COMANDO DA AERONÁUTICA

CENTRO DE INVESTIGAÇÃO E PREVENÇÃO DE ACIDENTES AERONÁUTICOS

FINAL REPORT
A - 149/CENIPA/2013

OCCURRENCE:	**ACCIDENT**
AIRCRAFT:	**PR-IVE**
MODEL:	**EC120B**
DATE:	**21AUG2013**

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 21AUG2013 accident with the EC120B aircraft, registration PR-IVE. The accident was classified [SCF-PP] “System/Component Failure or Malfunction (Powerplant)|Engine Failure in Flight”.

During a maintenance flight, the aircraft showed loss of engine oil pressure when flying at 1,200ft above the ground.

In the procedure for landing in autorotation, the tail of the helicopter collided against a concrete wall.

The aircraft had substantial damage.

The two occupants of the aircraft left unharmed.

An Accredited Representative of the Bureau d'Enquêtes et d'Analyses pour la Sécurité de l'Aviation Civile (BEA) - France, (State where the aircraft/engine were manufactured/designed) was designated for participation in the investigation.

CONTENTS

GLOSSARY OF TECHNICAL TERMS AND ABBREVIATIONS

ANAC	Brazil's National Civil Aviation Agency
BEA	Bureau d'Enquêtes et d'Analyses pour la Sécurité de l'Aviation Civile
CA	Airworthiness Certificate
CENIPA	Aeronautical Accident Investigation and Prevention Center
CMA	Aeronautical Medical Certificate
ENG P	Engine Pressure
FAP	Pilot Evaluation Sheet
FLI	Flight Limit Indication
IAE	Aeronautics and Space Institute
M01	Reduction Gearbox Module
M02	Gas Generator and Power Turbine Module
MMA	Aeronautical Maintenance Mechanic License
MPR	Procedures manual
NG	Engine Gas Generator Speed
NR	Number of Rotations
PCH	Commercial Pilot License – Helicopter
PN	Part Number
PPH	Private Pilot License – Helicopter
RBHA	Brazilian Aeronautical Certification Regulation
SBMT	ICAO Locator Designator – Campo de Marte Aerodrome, São Paulo - SP
SERIPA IV	Fourth Regional Aeronautical Accident Investigation and Prevention Service
SIPAER	Aeronautical Accident Investigation and Prevention System
SN	Serial Number
TMA	Terminal Control Area
TPP	Registration Category of Private Aircraft Service
TQ	Torque
TWR-MT	Control Tower of Campo de Marte Aerodrome, São Paulo, SP
UTC	Universal Time Coordinated
VEMD	Vehicle Engine Monitoring Display

1. FACTUAL INFORMATION.

Aircraft	**Model:** EC 120 B **Registration:** PR-IVE **Manufacturer:** Eurocopter France	**Operator:** *INDUSTR. BRAS. DE ART. REFRAT. IBAR* LTD.
Occurrence	**Date/time:** 21AUG2013 – 1340 UTC **Location:** *Marginal Tietê* **Lat.** 23º31'04"S **Long.** 046º39'19"W **Municipality – State:** São Paulo – SP	**Type(s):** "[SCF-PP] System/Component Failure or Malfunction (Powerplant)". **Subtype(s):** Engine Failure in Flight

1.1 History of the flight.

The aircraft took off from Campo de Marte Aerodrome - SP (SBMT) at 1328 (UTC) to conduct a local maintenance flight with a pilot and a mechanic on board.

After eight minutes of flight, on landing return, close to the Memorial position, at 1,200ft above the ground, the low engine oil pressure light (ENG P) came on.

After declaring an emergency, the pilot performed an autorotation procedure for landing on the right side of the Marginal Tietê.

During the flare, the aircraft crashed into a concrete wall causing the tail cone to rupture.

Figure 1 - View of the aircraft after the collision against a concrete wall.

The aircraft had substantial damage.

The two occupants of the aircraft left unharmed.

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 as well as sectioning of the tail cone (Figure 2).

Figure 2 - View of the fenestron and the main rotor sectioned.

1.4 Other damage.

Damaged concrete wall, broken telephone wiring and dents on the roof of a vehicle, due to detachment after the impact of the aircraft against the wall (Figure 3).

Figure 3 - Damages to the concrete wall and the car.

1.5 Personnel information.

1.5.1 Crew's flight experience.

Flight Hours	
	Pilot
Total	4.000:00
Total in the last 30 days	20:00
Total in the last 24 hours	00:15
In this type of aircraft	1.700:00
In this type in the last 30 days	20:00
In this type in the last 24 hours	00:15

N.B.: The Data related on flown hours were obtained with the pilot.

1.5.2 Personnel training.

The pilot took the Pilot Private course – Helicopter (PPH) in the Master Aviation School - SP, in 1998.

1.5.3 Category of licenses and validity of certificates.

The pilot had the PCH License and had valid EC20 (which included model EC120B) aircraft Rating.

The mechanic on board the aircraft had the MMA License and had valid airframe and powertrain Ratings.

1.5.4 Qualification and flight experience.

The commander was qualified and had experience in that 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 1476, was manufactured by Eurocopter France, in 2007, and it was registered in the TPP category.

The aircraft had valid Airworthiness Certificate (CA).

The airframe and engine logbook records were outdated.

The last inspection/check of the airframe, the “15FH/7D”, “25FH”, “100FH/12M” and “1M” type, was carried out on 30APR2013 by the Helibrás shop, in São Paulo-SP, having flown 1.305 hours and 36 min total and 7 hours e 42 min flown after the inspection.

The helicopter engine, turbo-axis type, model Arrius 2F, serial number (SN) 34541, has been installed on the aircraft since new.

1.7 Meteorological information.

The weather conditions were favorable for the visual flight.

1.8 Aids to navigation.

Nil.

1.9 Communications.

According to the transcripts of the communication audios between the PR-IVE and the control bodies, the pilot kept radio contact with the Campo de Marte Control Tower (TWR-MT) to report the drop of oil pressure occurrence and to declare the emergency condition.

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.

During the landing autorotation procedure, the aircraft collided with a concrete wall causing the collapse of the tail cone.

1.13 Medical and pathological information.

1.13.1 Medical aspects.

Not investigated.

1.13.2 Ergonomic information.

Nil.

1.13.3 Psychological aspects.

Not investigated.

1.14 Fire.

There was no fire.

1.15 Survival aspects.

Nil.

1.16 Tests and research.

Initially, the Arrius 2 F engine, SN 34541, which equipped the PR-IVE helicopter, was inspected at the HELIBRAS Company in Itajubá - MG, in order to identify the reason why the engine oil pressure dropped.

Representatives of the IAE, of the SERIPA IV, of HELIBRAS and of TURBOMECA participated in this analysis.

In the initial examination, it was found that the engine was externally without impact marks or damages resulting from forced landing. When attempting to turn it manually, it was observed that the reduction gear train of the Reduction Gearbox Module (M01) was seized.

The work was started by inspecting the engine lubrication system, where a large amount of particles was observed in the magnetic plugs and inside the crankcase (Figures 4 and 5).

Figure 4 - Magnetic Plug of the M01 with particles.

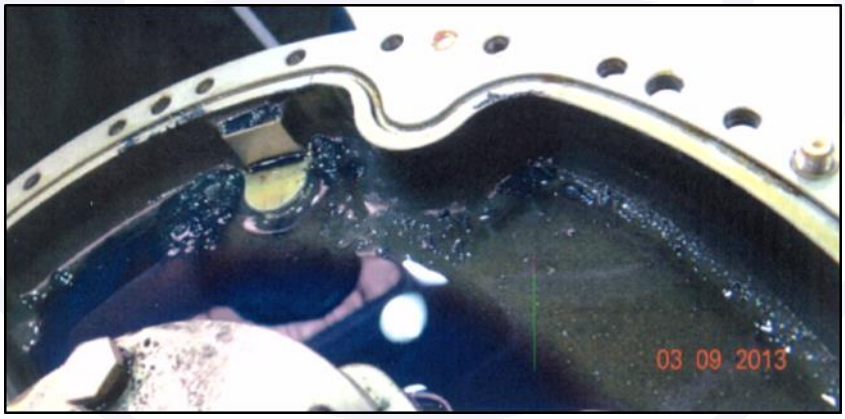


Figure 5 – Presence of particles inside the crankcase.

The main oil filter and its housing were clean and free of contaminants. The pre-clogging indicators of the engine oil filters were in their normal position.

It was also verified that the lubricating oil pump was assembled correctly. No abnormality was identified, either in functional bench test or in disassembly. There was no presence of particles or carbonization in the oil collected.

As such, no discrepancy was found in the lubrication unit, which could explain the low engine oil pressure light coming on.

Following this, the Gas Generator and Power Turbine - Module 02 (M02) was dismantled.

The flow test on the oil injector of the M02 front bearing showed no abnormality.

The coloring and marks found on the M02 front bearing roller tracks indicated that the bearings have suffered high temperature (Figure 6).

Figure 6 - M02 front bearing roller tracks with differentiated coloration in the track contact region.

Their rollers were oval and darkened (Figure 7).

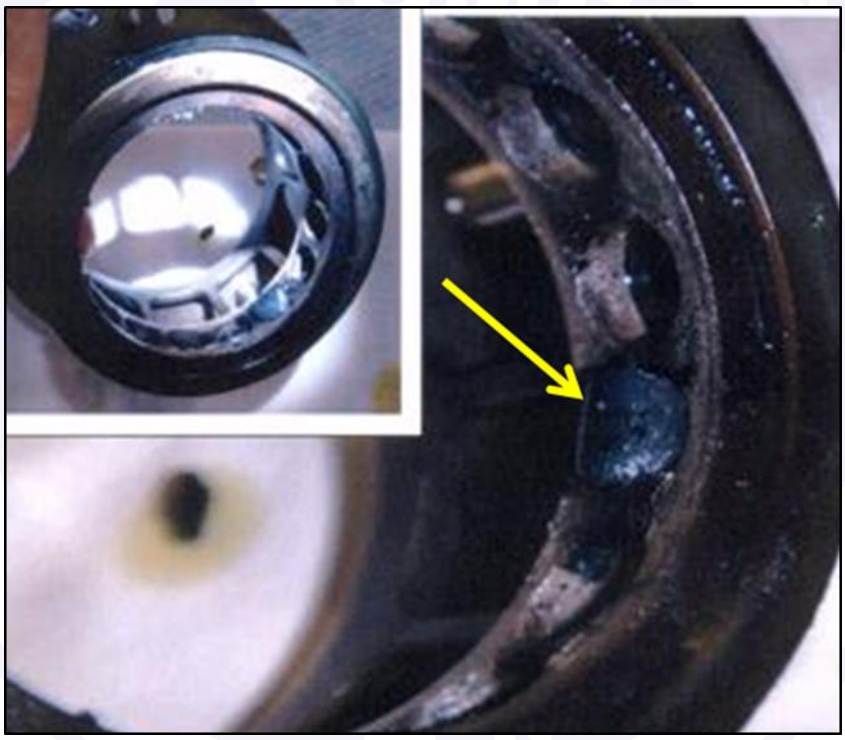


Figure 7 - Detail of the deformed rollers attached to the front bearing spacer of the gas generator. In highlight an overview of the bearing housing.

The rear bearing of the gas generator had friction and carbonization marks. Their rollers were not deformed (Figure 8).

Figure 8 - General view of the rear bearing of the gas generator.

The rear bearing of the power turbine also presented carbonization, with dark coloration and friction marks on its spacer (Figure 9).

Figure 9 – Overview of the engine power turbine rear bearing.

The centrifugal impeller blades contained strongly bent marks with centrifugal compressor cover (Figure 10).

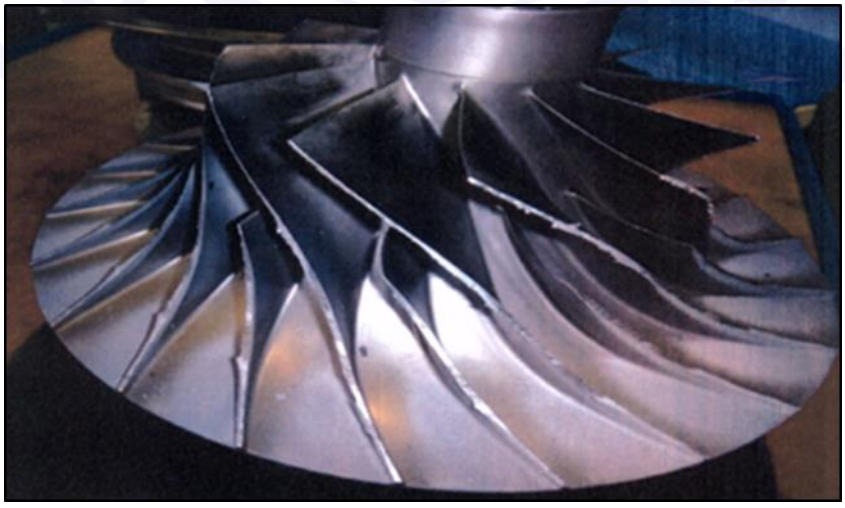


Figure 10 - Overview of impeller with brush marks on its blades.

The image of the centrifugal compressor cover showed the overtemperature due to the contact of the blades with the cover (Figure 11).

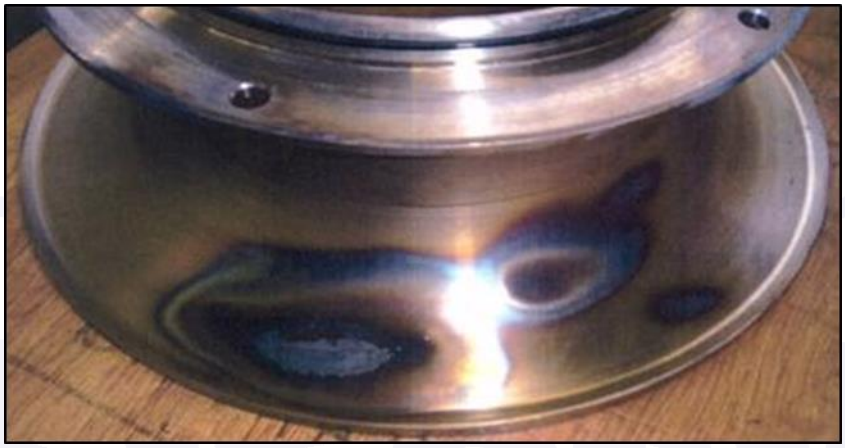


Figure 11 - External view of the compressor housing.

HP turbine blades had slight bends at the ends as well as small fractures at their trailing edges (Figure 12).

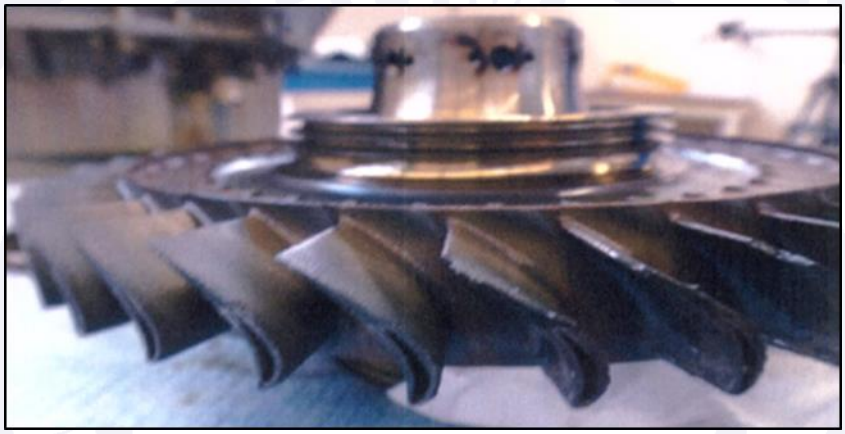


Figure 12 - View of the end of the vanes with brush marks.

The Data obtained through the Vehicle Engine Monitoring Display (VEMD) showed that the first recorded event, from 27 minutes and 45 seconds, indicated that the engine's TQ (torque) dropped to 9.5%.

Then, at 27 minutes and 50 seconds, the Flight Limit Indication (FLI LOSS) illumination occurred, when TQ reached 0.3%.

Finally, at 28 minutes and 13 seconds, it was also observed that the T4 temperature reached 1034° C, the TQ dropped to 0.0% and the Engine Gas Generator Speed (NG) reached 55%, which represents a value below ground idle. (Figure 13).

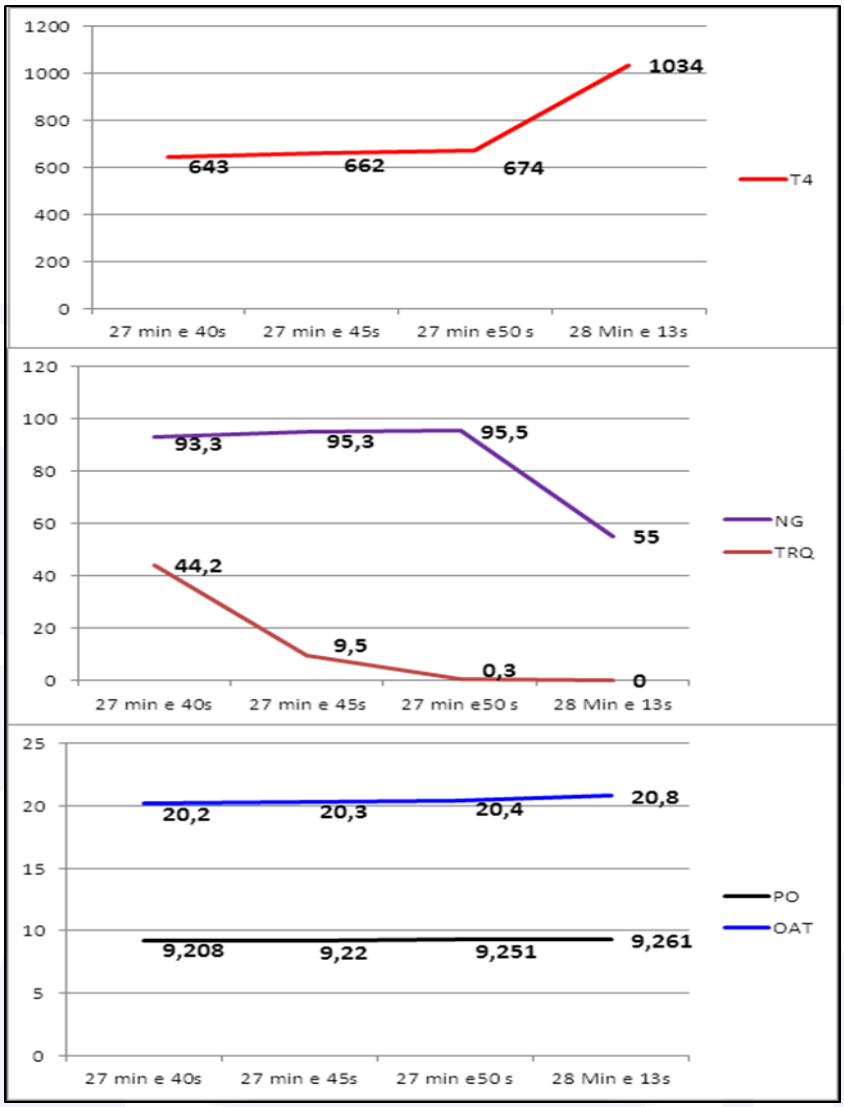


Figure 13 - Data chart of the VEMD.

After the analysis conducted by the IAE, it was agreed that the engine would be sent to France, in order to be examined by SAFRAN Turbomeca.

In this sense, TURBOMECA's Initial Investigation Report, despite not identifying the root cause for the loss of the engine oil pressure, showed that:

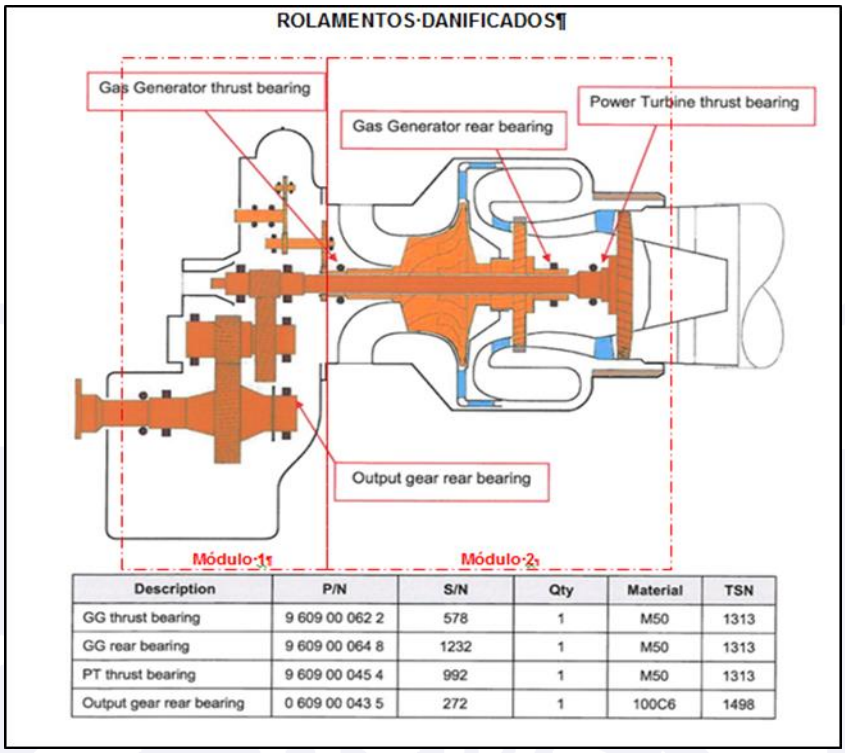
- The condition of the Gas Generator thrust bearing demonstrated a rupture of the oil film.

- The output gear rear bearing showed damage caused by significant contamination linked to the damage to the Gas Generator thrust bearing.

- The observations made on the Gas Generator rear bearing and the Power Turbine thrust bearing revealed that they operated in a high-temperature environment.

The signs of deterioration found in the bearings of the Gas Generator, revealed that there was rupture of the lubricating oil film.

The Generator Gas and Power Turbine bearings were damaged, due to the lack of lubrication or operation at high temperatures (Figure 14).



Description	P/N	S/N	Qty	Material	TSN
GG thrust bearing	9 609 00 062 2	578	1	M50	1313
GG rear bearing	9 609 00 064 8	1232	1	M50	1313
PT thrust bearing	9 609 00 045 4	992	1	M50	1313
Output gear rear bearing	0 609 00 043 5	272	1	100C6	1498

Figure 14 - Damaged bearings.

In that sense, it was decided that the investigations would be further deepened. To this end, SAFRAN HE set up a task force to review and analyze possible contributing factors to the drop in oil pressure, which resulted in engine failure in flight.

Based on the data collected in the VEMD, a scenario was elaborated, containing the probable chain of events that resulted in the landing in autorotation (Figure 15):

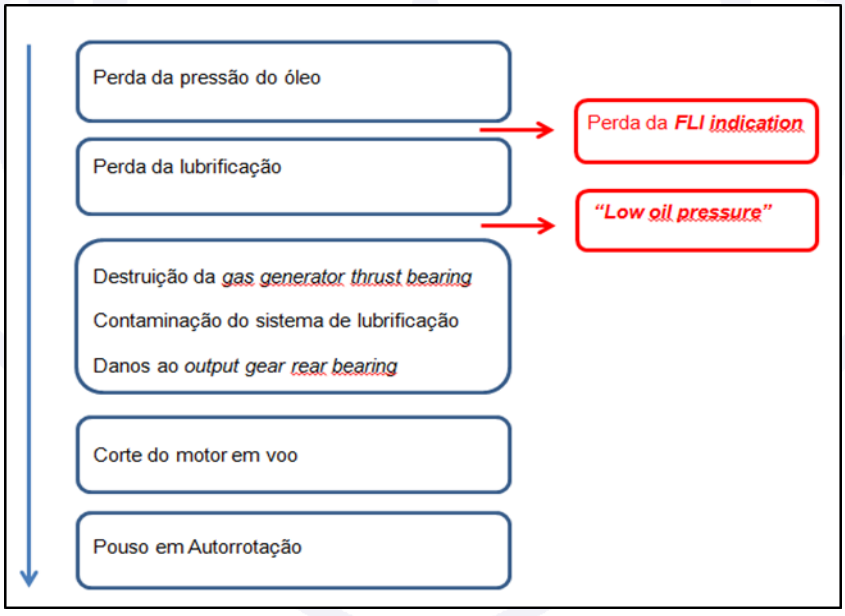


Figure 15 - Scenario containing the probable chain of events.
(Source: SAFRAN HE Investagion Review)

Among the possible factors analyzed, the following aspects were considered:

- Check valve failure:

• During the tests, the pressure parameters at the check valve were kept within the established limits;

• The pressure of the check valve complied with the parameters set forth in the maintenance manual; and

• simulations of possible zero pump flow or abnormal vibration were not sufficient to cause the oil pressure to drop.

- Obstruction of the lubrication system:

• no increase in oil temperature was observed indicating thermostatic valve failure; and

• no evidence of possible contamination or any non-compliance has been found in the lubrication system.

- Lack of oil:

• The amount of oil found after the accident was slightly above the minimum allowed, estimated at 3.1 liters.

1.17 Organizational and management information.

Nil.

1.18 Operational information.

After maintenance services and the incorporation of Service Bulletin 319 72 4078, Incorporation of modification TF78, the engine was installed in the aircraft.

The aircraft took off from Campo de Marte Aerodrome, with the pilot and a mechanic, to perform a maintenance flight.

Next to the Memorial position, keeping 1,200ft, after asking the TWR-MT for return instructions, the pilot, in addition to hearing the audible and luminous alarm, noticed in the instrument panel the indication of the pressure drop of the engine oil pressure (ENG P).

With engine oil pressure indicating 0.1bar, the pilot reported the problem to TWR-MT and requested clearance for landing on runway 12 of SBMT.

After the permission, it was found that the rotational speed of the main rotor (NR) dropped to approximately 320 RPM. Then, the pilot lowered the command of the collective, stopping the low-speed alarm. At that time, it was also noticed that the engine sound stopped.

Due to the intense vehicular traffic on the way and the presence of an electrification network, the pilot decided to turn to the right, in search of a more suitable place to make an emergency landing safely (Figure 16).

Figure 16 - Sketch of the trajectory and location of the accident.

At the final moment of the autorotation maneuver, after the flare, the fenestron collided with the wall of a water pumping station in the city of São Paulo, which caused the cone to break.

After the aircraft reached the ground, there was the setting of the rotor brake and the cut off of the fuel supply.

After the forced landing, the aircraft was removed to the HELIBRAS shop in Itajubá - MG.

According to the Pilot Evaluation Sheet (FAP 03), referring to the check flight performed on 07DEC2012, he performed, among others, autorotation maneuvers on the line, 90° and 180°, with satisfactory yield.

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

1.19 Additional information.

The Mandatory Service Bulletin 319 79 4075, Incorporation of modification TF75 - Lubrication unit check valve with seal-free piston was already implanted and incorporated into the Arrius 2 F engine, SN 34541, since its manufacture.

This modification consisted of replacing the check valve of the engine lubrication system with a piston valve free of seal (Figure 17).

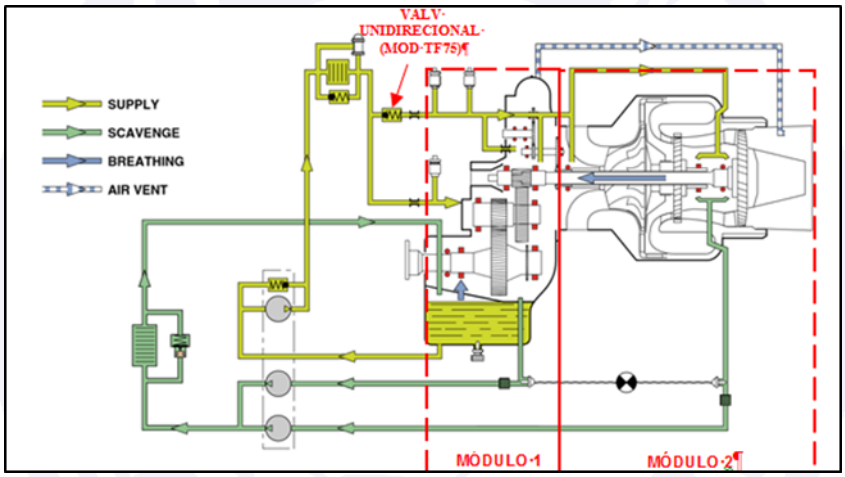


Figure 17 - Diagram of the engine lubrication system ARRIUS 2F.

The change aimed at eliminating the possibility of locking the one-way valve by failure of the seal. This failure could result, due to lack of lubrication, in damage to the bearings, leading to an engine failure.

On 24MAY2013, the PR-IVE recorded an event related to the lighting of the chip detector light. The engine had 1,313.3 hours of operation.

After the analysis of the particles, the engine was removed by a HELIBRAS shop, being sent to the TURBOMECA shop, in order to perform the following services:

- inspection of the fuel ejector glueing on the lubrication unit - P/N 0319150020;

- oil pump replacement - P/N 0319155050; and

- Module M01 replacement (Reduction Gearbox) - P/N 70EM018000.

The origin of the metal particles, in the ocorrence of 24MAY2013, found in the M01 and in the oil pump could come from an inadequate lubrication in the engine components, as described in a report issued by TURBOMECA.

It is also stated in the report that, during the M01 inspection, a degradation of the damper ring of the output pinion of this module was identified, the root cause of the reported event.

Thus, in order to avoid generation of metal particles due to wear of the damping ring of the M01 output gear, Service Bulletin 319 72 4078, “Incorporation of modification TF78 - Module M01 (Reduction Gearbox) - Output gear without damping ring” was also complied with.

After the completion of these services and the installation of the engine, the aircraft performed the tests on the ground. With verified ground compliance, the PR-IVE took off for a maintenance flight, during which the low-pressure oil lamp (ENG P) was turned on, culminating with the emergency landing.

It should be noted that the aircraft remained on the ground from 24MAY2013, when the engine was removed for maintenance, until it was reinstalled and the flight was performed on 21AUG2013.

Part II of the Engine Logbook of the aircraft did not have the records related to the services performed, as well as their approval for return to service.

In Part IV of the Aircraft Engine Logbook, no record of services related to the removal and installation of aircraft engine components was identified. Such services were inadequately written in Part II (primary maintenance records).

Part IV of the Aircraft’s airframe Logbook did not have records relating to the installation of the engine on the aircraft.

According to SAFRAN Turbomeca, in May 2010, a similar event occurred to another aircraft carrying the ARRIUS engine, in which, after the engine started and when the pilot accelerated the lever to the flight position, there was a sudden overheating of the engine. (932° C) at the same time as the TQ and oil pressure dropped. After the engine was cut off, the Gas Generator Thrust Bearing deteriorated, due to the lack of lubrication.

In August 2010, there is a record saying that, after the illumination of the ENG P light, the engine stopped in flight caused by the deterioration of the front bearings of the gas turbine. In this case, a possible failure of the oil pump may have contributed to the loss of oil pressure and consequent lack of lubrication in the engine.

As a recommended action, SAFRAN Turbomeca issued, in 2011, the Service Letter N° 2818/11 / ARRIUS2F, which reinforced the need to immediately carry out the autorotation procedure with the respective engine cut-off:

> The purpose of this Service Letter is to remind you that, following illumination of the “ENG P” warning light, the EUROCOPTER EC120 B Flight Manual requires immediate initiation of the autorotation procedure as soon as the engine oil pressure level is confirmed as low or nil. This autorotation procedure necessitates engine shutdown. This requirement is related to the velocity and extent of the engine damage once lubrication is interrupted.

According to ANAC records, at the time of the conclusion of the present investigation, there were 36 EC120B - Colibri aircraft equipped with the ARRIUS 2F engine in operation in Brazil.

1.20 Useful or effective investigation techniques.

Nil.

2. ANALYSIS.

It was a local maintenance flight, after performing a service of maintenance and installation of the engine model Arrius 2F, SN 34541.

On 24MAY2013, the PR-IVE had registered an incident related to the lighting of the chip detector light. After the analysis of the particles, the engine was removed by a HELIBRAS shop, being sent to the TURBOMECA shop.

During this maintenance, in addition to other services, the modification TF78 – “Module M01 (Reduction Gearbox) - Output gear without damping ring” was incorporated, which was intended to prevent the generation of metal particles, due to wear of the damping ring of the M01 output pinion.

After performing maintenance and ground testing, on 21AGO2013, the aircraft took off from Campo de Marte Aerodrome (SBMT), with the pilot and a mechanic, for a maintenance flight.

On the return, near the Memorial position, keeping 1,200ft, the pilot asked TWR-MT for landing instructions. In this circumstance, the instrument panel indicated the engine oil pressure drop, while the audible and luminous alarm of the fault in question was activated.

With the engine oil pressure indicating 0.1bar, the pilot requested clearance for landing on runway 12 of SBMT and informed TWR-MT that he had a low Engine Oil Pressure (ENG P) indication.

After receiving the authorization, the pilot noticed the fall of the NR. According to data collected from the VEMD, at the time that the NR dropped to 325 RPM, it was recorded that the T4 reached 1034° C, at the same time that the TQ dropped to 0.0% and the NG to 55%, value under that expected for ground idle. These parameters indicated that this was the moment in which the N2 gear locking occurred.

Engine overtemperature (T4 = 1,034 ° C) suggests that the recommendation to immediately perform the autorotation procedure with engine shutdown in the event of ENG P light was not promptly met.

The execution of this procedure, contained in Service Letter no. 2818/11 / ARRIUS2F, was intended to minimize the speed and extent of damage to the engine, due to lack of lubrication.

The fact that the autorotation maneuver did not start immediately after the "ENG P" light is on can be attributed to the pilot's concern to drive the aircraft to a safe location, since the helicopter flew over an area of intense vehicular movement.

Continuous to the loss of NR, the pilot lowered the command of the collective, stopping the alarm of low rotation. In this condition, the crewmember also stopped listening to the sound of the engine running, which confirms the failure recorded in the VEMD.

Due to the intense traffic of vehicles on the road and the presence of electric grid, the pilot decided to move to the right, in the search of a more suitable place to make the emergency landing safely.

In the final section of the autorotation maneuver, after the flare, the fenestron collided with the wall of a water pumping station of the city of São Paulo, which caused a rupture of the tail cone.

After the occurrence, the engine was analyzed, initially finding that the engine was externally without impact marks or damages, resulting from the forced landing.

When attempting to turn it manually, it was observed that the reduction gear train of the Reduction Gearbox Module (M01) was seized. A large amount of particles retained on the magnetic plugs and inside the front air intake casing was also verified.

No problems were identified in the oil pump or the contamination of the lubricating oil. However, it was found that M02 had been subjected to elevated temperature (T4 = 1.034C°),

which revealed possible lubrication failure. The lubrication failure could be confirmed by the loss of the oil pressure attested by the illumination of the ENG P light.

The analysis of the data contained in the VEMD revealed that the torque drop (TQ) probably occurred as a result of the pressure loss of the engine lubrication system. The oil pressure drop was also associated with other similar events occurred with aircraft carrying the Arrius 2F model.

In this sense, SAFRAN Turbomeca issued the Service Letter No. 2818/11 / ARRIUS2F, in 2011, which dealt with the procedure to be followed in case of the oil low-pressure light illumination.

In the same way, the Mandatory Service Bulletin 319 79 4075, Incorporation of modification TF75, was published, which dealt with the replacement of the check valve of the engine lubrication system by a piston valve free of seal and the Service Bulletin 319 72 4078, Incorporation of modification TF78, which was intended to remedy the generation of metal particles due to wear of the damping ring of the M01 output gear.

The Mandatory Service Bulletin 319 79 4075, Incorporation of modification TF75 had already been incorporated into the engine installed in the helicopter, while the Service Bulletin 319 72 4078, Incorporation of modification TF78 was incorporated on the occasion of maintenance work, due to the lighting of chip light detector.

After performing these maintenance services, the aircraft took off for a maintenance flight, during which the low-pressure oil light (ENG P) was turned on.

Thus, it couldn´t be discarded that the maintenance services performed on the aircraft contributed to the inflight engine failure.

The investigation of the engine components carried out by SAFRAN Turbomeca revealed that the rear bearing of the Generator Gas and the thrust bearing of the Power Turbine presented degradation, which originated from the lack of lubrication and operation with overtemperature (1034°C).

The signs of deterioration found in the bearings of the Gas Generator revealed that there was the rupture of the lubricating oil film.

After selecting and analyzing all possible faults that could have contributed, SAFRAN Turbomeca inferred that:

- a possible failure of the check valve and / or relief valves were discarded as contributing factors;

- no evidence of possible contamination or any non-compliance has been found in the lubrication system; and

- The amount of oil found after the accident was slightly above the minimum allowed. Thus, a possible oil retention in the cooling unit would not be able to cause loss of the system pressure.

The SAFRAN HE investigation report concluded that, after investigating all the factors considered as possible contributors, it was not possible to identify the root cause of the loss of the oil pressure and consequent failure of the engine in flight, which caused the emergency landing.

Although the origin of the problem that caused the loss of oil pressure was not identified, all the evidence suggests that there was a lack of lubrication, which led to the front gas generator bearing deterioration causing the gas generator mobile seizing and consequent engine over-temperature as well as the seizing of the reduction gear train of the Reduction Gear Module (Module 01) and finally, the stoppage of the engine in flight which caused the emergency landing.

3. CONCLUSIONS.

3.1 Facts.

a) the pilot had valid Aeronautical Medical Certificate (CMA);

b) the pilot had valid EC20 (which included model EC120B) aircraft Rating;

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

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

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

f) the airframe and engine logbook records were outdated;

g) maintenance services were performed, which included the replacement of the Reduction Gearbox (M01) and the oil pump;

h) service bulletin 319 72 4078, “Incorporation of modification TF78 - Module M01 (Reduction Gearbox) - Output gear without damping ring” has been complied with;

i) during the maintenance flight, the engine low oil pressure light (ENG P) was illuminated;

j) the engine failed in flight;

k) an emergency landing was performed in an autorotation procedure;

l) during the flare, the aircraft collided with a concrete wall causing the collapse of the tail cone;

m) engine examination revealed that the reduction gear train of the Reduction Gearbox Module (M01) was seized;

n) engine examination revealed that there was rupture of the lubricating oil film;

o) the Arrius 2 F engine, SN 34541, suffered an overtemperature (1,034° C);

p) the Generator Gas and Power Turbine bearings presented degradation, due to loss of lubrication;

q) no failures were observed in the operation of the check valve and / or the relief valves;

r) the amount of oil found after the accident was slightly above the minimum expected;

s) no evidence of possible contamination or any non-compliance was found in the lubrication system;

t) it was not possible to identify the root cause of the loss of oil pressure;

u) the aircraft had substantial damage; and

v) the occupants left unharmed.

3.2 Contributing factors.

- **Maintenance of the aircraft - indeterminate.**

It was not possible to exclude that the maintenance services performed on the aircraft contributed to the event.

- **Other - undetermined.**

It is possible that a non-identified factor has contributed to the inflight engine failure.

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".

Recommendations issued at the publication of this report:

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

A-149/CENIPA/2013 - 01 **Issued on 06/28/2019**

Act together with certified maintenance organizations so that any serious failure, malfunction or defect event related to the Arrius 2F engine that equip the EC120B - Colibri aircraft is reported to ANAC within 96 hours after its discovery, through service difficulties reports.

A-149/CENIPA/2013 - 02 **Issued on 06/28/2019**

Accomplish an audit at the Safran Helicopter Engines do Brasil shop, in order to verify the conformity of its procedures, especially in relation to the Arrius 2F engines.

A-149/CENIPA/2013 - 03 **Issued on 06/28/2019**

Accomplish an audit at the Helibras Shop, in São Paulo-SP, in order to verify the conformity of its procedures, especially in relation to the EC120B model.

A-149/CENIPA/2013 - 04 **Issued on 06/28/2019**

Disseminate the lessons learned in the present investigation, in order to raise the situational awareness of pilots and operators of the EC120B - Colibri aircraft, especially with regard to the possibility of inflight engine failure due to the loss of oil pressure of the lubrication system.

A-149/CENIPA/2013 - 05 **Issued on 06/28/2019**

Disseminate the lessons learned in this investigation, in order to alert operators and maintainers of the aircraft EC120B - Colibri on the importance of complying with Service Letter No. 2818/11 / ARRIUS2F, as a tool to prevent aircraft accidents.

5. CORRECTIVE OR PREVENTATIVE ACTION ALREADY TAKEN.

SAFRAN Turbomeca made a visit to SAFRAN HE Brazil, in order to verify the conformity of the maintenance.

Service Bulletin SB-319-79-4834 was issued on 21OCT2014, which deals with the inspection of the Oil-Pump Drive Link / Lubricating Device - Inspection.

On June 28th, 2019.

ANNEX A

COMMENTS BY THE BEA ON DRAFT FINAL REPORT

Below, there is a list of the comments forwarded by Bureau d'Enquêtes et d'Analyses pour la Sécurité de l'Aviation Civile – BEA on PR-IVE Draft Final Report that weren´t accept.

Comment	Chapter	Page	Text to be corrected (first … last word)	Text Proposed by BEA / Argumentation	CENIPA´s comment
1.	1.16	9	TURBOMECA or SAFRAN Turbomeca	We propose to replace all over the report TURBOMECA or SAFRAN Turbomeca with Safran Helicopter Engines (formely Turbomeca).	CENIPA uses in its reports the names of companies as they were at the time of the accident or the issuance of the technical reports.
2.	1.19	16	The origin of the metal particles found M01 and in the oil pump could come from an inadequate lubrication in the engine components, as described in a report issued by TURBOMECA.	This sentence is redundant with the previous sentence. We propose to remove it.	CENIPA believes that this information is complementary, not redundant.
3.	2	20	failure	We propose to replace with in flight shut-down.	According with the MCA 3-6/2017 - Brazilian Investigation Manual, published by CENIPA in 2017, which is based in ECCAIRS Taxonomy (ICAO), an in-flight engine failure occurred.

Comment	Chapter	Page	Text to be corrected (first ... last word)	Text Proposed by BEA / Argumentation	CENIPA´s comment
4.	2	20	Which, in addition to causing a drop in oil pressure, contributed to the increase in the engine temperature, causing the locking of the gear reduction train of the Reduction Gear Module (M01) and the consequent stoppage of the engine in flight, which caused the emergency landing.	We propose to replace with which led to the front gas generator bearing deterioration causing the gas generator mobile seizing and consequent engine over-temperature as well as the seizing of the reduction geart train of the Reduction Gear Module (Module 01) and finally, the in flight engine shut-down which caused the emergency landing.	The text was changed to: which led to the front gas generator bearing deterioration causing the gas generator mobile seizing and consequent engine over-temperature as well as the seizing of the reduction gear train of the Reduction Gear Module (Module 01) and finally, the stoppage of the engine in flight which caused the emergency landing.
5.	3.1	20	failed	We propose to replace with shut-down.	According with the MCA 3-6/2017 - Brazilian Investigation Manual, published by CENIPA in 2017, which is based in ADREP Taxonomy (ICAO), an in-flight engine failure occurred.
6.	3.1/5	21/22	SAFRAN Turbomeca do Brasil	We propose to replace with Safran Helicopter Engines (formely Turbomeca) Do Brasil.	CENIPA uses in its reports the names of the companies as they were at the time of the accident or the issuance of the technical reports.