COMANDO DA AERONÁUTICA

CENTRO DE INVESTIGAÇÃO E PREVENÇÃO DE ACIDENTES AERONÁUTICOS

FINAL REPORT
A - 150/CENIPA/2015

OCCURRENCE:	**ACCIDENT**
AIRCRAFT:	**PR-EDL**
MODEL:	**R66**
DATE:	**11NOV2015**

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 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 11NOV2015 accident with the R66 aircraft, registration PR-EDL. It was classified as “System / Component Failure”.

With about five minutes to reach the destination, the pilot heard a loud noise, accompanied by a trepidation that made it difficult to control the aircraft. Immediately, the pilot started the auto-rotation procedure, with the objective of making an emergency landing in an unprepared field.

During the landing, the main rotor blade cut off the tail cone of the helicopter.

The aircraft suffered substantial damage.

The pilot and passenger were unharmed.

An Accredited Representative of the NTSB - National Transportation Safety Board, USA (State where the aircraft was manufactured) was designated for participation in the investigation.

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GLOSSARY OF TECHNICAL TERMS AND ABBREVIATIONS

AFA	Air Force Academy
ANAC	(Brazil's) National Civil Aviation Agency
CA	Airworthiness Certificate
CENIPA	Aeronautical Accident Investigation and Prevention Center
CG	Center of Gravity
CHT	Technical Qualification Certificate
CMA	Aeronautical Medical Certificate
DCTA	Aeronautics' Science and Technology Department
DIVOP	Operational Disclosure
EMU	Engine Monitoring Unit
IAE	Aeronautics and Space Institute
LAT	Latitude
LONG	Longitude
Ltd.	Limited
NTSB	National Transportation Safety Board
PLH	Airline Pilot - Helicopter
RS	Safety Recommendation
TPP	Aircraft registration category of private air service
SBRF	ICAO location designator - Recife Aerodrome
SB	Service Bulletin
SIPAER	Aeronautical Accident Investigation and Prevention System
S/N	Serial Number
UTC	Universal Coordinated Time

1. FACTUAL INFORMATION.

Aircraft	**Model:** R66 **Registration:** PR-EDL **Manufacturer:** Robinson Helicopter	**Operator:** TOK Air Taxii
Occurrence	**Date/time:** 11NOV2015/1755 UTC **Location:** Trapiche Power Plant **Lat.** 08º30'29"S **Long.** 035º10'33"W **Municipality – State:** Sirinhaém - PE	**Type(s):** "System / Component Failure" **Subtype(s):**

1.1 History of the flight.

The aircraft took off from the Recife / Guararapes Aerodrome - Gilberto Freyre, PE, (SBRF), to the Cucaú Power Plant, PE, at 1737 (UTC), in order to perform a transport flight with a pilot and a passenger on board.

About five minutes to land, the pilot heard a loud noise, accompanied by a trepidation that made it difficult to control the aircraft. Immediately, the pilot started the auto-rotation procedure with the objective of making an emergency landing in an unprepared field.

During the landing, the main rotor blade cut off the tail cone of the helicopter (Figure 1).

The aircraft suffered substantial damage.

The pilot and passenger were unharmed.

Figure 1 - Overview of the aircraft at the crash site.

1.2 Injuries to persons.

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

1.3 Damage to the aircraft.

The aircraft had substantial damage in the main rotor blades and tail rotor blades; in the tail cone, in the vertical and horizontal stabilizers; in the tail rotor drive shaft assembly; in the tail rotor gearbox assembly and in the shaft weldment that transmits the power from the engine to the gearbox.

1.4 Other damage.

Nil.

1.5 Personnel information.

1.5.1 Crew's flight experience.

Hours Flown	
	Pilot
Total	8.000:00
Total in the last 30 days	24:00
Total in the last 24 hours	01:00
In this type of aircraft	300:00
In this type in the last 30 days	20:00
In this type in the last 24 hours	01:00

N.B.: The Data on flown hours were obtained from the pilot's statement.

1.5.2 Personnel training.

The pilot graduated at the Air Force Academy - AFA, in 1974.

1.5.3 Category of licenses and validity of certificates.

The pilot had the license of Airline Pilot - Helicopter (PLH) and had valid aircraft technical qualification in the B66 type.

1.5.4 Qualification and flight experience.

The pilot was qualified and had experience on this kind of flight.

1.5.5 Validity of medical certificate.

The pilot had valid Aeronautical Medical Certificate (CMA).

1.6 Aircraft information.

The aircraft, serial number 0149, was manufactured by Robinson Helicopter in 2012 and was registered in the Private Air Services category (TPP).

The aircraft had valid Airworthiness Certificate (CA).

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

The last 100-hours/12-months airframe inspection was performed on 18SEPT2015 by the Fênix Aircraft Maintenance and Recovery Ltd. shop, in Recife, PE, with 17 hours and 12 minutes flown after the inspection.

The last 200 hours/12 months engine inspection was performed on 18SEPT2015 by the Fênix Aircraft Maintenance and Recovery Ltd. shop, in Recife, PE, with 17 hours and 12 minutes flown after the inspection.

1.7 Meteorological information.

The conditions were favorable for the visual flight.

1.8 Aids to navigation.

Nil.

1.9 Communications.

Nil.

1.10 Aerodrome information.

The occurrence took place outside the Aerodrome.

1.11 Flight recorders.

Neither required nor installed.

1.12 Wreckage and impact information.

The accident occurred at the Trapiche Power Plant, at coordinates 08º30'29 "S / 035º10'33" W.

When performing the auto-rotation, when the aircraft touched the ground, the blades of the main rotor collided against the rear fuselage, resulting in the sectioning of the tail cone of the aircraft (Figure 2).

Figure 2 - View of the sectioned tail cone.

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 evidence of fire in flight or after impact.

1.15 Survival aspects.

Nil.

1.16 Tests and research.

At the site of the accident, researchers from the Aeronautical Accident Investigation and Prevention System (SIPAER) identified a rupture in the shaft weldment, which presented corrosion aspects (Figures 3 and 4).

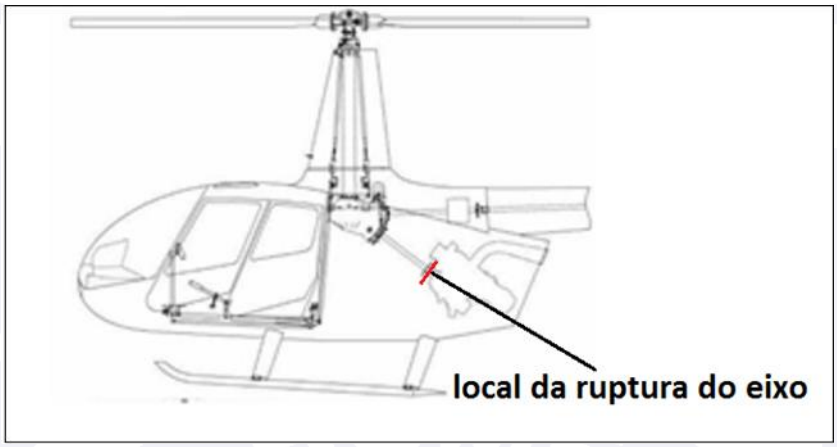

Figure 3 - Shaft Weldment shown in the set.

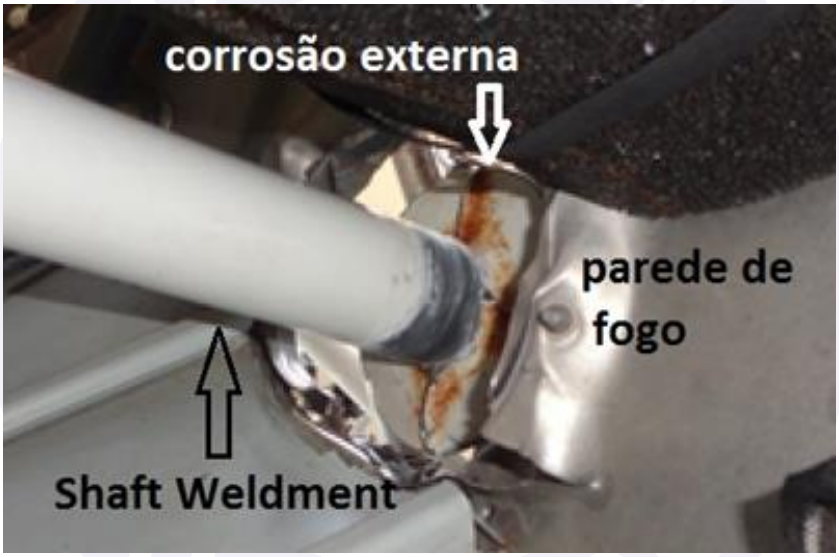

Figure 4 - View of the damaged component.

The component was sent to the laboratories of the Aeronautics' Science and Technology Department (DCTA) in order to undergo component failure analysis.

The technical report, prepared by the Aeronautics and Space Institute (IAE), based on visual, stereoscopic and metallographic analyzes, presented the following results:

> "The fracture of the analyzed power axis occurred by a mechanism of fatigue under twist, probably initiated in the region of the weld next to the deflector. The exact initiation of the fatigue process could not be determined due to the damage suffered after the shaft rupture. Despite this, there is evidence of corrosion in regions close to the fracture, which indicates that pites of corrosion may have facilitated the initiation of the fatigue process. Corrosion observed in the deflector region, both externally and internally, indicates that this region must undergo periodic inspections to verify and remove corrosion. It is also necessary to verify the need to apply protective paint on the inside of the tube of the power shaft".

1.17 Organizational and management information.

Nil**.**

1.18 Operational information.

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

The flight was normal when, with approximately five minutes to reach the destination, the pilot heard a loud noise followed by an intense vibration, which compromised the control of the helicopter.

Immediately, the pilot started the auto rotation procedure, with the purpose of making an emergency landing in an unprepared field on the Trapiche Power Plant lands.

In the emergency landing, at the moment the aircraft touched the ground, the pilot saw that the ground ahead was uneven. When the cyclic control was moved backwards, in order to stop the helicopter immediately, the aircraft tail cone was sectioned due to the impact between the two blades of the main rotor and that component (blade strike).

1.19 Additional information.

In section 3, Emergency Procedures, of the R66 Pilot's Operating Handbook, there is the following alert:

> CAUTION
>
> Do not apply aft cyclic during touchdown or ground slide to prevent possible blade strike to tail cone.

The manufacturer Robinson Helicopter had installed the shaft weldment in the assembly process of the aircraft.

As for Shaft Weldment, the 100-hour inspection card of the R66 aircraft Model states that:

> Inspect condition. Verify 0.2 inch minimum clearance between shaft weldment and firewall grommet; verify equal gap concentrically between shaft and box assembly hole edges. Adjust F174-1 support weldment rod ends per § 53-31 as required. Verify no shaft corrosion. Remove any light surface corrosion and apply wax or suitable corrosion inhibitor. Verify no cracks, corrosion, or fretting in fore and aft weldment. Verify proper installation, security, and operating clearance.

The 250-C300 / A1 engine is a turbo-shaft type, derived from the 250 Series II Model, developed especially for the Robinson R66 helicopter.

The 250 Series engine has a modular construction, reverse airflow, an axial compressor, a single-stage combustion chamber and four-stage turbine, two-stage turbine generator - NG (N1) and two stages turbine power - NP, this one being the free turbine stage (N2). The free turbine wheel (N2) is connected through gears (gear reduction box) to the output shaft, which transfers power through the shaft weldment to the gearbox (transmission) of the helicopter.

The analysis of the data extracted from the Engine Monitoring Unit (EMU) indicated that, at the beginning of the occurrence, the stable parameters characteristic of the cruise flight were interrupted by a sudden increase in N2. The decrease of the other engine parameters was also evidenced, as shown below in Figure 5.

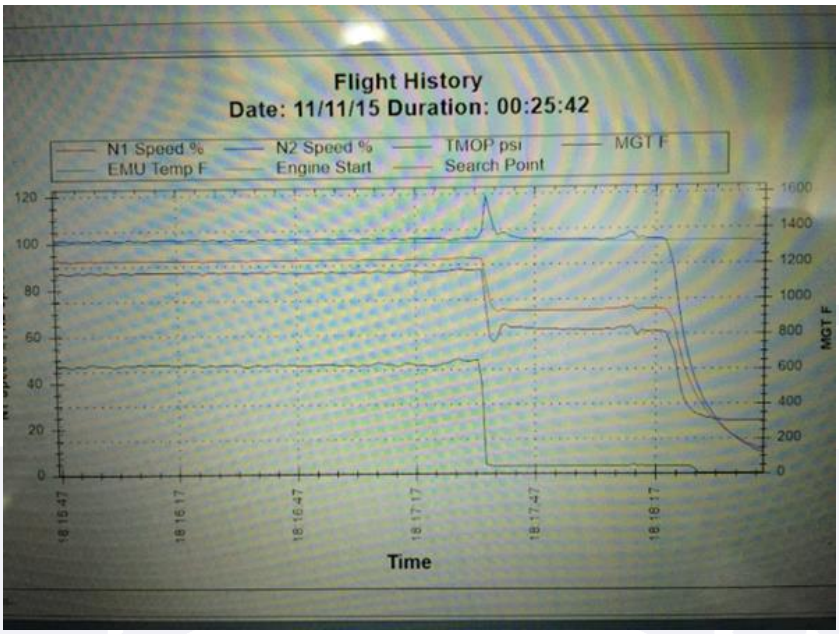

Figure 5 -Variation of the engine parameters moments before the accident.

On 15DEC2015, the aircraft manufacturer issued the R66 SERVICE BULLETIN SB-16, which dealt with the failure of the R66 aircraft's serial number (S / N) shaft welding between 0143 and 0172:

> A “LOT 20” F642-1 shaft weldment failed due to internal corrosion. This bulletin requires a specific lot number (LOT 20) of earlier F642-1 shafts to be upgraded to (current design) F642-6 shaft weldments, which have additional corrosion protection.

On 17DEC2015, the Aeronautical Accident Investigation and Prevention Center (CENIPA) issued the Operational Disclosure (DIVOP) n ° 011/2015, which dealt with shaft weldment, having as Recommended Action the compliance with R66 SERVICE BULLETIN SB -16.

On 22JAN2016, the aircraft manufacturer issued the R66 SERVICE BULLETIN SB-17, which dealt with the replacement of the F642-1 shaft weldment originally installed on aircraft S / N 001 to 172:

> R66 Helicopters equipped with F642-1 revision C and prior shaft weldments (originally installed on R66 S/N 0001 thru 0172), as well as spare F642-1 revision C and prior shaft weldments. TIME OF COMPLIANCE: Within next 25 flight hours or by 15 March 2016, whichever occurs first.

On 03FEB2016, CENIPA issued DIVOP No. 01/2016, which dealt with the inspection of component parts (shaft weldment).

Through a survey carried out with the R66 aircraft maintainers, it was verified the use of different procedures to comply with the requirements of the 100 hour inspection card, particularly for the identification of corrosion points in the weldment shaft, in the front and back parts of the fire wall.

1.20 Useful or effective investigation techniques.

Nil.

2. ANALYSIS.

It was a flight between SBRF and Cucaú Power Plant, with the purpose of transporting a passenger in the reverse section. With about five minutes to reach the destination, the pilot noticed a loud noise followed by an intense vibration that impaired the

control of the helicopter. Immediately, the pilot started the auto rotating procedure for an emergency landing in an unprepared area.

During the touchdown, the pilot spotted a landfall ahead of him, causing him to pull the cyclic command backward in order to avoid a possible collision of the aircraft against the obstacle.

Section 3 of the R66 Pilot's Operating Handbook-Emergency Procedures contained an alert regarding the risk arising from the cyclic command movement backwards during the touchdown.

At the site of the accident, it was identified that the shaft weldment was damaged.

The analyzes performed by the IAE / DCTA showed that there was a shaft weldment due to a torsional fatigue mechanism probably started in the region of the weld near the baffle. There were also signs of corrosion in the regions close to the fracture, which indicated that pites of corrosion could have contributed to the initiation of the fatigue process.

The data extracted from the EMU indicated that there was a sudden increase in the value of N2 and the decrease of the other parameters, evidencing that, during the cruise flight, a sudden decrease occurred in the workload that the engine performed, being possible to associate this fact to the sudden collapse of the shaft weldment.

In line with the course of the present investigation, the aircraft manufacturer identified the problem in Batch 20 of shaft weldment production (F642-1), regarding the lack of application of anticorrosive protection inside the component, which resulted in the emission of the R66 SERVICE BULLETIN SB-16, on 15DEC2015.

At the same time, CENIPA issued DIVOP No. 011/2015, of 17DEC2015, recommending compliance with R66 SERVICE BULLETIN SB-16, which dealt with the inspection of the shaft weldment component.

On 22JAN2016, the manufacturer issued the R66 SERVICE BULLETIN SB-17, which addressed the replacement of the shaft weldment (F642-1) originally installed on aircraft S / N 001 to 172.

Subsequently, some R66 model aircraft operators, who were not subject to compliance with R66 SERVICE BULLETIN SB-16, identified that the weldment shaft had corrosion points on the back of the aft. weldment area, as identified in Figure 6 below.

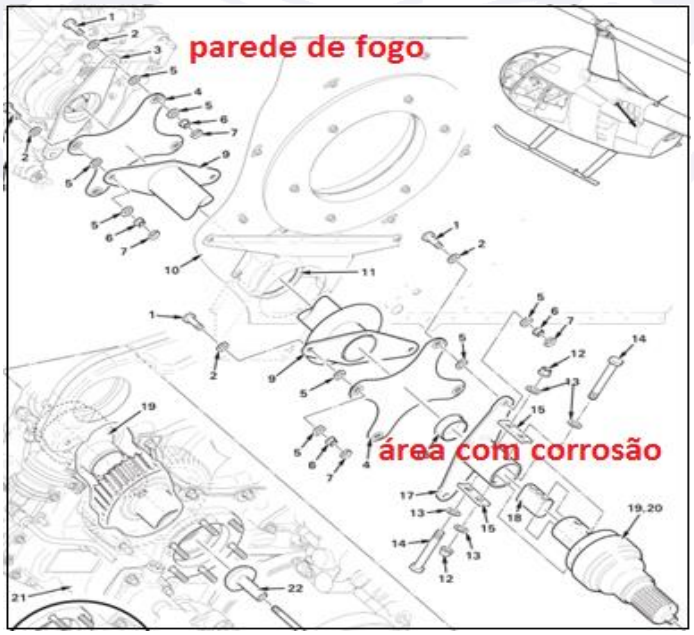

Figure 6 - Engine shaft weldment.

In the course of the investigation, it was identified the use of different procedures in the fulfillment of the inspection card of 100h, particularly in the one that aimed at the identification of corrosion points in the weldment shaft. This was associated with the difficulty of access and visualization of welded parts of the shaft weldment, before and after the firewall, as well as the lack of a better detailing of these procedures in the inspection card.

These facts led to the issuance of DIVOP No. 01/2016, on 03FEB2016, of CENIPA, which dealt with the inspection of component parts (shaft weldment). DIVOP recommended that helicopter maintainers, model R-66, should adopt judicious procedures to perform the inspection of the critical parts of the shaft weldment, before and after the firewall, in order to comply with the recommendation of the 100-hour inspection card.

It was not possible to ascertain the reasons why, during the last 100-hour inspection of the aircraft involved in the accident, there was no identification of the corrosion points on the weldment shaft.

3. CONCLUSIONS.

3.1 Facts.

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

b) the pilot had valid Technical Qualification Certificate (CHT).

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

d) the aircraft had valid Airworthiness Certificate (CA).

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

f) the airframe and engine logbooks records were up-to-date.

g) during the cruise flight, the pilot noticed a noise accompanied by a strong vibration in the aircraft;

h) the pilot decided, immediately, to carry out an emergency landing with an autorotation;

i) the emergency landing occurred in an unprepared field;

j) At the time of landing, the pilot turned the cyclic control backward to avoid collision of the aircraft against a landfall;

k) the blades of the main rotor have reached the tail cone of the aircraft;

l) at the site of the accident, it was observed that the shaft weldment was sectioned and presented corrosion in the area of the fracture;

m) the shaft weldment fracture was due to a torsional fatigue mechanism;

n) the aircraft suffered substantial damage; and

o) the pilot and the passenger were unharmed.

3.2 Contributing factors.

- **Control skills - a contributor.**

The sudden application of the cyclic control backwards during the emergency landing was decisive for the shock between the main rotor blades and the tail cone of the aircraft.

- **Manufacturing - a contributor.**

The shaft weldment, originally installed by the manufacturer, was part of a batch without due anti-corrosion treatment.

- **Aircraft maintenance - a contributor.**

Even though it had complied with the 100-hour inspection card, the maintainer did not identify the corrosion points that would result in the shaft weldment collapse.

- **Managerial oversight - a contributor.**

The lack of careful inspection of the 100-hour inspection card, to the point of inhibiting the identification of the corrosion point in the shaft weldment, referred to the contribution of this aspect, in the technical field.

- **Other - Technical Publication - undetermined.**

It is possible that the lack of a better detailing of the weldment inspection criteria on the 100-hour inspection card established by the aircraft manufacturer, notably with regard to the identification of corrosion points, has contributed to the collapse of that component in flight.

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, criminal, or administrative liability.

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".

Recommendations issued at the publication of this report:

To the Brazil's National Civil Aviation Agency (ANAC):

A-150/CENIPA/2015 - 01 **Issued on: 05/04/2018**

Acting with the manufacturer of the aircraft, seeking a better detailing of the weldment inspection criteria, on the 100-hour inspection card of the R66 aircraft, notably with regard to the identification of corrosion points in the weldment shaft in the front and back parts of the firewall.

A-150/CENIPA/2015 - 02 **Issued on: 05/04/2018**

Acting with the aircraft maintainer to ensure proper compliance with the shaft weldment inspection procedures established on the R66 model aircraft inspection card, specifically with regard to the identification of corrosion points on the weldment shaft, in the front and back parts of the firewall.

A-150/CENIPA/2015 - 03 **Issued on: 05/04/2018**

Acting together with the aircraft maintainer, in order to ensure the adoption of the appropriate mechanisms of Management Supervision, in the technical field, notably with regard to the monitoring of shaft weldment inspections, established in the 100-hour inspection card of aircraft model R66.

A-150/CENIPA/2015 - 04 **Issued on: 05/04/2018**

Analyze the feasibility of issuing an Airworthiness Directive based on the procedures described in R66 SERVICE BULLETIN SB-16 and R66 SERVICE BULLETIN SB 17 from the Robinson Helicopter Company.

5. CORRECTIVE OR PREVENTATIVE ACTION ALREADY TAKEN.

Issuance of the R66 SERVICE BULLETIN SB-16, which deals with the failure of the "Batch 20" F642-1 Shaft Corrosion of the aircraft R66, S / N between 0143 and 0172.

Issuance of the R66 SERVICE BULLETIN SB-17, which deals with the F642-1 Shaft Replacement of aircraft S / N 001 to 172.

Issuance of the DIVOP n° 011/2015, from 17DEC2015, by the CENIPA, recommending compliance with R66 SERVICE BULLETIN SB-16, which dealt with the inspection of the shaft weldment component.

Issuance of the DIVOP n° 01/2016, from 03FEB2016, by the CENIPA, which deals with the inspection of component parts (shaft weldment).

On April 5th, 2018.