COMMAND OF AERONAUTICS

AERONAUTICAL ACCIDENT INVESTIGATION AND PREVENTION CENTER

FINAL REPORT
IG - 551/CENIPA/2014

OCCURRENCE:	**SERIOUS INCIDENT**
AIRCRAFT:	**PR-RVC**
MODEL:	**AS-350B3**
DATE:	**21 JULY 2012**

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 Report does not resort to any proof production procedure for the determination of civil or criminal liability, and is in accordance with item 3.1, 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.

CONTENTS

SYNOPSIS

This is the Final Report of the serious incident involving the AS350 B3 aircraft, registration PR-RVC, on 21 July 2012. The incident was classified as “rotor-related”.

During the en-route phase of the flight, with the aircraft at an altitude of 4,500ft (FL045), the pilot felt a vibration in the control pedals of the tail rotor, and shortly after the vibration intensity had an increase and began to be perceived in the cockpit.

The pilot decided to make an emergency landing in a football pitch.

The aircraft occupants (two passengers and the pilot) got out uninjured.

The aircraft sustained substantial damage to the laminated half-bearings of the tail rotor blades.

An accredited representative of the French BEA (*Bureau d'Enquêtes et d'Analyses pour la Securité de l’Aviation*) was designated for participation in the investigation.

GLOSSARY OF TECHNICAL TERMS AND ABBREVIATIONS

ABRAPHE	Brazilian Helicopter Pilots Association
AD	Airworthiness Directive
ANAC	(Brazil's) National Civil Aviation Agency
APPA	Aircraft Owners and Pilots Association
ASB	Alert Service Bulletin
ATS	Air Traffic Services
BEA	*Bureau d'Enquêtes et d'Analyses pour la Securité de l'Aviation*
CENIPA	Aeronautical Accident Investigation and Prevention Center
CHT	Technical Qualification Certificate
CMA	Aeronautical Medical Certificate
DA	Airworthiness Directive
DSC	Analysis by means of Thermogravimetry
EASA	European Aviation Safety Agency
FAA	Federal Aviation Administration
IAE	Institute of Aeronautics and Space
INVH	Flight Instructor – Helicopter category
Lat	Latitude
Long	Longitude
PCH	Commercial Pilot – Helicopter category
PPH	Private Pilot – Helicopter category
PPR	Private Pilot – Airplane category
SERIPA	Regional Aeronautical Accidents Investigation and Prevention Service
SIPAER	Aeronautical Accidents Investigation and Prevention System
SIN	Safety Information Notice
SNPC	ICAO Location designator – Picos Aerodrome, State of Piauí
TGA	Analysis by means of Differential Scanning Calorimetry (DSC)
TPP	Private Air Services
UTC	Coordinated Universal Time

AERONAVE	**Model:** AS350 B3 **Registration:** PR-RVC **Manufacturer:** Eurocopter	**Operator:** Carvalho & Fernandes
OCORRÊNCIA	**Date/time:** 21 July 2012 / 11:35 UTC **Location:** Town's football pitch **Lat.** 05º48'50"S - **Long.** 042º30'14"W **Municipality - State:** *Barro Duro - Piauí*	**Type:** With rotor

1 FACTUAL INFORMATION

1.1 History of the occurrence

The Aircraft departed from SNPC at 07:45 local time, destined for Teresina, capital city of the State of Piauí, with the pilot and two passengers on board.

Approximately 48 minutes into the flight, with the Aircraft stabilized at FL045 and maintaining an indicated airspeed of about 135kt, the pilot noticed a moderate vibration in the control pedals of the tail rotor.

After approximately 2 minutes in that condition, and noticing that the vibration was increasing, the pilot decided to make an emergency landing in a football pitch located in the municipality of Barro Duro, State of Piauí.

Despite the pilot's difficulty controlling the aircraft, the landing was successful.

1.2 Injuries to persons

Injuries	Crew	Passengers	Third parties
Fatal	-	-	-
Serious	-	-	-
Minor	-	-	-
Uninjured	01	02	-

1.3 Damage to the aircraft

There was substantial damage to the laminated half-bearings of the tail rotor blades.

1.4 Other damage

Nil.

1.5 Personnel information

1.5.1 Information on the crew

HOURS FLOWN	
	PILOT
Total	2,000:00
Total in the last 30 days	10:00
Total in the last 24 hours	05:00
In this type of aircraft	1,000:00
In this type in the last 30 days	10:00
In this type in the last 24 hours	05:00

NB.: Information provided by the pilot.

1.5.1.1 Professional formation

The pilot did his Private Pilot course (airplane category) in the Aeroclube do Amazonas, State of Amazonas, in 1987.

He finished his Private Pilot course (helicopter category) on July 31, 2001.

1.5.1.2 Validity and category of licenses and certificates

The pilot had a Commercial Pilot license (helicopter category), and his technical qualifications concerning H350 aircraft, RBHS and Flight Instructor were valid.

1.5.1.3 Qualification and flight experience

The pilot had qualification and enough experience for the type of flight.

1.5.1.4 Validity of the medical certificate

The pilot had a valid Aeronautical Medical Certificate (CMA).

1.6 Aircraft information

The SN 7253 aircraft was manufactured by Helibras in 2012.

The aircraft airworthiness certificate was valid.

The airframe and engine logbooks records were up-to-date.

The last inspection of the aircraft contemplated “various types” and was conducted by an autonomous mechanic accredited by the ANAC. After this inspection, the aircraft flew 41 hours and 50 minutes.

1.7 Meteorological information

Prevailing weather conditions were VMC.

1.8 Navigational aids

Nil.

1.9 Communications

Nil.

1.10 Aerodrome information

Not applicable.

1.11 Flight recorders

Neither required nor installed.

1.12 Wreckage and impact information

Nil.

1.13 Medical and pathological information

1.13.1 Medical aspects

Nil.

1.13.2 Ergonomic information

Nil.

1.13.3 Psychological aspects

Nil.

1.13.3.1 Individual information

Nil.

1.13.3.2 Psychosocial information

Nil.

1.13.3.3 Organizational information

Nil.

1.14 Fire

There was no fire.

1.15 Survival aspects

Nil.

1.16 Tests and research

The four laminated half-bearings (P/N 704A33-633-261) of the Aircraft tail rotor assembly at the moment of the occurrence were sent to the Aeronautics and Space Institute (IAE).

The Division of Materials of the IAE carried out several exams (macroscopic, stereographic, metalographic, and thermal) in the referred component.

In the discussion of the results of the IAE report, the following is found:

- The analysis of the photographs, stereographs and micrographs indicates that there was degradation of the elastomer.

- The observed aspects indicate that the elastomer ended up melting, causing the failure with the interface of the metal blades, as well as the loss of volume and mass of the shock absorbing assembly.

- The metallic blades did not present evidence of weakening or fracture on account of fatigue, and the cause for its failure most likely was most likely due to an overload process. Such process may have been caused by loss of elastomer around the blade.

- The melting of the elastomer can be confirmed by the aspects of dripping found in the vicinity of the shock absorbing assembly, where it was possible to observe the melting of the elastomer and its draining along the surface.

- The analysis of the results obtained from the TGA and DSC tests indicated that the transition temperatures of the elastomer being examined were in accordance with values deemed acceptable by the manufacturer.

- Thus, it was deduced that the elastomer must not have degraded below the temperature to which it was designed to endure.

- Therefore, it can be deduced that some kind of heating occurred in the shocking absorbing assembly, with a source either external or internal.

- Cracks were found in the interface of the blades which had not degraded in the same tail rotor.

- These cracks were compatible with interface defects, which, under the effort of vibration would generate heat due to friction. Such heat is thought to have been sufficient to cause degradation of the elastomer.

1.17 Organizational and management information

The aircraft had been registered in the Private Air Services category.

The pilot was responsible for the issues related to the aircraft, including those pertaining to the maintenance.

1.18 Operational aspects

Approximately 48 minutes into the flight, when the aircraft was stable at FL045, maintaining a speed of 135kt IAS, the pilot felt moderate vibration in the control pedals of the tail rotor.

Roughly two minutes later, the vibration worsened and began to be noticed also in the cockpit.

At the same time, the pilot, observing the onset of a strange noise in the helicopter, lowered the collective and reduced speed. Nevertheless, both the vibration and the noise increased.

The pilot decided to the make an emergency landing in a football pitch located in the municipality of Barro Duro, State of Piauí.

At the moment of landing, the pilot had difficulty maintaining control of the aircraft around the vertical axis (yaw), since, in addition to the excessive vibration of the helicopter airframe, it was necessary to apply the pedals to great extent in order to maintain heading.

Figure 1 – Location of the half-bearings.

The aircraft flight manual prescribed a visual check of the laminated half-bearings during the pre-flight inspection for an evaluation of the general condition of that assembly.

The aircraft had a total of approximately 97 flight hours, and had undergone all pertinent inspections.

During the initial action, the investigating team observed that the four laminated half-bearings had been damaged.

Figure 2 – Overview of the hal-bearing.

Figure 3 – Overview of the elastomer's melting.

The laminated half bearings are devices whose objective is to hold and support the blades of the tail rotor, allowing them to switch the pitch.

They are composed of an elastomeric part covered by a metallic protection, mounted in pairs in the rotor head, in a total of four, being a pair for each blade.

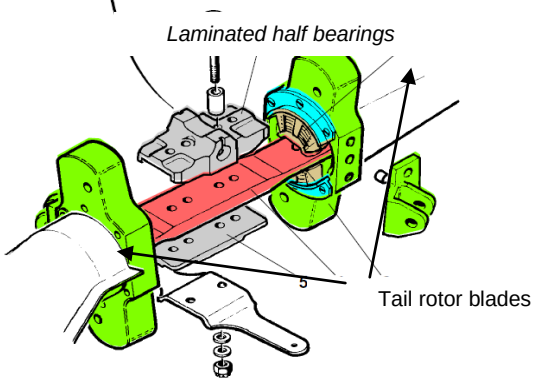

Figure 4 – *Assembly of the laminated half bearings in conjunction with the blades of the tail rotor.*

Besides accompanying the movement of the rotor blades during the shifts of pitch, the laminated half-bearings absorb the efforts and vibrations during high rotation of the rotor, maintaining its stability.

According to the Service Bulletin nº AS350-05.00.71, premature defects in the laminated half-bearings which equip the tail rotor blades were detected in several AS350 B3 helicopters, resulting in extreme structural vibration and, in a few cases, loss of control of the aircraft.

According to the *Airworthiness Directive* (AD) nº 2012-21-51, issued by the *Federal Aviation Administration* (FAA) on 17 October 2012, three cases of vibration originating in the tail rotor were reported during flights of AS350 B3 helicopters, and in all the occurrences the cause of vibration was identified as premature failure of the laminated half-bearings.

Alerted by these facts, Eurocopter had issued the *Safety Information Notice* (SIN) nº 2482-S-64, dated 20 July 2012 (one day before the occurrence of this serious incident).

The afore mentioned SIN refers to several reports of either cracks or defects in the elastomers of tail rotor laminated half-bearings of AS350 B3 e AS 355 NP helicopters, as well as the special attention to be paid to the verification of the elastomeric part of that component after the last flight of the day.

This same SIN contemplated procedures already described in the aircraft flight manual and relative to the external inspection – Station 4 – Tail Rotor Head, including,

among other aspects, the need to check for the presence of deep cracks and emergence (alterations on the surface) after the last flight of the day.

The criteria established for the evaluation of the deep cracks are found in the aircraft maintenance manual: tolerance of one defect per laminated half-bearing limited to a length of 5mm and a depth of 2mm.

On 31 July 2012, in reference to this investigation, the SIPAER issued the Safety Recommendation RSV nº 0235/2012 to the ANAC recommending the agency, based on the analysis of the premature failures of the laminated half-bearings of AS350B3 aircraft, to adopt measures aimed at ascertaining appropriate conditions for the maintenance of continued airworthiness of AS350B3 and AS355 NP aircraft.

On the same date, the SIPAER made the Safety Recommendation RSV nº 0236/2012 to the ANAC recommending the agency to issue an Airworthiness Directive (based on the SIN nº 2482-S-64 from the Eurocopter) aiming at establishing mandatory compliance with the procedures related to the monitoring of the tail rotor laminated half-bearings of AS350 B3e e AS355 NP helicopters.

On 19 September 2012, Eurocopter issued the Service Bulletin nº AS350-05.00.71, which established special criteria for the visual inspection of the tail rotor of the aircraft concerned by pilots and mechanics.

On 5 October 2012, the *European Aviation Safety Agency* (EASA) issued the *Emergency Airworthiness Directive* nº 2012-0207-E, after identifying primary failures in the laminated half-bearing P/N 704A33-633-261 (supplier P/N 5791530004), installed in conjunction with the tail rotor – blades P/N 355A12.0055.00 or P/N 355A12.0055.01, in AS350 B3 helicopters, with configuration AS350 B3.

Before the publication of the AD nº 2012-0207-E, an accident occurred involving an AS350B3 helicopter (in the configuration AS350 B3e). During the flight in question, the pilot felt strong vibrations coming from the tail rotor prior to losing control of the aircraft.

During the investigation of the accident mentioned above, it was found that, a few days before, a laminated half-bearing had been replaced in the same helicopter on two occasions on account of premature wear.

These new facts led the manufacturer to conclude that, if the premature wear was not detected and corrected opportunely, a tail rotor failure might occur, with a possible loss of control of the helicopter.

In order to correct this unsafe condition, Eurocopter issued the Emergency Alert Service Bulletin (ASB) nº 01.00.65, which became effective by means of the AD nº 2012-0217-E, issued by the EASA on 12 October 2012.

The referred AD resulted in alterations of the helicopter flight manual, imposing further limits to the flight envelope in order to reduce the dynamic loads on the tail rotor.

It also established new time intervals for the conduction of pre-flight and post-flight inspections, including the disassembling of the tail rotor for detection of damage and, depending on the findings, the replacement of all the laminated half-bearings.

On 19 December 2012, Eurocopter issued the SB nº 64.00.11 dealing with the modification of the chin weights of the tail rotor, with the objective of preventing any interference with the laminated half-bearings.

On 8 February 2013, the EASA issued the AD nº 2013-0029, establishing that, within a deadline of five months after the date when the AD became effective (1 March 2013) the

helicopters in question (AS350 B3e and AS355 NP) had to be modified in accordance with the instructions of the Eurocopter AS350 SB nº 01.00.66 issued on 15 February 2013.

The aircraft was within the weight and center of gravity limits specified by the manufacturer.

1.19 Additional information

After a research, another AS350B3e aircraft (total flight hours = 75) was found in a workshop in the interior of São Paulo, showing the same signs of premature wear of the laminated half-bearings.

This fact, together with a concern related to the effectiveness of the aircraft manufacturer control over the receipt of the SIN nº 2482-S-64 by the various operators and maintenance staff of the aircraft involved, created the opportunity for the issuance of the DIVOP nº 002/2012 by the CENIPA on 2 August 2012. In the DIVOP, the CENIPA emphasized the importance of the information and instructions contained in that Safety Information Notice (SIN) issued by the manufacturer for operators, pilots and maintenance staff of AS350 B3e and AS355 NP helicopters.

The compliance with the AD nº 2013-0029 altered the manufacturing plant modifications incorporated in the tail rotors of AS350B3e helicopters, which began to present a new configuration, now similar to the AS350 B3 aircraft.

1.20 Utilization of other investigation techniques

Nil.

2 ANALYSIS

During the investigation of this serious incident, it was observed that the four laminated half-bearings of the aircraft tail rotor had sustained damage.

The analysis of the laminated half-bearings indicated that the elastomer had sustained a melting process, which, in turn, cause a failure of the interface of the metal blades and the loss of both volume and mass of the tail rotor shock absorbing assembly as a whole.

The melting of the elastomer can be confirmed by means of the dripping aspects found in the vicinity of the shock absorbing assembly.

The metal blades of the tail rotor did not have evidence of weakening of fracture on account of fatigue, with the failure having occurred due to overload, probably as a result of the compromise of the shock absorbing assembly after the melting of the elastomer around the very blades.

The analyses of the obtained results indicated that the transition temperatures of the elastomer examined were in accordance with the values prescribed by the aircraft manufacturer, discarding the possibility that the degradation of the elastomer could have occurred at temperatures lower than the ones it had been designed to endure.

Such fact allowed the inference that some kind of heating (with a source that might have been either internal or external) occurred in the shock absorbing assembly.

Although there are no elements to attest the nature of the heat source responsible for the heating observed in the elastomers and their resulting degradation, it is possible to infer that the modification implemented in the tail rotors of the AS350B3 aircraft, which resulted in the creation of a new configuration (AS350B3e) may have contributed to a new

dynamics of effort absorption by the elastomers. Such dynamics had not yet been adequately addressed as far as the structure of the referred components was concerned.

The AS350B3e aircraft tail rotor modifications implemented by the manufacturer and later regulated by the *Airworthiness Directive* AD 2013-0029 (making the configuration of the aforementioned aircraft similar to that of the AS350B3 model) reinforce this hypothesis.

3 CONCLUSIONS

3.1 Facts

a) The pilot had a valid aeronautical medical certificate (CMA);

b) The pilot had a valid Technical Qualification Certificate (CHT) valid;

c) The pilot had qualification and enough experience for the flight in question;

d) The aircraft had a valid airworthiness certificate;

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

f) The aircraft was flying between the cities of *Picos* and *Teresina* in the State of Piauí when the pilot noticed a moderate intensity vibration in the tail rotor control pedals;

g) Upon confirming the increase of the vibration, the aircraft captain decided to make an emergency landing in a football pitch located in the municipality of *Barro Duro*, State of Piauí;

h) Despite the pilot's difficulty controlling the aircraft, the landing was successful;

i) During the investigation, it was observed that the four laminated half bearings of the tail rotor had been damaged;

j) The analysis of the laminated half-bearings indicated that the elastomer had melted, which, in turn, caused a failure of the interface of the metallic blades, and the loss of both volume and mass of the tail rotor shocking absorbing assembly;

k) The pilot and the two passengers got out uninjured; and

l) The aircraft sustained substantial damage to the half-bearings of the tail rotor blades.

3.2 Contributing factors

3.2.1 Human Factor

3.2.1.1 Medical Aspect

Nil.

3.2.1.2 Psychological Aspect

3.2.1.2.1 Individual information

Nil.

3.2.1.2.2 Psychosocial information

Nil.

3.2.1.2.3 Organizational information

Nil.

3.2.2 Operational Factor

3.2.2.1 Concerning the operation of the aircraft

Not a contributor.

3.2.2.2 Concerning ATS units

Not a contributor.

3.2.3 Material Factor

3.2.3.1 Concerning the aircraft

a) Design – undetermined

The early wear of the elastomer composing the tail rotor shock absorbing assembly of the AS350 B3e and AS355 NP helicopters, point to the possibility of a failure associated with modifications incorporated in its design.

3.2.3.2 Concerning ATS technology systems and equipment

Not a contributor.

4 SAFETY RECOMMENDATION

A measure of preventative/corrective nature issued by a SIPAER Investigation Authority or by a SIPAER-Link within respective area of jurisdiction, aimed at eliminating or mitigating the risk brought about by either a latent condition or an active failure. It results from the investigation of an aeronautical occurrence or from a preventative action, and shall never be used for purposes of blame presumption or apportion of civil liability.

In accordance with the Law n°12970/2014, recommendations are made solely for the benefit of the air activity operational safety.

Compliance with a Safety Recommendation is the responsibility of the holder of the highest executive position in the organization to which the recommendation is being made. An addressee who judges to be unable to comply with a Safety Recommendation must inform the CENIPA on the reason(s) for the non-compliance.

Safety Recommendations made by the CENIPA:

To the National Civil Aviation Agency (ANAC):

IG – 551/CENIPA/2014 – 001 Issued on 02/09/2014

Ascertain, based on the analysis of the premature failures of tail rotor laminated half-bearings of Esquilo helicopters, the existence of appropriate conditions for the maintenance of continued airworthiness of AS350B3e and AS355 NP helicopters of the Brazilian fleet.

IG – 551/CENIPA/2014 – 002 Issued on 02/09/2014

Publicize the content of this report at seminars, lectures and similar activities held for owners, operators and explorers of rotary-wing aircraft.

5 CORRECTIVE/PREVENTATIVE ACTION ALREADY TAKEN

The ANAC issued the DA 20-12-03, which became effective on 28 December 2012.

DA Nº 2012-12-03 - HELIBRAS / 39-1367, applicable to all HELIBRAS HB - 350B helicopters.

Issuance of the Operational Bulletin Nº 002/2012, forwarded to the various operators of AS350 B3e and AS355 NP Esquilo Aircraft.

6 DISSEMINATION

- (Brazil's) National Civil Aviation Agency - ANAC.
- *Bureau d'Enquêtes et d'Analyses pour la Securité de l'Aviation* (BEA) from France.
- HELIBRAS - Helicópteros do Brasil S.A.
- Brazilian Helicopter Pilots Association (ABRAPHE).
- Aircraft Owners and Pilots Association (APPA).
- SERIPA II.

7 APPENDICES

Nil.

On 02 / 09 / 2014.