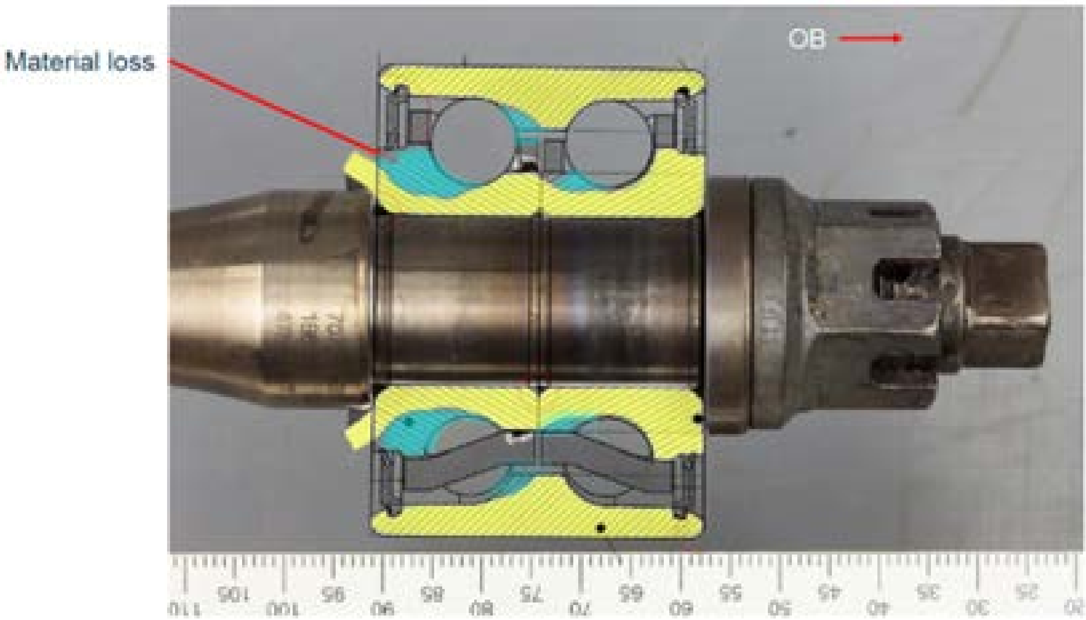

Figure 9

Failed bearing cross section (yellow) compared to a new bearing (teal)

Cages

One of the cages had fractured into two pieces. The other cage was heavily worn and fragmented. The fracture surfaces were too heavily damaged to assess the failure mechanism reliably (Figure 10).

Figure 10

Recovered cage fragments: a) cage failed in two pieces, b - e) heavily worn fragments of the second cage

Balls

Assessment of the balls identified surface deposits consistent with wear material from the cages and races. The surface of one of the balls displayed damage marks indicative of sliding rather than rolling (Figure 11).

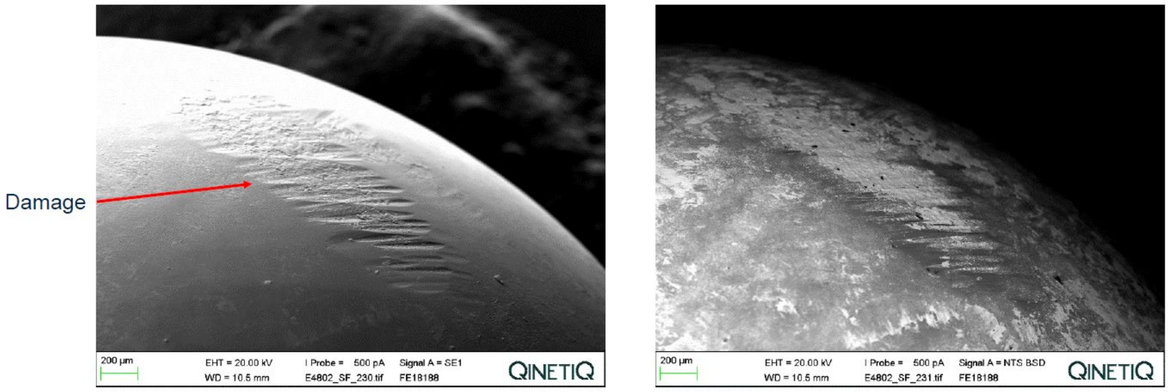

Figure 11

Damage marks on a ball, indicative of sliding rather than rolling

The dimensions of the balls were measured and found to be mostly below the specified diameter. The ball sizes are selected to tight tolerances at manufacture to avoid significant variation across each set of nine balls within a race. The range of measurements recorded suggested that half the balls had worn evenly and still had similar diameters within 1 µm of each other, while the other half had worn unevenly, with between 17-60 µm variation in diameter. It is likely these heavily worn balls were all fitted within the same race.

Recorded information

Health and Usage Monitoring System (HUMS)

The main functions of the HUMS fitted to the AW139 are Transmission Vibration Monitoring (TVM), Usage Monitoring (UM) and Rotor Track and Balance (RTB). UM includes logbook data, Transmission Usage Monitoring (TUM) and Structural Usage Monitoring (SUM).

The system includes 17 accelerometers. The installation can monitor 60 components, 50 on the main gearbox, four on the intermediate gearbox, four on the tail gearbox and two on the tail rotor driveshaft. The monitoring function provides 42 indicators, 14 for gears, 14 for pinions, two for shafts and 12 for transmission bearings. The tail rotor duplex bearing is not subject to vibration monitoring.

SUM data includes the continuous recording of a subset of flight parameters, which includes pedal position and airspeed.

HUMS data is stored in a dedicated PCMCIA memory card installed in the HUMS Cockpit Display Unit in the cockpit inter-seat console.

The operator or maintainer uploads HUMS data to the manufacturer's Heliwise system which processes the data and provides an interface for the customer to review the data. There are different levels of HUMS support available from the manufacturer. This helicopter was under a Premium level analysis contract. Under this scheme the operator is responsible for the HUMS data management and analysis (using Heliwise) and the manufacturer's support team is engaged when required.

Recorded information

The helicopter was fitted with a combined CVR and FDR. This recorded 25 hours of data and two hours of crew and cockpit area audio. The operator provided current HUMS data for the helicopter, and the helicopter manufacturer also provided historical HUMS data sets.

The bearing issue was found during maintenance after a flight. The flight was from Norwich to a series of rigs in the North Sea, north-east of Norwich. Seven rig landings were flown before returning to Norwich. During one of the legs flown between rigs the CVR recorded the pilot monitoring saying, "I'M JUST THINKING ABOUT THE PEDALS, THEY ALL SEEM A BITS STRANGE TO ME, LIKE WHEN I WAS FLYING IT, ONE SEEMS FURTHER FORWARD THAN THE OTHER." This was a passing, isolated comment and did not appear to be of great concern to the crew.

Operator HUMS review

The operator stated that they had reviewed the HUMS data, as per their normal practice, and not found anything relevant flagged by the system.

Manufacturer HUMS analysis report

The manufacturer was asked to analyse the HUMS data in relation to the investigation. They generated Technical Note: DSE-2022-002 revision A, dated 23 June 2022, titled 'AW139 31583 – HUMS Analysis Report for TR Duplex Bearing failure'. This provided a basic description of the system, an overview of the data transferred from G-CIMU to Heliwise after the event on 13 June 2022, and a focused review of the data relating to the tail rotor.

Heliwise did not trigger any arisings from the data transferred after the failure was found. The previous arising was recorded against the data transferred on 7 June 2022 and related to a single spurious main rotor track and balance acquisition value.

The report documented a routine maintenance activity summary supplied by the operator to the manufacturer in November 2021 indicating that among other activities, the tail rotor drive shaft bearing support, tail rotor head and tail rotor actuator servo had been removed, inspected and refitted. They requested for the trending analysis to be reset due to the changes.

The data analysis overview of the report stated:

> '*The TVM and RTB data related to the TGB and TR have shown a stable trend in the last 200 FH, which is the time frame of data viewable live on Heliwise. Data is not showing rising or concerning trend. The only HI slightly above the fleet average is the index FSA_S0O02 or TVM SYNC Acquisition 039 – Tail Gearbox, which measures the level of 2 per revolution of the TR mast.*
>
> *An increase of FSA_O02 values in case of maintenance activities on the TR, which includes the replacement of TR components, are quite common due to the change of the rotor balance. In some cases, the TR tuning can lead to*

an optimisation of the 1xRev but a worsening of the 2xRev, as the algorithm calculating the corrections to be applied is designed to optimize the 1xRev…'

The report concludes:

'*The analysis discussed above puts in evidence that the TVM signals acquired with the current TGB TVM sensor do not allow to highlight the TR duplex bearing failure occurred. The AW139, unlike the AW169 and AW189, does not have a dedicated sensor to monitor the tail rotor duplex bearing gearings. The TVM sensor A09 seems not allowing the properly monitor of the TR DB.*

The 2xRev, recorded the RTB and TVM SYNC acquisitions, even if slightly above the limit, increased due to the maintenance activities. Similar issues have been managed multiple times by the LHD HUMS Support Team, as discussed in paragraph 3.1. Due to this, it not possible to correlated an imbalance of the TR head configuration with the TR duplex bearing failure.'

AAIB review of trends associated with pedal position at speed

Prompted by the extent of bearing damage observed and comments captured by the cockpit voice recording during the prior flight, a further review of the pedal position behaviour was carried out by the investigation. This used the SUM data captured by HUMS using a method that is not part of the normal Heliwise monitoring mechanism.

With a serviceable duplex bearing providing a fixed relationship between the pedal position and the tail rotor blade pitch, the average pedal position while cruising at high speed should be approximately stable. The level of damage observed on the tail rotor bearing would have varied this relationship, resulting in a change in the pedal position required to achieve a required tail rotor thrust.

Historical Heliwise data that captured pedal positions during flights was obtained for G-CIMU. This covered nearly 900 flights, 400 flight hours, from early January 2022 the date of the discovery of the failed bearing.

Each flight was filtered to capture periods when the helicopter was flying between 145 and 150 KTAS. If more than 100 seconds of flight was found, the average pedal position was calculated for that period. Figure 12 shows the pedal position data, in recorded units. A changing trend in the relationship between airspeed and average pedal position is apparent starting from approximately 7 June 2022. This is approximately 15 flight hours before the failed bearing was discovered.

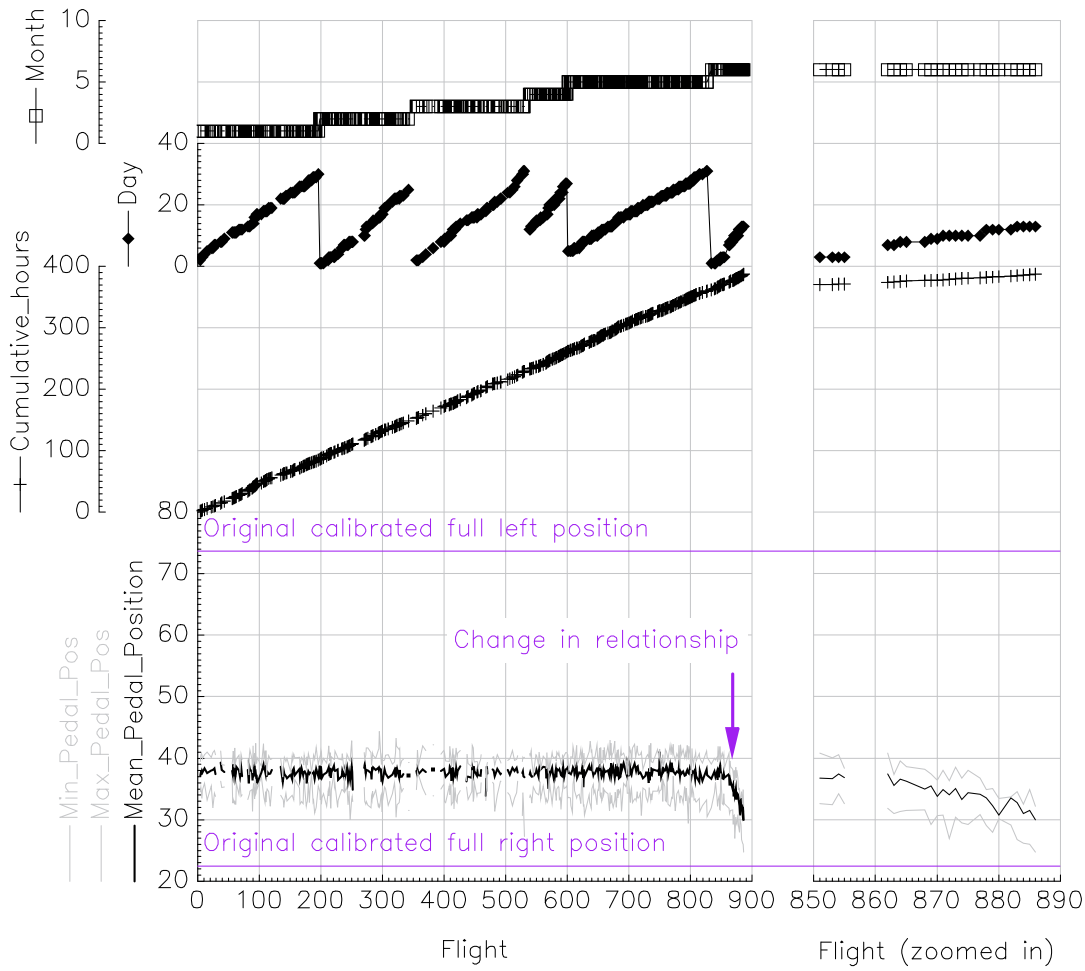

Figure 12

Average pedal position when flying between 145 KTAS and 150 KTAS for more than 100 seconds

A similar data review of four other helicopters, without bearing issues, was carried out to establish whether the variation in pedal position observed in the event helicopter before the observed change in pedal position, was normal. This showed similar variation around a relatively stable mean pedal position, albeit with different stable values reflecting variations in rigging/sensing of the pedal position.

Tests and research

In issuing the initial response SB and AD following the finding of the G-CIMU failed bearing, the helicopter manufacturer and EASA assessed that the likely cause of the bearing failure was brinelling damage to the bearing races during extraction of the bearing. However, the investigation could not identify any empirical evidence to support this finding, and a request was made to conduct a rig test to assess whether the postulated damage to the bearing races could be replicated in test conditions.

The test was conducted by the helicopter manufacturer using a hydraulic test rig which applied a measured force to the bearing inner race, until the bearing released from the slider housing. The test was conducted with the components at ambient temperature (between 18 and 28 °C). The test bearing and slider were specifically manufactured to the worst case tolerances providing the highest level of interference fit possible (0.025 mm) and the minimum amount of grease (1 g) was used in each side of the bearing. The extraction tool was also offset from perpendicular with the bearing face by 0.9° to increase the applied force on one side, replicating possible maintenance issues. The static limit load in the axial direction (F_z) quoted by the manufacturer's development load spectrum for the AW139 duplex bearing was 12,470 N. During the test the axial (F_z) load was progressively increased until the bearing released from the slider at a measured applied load of 18,894 N. The bearing also suffered a significant impact force after it released, as it unintentionally struck the end of the test rig (Figure 13).

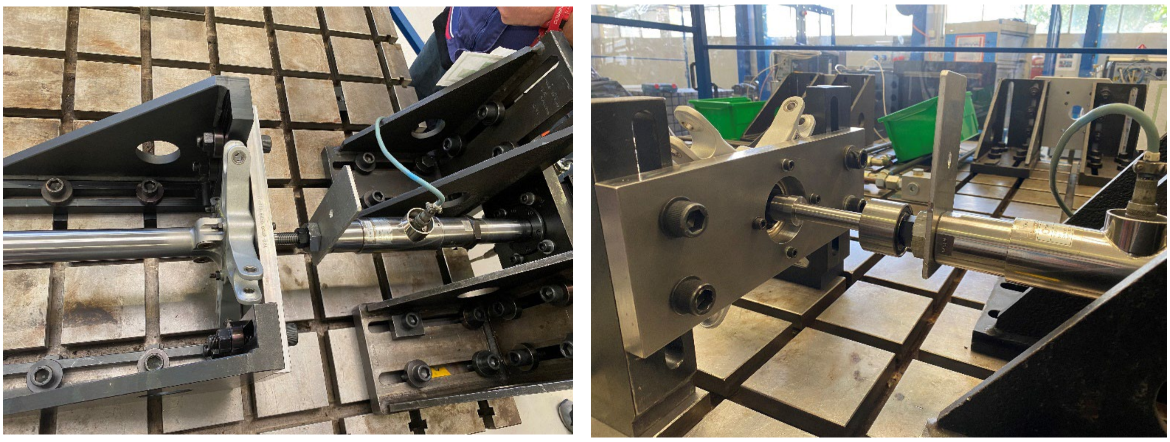

Figure 13

Test bearing before and after it released from the slider/spider assembly

Following removal from the test rig, the test bearing was initially X-rayed using a CT scanner, which did not show any evidence of damage to the race surfaces. It was then returned to the bearing manufacturer's facility for disassembly and inspection. The bearing was visually inspected using a microscope and the inner and outer race circumferential profiles were measured at various heights. The bearing manufacturer concluded that no damage was observed and there was no identifiable difference between the pre and post-test inspections of the bearing.

Other information

Service Bulletin 139-728

In October 2022, the helicopter manufacturer issued a second SB (139-728) applicable to AW139 helicopters where the duplex bearing had not been removed and refitted.

Part I of the SB required, within 50 hours or 2 months, the application of a slip mark on the locking nut installed on the input lever end of the tail rotor actuator control shaft. A further inspection for absence of rotation was required after every subsequent 50 hours of operation.

Part II of this SB required visual inspection of the tail rotor duplex bearing to check its external condition for absence of wear particles within any extruded bearing grease, for bearings which had accumulated more than 1,200 hours but had not been removed and refitted. The initial inspection was required within 50 hours or 2 months, with a repeat inspection every 100 hours.

Part III of the SB required inspection of the tail rotor duplex bearing for axial play and roughness in rotation where the bearing had accumulated more than 1,200 hours but had not been removed and refitted. The initial inspection was required within 50 hours or 2 months, with a repeat inspection every 300 hours or 1 year.

To summarise, all helicopters were required to have a slip mark applied on the actuator locking nut, which is inspected every 50 hours, but only bearings with over 1,200 hours accumulated operating time must be inspected for condition on a more frequent basis than required by the AMPI (100 and 300 hours compared to 600 hours).

EASA did not issue an AD to mandate these additional inspections.

G-CKYP

On 17 June 2022 a tail rotor duplex bearing was removed from service after failing an inspection and was sent to the helicopter manufacturer for further investigation. Following disassembly and cleaning, evidence of fatigue was observed on the bearing race. Given the possible significance to the investigation, the bearing was recovered from the manufacturer by the AAIB for further independent investigation. The bearing had accumulated 1,640 hours since new.

The bearing was sent for detailed forensic investigation at a specialist metallurgy lab using a protocol which was developed during the investigation of a failed AW169 tail rotor duplex bearing.

The bearing cages exhibited evidence of wear and some minor scratches but were both intact. The outer race surface for side one exhibited evidence of minor blemishes, likely imprints from rolled over debris, but no evidence of Rolling Contact Fatigue (RCF). However, side two exhibited imprints and surface-breaking RCF, which was confirmed by inspection under high magnification and using a scanning electron microscope. Cross sections of the races were etched and inspected, but there was no evidence of microstructural change and no Dark Etched Region (DER) was present under the surface.

The inner rings also demonstrated the presence of minor debris indentation marks on side one but no RCF. The inner ring from side two exhibited indentation marks and RCF similar to the outer race. Again, there was no evidence of microstructural change or a DER. The location of the damage was also lower than the normal running line of the bearing race, which is where the highest contact pressure usually occurs during in-service operation. In combination with the lack of DER, this suggested the damage may not have resulted exclusively from the operating loads on the bearing. The debris indent marks on the races and scratches on the cage, raised the possibility that contamination may have been present within the bearing leading to the initiation of the surface RCF (Figure 14).

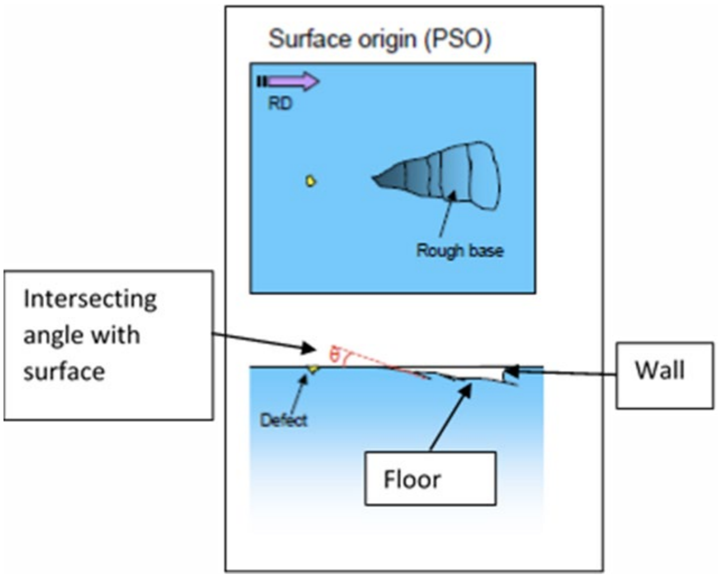

Figure 14

Illustration of typical surface RCF initiated from a surface defect

G-DVIO

On 3 January 2024, the AAIB received a notification from a British operator that they had rejected a tail rotor duplex bearing from an AW139 helicopter registered G-DVIO due to excess grease on the face of the bearing. The bearing was recovered by the AAIB and sent for disassembly and visual inspection by the same specialist lab. The bearing had 628 hours time since new.

Following disassembly, some minor wear was observed on the bearing cages, but there was no evidence of damage or RCF on the race surfaces. A cross section of the inner race was also examined for any subsurface microstructure changes, but no abnormalities were found.

AW169 bearing failure investigation

On 27 October 2018, G-VSKP an AW169 helicopter carrying a pilot and four passengers, lifted off from the centre spot of the pitch at the King Power Football Stadium in Leicester. The helicopter began to climb out of the stadium on a rearward flightpath while maintaining a northerly heading and with an average rate of climb of between 600 and 700 ft/min. The helicopter was briefly established in a right turn before an increasing right yaw rapidly developed, despite the immediate application of corrective control inputs from the pilot. The helicopter reached a radio altimeter height of approximately 430 ft before descending with a high rotation rate. The helicopter struck the ground on a stepped concrete surface, coming to rest on its left side. The impact damaged the lower fuselage and the helicopter's fuel tanks which resulted in a significant fuel leak. The fuel ignited shortly after the helicopter came to rest and an intense post-impact fire rapidly engulfed the fuselage. None of the occupants survived.

The investigation confirmed that the duplex bearing seized, causing the actuator control shaft to rotate, leading to the shaft unscrewing from the locking nut which kept it attached to the flight control input lever. Once the nut was released, it allowed the control shaft to slide out of the pin carrier. This isolated the control shaft from both the pilot's control inputs and the control shaft's position feedback mechanism for the hydraulic system. That in turn allowed the hydraulic actuator to continue to drive the shaft, moving the tail rotor blades to their most extreme negative pitch position.

The investigation determined the following causal factors for this accident:

1. Seizure of the tail rotor duplex bearing initiated a sequence of failures in the tail rotor pitch control mechanism which culminated in the unrecoverable loss of control of the tail rotor blade pitch angle and the blades moving to their physical limit of travel.
2. The unopposed main rotor torque couple and negative tail rotor blade pitch angle resulted in an increasing rate of rotation of the helicopter in yaw, which induced pitch and roll deviations and made effective control of the helicopter's flightpath impossible.
3. The tail rotor duplex bearing likely experienced a combination of dynamic axial and bending moment loads which generated internal contact pressures sufficient to result in lubrication breakdown and the balls sliding across the race surface. This caused premature, surface initiated rolling contact fatigue damage to accumulate until the bearing seized.

The duplex bearing used in the AW169 and AW189 tail rotor at the time was identical to the current AW139 bearing except for the specification of the steel used in the inner and outer bearing races.[8] As well as the accident bearing, three other bearings were removed from service which exhibited various levels of damage, similar to the accident bearing. A further bearing was subject to rig test to simulate the failure mechanism. This also resulted in similar damage to the bearings removed from service. The sequence of deterioration based on the findings from each of these bearings is shown in Table 1.

<table>
<tr><th></th><th>Inner race</th><th>Balls</th><th>Cage</th><th>Outer race</th><th>Grease</th></tr>
<tr><td>1</td><td>Witness mark band from passage of balls.</td><td rowspan="2">The ceramic balls impart a loading and traction force on the inner ring.</td><td rowspan="2"></td><td></td><td>The friction forces locally heat the bearing making the grease work harder, the grease is pushed out of the contact.</td></tr>
<tr><td>2</td><td>A dark etched region (DER) is formed under the raceway as the microstructure is changed.</td><td>Although loaded by the balls, the geometry of the contact reduces the local stress, no DER yet.</td><td rowspan="2">Grease, goes from brown to black, becomes thicker and sticky in consistency, with lumps. Some separation of the oil and thickener material.</td></tr>
<tr><td>3</td><td>Surface traction creates grain-flow and microcracks.</td><td>Increased friction at contact with inner ring, some sliding</td><td>Creation of witness marks within cage pockets.</td><td>Witness mark band from passage of balls. Ball sliding wear marks.</td></tr>
</table>

Footnote

[8] See report section 'Tail rotor duplex bearing development history'.

4	RCF macro-cracking and creation of ring debris. Heating of inner ring affecting bulk microstructure (Heat affected zone and softening). Damage progresses with time creating increasingly rough running surface for balls.	The balls display crazing from heat and traction forces, lots more sliding and stopping of individual balls.	Cage slows relatively to individual balls (caused by other balls sliding). Friction between spinning balls and cage pocket forces cage towards seal, resulting in cage deformation and wear.	DER formed below the race surface. Grain flow at surface leading to RCF micro-cracking and micro pitting. Surface becomes rougher and produces debris.	
5	Cage debris are free to move about the bearing, becoming adhered to the race rolling surface.		Cyclic loading of cage pockets by uneven ball procession drive fatigue cracks through narrow and wide ends of cage pockets		
6	A mix of cage, race and grease debris become over-rolled by the balls which are no longer constrained by the cage. A hybrid alloy material is deposited over the race surface.	With the cage broken the path the balls can take becomes more erratic and less confined. The balls run over the hybrid material rolling in more layers of debris.	Two pockets completely fail. Cage breaks into two sections, inertia throws them against the outer ring. Lots of cage debris is created adding to the mix of ring debris and remaining grease.	With the failure of the cage, the ball path is no longer stable and so can lead to plastic deformation of edge of raceway.	Grease continues to degrade. The friction present heats the grease fully degrading its properties, eventually turning it to dust.
7	Large subsurface cracks form within the weak hybrid layer of material, breaking out large chunks and re-depositing them.	Balls impart RCF loading conditions on the surface and subsurface of the hybrid material.	The cage continues to produce large amounts of debris. Hybrid debris flakes transfer to the cage pockets.	Hybrid debris flakes transfer to the outer race rolling surface and are over-rolled.	
8	A full race width piece of hybrid material fails through subsurface RCF. The chunk of material enters the pathway of the next ball.	The next ball cannot fit within the gap between the two raceways with the additional chunk of hybrid debris present. The ball stops relatively to the outer ring, applying torque to the normally stationary inner race.	The cage section with the jammed ball stops. The second cage section stops when it meets the first section. The bearing is seized	The locked bearing applies toque through the bearing housing, sliding the outer race within its housing.	
9	The torque on the inner race drives the rotation of the TRA control shaft.			The torque between the outer race and the housing is reduced by the rotation of the shaft.	

Table 1

Damage sequence identified on AW169/AW189 bearing failures

There was significant variation in the operating lives of the failed bearings examined in the investigation. The extent of damage observed was not consistent with a simple relationship of increasing flight hours, with the accident bearing showing the maximum level of distress, while having the lowest service life (330 hours).

Analysis of the evidence collected during the AW169 investigation suggested that only a limited subset of manoeuvres generated combined loads sufficient to cause contact pressures within the bearing, that over time resulted in grease deterioration and race damage. The inherent flexibility in helicopter manoeuvres and diversity of atmospheric conditions in which they operate, results in significant potential variability in the duration, magnitude and frequency of exposure to the potentially damaging contact pressures associated with this subset of manoeuvres. These differences in the timing and severity of exposure to high contact pressures for each individual helicopter affected, resulted in significant potential variation in the accrued bearing life at which accumulation of damage was initiated, the rate at which the damage progressed towards failure and the extent of the damage observable at the time when they were inspected, following removal from service due to a maintenance inspection or as the result of an incident or accident.

Soon after the accident the helicopter manufacturer introduced a number of emergency inspection measures on both the AW169 and AW189. These were introduced by Alert Service Bulletins (ASB) which were subsequently mandated by EASA in a combination of emergency and standard ADs.

The first of these was Emergency AD 2018-0241-E, issued on 7 November 2018 and referenced ASB 169-120 and 189-213, which were issued on 5 and 6 November 2018 respectively. It mandated a one-time visual inspection of the servo-actuator installation. The AD was then superseded by Emergency AD 2018-0250-E on 19 November 2018. In addition to the requirements of the first AD, a precautionary one-off inspection of the duplex bearing was added. This resulted in an initial number of bearings being rejected from helicopters in-service, some of which were sent to the AAIB for further investigation.

The helicopter manufacturer then published ASB 169-125 and ASB 189-214 on 21 November 2018. Consequently, EASA issued Emergency AD 2018-0252-E to mandate them. This introduced a one-time inspection and breakaway torque check of the duplex bearing and inspection and reinstallation of the servo-actuator castellated locking nut.

The manufacturer and airworthiness authority then determined that repetitive inspections of the duplex bearing were necessary for continued monitoring of the fleet. The helicopter manufacturer published ASB 169-126 and ASB 189-217 accordingly, and EASA issued Emergency AD 2018-0261-E in November 2018 to mandate these inspections. A steady number of bearings were removed from service and were sent to the bearing manufacturer. Some were selected for further investigation, using a standardised process agreed with the AAIB.

In the period following the introduction of these inspections, tail rotor system rig tests were being conducted by the helicopter manufacturer. The test results showed that as the duplex bearing degraded, its operating temperature increased consistently. A modification was therefore developed to install and repetitively inspect a thermal strip, as an additional warning indicator of the condition of the duplex bearing. This was introduced by the helicopter manufacturer in ASB 169-135 and ASB 189-224 and mandated by EASA through the issue of AD 2019-0023 on 1 February 2019.

Operator feedback from the repetitive tail rotor inspections allowed improved techniques to be developed and the helicopter manufacturer published ASB 169-148 and 189-237, to provide instructions for more in-depth inspections of the duplex bearing. EASA issued AD 2019-0121 on 3 June 2019[9] to require accomplishment of these actions.

After AD 2019-0121(R1) was issued, the helicopter manufacturer introduced into service a modification to the Vibration Health Monitoring (VHM) system fitted to the AW169 and AW189. The modification relocated an existing accelerometer sensor on the tail to the servoactuator control lever, to allow monitoring of the vibration signature of the duplex bearing and provide an optional aid for the continued airworthiness of the fleet.

While the modification itself was not mandated, the reporting of data from helicopters with the modification installed, was mandated. This requirement was included in a new AD 2019-0193 issued 7 August 2019, which also included revisions to the other inspection requirements and superseded AD 2019-0121(R1).

In early 2020, the helicopter manufacturer issued modification Service Bulletins 169-153 and 189-249. These introduced a new standard of tail rotor actuator. The control shaft now has a left-hand thread on the castellated lock nut and an additional washer fitted to the actuator end of the shaft. EASA then issued Airworthiness Directive 2020-0048 on 6 March 2020, which superseded AD 2019-0193.

This AD mandated the fitment of the new standard control actuator, with one-way interchangeability[10]. Fitting of the modified actuator alleviated the requirement to conduct an inspection of the castellated lock nut every 10 flight hours. All the other mandatory inspections were retained in the new AD.

The final change by the manufacturer was to develop a new tail rotor duplex bearing introduced into service by mandatory Service Bulletins 169-162 and 189-254 on 4 August 2020. Replacement with the new bearing was required within 400 flight hours or four calendar months of the SB issue date. The new bearing replaced the ceramic balls with steel balls. The new bearing had an introductory life limit of 400 flight hours. The SB also required time expired bearings to be returned to the manufacturer for inspection following replacement.

None of these safety actions were applied to the AW139 fleet, as the helicopter manufacturer considered it was not affected by this issue.

A further eight Safety Recommendations were made in the final AAIB report. The full report for this investigation can be found on the AAIB website.[11]

Footnote

9 This was reissued later in June 2019 as R1 to correct inconsistencies between the AD and the ASB.
10 The old part number actuator can be replaced by the new part number actuator, but not the other way around.
11 Aircraft Accident Report AAR 1/2023 - Leonardo AW169, G-VSKP - GOV.UK [accessed 1 May 2026].

Failure of critical parts in-service

Currently there is no requirement in the airworthiness regulations requiring manufacturers to conduct a sample assessment of critical parts, such as the tail rotor duplex bearing, for condition after removal from service, either at the end of its service life or following premature removal for unserviceability. This type of inspection programme could have helped to validate the assumptions used for the bearing discard life and inspection period calculations, and avoid in-service tail rotor control issues occurring by providing evidence of premature degradation of the bearing.

The general issue of inspecting critical parts following rejection from service is an ongoing concern that has been identified in several previous accident investigations, including the investigation into a fatal accident in 2016 caused by a gearbox failure on an Airbus Helicopters Super Puma LN-OJF[12], where a similar finding and recommendation was made to introduce an effective inspection programme.

In response, the European Union airworthiness authority included a proposed amendment to CS 29.602 in NPA[13] 2022-01, which introduced the concept of a Continued Integrity Verification Programme (CIVP). In February 2023 the proposed regulation amendments were withdrawn by EASA, following their review of comments received from the industry during the consultation process for the NPA. Although EASA have committed to continue to review potential regulation change, at the time of writing of this report no further proposals have been put forward and the concern remains unaddressed.

Two Safety Recommendations were subsequently made in the report into the AW169 accident[11], which was issued in September 2023, to address the safety concern that critical parts were not being inspected in-service or following premature removal from service, resulting in valuable evidence being lost. The text of these recommendations is shown below:

Safety Recommendation 2023-022

It is recommended that the European Union Aviation Safety Agency amend Certification Specification 29.602 to require manufacturers to implement a comprehensive post-removal from service assessment programme for critical parts. The findings from this should be used to ensure that reliability and life assumptions in the certification risk analysis for the critical part or the system in which it operates remain valid.

Safety Recommendation 2023-023

It is recommended that the European Union Aviation Safety Agency require manufacturers to retrospectively implement a comprehensive post-removal from service assessment programme for critical parts, approved to Certification

Footnote

12 See AAIB report AAR 1/2023 for more information on this accident. Aircraft Accident Report AAR 1/2023 - Leonardo AW169, G-VSKP - GOV.UK [accessed 1 May 2026].

13 Notice of Proposed Amendment.

Specification 29.602 requirements, already in service. The findings from this should be used to ensure that the reliability and life assumptions in the certification risk analysis for the critical part or the system in which it operates remain valid.

In response to recommendation 2023-22, EASA have stated that they will review the requirement for a CIVP. The AAIB have recorded this response as ‘partially adequate-open’, until a definitive response to the recommendation is received from EASA, allowing a final determination to be made.

EASA has rejected recommendation 2023-023, stating that they considered the existing regulations to be adequate to address the safety concern. The AAIB have recorded this response as ‘not adequate - closed’

Analysis

G-CIMU bearing failure

The failure sequence following seizure of a tail rotor duplex bearing was investigated and replicated by test during the accident investigation into G-VSKP, an AW169. A similar failure process occurred with the tail rotor duplex bearing found damaged during maintenance on G-CIMU, an AW139, which has an almost identical tail rotor system design to the AW169.

Seizure of the bearing results in rotation of the actuator shaft, which on the AW169, G-VSKP, accident resulted in the input lever locking nut unwinding due to the right-hand thread direction, and the lever subsequently becoming disconnected. Free rotation of the actuator shaft meant no further damage occurred to the bearing, allowing important evidence on the failure mechanism to be recovered. On the AW139 the same locking nut has a left-hand thread. This meant when the bearing seized on G-CIMU, the nut tightened, preventing the actuator shaft from rotating any further and transferring the drive torque back into the bearing, forcing it to rotate. This resulted in severe heating and deterioration of the bearing due to friction, causing significant damage to the bearing inner and outer races (more than experienced with bearings on the AW169) until they distorted and lost material sufficiently that they no longer provided any resistance to the axial movement of the actuator. This allowed the actuator shaft to extend into the cover cap and create the hole identified during the maintenance inspection and would have resulted in the effective loss of tail rotor blade pitch control in operation.

Evidence suggests the resistance to axial movement of the actuator started to reduce in the last 15 hours of operation as the bearing deformed, but it’s likely the complete loss of resistance occurred in the final moments of the last flight operated by the helicopter, as the crew did not report any control issues. Had this occurred while the helicopter was still airborne, then there would have been a similar loss of tail rotor control to that experienced on an AW139 in flight in 2012. If this had been in the hover phase of flight, for example during a landing on an oil rig, the outcome may have been more hazardous than the 2012 serious incident which managed to land.

Due to the level of damage exhibited on the G-CIMU bearing it was not possible to recover any evidence to identify what led to the initial seizure of the bearing. This was also the case with the investigation of a tail rotor duplex bearing failure on the AW139 in flight loss of tail rotor control in 2012. The other bearings inspected by the investigation did not provide any significant supporting evidence either. Although the bearing removed from G-CKYP showed evidence of RCF, the most likely explanation for this was one-off debris ingress. If this was a systemic issue for the bearing design or manufacturing process, it's likely that there would have been significantly more failures identified since the common bearing design was introduced into service on the AW139, AW189 and AW169 fleets.

AW169 and AW189 bearing failures

Some evidence of sliding rather than rolling was found on the balls from the G-CIMU bearing. Despite this, the overall lack of detailed evidence from the in-service failures of the AW139 bearings meant the investigation was unable to determine whether the AW139 bearing failures resulted from the same failure mechanism as that identified on the AW169 and AW189 bearings following the G-VSKP accident. However, there was also no evidence found that a common failure mechanism could be discounted. Given the similar bearing architecture and the medium size of the AW139 helicopter between the smaller AW169 and the larger AW189, this remains a significant risk. The manufacturer elected not to apply the same mitigation actions to the AW139, as introduced post-accident to the tail rotor system of the AW169 and AW189 helicopters, such as temperature indicating strips, a specific HUMS sensor and a new non-hybrid bearing. For the first two, the manufacturer stated this was not possible because of differences in the dimensions of the tail rotor actuator on the AW139. However, the new non-hybrid bearing could have been retrofitted to the AW139.

Manufacturer and EASA response

The initial response to the G-CIMU bearing failure, introduced by emergency SB and AD was aimed solely at refitted bearings. This response assumed that the removal and refitting process was responsible for the failure of the bearing. The introduction of the requirement not to refit bearings was introduced as a precaution following the 2012 incident but was not based on any empirical evidence. The rig test requested by the investigation demonstrated that removal of the bearing, even under worst case conditions, did not result in any damage to the bearing races and therefore could not have caused either of the bearing failures experienced in 2012 or 2022.

Following this finding, the manufacturer then introduced a repetitive inspection process on non-refitted bearings, but this was specifically targeted at higher life bearings above 1,200 hours. EASA chose not to mandate this inspection requirement, despite having done so for the initial inspection requirements after the failure was identified and for all the additional bearing inspection requirements on the AW169 and AW189 following the accident to G-VSKP. The findings from the AW169 investigation demonstrated that the bearing failure mechanism was not caused by routine RCF due to normal accumulation of operating time and the bearing which caused the accident failed after just 330 hours of operation. While the failure mechanism on the AW139 wasn't proven to be the same as the AW169, it has also not been proven to be a high life failure mechanism, and the existing inspection requirement offers limited additional protection from a low life failure below 1,200 hours.

When considered collectively the mitigation actions put in place by the manufacturer and EASA to address duplex bearing failures on the AW139 are substantially less than those introduced in response to the AW169 accident. While the left-hand thread on the actuator locking nut provides an effective mitigation to the tail rotor blade runaway scenario seen during the AW169 accident, and loss of control of the tail rotor with sufficient forward speed allows a controllable safe landing to be conducted as demonstrated with the 2012 incident. There is still a high risk associated with a loss of tail rotor control in the hover. This is particularly a concern for AW139 operations carrying passengers to offshore oil rigs, where all offshore landings and takeoffs transition to or from the hover.

The manufacturer and EASA were questioned by the investigation whether they considered the existing mitigation actions were sufficient. They stated that no additional actions were considered necessary at this time.

Even if the current mitigation for failure of the duplex bearing is considered sufficient, it is clear from the two incidents and the number of bearings removed from service that there is a premature failure mechanism present on a critical part which the manufacturer does not currently fully understand. Bearings removed from service for failing repetitive inspections are disposed of by the operator as there is no requirement to investigate them further. Waiting for bearings to fail completely and cause a loss of tail rotor control before investigating them is unlikely to provide any useful information, given the level of damage which occurs before an identifiable flight control issue highlights a problem.

Prior to the AW169 accident, there was no requirement in place, either regulatory or from the manufacturer, to conduct a sample assessment of bearing condition after removal from service for any of the AW139, AW189 or AW169 fleets. This could have helped to provide evidence of potential premature degradation issues, prior to the point where the level of damage resulted in evidence of the initial cause being lost. This requirement has now been introduced on the AW169 and AW189 replacement non-hybrid bearing, at least until sufficient service experience has been gained with the bearing.

This issue of inspecting critical parts following rejection from service is an ongoing concern that has been identified in several previous accident investigations, including the investigation into a fatal accident in 2016 caused by a gearbox failure on an Airbus Helicopters Super Puma LN-OJF[14], where a similar finding and recommendation was made.

Footnote

[14] See AAIB report AAR 1/2023 for more information on this accident. Aircraft Accident Report AAR 1/2023 - Leonardo AW169, G-VSKP - GOV.UK [accessed 1 May 2026].

In response, EASA included a proposed amendment to CS 29.602 in NPA[15] 2022-01, which introduced the concept of a CIVP. In February 2023 the proposed regulation amendments were withdrawn by EASA, following their review of comments received from the industry during the consultation process for the NPA. Although EASA have committed to continue to review potential regulation change, at the time of writing this report no further proposals have been put forward, and the concern remains unaddressed.

The introduction of a programme to sample and inspect tail rotor bearings at a range of accumulated operating hours, as well as those removed from service prematurely by operators, would potentially provide valuable evidence to assist the manufacturer in identifying the cause of premature tail rotor duplex bearing failures on the AW139.

Therefore, the following Safety Recommendation is made:

Safety Recommendation 2026-003

It is recommended that Leonardo Helicopters S.p.A. implement a comprehensive inspection and assessment programme for tail rotor duplex bearings fitted to the AW139, which samples serviceable bearings removed at a range of accumulated operating hours, as well as those removed as prematurely unserviceable by operators. The findings from this should be used to ensure that the current mitigation actions are adequate to address the airworthiness risk from a failure of the bearing leading to loss of tail rotor control.

Pedal position monitoring

The flight crew did not report controllability issues after the last flight before the bearing damage was discovered. The CVR did capture a comment by one of the pilots relating to the pedal positions being abnormal. The review of pedal position during cruise indicates that the relationship between the pedal position and the actuator position required to achieve the required tail rotor thrust was approximately stable until about 15 flight hours before the failure was found. It then progressively shifted.

Monitoring of trends in the average pedal position during cruise portions of flights provides a means of identifying a similar degradation of the tail rotor duplex bearing. Therefore, the following safety recommendation is made:

Safety Recommendation 2026-004

It is recommended that Leonardo Helicopters S.p.A. explore monitoring for pedal position trends under stable flight conditions to provide early indication of deterioration of the tail rotor duplex bearing, on all helicopter types fitted with such a bearing, as part of its Health and Usage Monitoring System programme.

Footnote

[15] Notice of Proposed Amendment.

Vibration monitoring of the tail rotor duplex bearing

The tail rotor duplex bearing is a critical part. As a result of the catastrophic failure of the AW169 tail rotor duplex bearing on G-VSKP, the manufacturer added a capability to monitor vibration of the bearing on the AW169 and AW189 fleet. It is understood from the manufacturer that the same implementation modification is not viable for the AW139 fleet due to differences in the tail rotor actuator design. However, other means may be possible. Therefore, the following recommendation is made:

Safety Recommendation 2026-005

It is recommended that Leonardo Helicopters S.p.A establish and introduce vibration monitoring of the AW139 tail rotor duplex bearing as part of its Health and Usage Monitoring System capability to provide early indication of deterioration of the bearing.

Conclusion

The failure of an AW139 tail rotor duplex bearing was identified during a post flight maintenance check from wear damage on the bearing/actuator cover. The extent of the damage to the bearing confirmed that a loss of tail rotor control event would likely have occurred had the helicopter continued to operate with the bearing in its degraded condition. Despite a full forensic assessment, the bearing was too badly damaged to determine the initial cause of failure.

It was identified that the bearing had been refitted to the helicopter, after removal for maintenance, in contravention of the AMM. The initial response by the helicopter manufacturer and regulator was to require removal of all AW139 duplex bearings which had been refitted, along with reducing the discard life of the bearing to align with the maintenance task interval. A SB and AD were issued to mandate this. The assumption by the manufacturer was that the removal process for the bearing caused damage that initiated the deterioration of the bearing. However, this was subsequently discounted by the results of a rig test. The manufacturer then issued a further SB reducing the inspection interval for high life bearings over 1,200 hours. No AD was issued to mandate this requirement.

The tail rotor duplex bearing is defined as a critical part and the failure of an almost identical design of bearing fitted to an AW169 helicopter, resulted in a fatal accident in 2018. None of the safety actions introduced on the AW169 and AW189 global fleets in response to this accident, were applied to the AW139 global fleet. The same failure mechanism could not be excluded by the investigation and no evidence was identified to suggest the failure was due to routinely accrued high service life on the bearing.

Three Safety Recommendations have been made relating to the introduction of an inspection programme to help identify the cause of the AW139 tail rotor duplex bearing failures and to introduce potential means of early identification of degradation of the bearing using data trends recorded by the HUMS system.

Safety actions/Recommendations

Safety Recommendation 2026-003

It is recommended that Leonardo Helicopters S.p.A. implement a comprehensive inspection and assessment programme for tail rotor duplex bearings fitted to the AW139, which samples serviceable bearings removed at a range of accumulated operating hours, as well as those removed as prematurely unserviceable by operators. The findings from this should be used to ensure that the current mitigation actions are adequate to address the airworthiness risk from a failure of the bearing leading to loss of tail rotor control.

Safety Recommendation 2026-004

It is recommended that Leonardo Helicopters S.p.A. explore monitoring for pedal position trends under stable flight conditions to provide early indication of deterioration of the tail rotor duplex bearing, on all helicopter types fitted with such a bearing, as part of its Health and Usage Monitoring System programme.

Safety Recommendation 2026-005

It is recommended that Leonardo Helicopters S.p.A establish and introduce vibration monitoring of the AW139 tail rotor duplex bearing as part of its Health and Usage Monitoring System capability to provide early indication of deterioration of the bearing.

Safety Actions

The helicopter manufacturer issued Technical Information Letter T-139-22-004 in June 2022 reminding operators that the tail rotor duplex bearings fitted to AW139 should not be refitted after removal, in accordance with the AMP.

A Temporary Maintenance Instruction 139-559 was issued in June 2022 by the helicopter manufacturer to modify the maintenance procedure to state clearly that a removed bearing must be discarded.

Emergency Alert SB 139-725 was issued in July 2022 by the manufacturer, along with Technical Information Letter T139-22-006 to provide directions on removal from service of bearings which had been refitted and or exceeded 2,400 FH.

EASA issued the Emergency Airworthiness Directive (EAD) No. 2022-0182-E, which mandated SB 139-725. The discard time of the bearing was also reduced from 3,000 FH to 2,400 FH in the AMPI Chapter 5.

Comments of the ANSV representing the state of design

Chapter 6.3 of Annex 13 to the Convention on International Civil Aviation provides that the State conducting the investigation shall send a copy of the draft Final Report to all States that participated in the investigation, inviting their significant and substantiated comments on the report as soon as possible. If the State conducting the investigation receives comments within the period stated in the transmittal letter, it shall either amend the draft Final Report to include the substance of the comments received or, if desired by the State that provided comments, append the comments to the Final Report. Those comments are included below.

ANSV AGENZIA NAZIONALE PER LA SICUREZZA DEL VOLO

30th April 2026

Air Accident Investigation Branch
Farnborough House, Berkshire,
Copse Road, Aldershot, Hampshire,
United Kingdom, GU11 2HH

Subject: comments on the draft final report about the AW139 registration marks G-CIMU incident.

Dear Sir,
thank you for having invited the ANSV to participate as Accredited Representatives in the investigation to the incident which occurred to AW139 registration marks G-CIMU, Norwich Airport, 13 June 2022, and for the opportunity to provide comment on the final report.
The ANSV together with its Technical Advisers, Leonardo Helicopters and the European Union Aviation Safety Agency, have extensively reviewed the final report.
A large number of detailed comments have been provided to the UKAAIB during the consultation phase.
In order to make as simple as possible to understand the key areas of disagreement from the ANSV perspective, they are summarized as follows.

1. **Occurrence classification**

The UKAAIB draft final report begins in the Synopsis paragraph: «*The failure of an AW139 tail rotor duplex bearing was identified during a post flight maintenance check from wear damage on the bearing/actuator cover. The extent of the damage to the bearing confirmed that a loss of tail rotor control event would likely have occurred had the helicopter continued to operate with the bearing fitted.*».
From the ICAO Annex 13, an incident is: «*an occurrence, other than an accident, associated with the operation of an aircraft which affects or could affect the safety of operation.*»
On the other hand a serious incident is: *«an incident involving circumstances indicating that there was a high probability of an accident and associated with the operation of an aircraft which, in the case of a manned aircraft, takes place between the time any person boards the aircraft with the intention of flight until such time as all such persons have disembarked, or in the case of an unmanned aircraft, takes place between the time the aircraft is ready to move with the purpose of flight until such time as it comes to rest at the end of the flight and the primary propulsion system is shut down. Note 1. The difference between an accident and a serious incident lies only in the result.»*
Considering the circumstances, the description of the event seems to fit with the classification of incident. Indeed, the original classification attributed by the UKAAIB was *incident.*
Now, withstanding the autonomy of a Safety Investigation Authority to open an investigation also on incidents and recognizing the quality of the investigation report, together with the interesting insights the report brings, it is important to highlight that the difference view on the classification remains something more meaningful than simply taxonomical: indeed, the classification provides the reader with an immediate information on the level of risk of an event, in this case without an actual flight and presented as potentially involving multiple fleets. Indeed, the report makes continuous and direct reference to the AW169 and its duplex bearing; while it is true there are commonalities in the two helicopters, in the respective tail structures and relevant duplex bearings, the AW139 and AW169, together with AW189, are different helicopters with duplex bearings that have different part

ANSV AGENZIA NAZIONALE PER LA SICUREZZA DEL VOLO

numbers. On the AW139 specifically, the fleet accumulated millions of flight hours[1] with no accidents for matters possibly related to the duplex bearing; over the years LH has managed all the notifications from the operators regarding potentially degraded bearings, performing the investigations on all bearings returned form service. In this framework, despite the monitoring system already in place and despite the request made by LH, only a limited number of bearings was returned to LH for investigation, showing no deterioration instead.
The duplex bearing from the one only in-flight case, from 2012, had a life significantly longer than the maximum allowed nowadays. In addition, that event ended without consequences for the helicopter and for the occupants. This would further demonstrate a failed duplex bearing does not imply necessarily an accident as consequence. Indeed, the event from 2012 was classified as incident. In fact, this supports the idea that the occurrence should be classified as incident and the report should be more addressed on the AW139 duplex bearing, better considering the robustness demonstrated in the reality of the operations.

2. **Normal airworthiness process**
The final report proposes three safety recommendations. Besides any possible consideration on the efforts needed for the implementation, that may make it not commensurate with the expected benefits, the positive intent for increasing safety is understood. However, the report seems to not give enough credit to the already efficient inspection and assessment activities set in the normal airworthiness process[2]. This is particularly meaningful considering also the introduction of SB 139-728, which requires operators to send to LH for further investigation any bearing found potentially degraded and removed from service.
All the above also considering that: «*Both the investigation and an audit by the UK regulator of the operator's maintenance procedures, identified that the maintenance process used to refit all the tail rotor duplex bearings at the operator's facility didn't comply with the AMM procedure.*».
Indeed, the occurrence should highlight mainly the uppermost importance of respecting maintenance provisions, in the airworthiness process, namely in this case the forbidden re-usage of bearings and the procedure that require operators to send to manufacturer for inspection and further investigation of any suspect duplex bearings found in service.

The ANSV applies the right to append this letter of comments to the final report, as permitted by ICAO Annex 13 section 6.3.

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[1] 4.690.742 FH (flight hours) at the date of 31 October 2025.
[2] Point 21.A.3A of Annex I (Part 21) to Regulation (EU) No 748/2012 defines the obligations applicable to the Type Certificate Holders (TCHs) to establish and maintain a system for collecting, investigating and analyzing occurrence reports. This includes, as per point 21.A.3A(a)(1), identification of adverse trends or deficiencies that might cause adverse effects on the continuing airworthiness of the product. In addition, acceptable means of compliance AMC1 21.A.3A(a) clarifies that, for parts whose failure could lead to an unsafe condition (and critical parts are candidates as they could have catastrophic effect upon the rotorcraft), the analysis function of the system should ensure that reports and information sent, or available, to the Design Approval Holder (DAH) are fully investigated so that the exact nature of any event and its effect on continuing airworthiness is understood. This may then result in changes to the design and/or to the Instructions for Continued Airworthiness (ICA), and/or in establishing a mitigation plan to prevent or minimize the possibility of such occurrences in the future, as necessary.
To comply with 21.A.3A, Leonardo Helicopters (LH) applies the relevant procedures accepted by EASA within the Approval Certificate EASA.21J.005 of the LH DOA dated 26/01/2004:
-occurrence reporting and management;
-guidance criteria for the classification of occurrence report, including the annex A, "Guidelines for adverse trend management applicable to critical parts".

Published: 21 May 2026.

AAIB Correspondence Reports

These are reports on accidents and incidents which were not subject to a Field Investigation.

They are wholly, or largely, based on information provided by the aircraft commander in an Aircraft Accident Report Form (AARF) and in some cases additional information from other sources.

The accuracy of the information provided cannot be assured.

Serious Incident

Aircraft Type and Registration:	Airbus A320-214, G-EZUK
No & Type of Engines:	2 CFM56-5B4/3 turbofan engines
Year of Manufacture:	2011 (Serial no: 4749)
Date & Time (UTC):	13 June 2025 at 0532 hrs
Location:	London Luton Airport
Type of Flight:	Commercial Air Transport (Passenger)
Persons on Board:	Crew - 6 Passengers - 180
Injuries:	Crew - None Passengers - None
Nature of Damage:	None
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	49 years
Commander's Flying Experience:	13,500 hours (of which 9,000 were on type) Last 90 days - 175 hours Last 28 days - 45 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot and further enquiries by the AAIB

Synopsis

The crew calculated takeoff performance to depart using the full-length of the runway, but the aircraft departed from a runway intersection, ie with a shorter take off run. The crew did not notice this during the takeoff roll but it was identified later the same day by the operator's Flight Data Monitoring (FDM) system.

Safety action was taken by the operator to amend their operating procedures to try to trap this takeoff performance error.

History of the flight

The aircraft was on a scheduled flight from London Luton Airport (LTN) to Málaga Costa del Sol Airport, Spain. The co-pilot was the PF for this sector.

During the crew's pre-flight planning, on their electronic flight bags (EFB), the co-pilot initially planned to takeoff from Intersection Alpha on Runway 25[1], with flaps at CONF 1+F[2]. However, he noted that they did not have the takeoff performance, given the aircraft's weight and the environmental conditions at the time. This was checked and confirmed by the

Footnote

[1] See *Airport Information* section.

[2] CONF 1+F is the operator's preferred flap setting for takeoffs and is the default option in the EFB's takeoff performance software. However, CONF 2 or 3 may be considered by the crew.

commander. They therefore agreed to do a calculation using the full-length of Runway 25, which permitted a takeoff. They then briefed for the departure including potential threats to be considered. While the aircraft's higher-than-normal weight was considered, should an immediate return to LTN be required, the takeoff from the full-length, rather than from an intersection, was not. Once all the pre-flight preparation was completed the crew requested permission from the ATC Ground controller to push back and start, from Stand 47 on the East Apron, about one minute ahead of the scheduled departure time. After a delay of two minutes, due to other aircraft taxiing out, the pushback and start was approved, during which the crew started just the left engine, as they had planned to conduct a single engine taxi[3].

Once the pushback was completed the commander requested clearance to taxi, to which ATC responded with, "ARE YOU [Intersection] ALPHA ABLE?". The commander replied "AFFIRM". ATC then cleared the aircraft to taxi via Taxiway Delta to Holding Point Alpha One.

During the taxi out the second engine was started[4]. During this time another aircraft requested push and start and advised ATC that they "CAN TAKE THE INTERSECTION" and another stated that they were "REQUIRING FULL-LENGTH". The aircraft was then transferred to the ATC Tower controller and as they approached Holding Point Alpha One they joined a queue of a few other aircraft awaiting to depart. At this time three preceding aircraft departed from Intersection Alpha.

The aircraft subsequently received clearance to line-up on Runway 25, at Intersection Alpha, behind a landing aircraft, followed by clearance to take off. The aircraft departed without event.

The aircraft returned to LTN later that day and the crew went off duty. Later the same day the commander was contacted by the operator. They informed him that the departure from LTN had automatically triggered a post-flight event on the operator's FDM system. The FDM trigger was the aircraft's low height at the far end of Runway 25 and "questionable runway length remaining" at the point of lift off. It was at this point that the commander realised they had made a mistake with their takeoff point compared to the performance they had calculated.

Given the aircraft flew back to LTN before this serious incident was identified, the CVR was not available as it had been overwritten.

Crews' comments

Neither crew member believed fatigue was a factor and described the pre-flight preparations as routine. They added that 90% of the time the aircraft has the performance to takeoff from the intersection at LTN.

Footnote

3 During a single engine taxi the second engine is started up at a convenient time prior to take off.
4 The second engine start sequence was completed about seven minutes before take off.

Commander

The commander stated that during their pre-flight preparations there were no time pressures or unusual distractions.

When ATC asked, “Are you intersection able?” he believes he replied “Affirm”, as it seemed appropriate, as this is what he had done recently many times before. He added that he had not flown a takeoff from LTN using the full-length for “at least a month or two”.

As the aircraft taxied towards the runway the crew completed the takeoff performance/PEDS review[5]. During the PEDS review the commander believed that he stated that they had calculated the takeoff performance from Intersection Alpha and would be departing from Intersection Alpha. However, neither he nor the co-pilot noticed this was incorrect.

While he was aware the aircraft became airborne a long way down the runway, he didn’t believe it to be anything unusual, as he attributed it to a possible tailwind component.

Co-pilot

The co-pilot stated that he did not recall hearing the request from ATC asking whether they were able to depart from Intersection Alpha.

During the commander’s PEDS review the co-pilot did not recall whether the commander mentioned departing from Intersection Alpha or the full-length.

Meteorology

LTN ATIS Information Whiskey, recorded at 0420 hrs, stated that the surface wind was from 190° at 4 kt, varying between 160° and 220°, visibility was 9,000 m with no significant cloud, temperature 14°C, dew point 14°C and the QNH was 1017 hPa.

Airport information

LTN has one runway orientated 07/25. The full-length of Runway 25 has a TORA of 1,982 m and an Accelerate Stop Distance Available (ASDA) of 2,219 m. From Intersection Alpha the TORA is 1,771 m and the ASDA is 1,828 m.

Footnote

[5] See *Operator’s manuals* section for more details on the PEDS review.

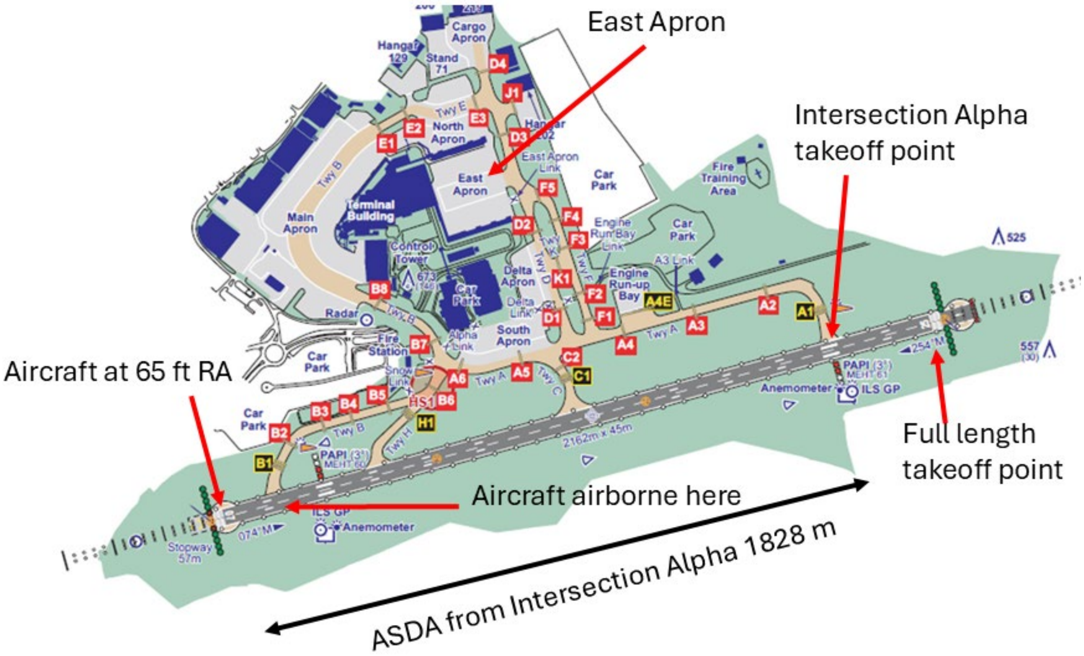

Figure 1

London Luton Airport Layout
(UK Aeronautical Information Publication (AIP))

Performance information

The crew calculated takeoff performance using flaps at CONF 1+F, for a takeoff from Runway 25 at LTN, at a weight of 68,887 kg. They input a wind from 160° at 4 kt as a worst case. Figure 2 shows the indications on the EFB showing that the takeoff was not permitted from Intersection Alpha for the conditions input.

The operator's FDM recorded that the aircraft lifted off about 310 m from the threshold of Runway 07 and was at 65 ft radio altitude over the threshold of Runway 07.

Analysis by the aircraft manufacturer suggested that in the event of an engine failure at V_1, with the takeoff continued, the obstacle clearance requirements of the net takeoff flight path would have been met. They also calculated that in the event of a rejected takeoff at V_1 with One Engine Inoperative (OEI) that the Accelerate Stop Distance Required (ASDR) would have been 1,666 m. In the event of a rejected takeoff at V_1 with All Engine Operative (AEO) the ASDR would have been 1,680 m. Given the ASDA from Intersection Alpha is 1,828 m, the margin would have been 187 m OEI and 173 m AEO. There was thus no runway overrun potential for all rejected takeoff scenarios.

Figure 2

Takeoff performance from Intersection Alpha, Runway 25

Operator's manuals

The operator's Flight Crew Operating Manual stated in '*Normal Procedures, TAKEOFF FROM INTERSECTION*', that the takeoff shift should be entered into the Multipurpose Control and Display Unit (MCDU). However, the operator stated that while it was available to use, it was not standard practice for this to be done. In this event it would have been left blank given they were required to use the full-length of the runway.

The AAIB contacted three other UK operators of the A320. They all stated that it was standard practice to enter the takeoff shift into the MCDU, if conducting a takeoff from an intersection.

The operator's Operating Manual Part B (OMB) stated in Section 2.3.10.1, '*All Engines Taxi at Departure*';

> **'DEPARTURE BRIEFING..CONFIRM**
>
> *The DEPARTURE BRIEFING CONFIRMATION (PEDS review) is aiming to:*
>
> *– Capture any changes affecting takeoff performance.*
>
> *– Final confirmation of takeoff performance data (actual vs computed).*
>
> *– Brief review/confirmation of departure briefing.*

When appropriate, [whilst taxing out to the runway] the PF requests the PM to conduct the PEDS review:

• ***Performance** – Actual takeoff position to be used and computed takeoff position shall be stated.*

• ***EOSID** [engine out standard instrument departure] **Procedure** – Standard/ Non-Standard EOSID (initial turn).*

• ***Departure (T/O RWY & SID)** – Check FMGC [Flight Management and Guidance Computer] RWY and SID referring to MCDU F-PLN page against ATC departure clearance.*

• ***Stop Altitude (initial)** – Check initial altitude as per SID/ATC departure clearance and FCU [Flight Control Unit] altitude setting (PFD [Primary Flight Display]).'*

The operator stated that the PEDS review does not require crews to crosscheck the departure point against calculated performance data, relying instead on memory.

In 'OMB 2.3.11.2, *LINE-UP Checklist*', it stated that the crew were to confirm that the line-up is performed on the intended runway/intersection and confirm the ATC clearance received.

Safety actions

As a result of this serious incident the operator conducted a review of their takeoff performance operating procedures. Changes were made to include recording the intersection used to calculate the takeoff performance. This could be in the MCDU. This would then be crosschecked against the takeoff position during taxi and validated during line-up prior to takeoff. These amendments were planned to be published by the operator in March 2026.

Human factors

NASA Ames Research Center conducted a study of memory errors in flight decks/cockpits, '*Human memory and cockpit operations*'[6].

Its findings stated that in highly familiar situations people tend to respond automatically with habitual actions, rather than thinking explicitly about each action, which requires much more mental effort. If the pilots had periodically reminded themselves that they were to do a takeoff using the full-length of the runway, they might have had a better chance of remembering to perform the correct action, though they would still have been somewhat vulnerable because habitual responses are difficult to inhibit.

Footnote

[6] Human memory and cockpit operations: An ASRS [Aviation Safety Reporting System] study, by J L Nowinski, J B Holbrook and R K Dismukes (2003) can be found here: https://studylib.net/doc/25913824/human-memory-and-cockpit-operations-nowinski-etal-isap03 [accessed 20 March 2026].

Other takeoff performance events

The AAIB reported on several takeoff performance serious incidents over the years leading up to this event. While some of these events had similar themes to this one (taking off from an incorrect intersection), there is a wide variation of reasons that can lead to an aircraft taking off with inappropriate thrust for the environmental and physical conditions.

Analysis

The aircraft was ready to depart slightly ahead of schedule and there were no external distractions that may have led to the crew rushing or forgetting their requirement to depart from the full-length of Runway 25.

While the crew briefed potential threats, including the aircraft's higher-than-normal weight, an opportunity was missed to highlight the requirement to takeoff from the lesser used full-length, as opposed to the more common intersection.

Once the push back was completed the commander requested clearance to taxi. ATC responded with, "ARE YOU [Intersection] ALPHA ABLE?" to which the commander incorrectly replied "AFFIRM". As the commander had departed from an intersection many times recently, this was likely to have been a habitual response, and it was not noticed by the co-pilot.

Despite another aircraft stating that they were "REQUIRING FULL-LENGTH", just before the aircraft was transferred to the Tower frequency, this did not cause the crew to realise that that they too required the full-length, as they may have been busy completing other tasks before departure. Added to the fact that they observed three preceding aircraft line-up and depart from the Intersection Alpha it is likely their mental model was reinforced by confirmation bias.

The PEDS review aimed to be the final check of the actual takeoff performance data versus that computed, and it relied on crew's memory. There was no requirement to crosscheck the performance that was stated by the PM against what was calculated. In this case the commander, as PM, believed he stated that they were taking off from the intersection and had planned to do so, probably because of habitual behaviour and confirmation bias. This was not captured by him or the co-pilot as it was likely engrained in their mental model from the initial call from ATC, and it was an habitual call.

It was not standard practice to enter the takeoff shift in the MCDU. Had it been used regularly, and had the crew seen it was blank for their full-length take off, it may have reminded them of the requirement to do so, or they might have queried why the takeoff shift distance had not been entered for the departure from the intersection.

Conclusion

The aircraft took off using a shorter TORA than had been used to calculate aircraft takeoff performance. While there were a few opportunities to trap this error, they were missed, probably by a combination of the crews' habitual behaviour and confirmation bias.

Takeoff performance serious incidents continue to occur, and this one demonstrated that crews must be resilient to confirmation bias and the normalising of regular types of departure.

Safety action

The operator took the following safety action:

> The operator reviewed and amended their take off performance procedures with the aim of making them more resilient to the type of error highlighted in this event.

Accident

Aircraft Type and Registration:	MW6-1-1, G-MNMW	
No & Type of Engines:	1 Rotax 582 piston engine	
Year of Manufacture:	1986 (Serial no: PFA 164-11144)	
Date & Time (UTC):	29 August 2025 at 1400 hrs	
Location:	Otherton Airfield, Staffordshire	
Type of Flight:	Private	
Persons on Board:	Crew - 1	Passengers - None
Injuries:	Crew - None	Passengers - N/A
Nature of Damage:	Significant damage to fuselage and right wing tip	
Commander's Licence:	National Private Pilot's Licence	
Commander's Age:	72 years	
Commander's Flying Experience:	1,970 hours (of which 154 were on type) Last 90 days - 4 hours Last 28 days - 10 hours	
Information Source:	Aircraft Accident Report Form submitted by the pilot	

Synopsis

During the circuit after a short local flight and return to Otherton Airfield, the pilot lined up on Runway 29 rather than Runway 25 as he had planned. Whilst altering his approach he became distracted by the presence of a 'No Fly Zone' near the airfield. As he manoeuvred, the airspeed decayed and the aircraft sank excessively and then struck the ground at the end of the runway. The aircraft fuselage and wing tip sustained damage as a result.

History of the flight

The pilot took off for a short local flight from Otherton Airfield which he completed without incident. On return to the airfield, he joined downwind for a left-hand circuit to Runway 25. As he continued the circuit, he realised that he had lined up on Runway 29 instead of Runway 25 so altered his approach accordingly. During this manoeuvre, the airspeed decayed and the aircraft sank excessively and struck a slightly raised area of ground between a ploughed field and the runway. The aircraft travelled a short distance and came to an abrupt stop. The pilot was uninjured and the aircraft sustained significant damage to its fuselage and wing tip.

Pilot's analysis

The pilot considered that there were two specific causal factors to this accident. When he realised that he had inadvertently lined up on Runway 29 he immediately altered his flight path to line up on Runway 25. However, he then became “preoccupied” with the designated ‘No Fly Zone’ alongside the airfield which was 180 m to the North of the Runway 25 threshold. This preoccupation was a distraction and this type of microlight, with a MTOW less than 400 kg and therefore high drag and low inertia, the airspeed rapidly decayed causing the excessive sink rate described by the pilot.

With hindsight the pilot felt that he should not have worried too much about the no fly zone and initiated a go-around.

AAIB observation

The pilot also informed the AAIB that he had flown numerous heavier piston and jet fixed wing aircraft. However, although he was familiar with this type of aircraft, he had not flown one for approximately 25 years. This accident shows that a lack of recency on an aircraft, when coupled with a seemingly unrelated distraction, can occasionally lead to an adverse event which fortunately in this case was not serious.

AAIB Record-Only Investigations

This section provides details of accidents and incidents which were not subject to a Field or full Correspondence Investigation.

They are wholly, or largely, based on information provided by the aircraft commander at the time of reporting and in some cases additional information from other sources.

The accuracy of the information provided cannot be assured.

Record-only investigations reviewed: March - April 2026

11 Dec 2025 **Gulfstream G600** **N318AG** Farnborough Airport

The aircraft was radar vectored for an ILS approach to Runway 24. The navigation source was the Flight Management System (FMS), with no changeover to the ILS. It was a visual day and when the glideslope did not capture the pilot disengaged the autopilot, wound down the altitude selector and followed the FMS Vertical Navigation (VNAV) glidepath. At 700 ft aal the aircraft entered altitude capture mode, and the autothrottles increased thrust. This destabilised the approach. The autothrottles were disconnected at 400 ft aal with the aircraft 40 kt above the landing threshold speed (VREF). The pilot flying decided to land on the threshold to maximise the landing distance available. The aircraft touched down on the displaced threshold, 196 ft short of the runway threshold.

28 Feb 2026 **Piper PA-18-150** **G-CVMI** Bosbury, Herefordshire

The takeoff commenced to the left of the runway to avoid a rut in the grass, then gently manoeuvred towards the centreline when clear of the rut. Once on the centreline, left rudder was applied to regain a track along the centre of the runway, but the aircraft continued to drift to the right and the right wing struck a small tree, yawing the aircraft into a ditch.

28 Feb 2026 **SD-1 Minisport** **G-CIZA** Bodmin Airfield, Cornwall

Shortly after takeoff the cockpit canopy became unlatched and flew open but remained attached. The effect of the propellor wash on the open canopy caused a rapid roll to the right which could not be controlled with aileron alone. By reducing power, the wings were levelled, but the aircraft was unable to climb and made a forced landing in a field ahead, clipping the top of a wire fence during the descent. The landing gear detached and the aircraft came to rest against a hedge. The pilot reflected that he had not verified that both front and rear canopy pins were secured before departure.

28 Feb 2026 **Cessna 150H** **G-BTES** Solent Airport Daedalus, Hampshire

Shortly after takeoff from Solent Airport Daedalus, a reduction in engine performance was observed. With insufficient altitude and deteriorating engine performance to safely return to the airfield the aircraft carried out a forced landing just off Lee-on-the-Solent beach. During the landing, the nose gear dug in causing the aircraft to flip and come to rest inverted. This successful forced landing highlights the importance of keeping the aircraft at flying speed and under control when faced with partial power loss or total engine failure.

28 Feb 2026 **Laser Z200 (Modified)** **G-BWKT** Henstridge Airfield, Somerset

After landing the aircraft overran the end of the runway and passed through a wire fence before coming to rest.

Record-only investigations reviewed: March - April 2026 cont

4 Mar 2026 **Piper PA-38-112** **G-RVRO** Liverpool Airport

During the flare, the aircraft's nose landing gear touched the runway first. The aircraft bounced twice, during which the propeller struck the runway and the nose landing gear was damaged, affecting directional control on the ground. The aircraft came to a halt just off the edge of the runway.

14 Mar 2026 **Pegasus Quik** **G-OMPW** Mount Airy Airfield, Yorkshire

Due to gusty conditions the aircraft made a heavy landing which caused the nose landing gear to fail. The aircraft slid off the side of the runway, into a ploughed area, at slow speed.

17 Mar 2026 **American AA-1 (Modified)** **G-AYHA** Field near Epworth, North Lincolnshire

The aircraft took off normally but, at 500 ft agl the engine stopped. A forced landing was carried out in a ploughed field immediately adjacent to the airfield. The aircraft landed normally but, after approximately 150 m, the nose landing gear dug in and the aircraft became inverted at slow speed.

18 Mar 2026 **SLA 80 Executive** **G-CEII** Turweston Aerodrome, Buckinghamshire

The aircraft bounced on landing, and when it touched down for the second time the right main landing gear collapsed.

18 Mar 2026 **Jodel D117A** **G-AYHX** Breighton Aerodrome, Yorkshire

At 300 ft agl, after takeoff, the engine stopped. The aircraft completed a forced landing in an adjacent field of willow saplings. During the ground roll the landing gear dug in and the aircraft came to rest inverted.

20 Mar 2026 **Bell 206L-1** **G-SUEY** Appledore, Kent

During descent into a private landing site at approximately 400 ft agl, there was a sudden loss of power and the aircraft entered autorotation. During touchdown, the tail stinger struck the ground but the helicopter did not turn over.

20 Mar 2026 **Cirrus SR20** **G-CTNG** Haverfordwest Airport, Pembrokeshire

The left pitot heat cover was left on and, during takeoff, the ASI reading did not increase as the aircraft accelerated along the runway. The takeoff was rejected but the aircraft ran off the paved surface and into a fence beyond.

Record-only investigations reviewed: March - April 2026 cont

28 Mar 2026	**Cirrus SR22T**	**N617KH**	Cotswold Airport (Kemble), Gloucestershire
	During landing the left wing contacted the runway, the aircraft departed the runway to the left and came to rest on the grass. Contact marking was observed on the runway from the left wing. A weather warning was in place for strong winds, and conditions were challenging. The aircraft pitot head required replacement.		
6 Apr 2026	**Cessna 150M**	**G-BPWG**	Sibson Aerodrome, Cambridgeshire
	A visiting aircraft aircraft took off from Sibson airfield to return to its base at Wilsford. As the aircraft turned onto the downwind leg, vibration and a rough running engine was experienced. Shortly afterwards, the engine stopped and there was a burning smell in the cockpit. A MAYDAY was declared and the aircraft landed safely in a local field to the south of Sibson Airfield.		
8 Apr 2026	**Piper PA-28-151 (Modified)**	**G-BXLY**	Exeter Airport
	The aircraft exited the runway and struck a parked aircraft during taxi to the parking area.		
19 Apr 2026	**Spitfire MK 26**	**G-CIXM**	Popham Airfield, Hampshire
	After landing, the aircraft turned off the grass runway before the taxiway exit. Both main landing gear wheels hit a rut. The aircraft tipped onto its nose.		
25 Apr 2026	**Pierre Robin DR400/180**	**G-NBDD**	Clacton Airfield, Essex
	The aircraft's approach to land was high and fast. The aircraft touched down and bounced twice before the nose struck the ground and the aircraft came to rest.		
26 Apr 2026	**Thruster TST MK1**	**G-MTGR**	Brown Shutters Farm Airfield, Somerset
	During circuits and landing training, the aircraft made a small bounce on landing and went off the runway. Control was taken by the instructor in an attempt to take off again but the aircraft clipped a bank and then a fence before landing in a field.		
30 Apr 2026	**Eurofox 912S(1)**	**G-OLOV**	Portmoak Airfield, Kinross
	During taxi out for a solo flight the aircraft wing struck a post on the airfield. The aircraft tipped up and the propeller struck the ground.		

Miscellaneous

This section contains Addenda, Corrections and a list of the ten most recent Aircraft Accident ('Formal') Reports published by the AAIB.

The complete reports can be downloaded from the AAIB website (www.aaib.gov.uk).

Bulletin Correction

AAIB File:	AAIB-30943
Aircraft type and registration:	Robinson R66, G-WBRN
Date and Time (UTC):	11 June 2025 at 0714 hrs
Location:	Chalfont St Peter, Buckinghamshire
Information Source:	Aircraft Accident Report Form

AAIB Bulletin No 02/2026, page 19 refers

Following publication of this report, the AAIB was made aware that a video recording of the accident existed taken from a factory-fitted airborne audio and image recorder located within the helicopter cabin. The content of the recording, which had not been made available to the AAIB during the investigation, showed that the published report did not properly reflect the circumstances of the accident. The investigation was re-opened to correct the record and to enable the publication of safety information related to VFR flight into IMC.

Report Title

Original title:

> Robinson R66 (G-WBRN), rollover during precautionary landing, Chalfont St Peter, Buckinghamshire, 11 June 2025

Amended title:

> Robinson R66 (G-WBRN), loss of control in flight, Chalfont St Peter, Buckinghamshire, 11 June 2025

Synopsis

Original text:

> During a planned VFR flight from Denham Airfield the pilot of a Robinson R66 encountered low cloud shortly after departure. The pilot was not qualified in instrument flying and unintentionally entered IMC around 700 ft agl, leading to spatial disorientation. Attempts to regain VFR conditions by climbing were constrained by controlled airspace. With thickening cloud and a lowering cloud base, the pilot decided to return to Denham. The helicopter broke cloud over fields and the pilot decided to make a precautionary landing. The landing was heavy, resulting in the helicopter rolling over. The pilot was uninjured, but the helicopter was significantly damaged. A section of blade tip was propelled nearly 180 m, embedding itself in a wisteria attached to the wall of a house.

Amended text:

> G-WBRN entered IMC at around 400 ft after departure. The autopilot was engaged initially but was disengaged subsequently after which the pilot lost control of the helicopter. It emerged from the bottom of the cloud in an extreme attitude, rolled level and entered a rapid yaw to the left, which continued until it struck the ground and rolled over. The pilot was uninjured, but the helicopter was significantly damaged.
>
> The pilot was not qualified to fly on instruments alone, and an opportunity to turn around was missed when the weather encountered after takeoff proved to be as forecast. There appeared to be confusion about autopilot modes and the autopilot was disengaged, leading to the loss of control.

History of the flight

Original text of the first paragraph:

> The pilot owner of a Robinson R66 planned for a regular flight from Denham Airfield, Buckinghamshire, to a private airstrip near Wellesbourne, Warwickshire. The helicopter was refuelled the night before and was positioned out of the hangar ready for an early morning departure.

Amended text:

> The pilot of G-WBRN, a Robinson R66 helicopter, planned for a regular flight from Denham airfield, Buckinghamshire, to a private airstrip near Wellesbourne, Warwickshire. The helicopter was refuelled the night before and was positioned out of the hangar ready for an early morning departure.

Original text of the second paragraph following Figure 1 on page 20 to the end of the History of the flight:

> The helicopter departed Runway 06 turning left over some lakes and routed north toward one of the visual reporting points for the airfield. The cloud base was not as imagined when viewed from the ground. The pilot was being pushed lower to try and maintain VMC, and he soon found himself intermittently entering cloud at around 700 ft agl with fleeting glimpses of the ground. He was starting to become disorientated and was surprised to find himself now on a westerly heading.
>
> At 900 ft agl and now IMC the pilot reported initiating a climb to see if he could get VFR on top of the cloud, but he was conscious that he was constrained by the base of the London TMA. He entered a climbing left turn, but after climbing an additional 300 ft the cloud was getting thicker and so he decided to descend and turn south to go back to Denham. The pilot was disorientated and increasingly anxious with the developing situation.

The helicopter was now in a descending left turn with an increasing rate of descent (Figure 2). The pilot had intermittent sight of the ground, broke cloud at a low height, and arrived in a "disorganised state" over some fields next to a paddock with outbuildings. He decided to make a precautionary landing.

The helicopter rolled over on landing. The pilot was uninjured in the accident, shutting off the fuel and electrics before exiting the helicopter. Total flight time was just under five minutes.

Amended text:

The following narrative was written by reference to video taken from a factory-fitted cockpit audio and video recorder.

The helicopter departed Runway 06 and began to turn left over some lakes at approximately 400 ft agl, but the pilot reported that the cloud base was not as he had imagined when viewed from the ground. Visual references began to deteriorate at about 250 ft agl and the helicopter entered cloud at around 500 ft agl, climbing at 500 to 700 ft/min and still in a slow left turn, which it continued onto a heading of approximately 330°M. The pilot engaged the autopilot[1] by pressing the STABILITY AUGMENTATION SYSTEM (SAS) mode button on the autopilot control panel. He then selected heading hold (hdg) and altitude hold (alt) modes, and the helicopter stabilised at 600 ft agl (approximately 800 ft amsl) and 85 kt. The pilot had a tablet device positioned on his lap which he frequently referenced for route navigation, and he incrementally moved the heading bug clockwise onto a target heading of 360°M. The helicopter followed the command to turn right.

The pilot stated that he initiated a climb to see if he could get VFR on top of the cloud, but he was conscious that he was constrained by the base of the London TMA. With the autopilot engaged, he pressed and held the trim[2] button when the heading was 345°M and placed the helicopter into a 1,500 ft/min climb. The helicopter climbed 400 ft (to approximately 1,200 ft amsl) and began to turn slowly left, reaching a heading of 268°M, while the pilot incrementally moved the heading bug to the right, onto approximately 045°M. During this climbing turn, the speed reduced to 34 kt, with the hdg and alt modes disengaging as the speed decelerated through 44 kt. The trim button was released and the autopilot re-trimmed in primary sas mode and corrected the helicopter to a steady attitude, adopting an initial heading of 274°M and gradually accelerating back to 85 kt. As the helicopter accelerated, the pilot again made incremental clockwise changes to the heading bug position, eventually reaching 160°M. However, the helicopter's heading drifted slowly left to 245°M.

Footnote

1 G-WBRN was fitted with a Genesys Aerosystems HeliSAS, which is described later in the Autopilot section.
2 The TRIM button removes forces from the cyclic control and temporarily suspends SAS operation.

The pilot stated he was becoming a little disorientated and was surprised to find himself now on a westerly heading, not northerly. He had made several heading bug selections on the Primary Flight Display (PFD) after glancing down at his tablet, but the helicopter had not turned and so he pressed the sas button, which disengaged the autopilot system.

The helicopter pitched to 15° nose-up, climbed 250 ft, to approximately 1,450 amsl, and slowly banked left to 35° angle of bank (AOB). The nose then dropped below the horizon, and the helicopter entered a descending left turn. With a 25° nose-down attitude and 50° left AOB the pilot attempted to re-engage the autopilot, selecting SAS, HDG and ALT modes. Approximately five seconds later, the helicopter emerged from the base of the cloud at approximately 600 ft agl with a 2,000 ft/min rate of descent and an audio warning: "WARNING TERRAIN TERRAIN" (Figure 2).

The pilot rolled level and pulled up, the hdg and alt modes disengaged leaving the SAS mode light green, and the helicopter entered cloud again, pitching to 60° nose-up. The pilot pressed the SAS button again, which disengaged the autopilot system. The helicopter rolled right to approximately 170° AOB, the nose dropped rapidly, and the helicopter emerged from the base of the cloud near inverted at approximately 450 ft agl with 3,000 ft/min rate of descent (Figure 3).

The helicopter rolled level with the pilot applying full power, but the main rotor RPM quickly fell below 80%, probably due to overpitching[3]. The pilot had been thrown to the left when the helicopter rolled inverted causing his left foot to push forward on the yaw pedal and it remained in that position as the helicopter entered a rapid yaw to the left. The yaw continued until the helicopter struck the ground in a field next to a paddock with outbuildings. A plan view of the flightpath is shown in Figure 4.

The subsequent impact with the ground was heavy. The skids were splayed and flattened, and the cross tubes that run laterally under the fuselage were fractured with the clamps deformed. The left skid that contacted the downward part of the slope collapsed, acting as a pivot point for the helicopter to roll over.

The main rotor blade struck the ground with high energy, chopping off the tail rotor and propelling a 70 cm section of blade tip, weighing 4.5 kg, nearly 180 m over a main road and a petrol station canopy and into a wisteria attached to the wall of a house (Figure 5). There was no damage caused to the house.

Footnote

[3] Overpitching: when the pilot raises the collective control lever, the pitch angle of the main rotor blades increases, increasing lift and drag. If the pitch is increased too much, the drag increases to a level such that the engine cannot maintain rotor rpm.

The total flight time was just under five minutes, and it was 58 seconds from the time the autopilot was disengaged (prior to the helicopter pitching to 15° nose-up and climbing 250 ft) until the helicopter struck the ground.

Figure 6 shows a sequence of images of the instrument panel during the loss of control described above.

Meteorology

Original text of the first two paragraphs:

> The flight was planned to be conducted within Area C and D of the Metform 215 (F215) Low Level Significant Weather Chart (Figure 3). The F215 chart covers a wide area and conveys the most likely meteorological conditions for the period. Guidance states that it is good practice to consult with observations along the route to obtain the fullest picture.
>
> The high pressure system sitting over the UK was giving rise to areas of low cloud around the departure airfield which was due to lift and break. At the time of departure London Heathrow Airport (Heathrow), which is 10 nm from Denham, was reporting conditions as overcast cloud between 400 and 500 ft agl. RAF Northolt, only 3.5 nm from Denham, was reporting broken cloud between 500 and 800 ft agl.

Amended text:

> The flight was planned to be conducted within Areas C and D of the Metform 215 (F215) Low Level Significant Weather Chart (Figure 7). The F215 chart covers a wide area and conveys the most likely meteorological conditions for the period. Guidance provided by the Met Office states that it is good practice to consult with observations along the route to obtain the fullest picture.
>
> The high pressure system sitting over the UK gave rise to areas of low cloud around the departure airfield that were due to lift and break. At the time of departure London Heathrow Airport (Heathrow), which is 10 nm from Denham and at an elevation of 83 ft, was reporting conditions as overcast cloud between 400 and 500 ft agl. RAF Northolt, only 3.5 nm from Denham and at an elevation of 115 ft, was reporting broken cloud between 500 and 800 ft agl.
>
> Aircraft departing Runway 06 at Denham, route via the Maple Cross VRP, which is at an elevation of 165 ft, with terrain elevation up to 350 ft between the airfield and VRP.

The final paragraph at the bottom of page 22 is deleted.

> Consideration must also be given to the low flying rules by not flying closer than 500 ft to any person, vessel, vehicle or structure once the takeoff is completed.

Applicable regulations and local rules

A new section is added following *Meteorology*:

> In the UK Standardised Rules of the Air, SERA.5001 gives '*VMC and distance from cloud minima'*. To remain VMC in Class D and G airspace (the classes of airspace through which G-WRBN flew), helicopters must remain clear of cloud, in sight of the surface, and with a flight visibility of 3 km (Class D) or 1,500 m (Class G).
>
> The Rules of the Air (Amendment) Regulations 2005 contain regulations on '*Low Flying'* in regulation 5, and these regulations require aircraft to fly no closer than 500 ft to any person, vessel, vehicle or structure. The regulations also prevent aircraft from flying over congested areas below a height of 1,000 ft above the highest fixed obstacle within 600 m of the aircraft; and below a height that would permit the aircraft to land clear of the congested area following a loss of power.
>
> Within the Denham Local Flying Area (LFA) (that part of the ATZ that lies within Class D airspace), aircraft are normally limited to 1,000 ft amsl, to allow a margin of error against the maximum altitude of the LFA, which is 1,200 ft amsl.

Aircraft

A new section is added following *Applicable regulations and local rules*:

> The Robinson R66 helicopter is approved for VFR day and night operations only. G-WBRN had a factory fitted cockpit camera system and an optional Genesys HeliSAS autopilot installed.
>
> *Cockpit camera*
>
> The cockpit camera is forward mounted in the roof lining and records 4K video, intercom audio, radio communication and GPS position. The data is stored both internally and on a removable flash drive located in the front of the camera housing. The internal memory records the most recent three hours of video and is not user accessible.
>
> *Autopilot*
>
> The Genesys Aerospace HeliSAS autopilot system provides 2-axis stability and autopilot functions. The autopilot's primary mode is as a Stability Augmentation System, which maintains a steady attitude for the helicopter through inputs to the cyclic in the pitch and roll channels. This is felt by the pilot as a light centering force on the cyclic control. The system does not provide collective or yaw flight control inputs, which must be manually controlled by the pilot. When the SAS is engaged, additional autopilot modes maybe layered on top, such as heading hold and altitude hold.

The POH states:

'The autopilot is intended to enhance safety by reducing pilot workload. It is not a substitute for adequate pilot skill nor does it relieve the pilot of the responsibility to monitor the flight controls and maintain adequate outside visual reference.'

The HeliSAS control panel is located on the main instrument panel below the PFD. It consists of a row of buttons and corresponding annunciator lights. A dark annunciator indicates that the mode is off, white indicates that the mode is in standby or armed, and green indicates that the mode is engaged (Figure 8).

On power-up and after performing a self-test, the SAS enters standby mode and the SAS annunciator is a steady white. SAS can be engaged by pressing the SAS button on the control panel or by pressing the TRIM button on the cyclic for 1.25 seconds. On SAS engagement, angles of less than 10° in pitch and roll will be held. If the pitch or roll angle is larger, the system assumes the helicopter is in an unusual attitude and gently levels the helicopter. When engaged, the SAS annunciator turns green. Additional modes are selected by pressing the appropriate button with the annunciator light indicating green when the mode is engaged.

Modes are disengaged using the appropriate button on the control panel or the AP OFF button on the cyclic control. If using the AP OFF button with additional modes engaged, the first push will disengage those modes and another push will disengage the SAS. Disengagement of SAS is accompanied by four headset beeps. There are no beeps for intentional disengagement of additional modes. The system will automatically revert to primary SAS mode and disengage any additional modes at airspeeds below 44 kt or above 140 kt. Automatic disengagement of additional modes is accompanied by a single headset beep.

The system is designed to allow the pilot to 'fly through' the autopilot, overriding the force applied to the cyclic control to allow the pilot to manoeuvre without disengaging the system. The trim button is then used to re-trim the SAS to a new datum attitude.

The POH states:

'The autopilot is not certified for flight in Instrument Meteorological Conditions (IMC). Adhering to appropriate VFR weather minimums is essential for safety.

If an inadvertent loss of outside visual reference occurs, the pilot must regain visual conditions as quickly as possible while avoiding abrupt, disorienting maneuvers. The following procedure is recommended:

1. *If not already engaged, immediately engage autopilot SAS mode and allow autopilot to recover from unusual attitude if one has occurred.*

2. *Select heading and altitude to ensure terrain and obstacle clearance. Turns and/or climbs may be required. Engage additional autopilot modes as desired for workload reduction.*

3. *While maintaining terrain and obstacle clearance, maneuver toward conditions of improved visibility.'*

Training

The HeliSAS system is optional equipment and there is no specific training required for the award of a type-rating.

VFR flight into IMC

Original text:

When a pilot unqualified in instrument flying unintentionally enters IMC when on a VFR flight, spatial disorientation may occur. The pilot is unable to correctly interpret the aircraft's attitude, altitude or speed. Control inputs may be made based on false perception, leading to a loss of control.

Research into spatial disorientation for pilots that are not instrument qualified, showed that loss of control will likely occur between 60 seconds and 178 seconds on average after losing visual references. An analysis of helicopter accidents and incidents in the UK between 2000-2010 showed that 68% of inadvertent VFR flight into IMC resulted in a fatal accident.

The CAA has published guidance for general aviation pilots in their Safety Sense Leaflet 33 - *'VFR Flight into IMC'* on how to avoid and respond to such a scenario. It states:

'If the weather is closing in all around, consider a precautionary landing in a field – it may seem like an extreme option that could result in damage to the aircraft, however this is preferable to experiencing a loss of control accident, which is normally fatal.'

Amended text:

The pilot did not hold an Instrument Rating. Research into spatial disorientation for pilots that are not instrument qualified, showed that loss of control will likely occur between 60 and 178 seconds, on average, after losing visual references. An analysis of helicopter accidents and incidents in the UK between the years 2000 and 2010 showed that 68% of inadvertent VFR flight into IMC resulted in a fatal accident.

The CAA has published guidance for general aviation pilots in Safety Sense Leaflet 33, *'VFR Flight into IMC',* on how to avoid and respond to such a scenario. The aim is to retain control of the aircraft and exit IMC:

> *'**Stay in Control:** Transition to instrument flight. Focus on the attitude indicator and make small corrections to maintain heading and altitude. Trust your instruments. Avoid making large control inputs or power changes. Ensure the aircraft is in trim. If the aircraft has an autopilot, engaging it will allow you to retain control of the aircraft and free up capacity for situational awareness.'*

The CAA has also published Safety Sense Leaflet 17, *'Helicopter Airmanship', and* Aeronautical Information Circular P 137/2019, *'Helicopter flight in degraded visual conditions'.* The AIC was issued as part of an education campaign to provide '*guidance on the problems and hazards associated with flight in degraded visual conditions'.* The AIC discusses the meaning of flight '*with the surface in sight'* and considers helicopter stability and the nature and sufficiency of visual cues. It states that three main scenarios, alone or in combination, may result in an accident:

> 'a) Loss *of control when attempting a manoeuvre to avoid a region of impaired visibility;*
>
> *b) Spatial disorientation or loss of control when transferring to instrument flight following an inadvertent encounter with IMC;*
>
> *c) Loss of situ*ational awareness resulting in controlled flight into terrain.'

Precautionary landing

This section is deleted:

> The pilot emerged from the base of the cloud and regained sufficient visual references to make a precautionary landing. The area immediately in front was a paddock with horses and so the pilot manoeuvred to an adjacent field. This field was overgrown, uneven and with a marked slope.
>
> The landing was firm and the helicopter rolled over. The main rotor blade struck the ground, and a 70 cm section of blade tip was propelled nearly 180 m over a main road and a petrol station canopy before embedding itself in a wisteria attached to the wall of a house (Figure 4).

Analysis

Meteorology

Original text:

> The pilot believed from his ground observation that conditions had improved. A check of actual observations from aerodromes in the locality would indicate this was not the case, with both Heathrow Airport and RAF Northolt reporting extensive low cloud.
>
> Denham Airfield is at an elevation of 215 ft amsl, which is higher than Northolt (126 ft amsl) and Heathrow (83 ft amsl). Northolt was reporting broken cloud between 500 and 800 ft agl, indicating that the cloud base in the locality of Denham was likely to be between 400 and 700 ft agl.
>
> Given the built-up area and terrain elevation around Denham, the weather conditions in the locality were not compatible with the requirements of VFR flight, as set out in the Skyway Code.

Amended text:

> The Met Office was forecasting isolated areas of scattered or broken cloud in Area C of the Metform 215, which included Denham Airfield, with a base of between 700 and 1,200 ft amsl and with the top forecast to be 1,500 ft amsl. Although the pilot believed from his ground observation that conditions were suitable for flight, the actual weather observations from aerodromes in the locality indicated this would probably not be the case, with both Heathrow Airport and RAF Northolt reporting extensive low cloud. Denham Airfield is at an elevation of 215 ft, which is higher than Northolt (126 ft) and Heathrow (83 ft). Northolt was reporting broken cloud between 500 and 800 ft agl, indicating that the cloud base in the locality of Denham was likely to have been between about 400 ft and 700 ft agl (615 ft and 915 ft amsl).
>
> With terrain elevation up to 350 ft along the route towards the Maple Cross VRP, it is unlikely that the weather conditions in the locality permitted flight clear of cloud and with the surface in sight, while also maintaining 500 ft separation from any person, vessel, vehicle or structure. The decision to fly in those weather conditions, therefore, carried with it a significant risk of VFR flight into IMC. The numerous congested areas locally would also have made it difficult to route around the lowest cloud while remaining more than 1,000 ft above obstacles in those congested areas.

Spatial disorientation

This section is deleted:

> Spatial disorientation can lead to a loss of control in as little as one to three minutes, and accidents following a loss of control are often fatal. The pilot recognised he was disorientated and felt increasingly anxious at his worsening situation. His decision to make a precautionary landing was in accordance with CAA guidance.

Landing

This section is deleted:

> Having experienced the stress of inadvertent VFR flight into IMC, the pilot regained sufficient visual references with the ground for a precautionary landing. He states that he arrived in a "disorganised state" and made a rushed assessment of the landing area. The chosen field was overgrown, uneven and with a slope.
>
> The landing was heavy. The skids were splayed and flattened, and the cross tubes that run laterally under the fuselage were fractured with the clamps deformed. The left skid that contacted the downward part of the slope collapsed, acting as a pivot point for dynamic rollover to occur.
>
> The main rotor blade struck the ground with high energy, sufficient to propel a section of blade tip weighing 4.5 kg nearly 180 m. There was no damage caused to the house.

VFR flight into IMC

A new section is added after *Meteorology*:

> On departure from Denham the cloud base was lower than the pilot expected, and the video recording showed that visual references were starting to deteriorate from about 250 ft agl. The opportunity to immediately return to the airfield was not taken and the pilot continued to climb until all visual references were lost at around 500 ft agl. With the helicopter now in IMC, the decision to engage the autopilot with SAS, HDG and ALT modes stabilised the situation and allowed the pilot to maintain control of the aircraft. This was in line with the guidance in the POH and CAA Safety Sense Leaflet 33.

Use of the autopilot

A new section is added after *VFR flight into IMC*:

> The pilot stated that his intention was to climb to see if he could regain VFR conditions, but this was unlikely to have been successful because he was limited to an altitude of 1,200 ft within the LFA and the top of the cloud layer

was forecast to be at 1,500 ft amsl. The autopilot remained engaged as the pilot 'flew through' the system using the TRIM button, and when selecting the climbing attitude the pilot introduced a small angle of bank to the left. There was no input on the collective control to increase power for the climb and so the speed reduced. As the speed reduced, the helicopter yawed to the left, adding to the roll to the left.

At 44 kt the hdg and alt modes automatically disengaged but this did not appear to have been recognised by the pilot. The SAS mode remained engaged. On releasing the trim button, the attitude was approximately 20° nose-up and with 10° AOB. The SAS assumed the helicopter was in an unusual attitude and gently levelled the helicopter, allowing it to accelerate. The increased yaw and the slight AOB to the left probably accounted for the change in heading from 274°M to 245°M. During this period, the pilot repeatedly moved the heading bug clockwise, eventually reaching 160°M, but the helicopter did not follow the heading command because hdg mode was not engaged. The pilot appeared to recognise that the heading was not following the command but did not appreciate the reason, and this confusion is likely to have contributed to the disorientation that he reported and the surprise he reported at finding the helicopter heading west, not north. Frequent reference to the tablet on his lap – looking down and then ahead again – would also have added to any spatial disorientation the pilot may have been experiencing. It would also have reduced his ability to effectively scan the helicopter's flight instruments – Safety Sense Leaflet 33 emphasises the importance of the attitude indicator – to monitor and control the flightpath, something that is important regardless of whether an autopilot is engaged.

Loss of control

A new section is added after *Use of the autopilot:*

In what appeared to be an attempt to correct the situation, the pilot pressed the SAS button once, and the annunciator turned white to indicate the autopilot system had disengaged. The subsequent flightpath of the helicopter, described earlier and exemplified in Figures 2 and 3, included high nose-up and nose-down attitudes, and AOB up to almost 180°. During this period, the pilot glanced at his tablet and tried to engage the autopilot even with the helicopter in a nose-low, high AOB attitude, and with a high rate of descent while close to the ground. It appeared to be the sight of the ground (Figure 2) that re-orientated the pilot briefly, leading him to reduce the AOB and enter a climb. However, once in cloud again, there was a further loss of control, leading to the final accident sequence.

When a pilot unqualified in instrument flying enters IMC when on a VFR flight, spatial disorientation is likely to occur. Without training on how to conduct an effective and systematic instrument scan, pilots are unlikely to correctly interpret the aircraft's attitude, altitude or speed to enable them to control the flightpath.

Control inputs are likely to be made based on false perceptions, leading to a loss of control in between 60 and 178 seconds. It appeared likely that this accounted for the erratic flightpath of G-WBRN and the subsequent loss of control, which occurred 58 seconds after the autopilot was disengaged. The situation would have been made worse by a lack of training in instrument flying, confusion about autopilot modes, and periodic glances away from the flight instruments towards the tablet and autopilot controls.

Conclusion

Original text:

The weather in the locality of Denham airfield was unsuitable for a planned VFR flight. Soon after departure the pilot entered IMC and suffered spatial disorientation. Faced with a deteriorating weather situation, the pilot decided to return to Denham. The helicopter broke cloud close to the ground and the pilot made a rushed precautionary landing into a field that was overgrown and with a slope. The landing was heavy, and the helicopter suffered dynamic rollover.

Amended text:

The weather in the locality of Denham Airfield was, at best, marginal for VFR flight and soon after departure the helicopter entered IMC. The autopilot was engaged and the pilot attempted to climb to regain VMC. The pilot referred frequently to the tablet on his lap and tried to control the helicopter's heading using the autopilot, apparently unaware that the correct mode had not been selected. When the autopilot, including the SAS, was disengaged, the pilot was unable to control the helicopter using flight instruments alone. The helicopter emerged from cloud in an extreme attitude, rolled upright but then yawed rapidly to the left until it struck the ground and rolled over.

The following factors probably contributed to the loss of control:

- A decision to fly when the weather forecast was, at best, marginal for VFR flight.
- A missed opportunity to descend and turn around when deteriorating visual references immediately after takeoff confirmed the validity of the weather forecast.
- A lack of training in instrument flying.
- Confusion about autopilot modes.
- Frequent reference to a tablet and selection of autopilot controls, which were a distraction to monitoring flight instruments and controlling the flightpath.

Images

The following images were added, and the Figure numbers in the text were adjusted accordingly:

Figure 2
Terrain warning

Figure 3
Emerging from base of cloud nearly inverted

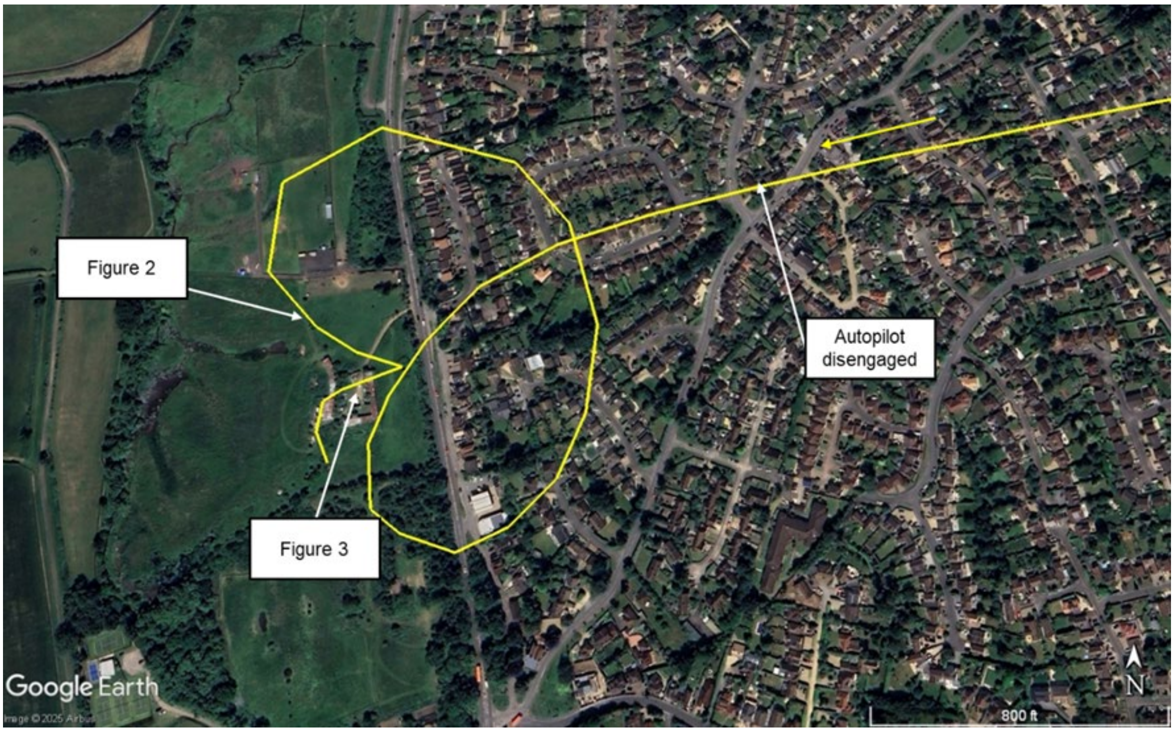

Figure 4
ADS-B flightpath data from FlightAware

Figure 6

Loss of control sequence of events

Figure 8

HeliSAS control panel

The online version of this report was corrected on 19 May 2025.

TEN MOST RECENTLY PUBLISHED FORMAL REPORTS ISSUED BY THE AIR ACCIDENTS INVESTIGATION BRANCH

3/2015 Eurocopter (Deutschland) EC135 T2+, G-SPAO Glasgow City Centre, Scotland on 29 November 2013.
Published October 2015.

1/2016 AS332 L2 Super Puma, G-WNSB on approach to Sumburgh Airport on 23 August 2013.
Published March 2016.

2/2016 Saab 2000, G-LGNO approximately 7 nm east of Sumburgh Airport, Shetland on 15 December 2014.
Published September 2016.

1/2017 Hawker Hunter T7, G-BXFI near Shoreham Airport on 22 August 2015.
Published March 2017.

1/2018 Sikorsky S-92A, G-WNSR West Franklin wellhead platform, North Sea on 28 December 2016.
Published March 2018.

2/2018 Boeing 737-86J, C-FWGH Belfast International Airport on 21 July 2017.
Published November 2018.

1/2020 Piper PA-46-310P Malibu, N264DB 22 nm north-north-west of Guernsey on 21 January 2019.
Published March 2020.

1/2021 Airbus A321-211, G-POWN London Gatwick Airport on 26 February 2020.
Published May 2021.

1/2023 Leonardo AW169, G-VSKP King Power Stadium, Leicester on 27 October 2018.
Published September 2023.

2/2023 Sikorsky S-92A, G-MCGY Derriford Hospital, Plymouth, Devon on 4 March 2022.
Published November 2023.

Unabridged versions of all AAIB Formal Reports, published back to and including 1971, are available in full on the AAIB Website

http://www.aaib.gov.uk

GLOSSARY OF ABBREVIATIONS

aal	above airfield level
ACAS	Airborne Collision Avoidance System
ACARS	Automatic Communications And Reporting System
ADF	Automatic Direction Finding equipment
AFIS(O)	Aerodrome Flight Information Service (Officer)
agl	above ground level
AIC	Aeronautical Information Circular
amsl	above mean sea level
AOM	Aerodrome Operating Minima
APU	Auxiliary Power Unit
ASI	airspeed indicator
ATC(C)(O)	Air Traffic Control (Centre)(Officer)
ATIS	Automatic Terminal Information Service
ATPL	Airline Transport Pilot's Licence
BMAA	British Microlight Aircraft Association
BGA	British Gliding Association
BBAC	British Balloon and Airship Club
BHPA	British Hang Gliding & Paragliding Association
CAA	Civil Aviation Authority
CAVOK	Ceiling And Visibility OK (for VFR flight)
CAS	calibrated airspeed
cc	cubic centimetres
CG	Centre of Gravity
cm	centimetre(s)
CPL	Commercial Pilot's Licence
°C,F,M,T	Celsius, Fahrenheit, magnetic, true
CVR	Cockpit Voice Recorder
DME	Distance Measuring Equipment
EAS	equivalent airspeed
EASA	European Union Aviation Safety Agency
ECAM	Electronic Centralised Aircraft Monitoring
EGPWS	Enhanced GPWS
EGT	Exhaust Gas Temperature
EICAS	Engine Indication and Crew Alerting System
EPR	Engine Pressure Ratio
ETA	Estimated Time of Arrival
ETD	Estimated Time of Departure
FAA	Federal Aviation Administration (USA)
FDR	Flight Data Recorder
FIR	Flight Information Region
FL	Flight Level
ft	feet
ft/min	feet per minute
g	acceleration due to Earth's gravity
GNSS	Global Navigation Satellite System
GPS	Global Positioning System
GPWS	Ground Proximity Warning System
hrs	hours (clock time as in 1200 hrs)
HP	high pressure
hPa	hectopascal (equivalent unit to mb)
IAS	indicated airspeed
IFR	Instrument Flight Rules
ILS	Instrument Landing System
IMC	Instrument Meteorological Conditions
IP	Intermediate Pressure
IR	Instrument Rating
ISA	International Standard Atmosphere
kg	kilogram(s)
KCAS	knots calibrated airspeed
KIAS	knots indicated airspeed
KTAS	knots true airspeed
km	kilometre(s)

kt	knot(s)
lb	pound(s)
LP	low pressure
LAA	Light Aircraft Association
LDA	Landing Distance Available
LPC	Licence Proficiency Check
m	metre(s)
mb	millibar(s)
MDA	Minimum Descent Altitude
METAR	a timed aerodrome meteorological report
min	minutes
mm	millimetre(s)
mph	miles per hour
MTWA	Maximum Total Weight Authorised
N	Newtons
N_R	Main rotor rotation speed (rotorcraft)
N_g	Gas generator rotation speed (rotorcraft)
N_1	engine fan or LP compressor speed
NDB	Non-Directional radio Beacon
nm	nautical mile(s)
NOTAM	Notice to Airmen
OAT	Outside Air Temperature
OPC	Operator Proficiency Check
PAPI	Precision Approach Path Indicator
PF	Pilot Flying
PIC	Pilot in Command
PM	Pilot Monitoring
POH	Pilot's Operating Handbook
PPL	Private Pilot's Licence
psi	pounds per square inch
QFE	altimeter pressure setting to indicate height above aerodrome
QNH	altimeter pressure setting to indicate elevation amsl
RA	Resolution Advisory
RFFS	Rescue and Fire Fighting Service
rpm	revolutions per minute
RTF	radiotelephony
RVR	Runway Visual Range
SAR	Search and Rescue
SB	Service Bulletin
SSR	Secondary Surveillance Radar
TA	Traffic Advisory
TAF	Terminal Aerodrome Forecast
TAS	true airspeed
TAWS	Terrain Awareness and Warning System
TCAS	Traffic Collision Avoidance System
TODA	Takeoff Distance Available
UA	Unmanned Aircraft
UAS	Unmanned Aircraft System
USG	US gallons
UTC	Co-ordinated Universal Time (GMT)
V	Volt(s)
V_1	Takeoff decision speed
V_2	Takeoff safety speed
V_R	Rotation speed
V_{REF}	Reference airspeed (approach)
V_{NE}	Never Exceed airspeed
VASI	Visual Approach Slope Indicator
VFR	Visual Flight Rules
VHF	Very High Frequency
VMC	Visual Meteorological Conditions
VOR	VHF Omnidirectional radio Range

Air Accidents Investigation Branch