COMANDO DA AERONÁUTICA

CENTRO DE INVESTIGAÇÃO E PREVENÇÃO DE ACIDENTES AERONÁUTICOS

FINAL REPORT
IG - 505/CENIPA/2021

OCCURRENCE:	**SERIOUS INCIDENT**
AIRCRAFT:	**PR-SSK**
MODEL:	**A109E**
DATE:	**20FEB2011**

NOTICE

According to the Law nº 7565, dated 19 December 1986, the Aeronautical Accident Investigation and Prevention System – SIPAER – is responsible for the planning, guidance, coordination and execution of the activities of investigation and prevention of aeronautical accidents.

The elaboration of this Final Report was conducted taking into account the contributing factors and hypotheses raised. The report is, therefore, a technical document which reflects the result obtained by SIPAER regarding the circumstances that contributed or may have contributed to triggering this occurrence.

The document does not focus on quantifying the degree of contribution of the different factors, including the individual, psychosocial or organizational variables that conditioned the human performance and interacted to create a scenario favorable to the accident.

The exclusive objective of this work is to recommend the study and the adoption of provisions of preventative nature, and the decision as to whether they should be applied belongs to the President, Director, Chief or the one corresponding to the highest level in the hierarchy of the organization to which they are being forwarded.

This Final Report has been made available to the ANAC and the DECEA so that the technical-scientific analyses of this investigation can be used as a source of data and information, aiming at identifying hazards and assessing risks, as set forth in the Brazilian Program for Civil Aviation Operational Safety (PSO-BR).

This Report does not resort to any proof production procedure for the determination of civil or criminal liability, and is in accordance with Appendix 2, Annex 13 to the 1944 Chicago Convention, which was incorporated in the Brazilian legal system by virtue of the Decree nº 21713, dated 27 August 1946.

Thus, it is worth highlighting the importance of protecting the persons who provide information regarding an aeronautical accident. The utilization of this report for punitive purposes maculates the principle of "non-self-incrimination" derived from the "right to remain silent" sheltered by the Federal Constitution.

Consequently, the use of this report for any purpose other than that of preventing future accidents, may induce to erroneous interpretations and conclusions.

N.B.: This English version of the report has been written and published by the CENIPA with the intention of making it easier to be read by English speaking people. Taking into account the nuances of a foreign language, no matter how accurate this translation may be, readers are advised that the original Portuguese version is the work of reference.

SYNOPSIS

This is the Final Report of the 20FEB2011 serious incident with the A109E aircraft model, registration PR-SSK. The accident was classified as “[SCF-NP] System/Component Failure or Malfunction Non-Powerplant – With Flight Controls and [LOC-I] Loss of Control in Flight”.

During the take-off positioning, while hovering in the parking area, the tail rotor lost efficiency due to the detachment of components from its drive shaft. The helicopter started an abrupt 180º turn to the right, followed by an emergency landing commanded by the pilot.

The aircraft had minor damage restricted to the tail rotor drive system.

The pilot and passengers left unharmed.

An Accredited Representative of the *Agenzia Nazionale per la Sicurezza del Volo* (ANSV) - Italy, (State where the aircraft was designed) was designated for participation in the investigation.

CONTENTS

GLOSSARY OF TECHNICAL TERMS AND ABBREVIATIONS 5

1. FACTUAL INFORMATION. 6

1.1 History of the flight. 6
1.2 Injuries to persons. 6
1.3 Damage to the aircraft. 6
1.4 Other damage. 6
1.5 Personnel information. 6
1.5.1 Crew's flight experience. 6
1.5.2 Personnel training. 7
1.5.3 Category of licenses and validity of certificates. 7
1.5.4 Qualification and flight experience. 7
1.5.5 Validity of medical certificate. 7
1.6 Aircraft information. 7
1.7 Meteorological information. 13
1.8 Aids to navigation. 13
1.9 Communications. 13
1.10 Aerodrome information. 14
1.11 Flight recorders. 14
1.12 Wreckage and impact information. 14
1.13 Medical and pathological information. 14
1.13.1 Medical aspects. 14
1.13.2 Ergonomic information. 14
1.13.3 Psychological aspects. 14
1.14 Fire. 14
1.15 Survival aspects. 14
1.16 Tests and research. 14
1.17 Organizational and management information. 15
1.18 Operational information. 16
1.19 Additional information. 16
1.20 Useful or effective investigation techniques. 16

2. ANALYSIS. 16

3. CONCLUSIONS. 18

3.1 Facts. 18
3.2 Contributing factors. 18

4. SAFETY RECOMMENDATION. 19

5. CORRECTIVE OR PREVENTATIVE ACTION ALREADY TAKEN. 19

GLOSSARY OF TECHNICAL TERMS AND ABBREVIATIONS

AD	Airworthiness Directive
ANAC	Brazil's National Civil Aviation Agency
ANSV	Agenzia Nazionale per la Sicurezza del Volo
AW	AgustaWestland
AWdB	AgustaWestland of Brazil
CA	Airworthiness Certificate
CENIPA	Aeronautical Accident Investigation and Prevention Center
CMA	Aeronautical Medical Certificate
EASA	European Union Aviation Safety Agency
IFRH	Instrument Flight Rating - Helicopter
OM	Maintenance Organization
PIC	Pilot in Command
PLH	Airline Pilot License – Helicopter
PN	Part Number
PPH	Private Pilot License – Helicopter
SBMT	ICAO Location Designator – Campo de Marte Aerodrome, São Paulo - SP
SDDW	ICAO Location Designator - Marina Verolme Helipad, Angra dos Reis - RJ
SEM	Structural Repair Manual
SIPAER	Aeronautical Accident Investigation and Prevention System
SRM	Structural Repair Manual
SN	Serial Number
TPP	Registration Category of Private Service
UTC	Universal Time Coordinated

1. FACTUAL INFORMATION.

Aircraft	**Model:** A109E **Registration:** PR-SSK **Manufacturer:** Agusta S.p.A	**Operator:** *Casa Bahia Comercial* LTD.
Occurrence	**Date/time:** 20FEB2011 - 1820 UTC **Location:** Marina Verolme Helipad **Lat.** 22°59'53"S **Long.** 044°14'55"W **Municipality – State:** Angra dos Reis – RJ	**Type(s):** "[SCF-NP] System/Component Failure or Malfunction Non-Powerplant and [LOC-I] Loss of Control in Flight" **Subtype(s):** With Flight Controls

1.1 History of the flight.

The aircraft was preparing to take off from an unregistered location in Angra dos Reis - RJ to the Campo de Marte Aerodrome (SBMT), São Paulo - SP, at about 1820 (UTC), to transport personnel, with a Pilot in Command (PIC) and two passengers on board.

During the hover, inside the parking area, the PIC applied the left pedal to reposition the aircraft and start the taxi to the take-off position. When performing the maneuver, the pilot noticed the left pedal sinking and, at the same time, an abnormal noise. In the next instant, the aircraft began a rapid right turn.

The pilot performed the collective lowering, and the aircraft turned 180 degrees until the first touchdown with the landing gear, followed by a turn of another 40 degrees until it came to a complete stop.

The aircraft had minor damage, and the occupants left unharmed.

1.2 Injuries to persons.

Injuries	Crew	Passengers	Others
Fatal	-	-	-
Serious	-	-	-
Minor	-	-	-
None	1	2	-

1.3 Damage to the aircraft.

The aircraft had only minor damage to the tail rotor drive system.

1.4 Other damage.

None.

1.5 Personnel information.

1.5.1 Crew's flight experience.

Flight Hours	PIC
Total	8.000:00
Total in the last 30 days	40:00
Total in the last 24 hours	03:00
In this type of aircraft	1.200:00
In this type in the last 30 days	40:00
In this type in the last 24 hours	03:00

N.B.: The data related to the flown hours were obtained through the pilot's statement.

1.5.2 Personnel training.

The PIC took the PPH course at the *Santana Escola de Pilotagem*, in 1982.

1.5.3 Category of licenses and validity of certificates.

The PIC had a PLH License and had a valid A109 aircraft type Rating (which included the A109E model) and an IFRH Rating.

1.5.4 Qualification and flight experience.

The PIC was qualified and had experience in the kind of flight.

1.5.5 Validity of medical certificate.

The PIC had a valid CMA.

1.6 Aircraft information.

The aircraft, serial number 11671, was manufactured by Agusta S.p.A, in 2006, and was registered in the TPP Category.

The aircraft's CA was valid.

The airframe and engine logbook records were updated.

The aircraft manufacturer made available, in the Maintenance Planning Manual, three inspection program plans; Standard Inspection Program, Extended Inspection Program, and Progressive Inspection Program.

The operator chose to comply with the Extended Inspection Program which consisted of a 50-hour/30-day basic inspection, 200-hour inspection, 400-hour inspection, 800-hour inspection, 3,200-hour inspection, and 12-month inspection.

The last aircraft inspection, the “50 hours/30 days” type, was carried out on 22JAN2011, by a qualified mechanic, with the aircraft having 1.844 hours and 36 minutes in total and 32 hours and 48 minutes flown after the inspection.

On 04NOV2010, a 200-hour inspection was performed on the aircraft. On that occasion, the Long Section safety pin of the tail rotor drive shaft was checked, without any records of abnormalities.

The aircraft had not reached the operating time for the largest and most comprehensive inspection planned by the manufacturer, which would be performed within 3,200 hours.

The aircraft had, at the time of the occurrence, 1.877 hours and 24 minutes of operation and 10.339 landings.

Description of the tail rotor drive system.

The tail rotor drive system received engine power through the main transmission by the drive shaft and a 90º Gearbox. This Gearbox enabled a 90º change of drive direction and a 2.8 to 1 reduction between the input and output shafts.

The system included a tail rotor drive shaft (divided into three sections); a 90° Gearbox, and a monitoring system (Figure 1).

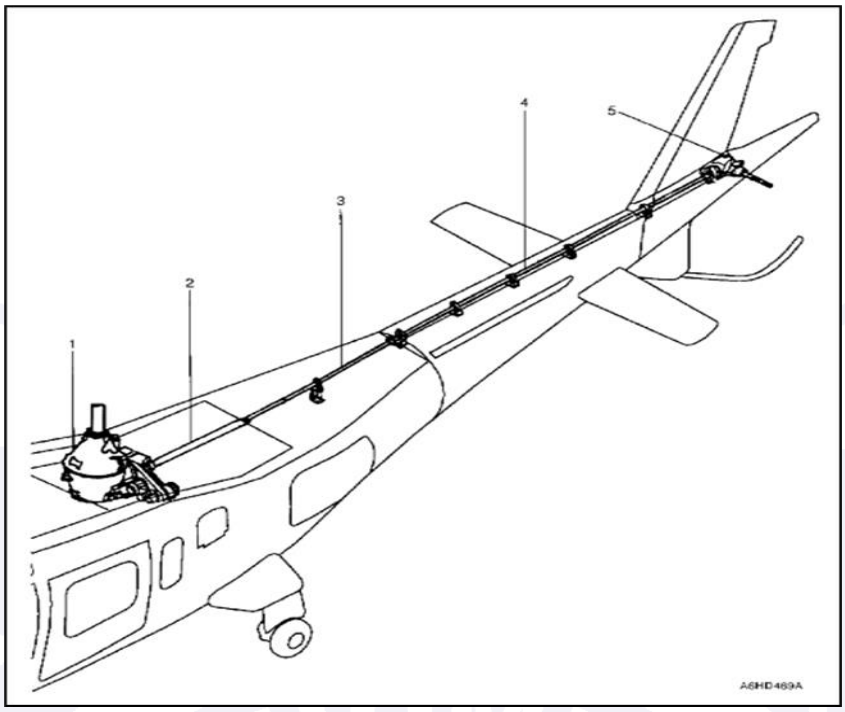

Figure 1 - Tail rotor drive system components: (1) Main Transmission; (2) Forward Section; (3) Middle Section; (4) Long Section and (5) 90º Gearbox.

The three sections of the tail rotor drive shaft were the Forward, Middle, and Long sections, and there were seven sets of brackets called Hanger.

The drive shaft sections were joined using adapters and the Thomas couplings.

The Middle and Long sections had, at one end, slots for coupling and, at the other end, an adapter fixed to the shaft using adhesive, which guaranteed the locking of the set, allowing the transmission of both rotational movement and small longitudinal movements.

In the Long Section, the adapter fixed at one end of the shaft had a hole through it, where a safety pin with a cotter pin was inserted.

This safety pin underwent periodic inspections and must have freedom of rotational movement.

In the event of a detachment or failure of the adhesive, the safety pin would suffer stresses, which could be identified in the scheduled inspection. The pin was not considered a structural component. This function was performed exclusively by the adhesive.

The safety pin inspection frequency was 200 hours, according to the operator-defined inspection program (Extended Inspection Program), and no discrepancies were registered in the records of compliance with this inspection.

In this case, the failure occurred at the end of the Long Section, where the adapter was installed. The adhesive was not able to maintain the rigidity of the fixture and allowed the shaft to rotate in relation to the adapter, also causing the pin to split.

Major repairs to the aircraft before the occurrence

In November 2009, with the aircraft at 1.608 hours and 48 minutes and 8.825 cycles, during the second inspection of 800 hours, which took place at the facilities of the Maintenance Organization (OM) AgustaWestland do Brasil (AWdB) - manufacturer representative, damage to the Tail Boom, below the support of bearing nº 4 of the tail rotor drive shaft was identified (Figures 2 to 5).

Figure 2 - Tail Boom region where the crack was found.

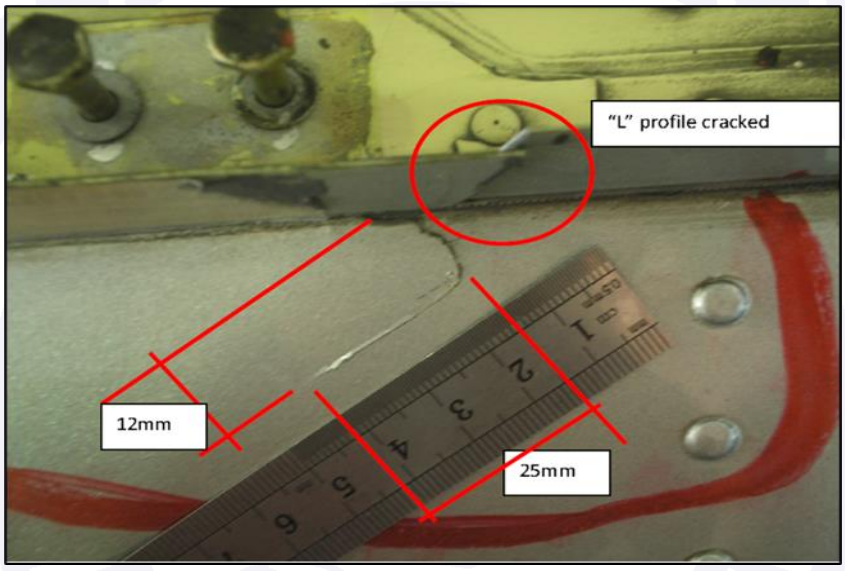

Figure 3 - "L" profile and cracked tail boom surface.

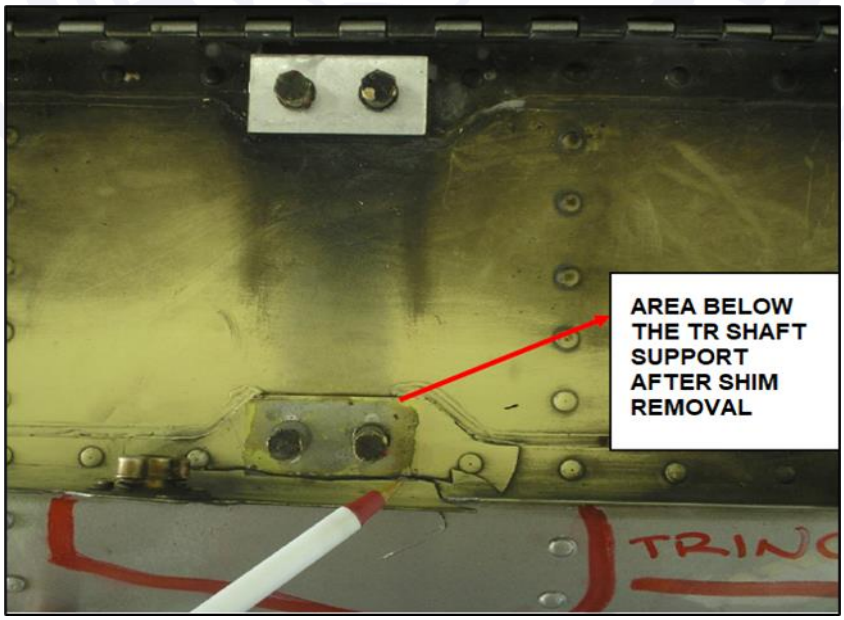

Figure 4 - Crack located below the tail rotor drive shaft support.

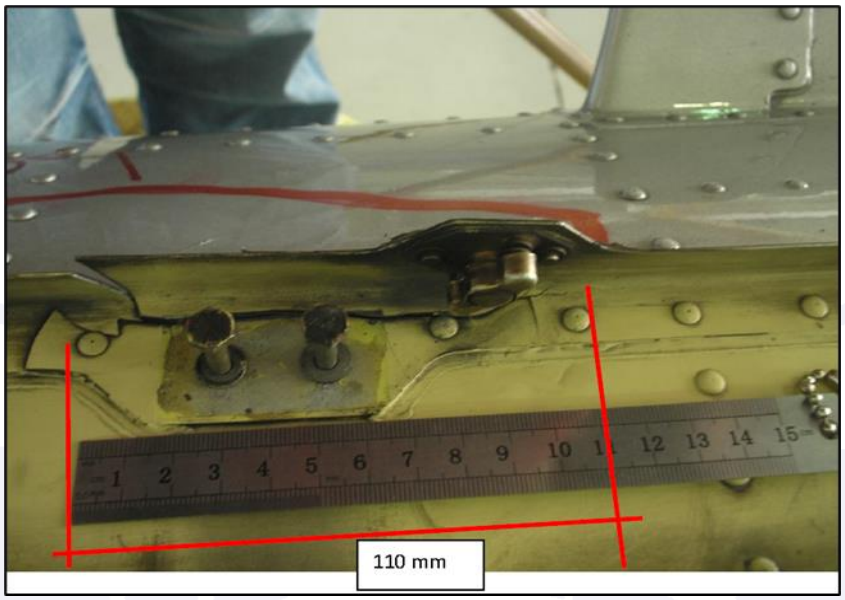

Figure 5 - Crack length along the longitudinal axis.

In an interview with the OM officials, it was reported that the crack was discovered when they heard an abnormal noise at the moment they moved the helicopter's main rotor while they were placing the aircraft inside the hangar.

During the investigation of the noise's origin, the mechanics identified that it came from the friction between the parts of the crack below the support of bearing nº 4, and it was not possible to determine the beginning of the crack or the time of its propagation.

Initially, the OM consulted the SEM, issued by the aircraft manufacturer, to verify the existence of technical instructions to guide the repair. However, the SRM did not contain repair instructions that adequately covered the location and type of damage found.

As there is no provision for this type of repair, the OM presented a proposal for procedures to remedy the damage based on the procedures contained in the SRM, Section 4-2-26 (Tail Boom Skin - Repair) and requested guidance from the engineering company. This proposal was accepted and deemed adequate, with the manufacturer's recommendation that special attention is paid to shaft alignment after service.

The repair procedure proposed by the OM and accepted by the manufacturer was not submitted for approval by the ANAC.

Also, the engineering project, or equivalent document, issued by the manufacturer was not presented to the researchers. Likewise, it was not stated in the repair instructions established by the manufacturer whether there would be implications for the continued airworthiness of the aircraft due to the repair performed or if there would be any procedure to verify possible hidden failures as a consequence of the identified damage.

The OM performed the repair in accordance with what it had suggested to the manufacturer. However, the repair was redone without consulting the manufacturer and without any record of approval of this new procedure.

The repair procedure prevised in the SRM consisted of placing a plate above and another below the crack, as shown in Figures 6 and 7.

PROCEDURE
(Fig. 4-2-26)

A. Remove paint from damaged area. Refer to the applicable Maintenance Manual.

B. Stop drill crack with holes dia. 1.8 - 2 mm.

C. Prepare a plate using 2024T3 AMS-QQ-A-250/5 thickness 0.51 mm for the internal side of tail boom of suitable dimension to overlap the area with crack, as shown in figure.

D. Prepare a plate using 2024T3 AMS-QQ-A-250/5 thickness 0.81 mm for the external side of tail boom of suitable dimension to overlap the area with crack, as shown in figure.

E. Deburr then clean the area, internal and external sides, and plates with solvent (LCM037).

F. Position the plates in place an countermark the rivets holes position.

G. Remove plates and drill holes for rivets.

H. Deburr and clean the area with solvent (LCM037).

I. Apply sealant (LCM062) on mating surfaces then position the plates in place and secure by rivets as shown in figure.

J. Bond and seal all-around with sealant (LCM062).

Figure 6 - Procedure prevised in the SRM, Section 4-2-26.

Figure 7 - Repair performed in accordance with the manufacturer's authorization.

Among other procedures, a cut was made on the surface of the Tail Boom, which was replaced by a new metal plate (Figures 8 and 9).

Figure 8 - Image of the external view of the redone repair.

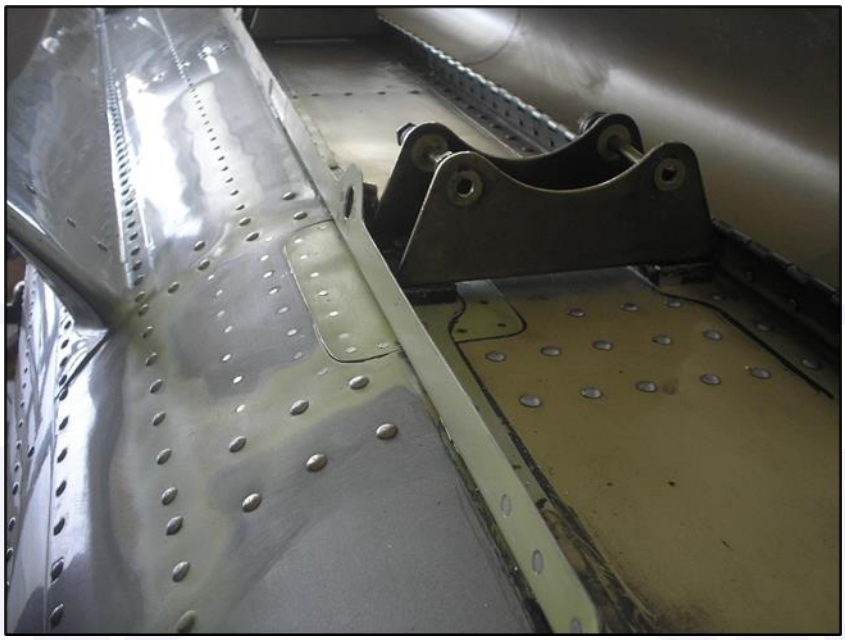

Figure 9 - Repair modified by maintenance.

After the service, form SEGVOO 001 - Major Modification/Repair Record was issued, citing that the technical data used were only those of the SRM, Section 4-2-26 (Tail Boom Skin - Repair) and 3-12 (Tail Rotor Hanger Bearing Supports Alignment Procedure). This document contained the alignment of the support. However, there was no record of this procedure in the repair work order.

It is important to mention that section 4-2-26 of the SRM was developed for a typical repair on the Tail Boom surface and not for a region where the tail shaft bearing support was fixed and, also, the mentioned repair did not foresee the cutout of the plate where there was the crack.

It also contained, in section 3-6-4 of the SRM (Doubler Repair of Skins and Webs), limitations regarding the type of repair on the surface of the Tail Boom, restricting the service to damage whose edge was at least 50 mm from the nearest adjacent structure (Figure 10).

3-6-4. DOUBLER REPAIR OF SKINS AND WEBS
(Fig. 3-28)

A. APPLICATION.
For repair of damaged aluminium webs and skins.

B. RESTRICTIONS.

(1) Edge of damage must be a minimum of 50 mm from nearest adjacent structure, after clean-up.

(2) Minimum distance between repair cleanup areas is 100 mm.

(3) Damage limited to a maximum of 20 percent of the skin area after clean-up.

(4) Overlapping of repair doublers is not permitted.

Figure 10 - Tail Boom surface repair restrictions.

In the event, the fissure boundary was less than 20 mm from two of the Tail Boom caves (Figures 11 and 12).

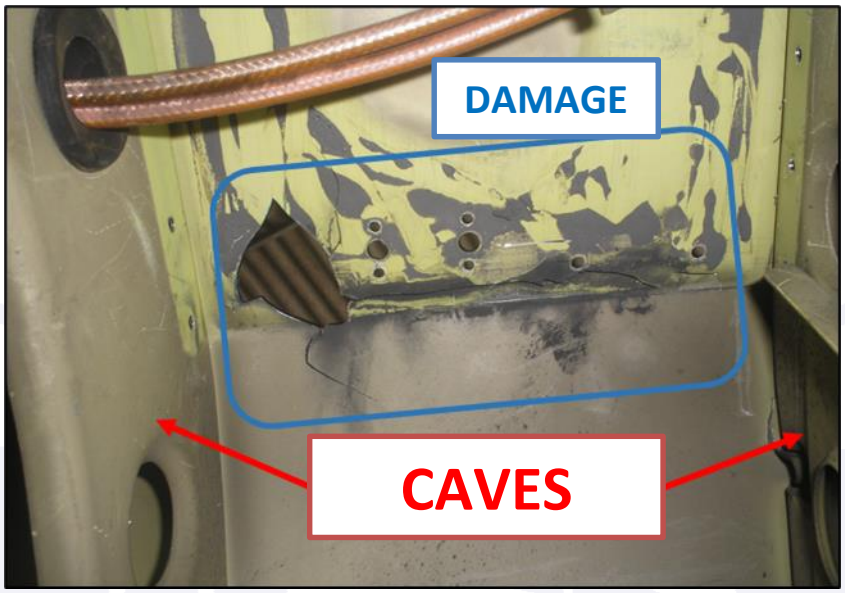

Figure 11 - Internal image of the Tail Boom showing the damage, highlighting the position of the caves.

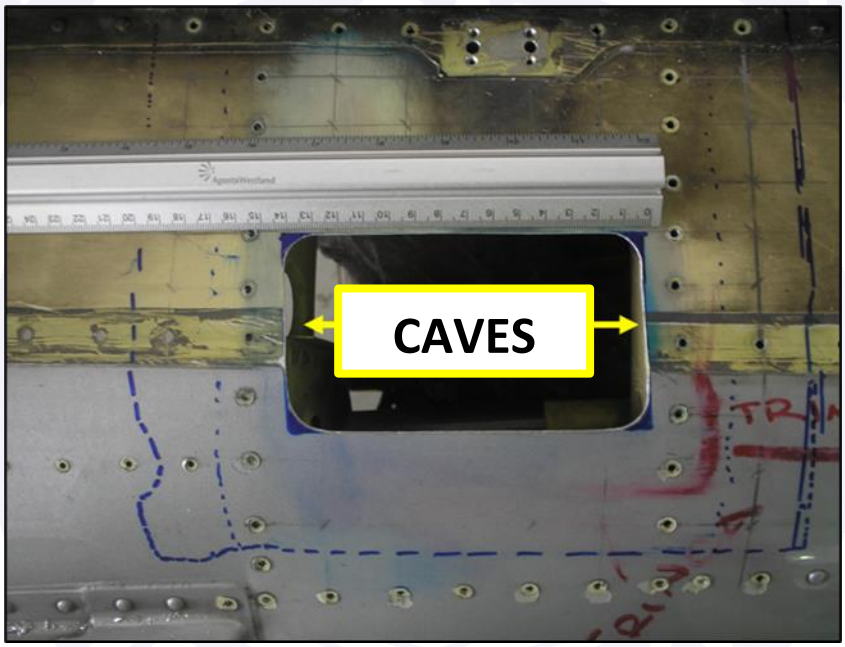

Figure 12 - Image of the cutting in the Tail Boom, highlighting the position of the caves.

Upon completion of the repairs, in December 2009, the aircraft was approved for service return, maintaining the tail rotor drive shaft that was previously installed on the aircraft.

1.7 Meteorological information.

Nil.

1.8 Aids to navigation.

Nil.

1.9 Communications.

Nil.

1.10 Aerodrome information.

At the time of the occurrence, the helipad was not registered, having only been opened to air traffic on 30MAY2012, through the ANAC Ordinance No. 1067/SAI, of 29MAY2012, receiving the designation SDDW - Private Helipad Marina Verolme, Angra dos Reis - RJ.

The place had 21 x 21 m, of grass, with an altitude of 13 ft. and approach heading 110º.

1.11 Flight recorders.

Neither required nor installed.

1.12 Wreckage and impact information.

The damage to the aircraft was restricted to the internal parts of the tail rotor drive shaft, without the visual presentation of wreckage (Figure 13).

Figure 13 - Aircraft after the occurrence.

1.13 Medical and pathological information.

1.13.1 Medical aspects.

Nil.

1.13.2 Ergonomic information.

Nil.

1.13.3 Psychological aspects.

Nil.

1.14 Fire.

There was no fire.

1.15 Survival aspects.

Nil.

1.16 Tests and research.

During the analysis of the internal parts of the Tail Boom, it was identified the detachment, due to degradation, of the adhesive used in the junction of the semi-parts of

the tail rotor drive shaft, between the Long Shaft and the adapter, with the rupture of the safety pin.

In order to determine possible material failures that could have occurred in the tail rotor drive shaft, examinations, tests and research were carried out at the facilities of AgustaWestland (AW) in Italy, which issued the following analysis:

- Color change on axis

A small area of the shaft was cleaned to remove the apparent color change in the paint and the possibilities of thermal and chemical interference in the material were discarded.

- Axis marks

The analysis confirmed that the identified risks corresponded to the position of the prisms used in the alignment procedure performed at the AWdB after the accident, with no relation to the event.

- General conditions of the Thomas Coupling

The coupling was inspected and the torque values of the two bolts were verified and found to be within specifications. All coupling parts were dismantled and inspected using a stereo microscope. They were considered to be in good condition.

- Axis alignment

The shaft was analyzed to verify that the alignment procedure complied with the AW procedure. The measurement showed slightly different values than the measurement previously performed on the AWdB. However, they were still within the expected specifications.

- Shaft dimensions

The recorded measurements of shaft and adapter diameters were verified and were within design tolerances.

- Quality of the adhesive and the production process

In order to assess the quality of the adhesive and the bonding procedure of the damaged set, an ultrasonic inspection was performed on the undamaged front adapter, and no evidence of detachment was found.

According to the manufacturer, in the manufacturing process, both the rear and front adapters were glued with the same prepared material, following the same quality criteria. Therefore, if deficiencies were present in the inspected adapter, whether in the adhesive material or the process, there would be a suggestion of a possible similar failure in the failed adapter.

- Analysis of damaged parts with a stereo microscope

In the analysis of failures on the external surface of the damaged shaft, residues of adhesive material were found. The presence of adhesive residue was confirmed on the inner surface of the detached adapter. Also, on the surfaces of the shaft and adapter, there were traces of treatment and preparation for bonding, denoted by the reduced presentation of microvoids.

The front axle adapter was sectioned to check its bonding condition and then its connection was mechanically undone. The adhesive remained almost completely adhered to the shaft surface.

1.17 Organizational and management information.

Nil.

1.18 Operational information.

The aircraft was within the weight and balance limits specified by the manufacturer.

At the time of the occurrence, the aircraft was hovering inside the parking area. The pilot, when pressing the left pedal to reposition the aircraft, heard a noise outside the cabin. Simultaneously, the left pedal went to the bottom, and the helicopter started an abrupt right turn.

Instinctively, the pilot lowered the collective in order to return to the ground, and the aircraft made a turn of approximately 180 degrees before touching the grass. The left main landing gear was the first to touch the ground, followed by the nose wheel. Still, the helicopter turned about 40 degrees to a complete stop.

The pedal sinking was due to the disconnection of the tail rotor drive shaft. From that moment, there was a loss of directional control of the aircraft.

1.19 Additional information.

After the occurrence, repairs were performed on the aircraft, with the replacement of the damaged axle. Then the aircraft was transferred to the AWdB shop.

On 02MAR2011, a check of alignment of the Tail Boom supports was carried out. Bearing support n°4 was found to be 1 mm out of alignment, despite having been aligned in November 2009 (Figure 14).

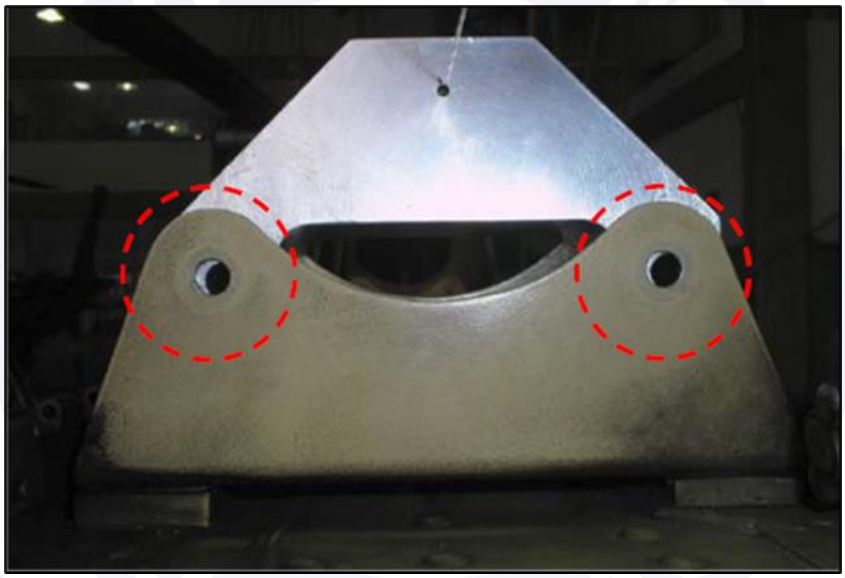

Figure 14 - Bearing support n°4 out of alignment.

On that occasion, a discrepancy in the torques applied to the support screws was observed, which were approximately twice the predicted value of 20 to 25 lb/in².

1.20 Useful or effective investigation techniques.

Nil.

2. ANALYSIS.

It was a private flight to transport personnel.

During the hover, before the take-off, there was a loss of actuation of the tail rotor, which led the aircraft to lose control. The helicopter turned sharply to the right and the PIC fully lowered the collective to return to the ground.

The Investigation Team verified that the loss of performance of the tail rotor was due to the detachment of the semi-parts of its drive shaft, between the Long Shaft and the

adapter, and discarded the contribution of the actuation in the controls, as well as any meteorological adverse factor.

It was found that, in November 2009, a repair of cracks had been carried out in the Tail Boom, below the support of bearing nº 4, however, on that occasion, the origin of these cracks was not verified, nor how long the support was operating misaligned from the shaft.

It was not stated in the repair instructions established by the manufacturer whether there would be implications for the continued airworthiness of the aircraft due to the repair performed or if there would be any procedure to verify possible hidden failures as a consequence of the identified damage.

In addition to not having verified such impacts, the service authorized by the manufacturer was not the same performed on the aircraft. The authorization prevised a service based on section 4-2-26 of the SRM, including the placement of an external and an internal metal plate to the Tail Boom, accommodating the damaged area between the two, among other procedures.

This type of repair was initially followed by maintenance and, later, it was redone, cutting the damaged area and replacing part of the sheet. No documentation was presented authorizing the modification of the procedure that had been previously agreed between the OM and the manufacturer, nor was this recorded in the aircraft's records.

The service was likely redone due to the repaired area being located exactly where the support was supported, thus making axle alignment difficult, due to the unevenness caused in the Tail Boom surface.

After the repair, the manufacturer requested the alignment of the supports, which was declared in SEGVOO-001. However, in the repair work order, there was no indication of the service being performed.

On 04NOV2010, during a 200-hour inspection, the Long Section safety pin of the tail rotor drive shaft was checked, and no abnormality was recorded. Thus, it is assumed that there was freedom of movement of the latter, as predicted.

Regarding the occurrence, it was verified that the detachment of the semi-parts of the tail rotor drive shaft occurred due to the degradation of the adhesive used in the joint, with the consequent sectioning of the Long Section safety pin.

During the repair services, after the occurrence, there was a misalignment of 1mm in the support nº 4, which supposedly had been aligned in 2009, due to the repair of the Tail Boom cracks. In this evaluation, it was observed that there was also a discrepancy in the torques applied to the support screws, which were approximately twice the value due.

In the manufacturer's analysis, after the occurrence, it was verified that the adhesive material did not present any deficiency in the product or in its application that would indicate that the detachment occurred due to a manufacturing deficiency.

Thus, it was concluded that the cracks on the surface of the Tail Boom, in the region of bearing nº 4, allowed an unforeseen movement of the support, which may have allowed an orbital movement of the shaft.

This mobility has likely caused a minimum, but important displacement of the tail rotor drive axis in the longitudinal direction, causing, in the adapter adhesive, efforts in unforeseen directions above its limits, which provoked its weakening and fissures that, with time, increased exponentially.

It is also possible that, after the alignment service performed during the Tail Boom repair, the plate installed to replace the area with the cracks had worked, moving and misaligning the support nº 4.

Thus, the most likely hypothesis to explain the detachment of the adhesive from the Long Shaft adapter and the consequent loss of performance of the tail rotor was due to the cracks in the surface of the Tail Boom, combined with a misalignment of the support nº 4, which caused unforeseen efforts in the adhesive.

The Investigation Team concluded that the repair of the cracks in the Tail Boom, below support nº 4, contributed to the occurrence since it did not follow the procedures authorized by the aircraft manufacturer. In addition, possible hidden failures were not taken into account due to the movement of support nº 4 while there were cracks in the Tail Boom and, therefore, there was no replacement of the tail rotor drive shaft when performing the repair service.

Finally, the support alignment task, although registered in SEGVOO 001, was not entered in the service order, which denotes an inadequacy in the OM's management supervision, which may also have contributed to this occurrence.

3. CONCLUSIONS.

3.1 Facts.

a) the pilot had a valid CMA;

b) the pilot had valid aircraft type A109 (which included model A109E) and IFRH Ratings;

c) the pilot was qualified and had experience in the type of flight;

d) the aircraft had a valid CA;

e) the aircraft was within the weight and balance limits;

f) the airframe and engine logbook records were updated;

g) the weather conditions were favorable for the flight;

h) in the second inspection of 800 hours, cracks were found in the Tail Boom in the area of support nº 4;

i) the repairs carried out at the time did not take into account the extent of damage caused to the shaft by the cracks in the Tail Boom;

j) there was no record, in the service order, reporting the alignment of the supports;

k) the maintenance performed on the aircraft, when repairing the tail boom cracks, was performed in a manner different from that authorized by the manufacturer;

l) during the hover, before the take-off, the pilot stepped on the left pedal and the aircraft started a violent directional turn to the right;

m) the pilot immediately performed the lowering of the collective and the aircraft turned 180 degrees until the first touchdown with the landing gear, followed by a turn of more 40 degrees until the total stop;

n) in the maintenance, after the occurrence, a misalignment of 1 mm of the support nº 4 was observed;

o) the aircraft had minor damage; and

p) the pilot and the passengers left unharmed.

3.2 Contributing factors.

- **Aircraft maintenance – a contributor.**

On the occasion of the repair of the Tail Boom cracks, the procedures previously agreed with the manufacturer were not followed, in addition to not having taken into account

the possible hidden failures due to the movement of support nº 4 resulting from the identified cracks.

Thus, the inadequacy of the maintenance services performed contributed to the detachment of the adhesive from the Long Shaft adapter and the consequent loss of performance of the tail rotor, with the shear of the Long Section pin.

- **Managerial oversight – undetermined.**

Failure to record the support alignment task after the crack repair service; the failure to consider the possible hidden failures, due to the operation of the aircraft while there were cracks in the Tail Boom and the failure to replace the tail rotor drive shaft, after the repair service, denoted inadequacies of the OM's management supervision, in the technical scope, which may also have contributed to this occurrence.

4. SAFETY RECOMMENDATION.

A proposal of an accident investigation authority based on information derived from an investigation, made with the intention of preventing accidents or incidents and which in no case has the purpose of creating a presumption of blame or liability for an accident or incident. In addition to safety recommendations arising from accident and incident investigations, safety recommendations may result from diverse sources, including safety studies.

In consonance with the Law n°7565/1986, recommendations are made solely for the benefit of the air activity operational safety, and shall be treated as established in the NSCA 3-13 "Protocols for the Investigation of Civil Aviation Aeronautical Occurrences conducted by the Brazilian State".

Nil.

5. CORRECTIVE OR PREVENTATIVE ACTION ALREADY TAKEN.

Soon after the occurrence, on 25FEB2011, the EASA, in preventive action, issued an Emergency Airworthiness Directive (AD) nº 2011-0031-E, which determined that operators of A109E aircraft, of all serial numbers equipped with Part Number (PN) 109-8412-02-1 and 109-8412-02-3 tail rotor drive shafts to perform an inspection of the axle safety pin to check its freedom of movement, with consequent axle replacement if there was no looseness.

During the investigation, the EASA concluded that the detachment was a one-off failure, issuing, on 26JUL2011, the AD Cancellation Notice nº 2011-0031-CN, which canceled the aforementioned AD.

On November 3th, 2022.