COMANDO DA AERONÁUTICA

CENTRO DE INVESTIGAÇÃO E PREVENÇÃO DE ACIDENTES AERONÁUTICOS

FINAL REPORT
IG - 114/CENIPA/2016

OCCURRENCE:	**SERIOUS INCIDENT**
AIRCRAFT:	**PP-EJK**
MODEL:	**AS 350 B2**
DATE:	**31AUG2016**

NOTICE

According to 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 by taking into account the contributing factors and hypotheses raised. Therefore, the report is a technical document reflecting 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 into the Brazilian legal system by 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, using this report for any purpose other than preventing future accidents may induce 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 31AUG2016 serious incident with the AS 350 B2 aircraft model, registration PP-EJK. The serious incident was classified as “[LOC-I] Loss of Control in Flight and [LALT] Low Altitude Operation”.

During a firefighting training flight, the aircraft lost lift when refueling the Bambi Bucket and abruptly sank until the tail rotor collided with a lagoon surface.

The aircraft had substantial damage.

The crewmembers were not injured.

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

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GLOSSARY OF TECHNICAL TERMS AND ABBREVIATIONS

ADE	Direct State Administration Registration Category
ANAC	Brazil's National Civil Aviation Agency
BKN	Broken (5-7 oktas)
CA	Airworthiness Certificate
CENIPA	Aeronautical Accident Investigation and Prevention Center
CIV	Pilot`s Flight Logbook
CMA	Aeronautical Medical Certificate
HMNT	Single-Engine Turbine Rating - Helicopter
IFRH	Instrument Flight Rating - Helicopter
MCA	Aeronautics Command Manual
METAR	Meteorological Aerodrome Report
NSCA	Aeronautics Command System Standard
OEE	Special Equipment Operator
OGE	Out Ground Effect
OM	Maintenance Organization
PCH	Commercial Pilot License – Helicopter
PIC	Pilot in Command
PPH	Private Pilot License – Helicopter
RBAC	Brazilian Civil Aviation Regulation
RBHA	Brazilian Aeronautical Certification Regulation
SBBH	ICAO Location Designator - Pampulha Aerodrome - Carlos Drummond de Andrade, Belo Horizonte - MG
SERIPA III	Third Regional Aeronautical Accident Investigation and Prevention Service
SIPAER	Aeronautical Accident Investigation and Prevention System
SJLY	ICAO Location Designator – BH Helicenter, Nova Lima - MG
SN	Serial Number
UTC	Universal Time Coordinated
VI	Indicated Air Speed
VRS	Vortex Ring State

1. FACTUAL INFORMATION.

Aircraft	**Model:** AS 350 B2 **Registration:** PP-EJK **Manufacturer:** HELIBRAS	**Operator:** Minas Gerais Military Police
Occurrence	**Date/time:** 31AUG2016 - 1740 UTC **Location:** Lagoa dos Ingleses **Lat.** 20°10'05"S **Long.** 043°53'36"W **Municipality – State:** Nova Lima – MG	**Type(s):** "[LOC-I] Loss of Control in Flight and [LALT] Low Altitude Operation" **Subtype(s):** NIL

1.1 History of the flight.

The aircraft took off from the Pampulha Aerodrome - Carlos Drummond de Andrade (SBBH), Belo Horizonte - MG, at about 1725 (UTC) to perform a local firefighting training flight with the Bambi Bucket equipment, with two crewmembers on board, one being the PIC and the other an OEE.

About fifteen minutes into the flight, while refueling the Bambi Bucket, the aircraft lost lift and abruptly sank until its tail rotor collided with a lagoon surface. After the impact, the PIC managed to regain control of the aircraft and made the landing at the BH Helicenter BH (SJLY), Nova Lima - MG.

The aircraft had substantial damage. The two crewmembers left unharmed.

1.2 Injuries to persons.

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

1.3 Damage to the aircraft.

The aircraft had substantial damage to the gearbox, rear camshaft, and tail rotor assembly due to impact against the lagoon surface (Figure 1).

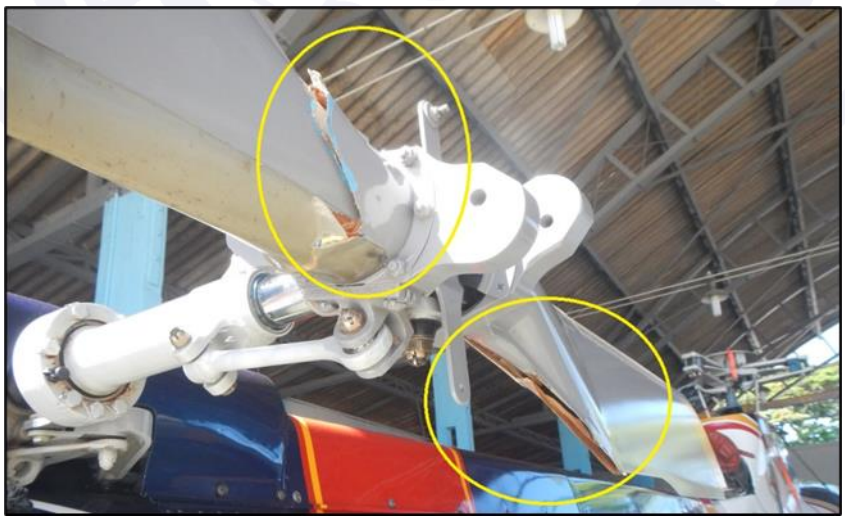

Figure 1- Detail of damage to the tail rotor assembly.

1.4 Other damage.

None.

1.5 Personnel information.

1.5.1 Crew's flight experience.

Flight Hours	PIC
Total	1.155:00
Total in the last 30 days	10:00
Total in the last 24 hours	05:00
In this type of aircraft	1.145:00
In this type in the last 30 days	10:00
In this type in the last 24 hours	05:00

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

1.5.2 Personnel training.

The PIC took the PPH course at the *Companhia de Radiopatrulhamento Aéreo* - MG, in 2005.

1.5.3 Category of licenses and validity of certificates.

The PIC had a PCH License and had valid HMNT, H350 and IFRH Ratings.

1.5.4 Qualification and flight experience.

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

1.5.5 Validity of medical certificate.

The pilot had a valid CMA.

The Special Equipment Operator`s CMA expired in 17JUL2016.

1.6 Aircraft information.

The aircraft, serial number (SN) AS2963, was manufactured by HELIBRAS in 1997 and was registered in the ADE Category.

The aircraft`s CA was valid.

The airframe and engine logbook records were updated.

The last major inspection of the aircraft, the "5,000 hours/72 months" type, was carried out on 19AUG2016 by the OM *Claro Aviação*, in Belo Horizonte - MG, with 19 hours and 40 minutes flown after the inspection.

1.7 Meteorological information.

The METAR from SBBH, approximately 09 nautical miles from the accident site, provided the following information:

METAR SBBH 311700Z 03006KT 9999 BKN035 11/31 Q1017 =

METAR SBBH 311800Z 03006KT 9999 BKN035 25/15 Q1017 =

Weather conditions were favorable for the visual flight with visibility above 10 km, cloudy with a ceiling of 3,500 ft. The wind had a direction of 030° with an intensity of 06 kt.

1.8 Aids to navigation.

Nil.

1.9 Communications.

Nil.

1.10 Aerodrome information.

The occurrence took place out of the Aerodrome.

1.11 Flight recorders.

Neither required nor installed.

1.12 Wreckage and impact information.

The impact occurred in Lagoa dos Ingleses, in Nova Lima - MG. After the aircraft abruptly lost altitude, the tail rotor touched the water surface, and which caused substantial damage to the aircraft.

The pilot managed to regain control of the helicopter and head for SJLY.

1.13 Medical and pathological information.

1.13.1 Medical aspects.

No evidence was found that problems of physiological nature could have affected the flight crew's performance.

1.13.2 Ergonomic information.

Nil.

1.13.3 Psychological aspects.

No evidence was found that problems of physiological nature or incapacitation could have affected the flight crew's performance.

1.14 Fire.

There was no fire.

1.15 Survival aspects.

Nil.

1.16 Tests and research.

Nil.

1.17 Organizational and management information.

On the date of the occurrence, the Public Security air operations met the requirements established in Subpart K of the RBHA No. 91, and regarding training, section 91.959 established that:

> [...]
>
> (d) It is the responsibility of the Agency to establish minimum standards for training crews concerning public security and/or civil defense operations specified in paragraph 91.953(b) of this regulation.
>
> [...]

As of 12APR2019, with the publication of the RBAC No. 90, entitled "Requirements for special public aviation operations" the necessary requirements for special training for helicopter air operation were established in Subpart BB. with external load from the Public Air Units.

1.18 Operational information.

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

The mission consisted of an annual firefighting training flight using Bambi Bucket equipment. These flights took place annually before the start of the firefighting period.

The last flight of this type was carried out at the end of the fire period of the previous year, more precisely in October 2015 (10 months before the serious incident).

Initially, the aircraft took off from SBBH to Nova Lima - MG, where the Bambi Bucket tests, and reconnaissance flights were performed to locate a line of fire for training.

There would be four trips to fight the fire, which consisted of capturing water in Lagoa dos Ingleses, flying en route and dispersing water over the fire. In the fourth fueling, the PIC reported that, after keeping the aircraft in hover, he started the descent with visual references and aided by the OEE, which, according to the operator's doctrine, should assist the pilot in the approach indicating the distance to the water.

According to the pilot, the descent was performed on the lagoon surface, with an external load (Bambi Bucket), without horizontal displacement.

At one point, the aircraft began an abrupt descent, estimated by the crew at 20 meters, with the consequent impact of the tail rotor on the water's surface. Although the aircraft had abnormal vibrations due to damage to the tail rotor, the pilot managed to regain control and land at BH Helicenter one minute into the flight.

The pilot reported that he did not see any emergency lights on inside the aircraft. The lagoon's water surface was calm and without turbulence, so the lagoon presented a large water mirror.

The pilot also reported that, after noticing the excessive loss of altitude, he applied the collective at maximum upwards and placed the cyclic forward, which did not prevent the helicopter from contacting the water.

1.19 Additional information.

On 07FEB2011, the Eurocopter An EADS Company published Safety Information Notice No. 2335-S-00, which, among other topics, addressed the issue of Vortex Ring State (VRS) or vortex stall.

The document highlighted that the VRS was a powered flight condition in which the helicopter "lost" its own rotor flow. As a result, the rate of descent increased rapidly, about three times higher than before, for the same engine power.

The VRS could occur in case of descent with power at a speed lower than 30 kt, and with a rate of descent close to the deflection speed of the main rotor. The deflection speed or induced speed was defined as the speed of the air flow drawn in through the rotor disk.

For a two-blade helicopter with a rotor diameter of 11 meters and a weight of 1,000 kg, the induced speed was 6.5 m/s (1,300 ft/min).

Therefore, although the VRS depended on the type of helicopter and its weight, the rate of descent was generally regarded as dangerous when it exceeded 500 ft/min.

Among the effects caused by vortex stall were the following:

- vibrations when vortices leave the blade tips;

- less smooth pitch and roll commands because of unstable airflow that constantly modifies the thrust and momentum of the command;

- fluctuations in power demand resulting from the fact that significant changes in drag cause variations in thrust; and

- abnormally high rate of descent when the vortex is developing and can exceed 3,000 ft/min.

In this regard, the MCA 3-6 - SIPAER Investigation Manual, 2017, highlighted that the vortex stall was the phase of descending flight characterized by unstable airflow through the rotor blades.

It occurred when the helicopter was at a speed lower than the translational lift, with a rate of descent equal to approximately ¼ of the downwash speed and collective pitch command partially applied.

The effects of the vortex peaked when the rate of descent reached values approximately equal to ¾ of the induced speed, causing strong vibrations and uncommanded pitch and roll oscillations, possibly leading to loss of aircraft control (Figure 2).

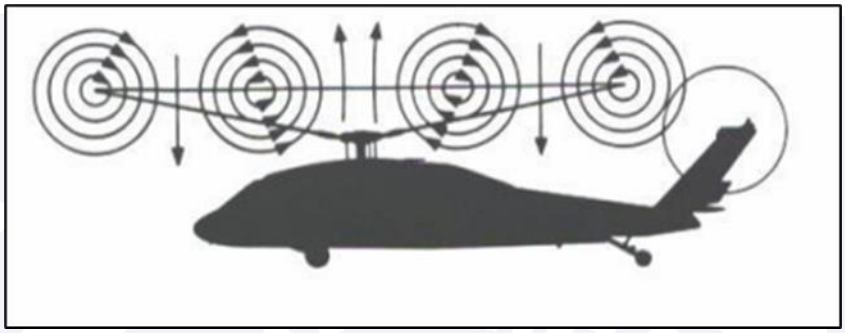

Figure 2 - State of the vortex rings. Source: MCA 3-6.

Regaining control of the helicopter, according to Safety Information Notice No. 2335-S-00, could be done by acting on the cyclic and/or collective. However, according to the rotor system, an action on the cyclic alone might be insufficient to modify the helicopter's attitude and increase speed. Thus, to regain control of the helicopter the collective should be reduced to a minimum pitch. However, the height loss while regaining control by reducing the collective pitch was greater than the corresponding height loss by action on the cyclic because the descent ratio in autorotation at low speed was too high.

Therefore, the Safety Information Notice continued. The following control recovery actions should be performed still in the early stages of the event to minimize height loss, namely:

- move the cyclic effectively forward to obtain an accelerating attitude and increase speed;

- regain control of the helicopter when the indicated speed (VI) reaches 40 kt; and

- if the speed does not increase, decrease the collective to enter autorotation, and then move the cyclic stick forward as necessary to increase speed.

Basically, these maneuvers, called by the manufacturer classical techniques, recommended that, in order to escape the VRS, the collective should be lowered (if necessary) and the cyclic moved forward to exit the swirling air column.

Because control recovery actions result in considerable height loss, it would be imperative to avoid the VRS, especially when close to the ground. Thus, a rate of descent greater than 500 ft/min should be avoided for a speed less than 30 kt in powered flight.

The publication that some operations should be performed with extreme caution, among which were hovering flight out of ground effect and approaching with a tailwind.

A few years after this publication, Airbus Helicopters issued, on 02APR2020, the Safety Information Notice N°3463-S-0. At that time, it was warned that entry into VRS could be initiated with fluctuations in rotor thrust and increased vibration levels, continuing with a light feeling in the seat that, if no immediate action was taken by the pilot, the VRS

would quickly become a dangerous situation, especially when the helicopter was near the surface.

In this condition, the aircraft could experience extremely high descent ratios, while losing the effectiveness of the cyclic and yaw command. Without proper application of commands in the time required for recovery, the VRS would usually evolve into an accident. A fully developed vortex stall proves to be extremely dangerous and often fatal.

In that same publication, the “Vuichard Recovery Technique” was presented. This method, in addition to the classical techniques published in Safety Information Notice N° 2335-S-00, recommended the use of the collective at the same time that a lateral command of the cyclic was applied, maintaining the direction control with the pedals. Thus, this procedure was designed to allow the exit of the VRS through a lateral movement of the helicopter.

Although the document does not specify which side to escape to, in the case of the AS 350, it would be recommended to control the cyclic to the advancing blade side, i.e. to the left. Under this condition, a coordinated flight would be maintained by applying the right pedal.

However, the document went on to state that in flight, should the pilot not have recognized the early warnings and be effectively experiencing a vortex stall, the "classical techniques" were the effective ones to enable recovery.

In turn, the "Vuichard Recovery Technique" could be applied in the case of fully developed VRS under specific operating conditions such as a final approach with a tailwind or with the helicopter facing an in-flight obstacle.

The document further advised that the recognized techniques for recovery from a VRS should not be trained in flight, but should be practiced, without risk, in a flight simulator if it can do so.

In-flight training should focus only on recognizing the first signs and field actions to avoid entering a vortex stall, i.e., "Recognize and Avoid".

Consequently, Airbus Helicopters warned, early detection and prevention of the VRS were considered fundamental. Pilots should understand the importance of early recovery and be trained to detect a VRS in its early stages, recognizing the first warning signs.

Basically, the symptoms experienced by the crewmembers were increased vibration, pitch and roll movements, and an increased rate of descent, even with the collective upward application.

On the occasion of the Final Report A-060/CENIPA/2014 of the accident that occurred with the PP-SSP, this topic had already been addressed. On that occasion, some situations that could lead to the development of vortex stall, and therefore, should be avoided were highlighted:

- descents with applied power, low speed, and high ratio

The rate of descent required for this condition to occur differs between different types of helicopters. However, it is generally greater than 500 ft/min with little or no forward speed. This situation is aggravated and becomes more dangerous with a heavy helicopter, on a hot day due to the greater need for power to maintain the hover.

- maneuvers and approaches with a tailwind

In general, maneuvers with tailwinds will always be critical, especially approaches. On such approaches, the swirling airflow, which would be left behind on a normal approach, would be thrown back toward the helicopter, causing the aircraft to enter the downwash itself and causing the vortex to stall.

- quick stops

When a helicopter aggressively flares at a sudden stop, with the rotor disk tilted well back, the horizontal airflow starts to come from the underside of the rotor disk due to the direction of travel and the aircraft's attitude. If a rate of descent is initiated in this situation, the airflow displacement verticalizes even more and the aircraft ends up entering the downwash zone once again.

- training autorotation recovery

The recovery from an autorotation in which power is applied before leveling the aircraft, in the flare, is similar to the situation of the fast stop on the straight, mentioned above. It is important to consider that this would not happen in a real situation of autorotation (with the engines cut off) because, due to the lack of power, with the application of the collective there would be no induction of airflow in the direction of displacement of the aircraft.

In addition, the attempt to hover out of the ground effect above the OGE hovering ceiling and maintain this hover without effectively controlling the altitude was a contributing factor to the occurrence of the vortex stall.

On 07JUN2002, Airbus Helicopters also published Safety Information Notice N°3349-S-25, in which it informed that it had recently participated in several investigations into accidents and serious incidents during firefighting operations involving helicopters equipped with the Bucket type.

On the subject, the company created a series of guidelines for the installation of the equipment, thus highlighting the importance of complying with the recommendations contained in the Bucket manufacturer's Operations Manual.

1.20 Useful or effective investigation techniques.

Nil.

2. ANALYSIS.

It was a local firefighting training flight using Bambi Bucket equipment.

According to the available information, there was no evidence that the aircraft systems contributed to the occurrence. The airframe and engine logbook records were updated.

It was found that conditions were favorable for the visual flight with visibility above 10 km, with a ceiling of 3,500 ft. The wind had a direction of 030° with an intensity of 06 kt.

The lagoon`s water surface was calm and without turbulence, forming a large water mirror.

This type of operation took place annually before the start of the firefighting period.

At the time of the serious incident, the Public Security air operations met the requirements established in Subpart K of RBHA 91, and it was the responsibility of the Public Security Agency to establish minimum standards for crew training.

Despite being qualified and having experience in the type of flight, it had been about ten months since the crew performed this type of operation. Thus, it is inferred that there may have been an inadequacy in the planning carried out by the organization, especially with regard to the frequency of training and its risk management.

The OEE`s CMA was expired. Although there is no evidence of contribution from the medical aspect, this crewmember failed to carry out a series of tests to certify that his health conditions would not present any risk to flight safety.

About the flight, this was the fourth supply over the lagoon, and the PIC reported that, after keeping the aircraft in hover, it started the descent with visual references and assisted by the OEE, which, according to the operator's doctrine, should assist the pilot in the approach, indicating the distance to the water.

The PIC reported that he performed this descent with the external load (Bambi Bucket) and without horizontal displacement on the lagoon surface. In this condition, there was an abrupt and uncontrolled increase in the aircraft`s rate of descent. As a result, the tail rotor hit the water surface. Although the aircraft had abnormal vibrations resulting from damage to the tail rotor, the pilot was able to regain control and land at the BH Helicenter.

According to the PIC description, all indications point to the occurrence of a vortex stall since the PP-EJK, in an attempt to perform a hover out-of-ground effect with external load, started a vertical descent with a rate greater than 500 ft. /min, without effective control, with little or no forward speed (less than 30 kt).

Allied to this, the high use of engine power, without sustaining the effective height maintenance, causing the tail rotor to touch the lagoon surface, was also revealed as evidence of the vortex stall.

Regarding these signs, Safety Information Notice N° 2335-S-00 warned that, in a VRS situation, the rate of descent would increase rapidly, about three times higher than before, for the same engine power. Thus, corrective measures should be performed at the beginning of the event to minimize the loss of height. To this end, according to the Safety Information Notice, control recovery actions could be carried out by acting on the cyclical and/or the collective.

From this perspective, the PIC's report indicated that one of the actions he implemented to minimize the effect of the vortex stall and regain control of the helicopter differed from that recommended in the Safety Information Notice. According to the document, control recovery actions should be performed in the early stages of the event to minimize height loss.

Basically, these maneuvers, called by the manufacturer classical techniques, recommended that, in order to escape the VRS, the collective should be lowered (if necessary) and the cyclic moved forward to exit the swirling air column.

Thus, based on the reports, there was no effective understanding of the vortex stall indicators as the PIC reported that, after noticing the excessive loss of altitude, he applied maximum power to the collective and placed the cyclic ahead, which did not avoid the helicopter's contact with the water.

It is important to highlight that the forward cyclic movement with the use of power, through the collective, caused the opposite effect to what was expected, as this increased the stalled area in the inner section of the rotor disk also increasing the descent rate of the aircraft.

In the case of the Vuichard Recovery Technique method, which recommended the use of the collective, this command was only applied together with the lateral command of the cyclic, maintaining control of the direction with the use of the pedals.

Thus, according to Airbus Helicopters, this technique could only be applied in the case of a fully developed VRS under specific operating conditions, such as a final approach with tailwind or with the helicopter facing an obstacle in flight which was not the case of that occurrence.

In this context, the use of classical techniques would be more effective in enabling recovery. Under no circumstances should there be a combination of power application with forward cyclic movement. Thus, without the proper application of commands and sufficient

time for recovery, the VRS evolved into this serious incident, which caused damage to the aircraft.

As the attempt to recover can generate a great loss of height, the movement of the cyclic forward to accelerate the aircraft, without lowering the collective, would cause a smaller loss of height. Thus, this was the most suitable alternative for the recovery of the experienced condition.

Therefore, early detection of VRS signals and their prevention should be considered a critical criteria for safe operation. As such, pilots must understand the importance of early recovery and be trained to detect the VRS at an early stage by recognizing early warning signs.

Therefore, the recognized techniques for recovering a VRS must be practiced, without risk, in a flight simulator, if it has the capacity to do so. In-flight training should only focus on recognizing the first signs and the field actions to avoid entering a vortex stall, i.e.: “Recognize and Avoid”.

3. CONCLUSIONS.

3.1 Facts.

a) the pilot had a valid CMA;

b) the OEE`s CMA expired in 17JUL2016;

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

d) the last operation of this type had been carried out at the end of the burning season of the previous year;

e) the aircraft had a valid CA;

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

g) the airframe and engine logbook records were updated;

h) the weather conditions were favorable for the flight;

i) while refueling the Bambi Bucket, the aircraft began an abrupt and uncontrolled descent, estimated by the crew at 20 meters;

j) after noticing the excessive loss of altitude, the PIC applied the collective at maximum upwards and placed the cyclic forward, which did not prevent the helicopter from contacting the water;

k) the aircraft had substantial damage; and

l) the crewmembers were not injured.

3.2 Contributing factors.

- **Control skills – a contributor.**

There was the application of maximum collective after the abrupt increase in the descent rate. This application of power, through the use of the collective, resulted in the opposite of the desired effect, increasing the “stalled” area in the inner section of the rotor disk.

- **Training – undetermined.**

Due to the probable lack of specific training to identify the signals compatible with the vortex stall and the theoretical knowledge of the techniques recommended for the recovery of a VRS, the commands were not applied effectively to recover the helicopter.

- **Perception – a contributor.**

There were difficulties in recognizing and understanding the characteristic signs that the helicopter was under a condition that would lead to a vortex stall.

- **Management planning – undetermined.**

It was inferred that there may have been an inadequacy in the planning carried out by the organization, especially with regard to the frequency of training and risk management.

- **Decision-making process – a contributor.**

The PIC presented difficulties in perceiving and choosing the recommended actions to act properly in relation to the vortex stall condition.

Thus, the decision to try to regain control of the aircraft through the application of power proved to be ineffective, contributing to the collision of the aircraft against the lagoon.

4. SAFETY RECOMMENDATION.

A proposal of an accident investigation authority based on information derived from an investigation made intending to prevent 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 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 Brazil's National Civil Aviation Agency (ANAC):

IG-114/CENIPA/2016 - 01 **Issued on 03/23/2023**

Disseminate the lessons learned in the present investigation to the Public Air Units that operate according to the rules of RBAC 90, to complement the guidelines contained in the special training for air operation of helicopters with external load, in particular on the need to recognize the first signs and the field actions to be taken to prevent a vortex stall from occurring.

5. CORRECTIVE OR PREVENTATIVE ACTION ALREADY TAKEN.

None.

On March 23th, 2023.