COMANDO DA AERONÁUTICA

CENTRO DE INVESTIGAÇÃO E PREVENÇÃO DE ACIDENTES AERONÁUTICOS

FINAL REPORT
A - 047/CENIPA/2018

OCCURRENCE:	**ACCIDENT**
AIRCRAFT:	**PT-HYV**
MODEL:	**AS-350BA**
DATE:	**15MAR2018**

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 15MAR2018 accident with the AS 350 BA aircraft model, registration PT-HYV. The accident was classified as “[LALT] Low Altitude Operations”.

During the inspection in the transmission line, after 15 minutes of flight, there was the touch of part of the aircraft with the transmission line, causing the aircraft to fall.

The aircraft had substantial damage.

The pilot and the three passengers suffered minor injuries.

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

AC	Advisory Circular
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
CELPA	Pará Power Stations
CG	Center of Gravity
CLT	Consolidation of Labor Laws
CM	Registration Certificate
CMA	Aeronautical Medical Certificate
CRM	Crew Resource Management
CTM	Technical Maintenance Control
EO	Operating Specifications
FAA	Federal Aviation Administration
GRAESP	Air Group of Public Security from the State of Pará
HMNT	Single Turbo Helicopter Rating
IGE	In Ground Effect
LTE	Loss of Tail Rotor Effectiveness
MAXCAPPI	Maximum Constant Altitude Plan Position Indicator
METAR	Meteorological Aerodrome Report
MGO	General Operations Manual
OGE	Out of Ground Effect
OM	Maintenance Organization
PCH	Commercial Pilot License – Helicopter
PLA	Airline Pilot License - Airplane
PPH	Private Pilot License - Helicopter
PTO	Operational Training Program
REDEMET	Aeronautics Command Meteorology Network
SAE	Aircraft Registration Category of Specialized Air Service
SALVAERO-AZ	Amazon Region Search and Rescue Coordination Center
SBBE	ICAO Location Designator - Val de Cans / Júlio Cezar Ribeiro Aerodrome, Belém - PA
SBMQ	ICAO Location Designator - Alberto Alcolumbre Aerodrome, Macapá - AP
SERIPA	First Regional Aeronautical Accident Investigation and Prevention Service
SIPAER	Aeronautical Accident Investigation and Prevention System
SNVS	ICAO Location Designator – Breves Aerodrome - PA

S/N	Serial Number
TCU	Towering Cumulus
TPX	Aircraft Registration Category of Non-Regular Public Air Transport
UTC	Universal Time Coordinated
VFR	Visual Flight Rules
VMC	Visual Meteorological Conditions

1. FACTUAL INFORMATION.

Aircraft	**Model:** AS 350 BA **Registration:** PT-HYV **Manufacturer:** Helibras	**Operator:** Maricá Air Taxi Ltd.
Occurrence	**Date/time:** 15MAR2018 - 1500 UTC **Location:** Out of the Aerodrome **Lat.** 01°39'00"S **Long.** 050°07'29"W **Municipality – State:** Curralinho – PA	**Type(s):** "[LALT] Low Altitude Operations" **Subtype(s):** NIL

1.1 History of the flight.

The aircraft took off from an eventual landing area, located in the municipality of Curralinho - PA, to the Breves Aerodrome (SNVS) - PA, at about 1445 (UTC), in order to perform inspection on part of the transmission line of electricity between these municipalities, with a pilot and three passengers on board.

After 15 minutes of flight, during an approach to the right side of the transmission line, there was a collision of the aircraft's tail against the cables, causing loss of control. The aircraft crashed into the ground in a swampy area of the jungle.

Figure 1 - View of the PT-HYV after the accident.

The aircraft had substantial damage.

The pilot and the three passengers suffered minor injuries.

1.2 Injuries to persons.

Injuries	Crew	Passengers	Others
Fatal	-	-	-
Serious	-	-	-
Minor	1	3	-
None	-	-	-

1.3 Damage to the aircraft.

The aircraft had substantial damage to the engine, main rotor, tail rotor, structure, cockpit, passenger cabin, tail cone, windshield, landing ski, stabilizers, engine fairings, transmission and rotor drive shaft tailed.

1.4 Other damage.

There was damage to the wires and breakage of a transmission line pole.

1.5 Personnel information.

1.5.1 Crew's flight experience.

Flight Hours	Pilot
Total	15.000:00
Total in the last 30 days	04:00
Total in the last 24 hours	01:15
In this type of aircraft	250:00
In this type in the last 30 days	04:00
In this type in the last 24 hours	01:15

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

1.5.2 Personnel training.

The pilot took the PPH course, in 2010.

1.5.3 Category of licenses and validity of certificates.

The pilot had the PCH License and had valid HMNT Rating.

The pilot also had the PLA License.

1.5.4 Qualification and flight experience.

There was no evidence of specific training to perform this type of mission, as previsedin the company's training manual.

1.5.5 Validity of medical certificate.

The pilot had valid CMA.

1.6 Aircraft information.

The aircraft, serial number AS2720, was manufactured by Helibras, in 1994, and it was registered in the TPX and SAE categories.

The aircraft had valid Airworthiness Certificate (CA).

The airframe and engine logbook records were updated.

The last inspection of the aircraft, the "50hours" type was carried out on 08MAR2018 by the maintenance organization Maricá Air Taxi, in Belém - PA, with the aircraft having flown 2 hours and 42 minutes after the inspection.

The last inspection of the aircraft, the "100hours" type was carried out on11JAN2018 by the maintenance organization Maricá Air Taxi, in Rio de Janeiro - RJ, with the aircraft having flown 35 hours and 06 minutes after the inspection.

1.7 Meteorological information.

According to the pilot's report, the weather conditions were favorable, with only one Towering Cumulus (TCU), about 3 NM to the right of the route, but without influencing the flight.

It was verified, according to the images of the weather radar and reports of observers, that the conditions were favorable for the visual flight, with good visibility and few clouds on the route.

The images obtained in the REDEMET, of the MAXXCAPPI, showed that the significant formations closest to the accident site, at the approximate moment of impact, were around 45 NM, this information confirms the reports collected during the investigation (Figure 2).

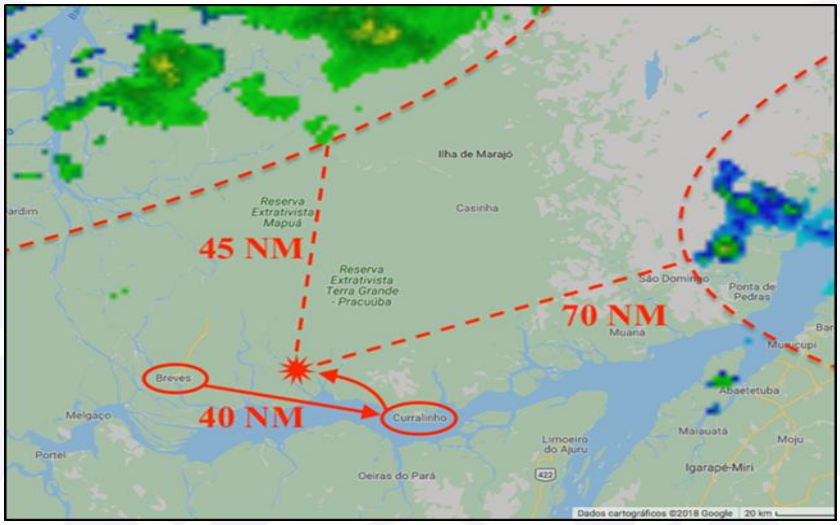

Figure 2 - MAXXCAPPI Radar Image from 15MAR2018, 1500 (UTC).
Source: REDEMET.

The METAR of SBBE and SBMQ, the closest airports, 100 NM and 116 NM away, respectively, from the accident site, contained the following information:

SBBE 151500Z 07007KT 9999 BKN020 BKN100 26/24 Q1013 =

SBMQ 151500Z 06006KT 9999 VCSH BKN018 BKN090 27/25 Q1014 =

According to what is described above, the wind in SBBE had a direction of 070º, with an intensity of 7kt, with visibility above 10km and cloudy sky, with a cloud layer of 5 to 7 octaves, at 2,000ft and at 10,000ft.

In SBMQ, the wind had a direction of 060°, with an intensity of 6kt, with visibility above 10km and cloudy sky, with a cloud layer of 5 to 7 octaves, at 1,800ft and 9,000ft.

According to the 1200 (UTC) wind chart, valid until 1800 (UTC), the wind, at FL 050, had an approximate direction of 265º, with an intensity of 25kt (Figure 3).

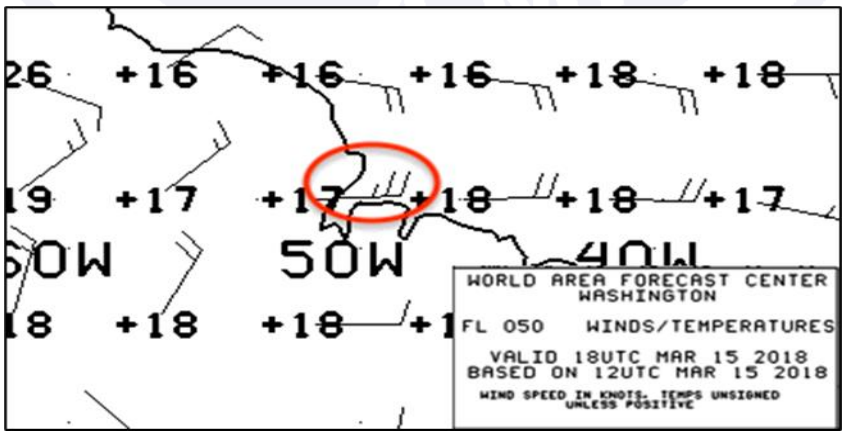

Figure 3 - Cut of the wind chart of 15MAR2018, FL050, from 1200 (UTC), valid until 1800 (UTC). Source: REDEMET.

Also in this context, in the region close to the event, the Surface Chart at 1200 (UTC), updated at 1421 (UTC), showed a 50° wind direction, with intensity between 1 and 2kt (Figure 4).

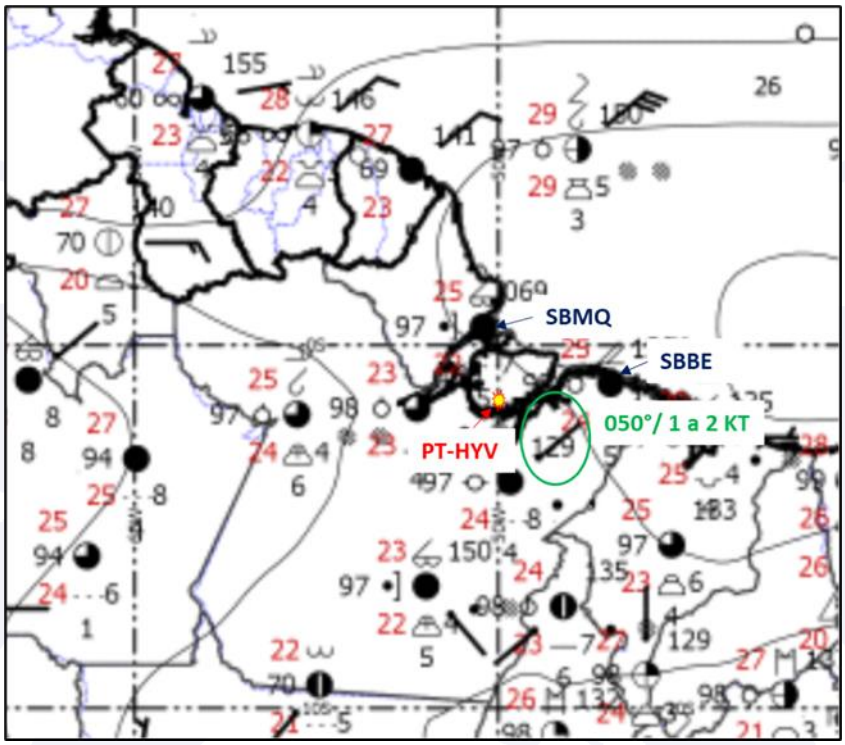

Figure 4 - 1200 (UTC) Surface Chart, with updated information at 1421 (UTC), of 15MAR2018.
Source: Adapted from REDEMET.

Analyzing these data, differences in wind direction and intensity were found in the regions around the occurrence site. However, it should be considered that the information from the charts is approximate and represents large areas of the region. At the same time, one cannot rule out the condition present in the microclimate of the Amazon, which can vary considerably during the various periods of the day.

That said, it was not possible to state, with accurate precision, the direction and intensity of the wind at the time and place of the accident. However, according to the pilot's report, there was a tail wind component at the time of the occurrence.

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.

After the impact, the aircraft was abandoned by the occupants.

The pilot returned to the aircraft to shutdown the engine, as it had remained in operation after the impact.

The shutdown was performed using the Shut-Off lever (device for use in emergency situations), since it was not possible to do it using normal procedures. Afterwards, the battery and other equipment were disconnected.

1.13 Medical and pathological information.

1.13.1 Medical aspects.

Nil.

1.13.2 Ergonomic information.

Nil.

1.13.3 Psychological aspects.

The pilot started his experience as a private airplane pilot. In the course of his professional performance in aviation, he accumulated more than 15 thousand flight hours.

According to his report, he considered himself a calm and motivated person for the type of performance. He had been familiar with the type of mission for six years.

He maintained good expectations for general aviation and reported being an admirer of aviation in the North.

He said he was conditioned to keep control of the situations. He sought to carry out self-analysis of what he needed to evolve since he considered himself to be quite demanding on himself, as well as a questioner when he thought something was out of the standards.

From the operator's perspective, the pilot was described as a professional with good social contact with all sectors of the company and with customers.

As reported by the passengers, the pilot had knowledge of the location of the occurrence and the route between the locations, due to the fact that it is a routine activity.

According to information obtained during the investigation, the pilot presented a rational operational profile, used to keep updated in the search for new knowledge, in the characteristics of the aircraft, and the planning of missions and tasks. He reported that he only performed what was possible and safe, performing only what made him comfortable during the flights.

The day before the occurrence, the pilot reported having had an adequate diet, a good night's sleep and not having drunk alcohol. In addition, he did not use prescription drugs.

Based on the report itself, after the collision with the pole, the pilot prepared for the impact, checking the instruments and trying to remain calm and serene to manage the problem, following the knowledge acquired about the instructions and procedures of the aircraft, as well as emergency training and survival courses.

According to reports, the pilot sought to ensure the safety and rescue of passengers, using the aircraft's radio to call for help.

It was also reported that passengers suggested leaving the wreckage area to seek help, but were convinced by the pilot that the best place to wait for the rescue would be near the aircraft.

According to the report, the pilot considered that, for the type of mission, his performance was on schedule.

1.14 Fire.

There was no fire.

1.15 Survival aspects.

After the impact, the aircraft was abandoned by the occupants.

The pilot returned to the cabin, making radio contact with a regular aviation aircraft, going over the coordinates of the accident site and the state of the occupants.

Once the information was passed on to the SALVAERO-AZ, the search and rescue means were activated to assist the survivors.

The pilot and passengers were rescued by the GRAESP, in the late afternoon of the same day of the incident.

The location of the wreckage was made visually, due to the smoke from a campfire made by the occurrence.

1.16 Tests and research.

Nil.

1.17 Organizational and management information.

The aircraft was operated by Maricá Air Taxi, whose main base was in the city of Rio de Janeiro - RJ.

At the time of the occurrence, the organization operated four helicopters, as stated in the company's EO.

The operator had five aircraft commanders, one of whom remained in the city of Belém - PA, who was responsible for operations in the region, being on standby during the week and taking breaks on Saturdays and Sundays.

The pilot in question had been an employee of the company for six months, being assigned to operate from the city of Belém - PA.

His formal employment contract was governed by the CLT, based on the last convention of the aeronaut union. He performed, on average, 11 flight hours/month, operating Air Taxi and Air Inspection flights.

It was verified that the company did not have a CTM in Belém - PA, with all the flight and fuel information being transferred to the base, this control remaining in that location.

In addition, it was verified that there was a company mechanic in Belém - PA, able to carry out inspections of the types “5, 10, 15, 25, 30, 50 and 100 hours”.

The company said it has control over the aircraft inspections due dates, ratings, certificates and training for pilots and mechanics, and all operating manuals, in addition to having an internal quality control manual, with frequent audits in all sectors of the company.

It was verified that the company had a structured training sector, having a PTO with initial approval, as provided by the ANAC.

According to the information obtained, the operational processes established by the organization determined that the use of the checklist in operations was encouraged, mandatory and required by the company, as provided for in the MGO.

Regarding the training processes offered by the organization, the pilot had completed the initial training, with good performance in the theoretical and practical tests valid for admission. His CRM was updated.

It is worth mentioning that, according to reports, since the period in which he completed the initial training for newly hired pilot, until the date of the accident, he had not participated in any flight safety event promoted by the company in Rio de Janeiro - RJ, nor did he receive

information that could contribute to the risk management of operations, due to the fact that he was based in Belém - PA.

Likewise, it was informed that, for the hiring of new crewmembers, the company contemplated the requirements present in the MGO, also focusing on adaptations and training required in the PTO.

As previsedin the company's PTO, in item 3.3, of module 3, the pilot who was assigned to carry out transmission line inspection operations should undergo specific training to perform this type of mission, which training was not proven by the company to the pilot in question.

The company's MGO also stipulated that no crewmember assigned to a particular mission should perform it without having undergone special training related to the operation.

In the organizational context, it was reported that there was no systematic monitoring of the pilot's performance. According to the information obtained, the performance feedback followed the internal regulation and, at the time of the occurrence, the pilot had not completed enough time to receive such an evaluation, as he had only been in the company for six months, and this feedback would only take place twelve months after the completion of the initial training, in the periodic training.

1.18 Operational information.

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

The purpose of the flight was to inspect the electric power transmission line, so that any abnormalities were identified, such as: vegetation touching the wiring, defects in the posts, defects in the insulators, etc.

The line inspection was carried out 3 meters above the wiring and with lateral clearance. A speed that varied between taxi and 40kt was also maintained, and landing could occur if necessary and applicable.

On 15MAR2018, the aircraft took off from the municipality of Breves - PA, at approximately 1105 (UTC), to the municipality of Curralinho - PA, with a pilot and three technicians from the CELPA on board.

According to what was reported, at a given moment on this route, the technicians identified an area where there were trees touching the wiring, a fact that was considered harmful to the transmission line.

A landing was performed in the vicinity of this site, where the helicopter remained for 50 minutes until the completion of the service. According to information, after the correction of the problem with the trees, the inspection of the line continued until the municipality of Curralinho.

In Curralinho, coordination was carried out between CELPA technicians and their operational base, with the expectation of the mission interruption. In this situation, it was decided to return to Breves, overflowing from a point on the route, about 20 NM from Curralinho, in order to investigate another problem in the transmission line (Figure 5).

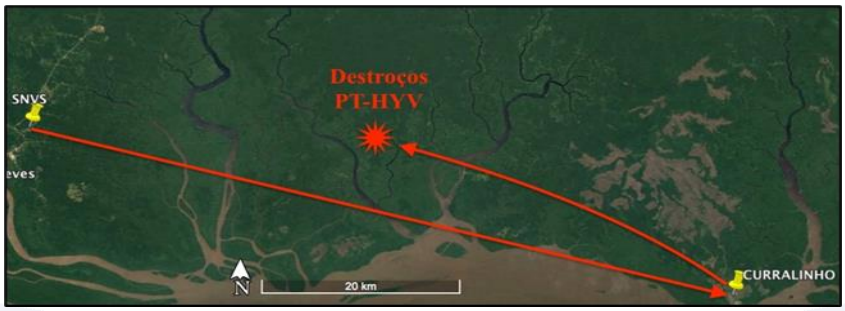

Figure 5 - Route of the PT-HYV until the accident site.
Source: Adapted from Google Maps.

The flight was made directly to the region where the possible problem would be investigated, at a height of 300ft.

When approaching the site, with approximately 15 minutes of flight, the speed and height were reduced to start the inspection on the line. Moments later, an attempt was made to establish a hover flight.

According to the investigation, before the hovered flight, the pilot was carrying out the inspection on the transmission line at speeds below 30kt.

There wasn't, close to the position where the possible problem would be, an open space that would allow the landing. Thus, it was decided to perform an approach to the hover flight OGE, at a distance of 3 meters from the wiring, with the aircraft being positioned to the right and above the transmission line.

As reported, already close to the hover flight, there was a strong turbulence that caused the aircraft to sink, resulting in the aircraft's tail cone touching against the wires of the electric power transmission line.

As verified, there was no verification of the torque indicator instrument in the transition to the hover flight, as the pilot would be concerned with the distance between the aircraft and the transmission line.

According to what was reported later, in addition to the sinking, there was a rapid turn of the nose to the right, with no time for the pilot to react, that is, there was no application of the opposite pedal to try to correct the turn.

According to the passengers' report, they heard the pilot comment that he thought he had lost control of the pedal. However, they did not confirm the turn of the nose to the right, but reported that, during the attempt to establish the hover flight, the tail cone got stuck in the wiring.

In an attempt to get out of that condition, the aircraft was commanded to the right. In this maneuver, however, the tail rotor reached the wiring, being this component broken and damaged (Figure 6).

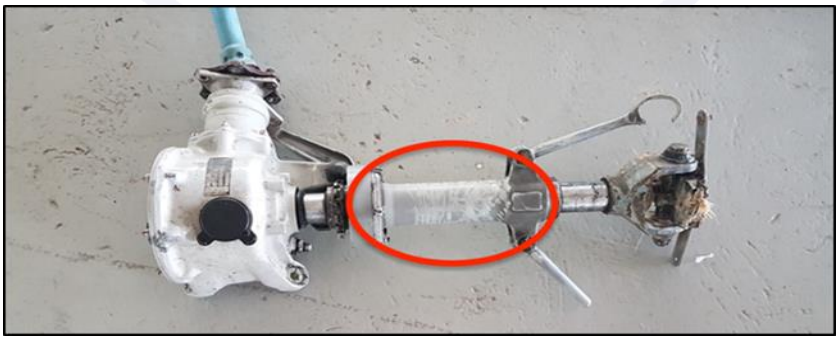

Figure 6 - Marks of the collision of the rotating plateau of the tail rotor against the cables of the transmission line.

With the loss of the anti-torque effect provided by the tail rotor, the aircraft's nose was turned to the left. During this turn, the right part of the aircraft's tail cone collided with the pole and detached from the helicopter (Figures 7 and 8).

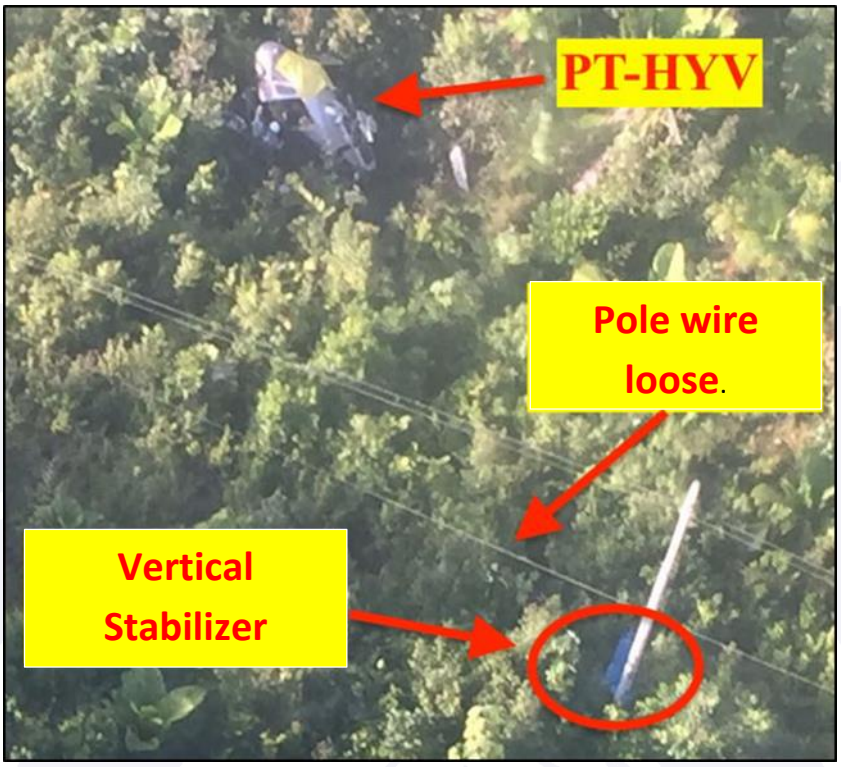

Figure 7 - Aerial view of the aircraft at the accident site, with emphasis on the pole and the vertical stabilizer.

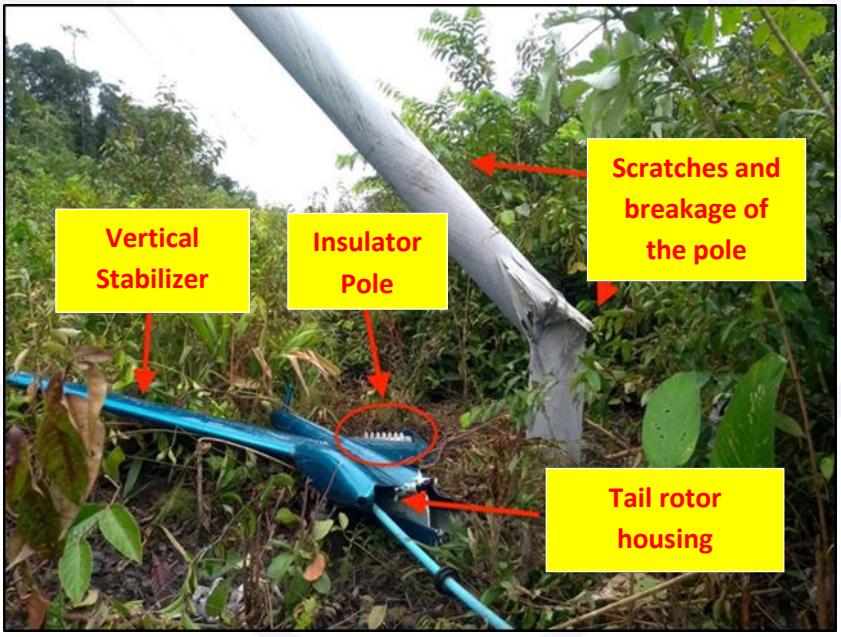

Figure 8 - Vertical stabilizer of the aircraft next to the pole broken by the impact.

Then, the aircraft continued turning its nose to the left, losing height until it collided with uneven and swampy terrain, remaining in a 30° pitch up attitude (Figure 9).

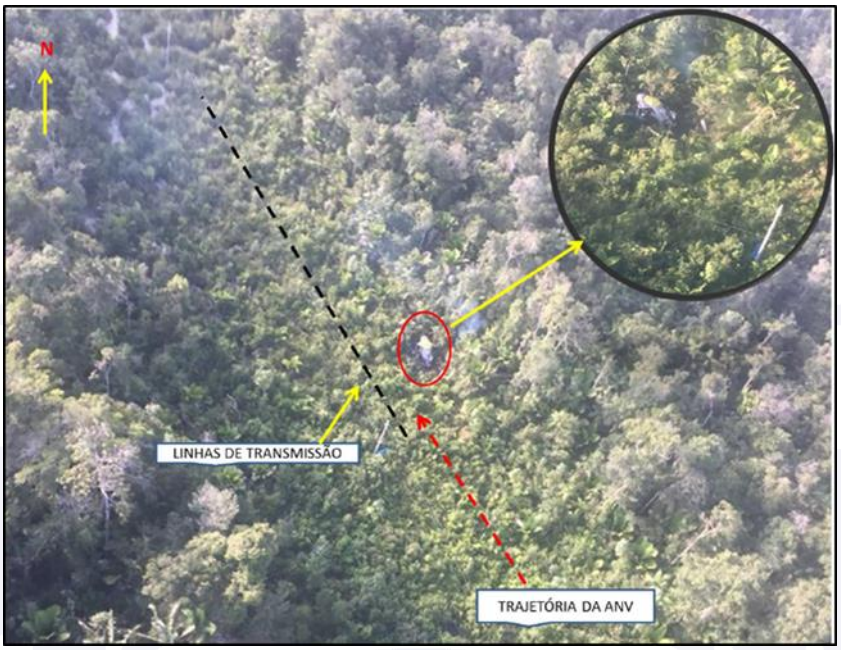

Figure 9 - Aerial view of the accident site, with emphasis on the PT-HYV.

According to information, the aircraft's engine behaved normally during the occurrence, but there was no verification of the engine instruments and torque indicator in the transition to the hover flight, because, at that moment, the pilot informed that he would be concerned with the distance between the aircraft and the transmission line.

According to reports by the CELPA technicians, the affected transmission line was 11 meters high and, as the pilot informed, the hover was made at a distance of approximately 3 meters above the wiring.

During the investigation, it was verified that there was tail wind at the time of the accident and that the pilot did not know how to indicate the wind limit of the aircraft for the hover flight.

1.19 Additional information.

Ground Effect:

The MCA 3-6/2017, clarified that:

> "Compared with the performance required for the hover flight out of ground effect (OGE), the hover flight in ground effect (IGE) shows significant gains in the production of lift and in the reduction of power required, with the same gross weight when hovering at an approximate distance from a rotor disk, or less, above the ground. Close to the surface, there may be no flow in the vertical direction.
>
> Therefore, the induced speed in the rotor is reduced and the pressure below the rotor disk is increased. The consequence is the decrease in power, due to the decrease in induced speed, maintaining, however, the same lift. In other words, what happens is that the induced power used to keep the flight hovered (lift = weight) in ground effect is less than that needed to hover out of ground effect."

Figure 10 shows the circulation of the wind in hoverings out of ground effect (OGE) and inside the soil effect (IGE).

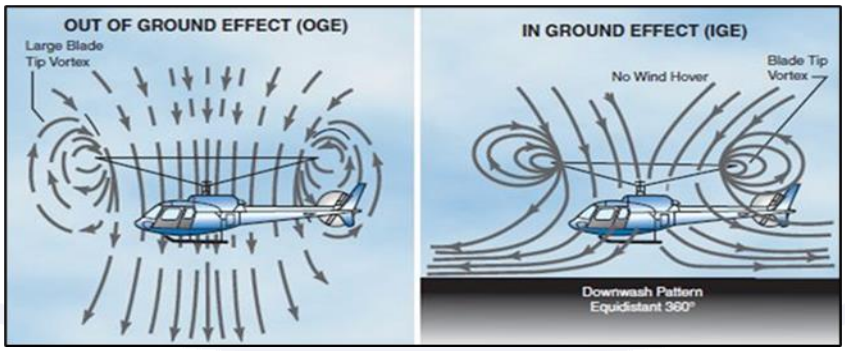

Figure 10 - Diagram of hovering OGE and hovering IGE.
Source: https://www.faasafety.gov/gslac/alc/course_content_popup.aspx?cID=104&sID=449

The hover OGE is defined when the aircraft performs this maneuver with an altitude greater than the diameter of the aircraft's rotor.

The rotor diameter of the AS 350 BA is 10.69 meters and, considering that, before touching the transmission line, the aircraft approached the hover at approximately 14 meters in height, then it was a hover OGE.

According to the information obtained in the cargo manifests and in the logbook, the aircraft took off from Curralinho, at 1445 (UTC), weighing 1,862kg and arrived at the accident site 15 minutes after takeoff, with approximately 1,830kg.

It was verified in item 2.2 Wind Envelop in Hover, of section 5.1 Regulatory Performance Data, of the Flight Manual of the AS 350 BA, the information that the hovered flight could be sustained with winds up to 17kt in any direction.

In addition, it was verified that, in the Flight Manual of the AS 350 BA, the graphics available for calculations related to the performance of the aircraft, during hovered flight OGE, considered the wind condition equal to zero. There were no charts related to the hovering OGE that considered the influence of the wind in the Flight Manual.

Using the weight data of the aircraft (1,830kg), together with the report of the external temperature at the time of the occurrence (32° C) and inserting such information in the hover performance graph, the maximum altitude of the hover OGE, for the zero wind conditions, was 4,500ft (Figure 11).

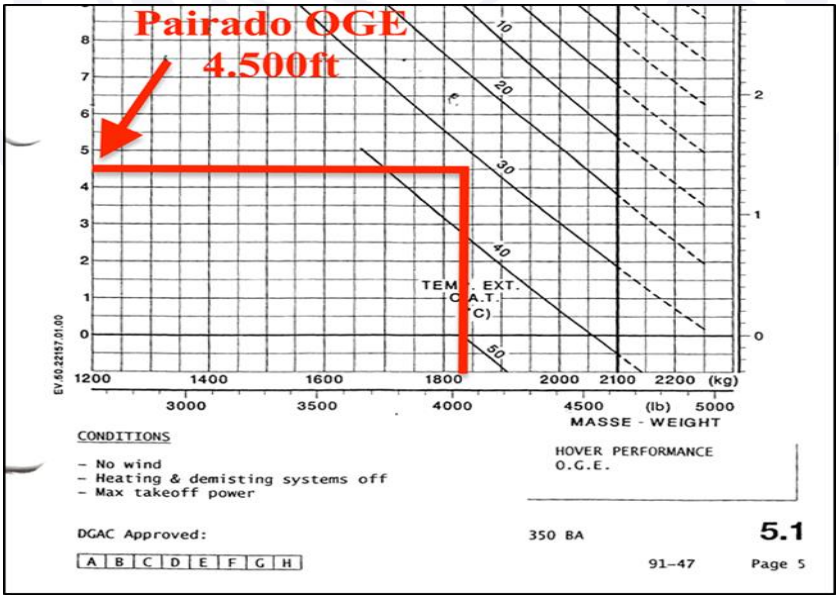

Figure 11 - Calculation graph of the hover OGE of the AS 350 BA.
Source: AS 350 BA flight manual.

- Translational Lift:

The MCA 3-6/2017 explained that the additional lift is obtained with the same power as the hover after the speed increase ahead. At low speeds, the translational lift is almost imperceptible to the pilot.

Also, according to the Manual, as soon as it reaches the range of 12 to 16kt, translational lift begins to manifest itself through a slight vibration. At this speed, the rotor leaves the vortex region and enters the undisturbed air.

- Loss of Tail Rotor Effectiveness (LTE)

Also, according to the MCA 3-6/2017:

> The loss of effectiveness in the tail rotor, or unexpected yaw, is a critical aerodynamic phenomenon that occurs at low speed. This phenomenon does not stop on its own and, if not corrected, can cause loss of control of the aircraft. The loss of effectiveness of the tail rotor is not related to equipment or maintenance failures, and can occur in all helicopters with a main rotor and a tail rotor.

Some factors interfere with the severity of the loss of efficiency of the tail rotor:

- gross weight and altitude density;

- speed indicated below 30kt;

- hovered OGE, which requires higher power and torque values, reducing the margin between the available power and the power required for hovering; and

- drop of RPM of the main rotor.

With regard to the direction of the yaw generated by the LTE, this factor is basically related to the aircraft design, which can be to the right or left, depending primarily on the direction of rotation of the main rotor.

Thus, the PT-HYV, model AS 350 BA, had the main rotor rotating clockwise, which would generate a nose turn to the left in the case of an LTE (Figure 12).

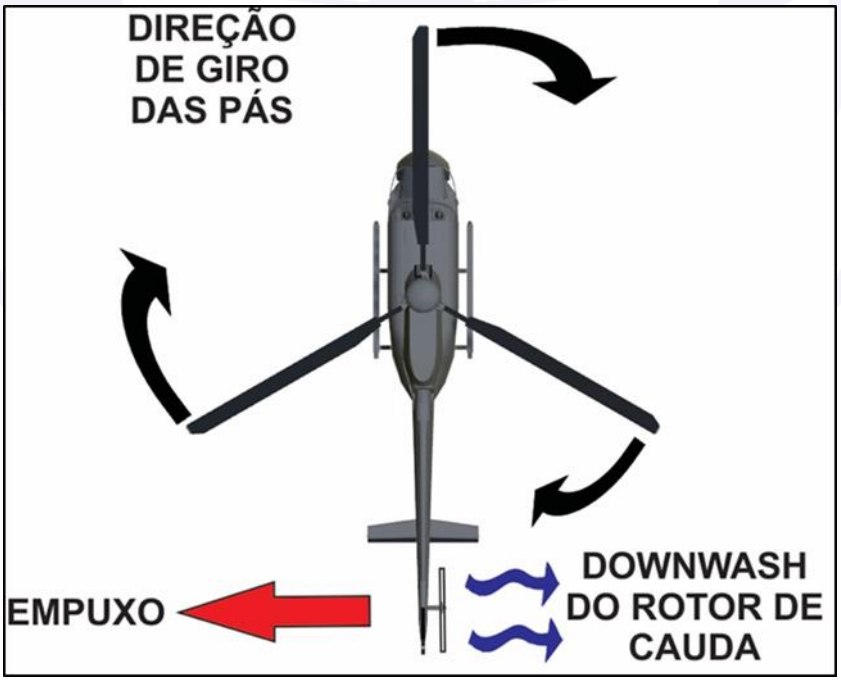

Figure 12 - Diagram of the rotation direction of the blades and the thrust of the AS 350 BA.
Source: Adapted https://www.simpleplanes.com/a/d2Gucn/AS350-Ecureuil.

- Vortex Stall:

Vortex stall is the phase of the descending flight characterized by unstable air flow through the rotor blades. It occurs when the helicopter is at a lower speed than the translational lift, with a descent rate equal to approximately ¼ of the downwash speed and the collective step command partially applied.

- Weathercock Stability

The term Weathercock refers to the old wind direction indicators in the shape of a rooster, used in old houses. Its operation is similar to a vertical drift.

The condition known as Weathercock Stability is caused due to the existence of tailwind, between the relative quadrants from 120º to 240º, when the flight speed is below the translational lift, generating the tendency of the aircraft to yaw to align itself with the direction of the wind.

Regarding the Weathercock phenomenon, the FAA published the Advisory Circular (AC) n° 90-95 - UNANTICIPATED RIGHT YAW IN HELICOPTERS, clarifying that tail winds, impacting between 120° to 240° quadrants, may cause an increase in the pilot's workload. One of the main characteristics of this condition is to allow the acceleration of the yaw rate, and make the nose of the helicopter tend to catch the wind coming from these regions, in case the pilot does not use the pedals to make the corrections (Figure 13).

(2) Weathercock stability (120° to 240°). (See figure 2.)

(a) Tailwinds from 120° to 240°, like left crosswinds, will cause a high pilot workload. The most significant characteristic of tailwinds is that they are a yaw rate accelerator. Winds within this region will attempt to weathervane the nose of the aircraft into the relative wind. This characteristic comes from the fuselage and vertical fin.

(b) The helicopter will make a slow uncommanded turn either to the right or left depending upon the exact wind direction unless a resisting pedal input is made. If a yaw rate has been established in either direction, it will be accelerated in the same direction when the relative winds enter the 120° to 240° area unless corrective pedal action is made.

Figure 13 - AC 90-95 Weathercock Stability (120° to 240°).
Source: FAA.

1.20 Useful or effective investigation techniques.

Nil.

2. ANALYSIS.

It was an inspection flight on an electric power transmission line, with a pilot and three passengers on board. The aircraft was within the weight and balance limits.

The flight, which originated this occurrence, was intended to inspect part of the electric power transmission line between the municipalities of Breves and Curralinho, in order to identify possible abnormalities in the power grid and provide a general check of the region.

The aircraft was operated by a company that was registered in the TPX and SAE Categories, with authorization for the type of operation intended.

The pilot was qualified for the type of flight, and it is a routine to carry out this type of operation.

It was found that the pilot had about 250 hours of flight in the model of the aircraft. It is possible that this number of hours did not provide the ideal experience so that the pilot could manage all the situations presented during a line inspection mission.

In addition, the pilot did not find any special training for aerial inspection flights, as provided for in item 3.3, module 3, of the company's PTO.

The lack of training and experience in the aforementioned model may have diminished the pilot's perception of critical analysis of operational conditions in this type of mission, such as the effects of the wind on a hover out of ground effect, among others.

At 1445 (UTC), there was the takeoff from Curralinho to a defined point 20 NM from that location.

With 15 minutes of flight, the speed reduction was requested to check the transmission line and, later, the hover was requested.

According to the pilot's report, the approach was made with tailwind. With reduced speed and close to the hovering flight, the aircraft sank and there was a nose turn to the right.

This situation caused the lower part of the aircraft's tail to collide with the transmission line wires, staying onto them. In an attempt to get out of this situation, the aircraft was commanded towards the right, however, at that moment, the tail rotor reached the wiring, and this component was damaged and destroyed, which resulted in the loss of the anti-torque, causing the nose to turn left.

During this turn, the right part of the aircraft's tail cone collided with the pole, breaking it and detaching itself from the aircraft.

It was analyzed that the reports on the unfolding of the accident coincided with the evidence of the friction marks found on the rotating plateau of the tail rotor with the wiring (Figure 6) and also with the impact mark on the right side of the tail cone (Figure 14).

Figure 14 – PT-HYV Tail cone.

In the sequence, the aircraft continued turning with the nose to the left, with variations of pitch and losing height until it collided with the ground.

According to information obtained during the investigation, before performing the hover, the pilot operated below 30kt, with tailwind, possibly being close to losing translational lift.

According to the doctrine of operation, during hover or runway approaches, the helicopter initially flies in non-turbulent air until it reaches the speed range of 16 to 12kt, when, then, the helicopter enters the disturbed air and loses translational lift. At that point, the rate of descent increases, unless power is applied to compensate for the decrease in translational lift. Thus, the pilot must act on the pedals to modify the traction on the tail rotor, compensating for the increase in power.

In the same way, the tailwind component can cause an increase in the pilot's workload, in addition to causing the nose to turn in the direction of the wind. At the same time, in tailwind approaches, when losing translational lift, the sudden increase in power required to maintain the hover can exceed the tail rotor's anti-torque capacity, especially with high weight, temperature and altitude.

In the present case, according to the information collected, the hover was established at approximately 14 meters or 42ft in height, a profile framed in the hovered OGE.

Bearing in mind that the accident occurred close to sea level and the fact that the OGE performance graph indicates that a hover flight at a pressure altitude of up to 4,500ft is allowed, it is inferred that there was power available for the hover flight in question. It is noteworthy that in the OGE performance graph, the wind established for the definition of the operating parameters was zero.

It is not known what the actual tail wind component was at the time of the accident.

Thus, without knowing what the actual wind direction and intensity was at the time of the operation, and without a graph that included the tail component, it was not possible to measure its influence on the hovered OGE flight in those conditions.

However, it is important to note that approaches for hovering with tailwind are not recommended, as they require greater workload from the pilot and more power available, compared to those with calm wind or headwind. These approaches, usually, require an anticipation in the use of the commands and greater amplitude in their use to maintain the desired position of the aircraft, since the wind with tail component can cause different reactions in the flight stability.

In this situation, there is a tendency to occur more variations in all the axes of flight, including being possible that the tail wind turns its nose to the side in which the wind falls.

Another point of emphasis in the aerodynamics of the helicopter flight is that, during the reduction of speed for the hover flight, there is a moment when the aircraft loses its translational lift, which can cause the loss of height if the collective command is not used with the adequate anticipation.

In this condition, it was reported that, before attempting to hover, the pilot operated below 30kt, so it can be inferred that the aircraft was close to losing translational lift, which required greater pilot anticipation in the performance and use of the commands, in order to avoid the inadvertent sinking of the aircraft in the transition to the hovered OGE.

With these facts, there is a possibility that the sinking of the aircraft, moments before the touch of the tail on the transmission line, occurred due to the loss of translational lift and the influence of the tail wind component.

In addition, as reported, the approach was performed 3 meters above the line, with the wiring being on the left and below the aircraft and the pilot occupying the right seat, which would presumably make it difficult to visualize the wiring (Figure 15).

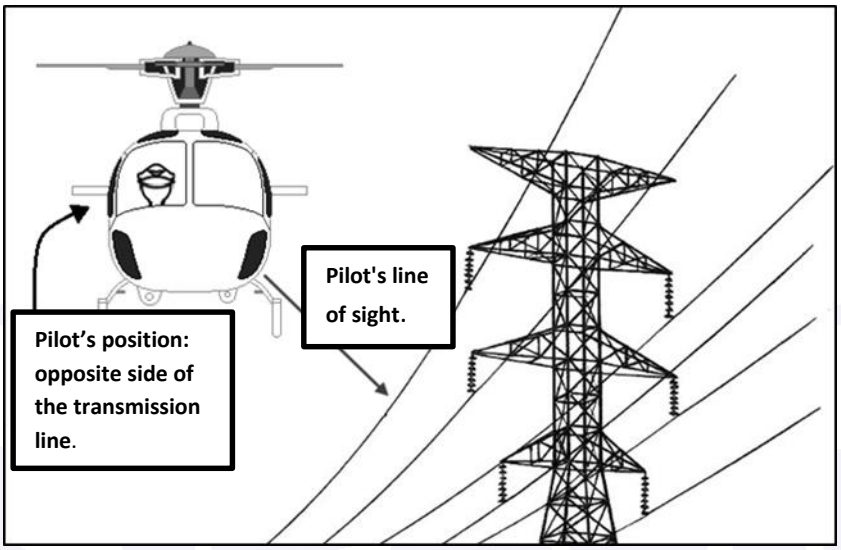

Figure 15 - Representative diagram, out of scale, of the aircraft's position in relation to the transmission line cables.

Because the visualization of the wiring is impaired, it is possible that the attempt to establish and maintain the distance of 3 meters, with tail wind component, was carried out imprecisely, leading to an involuntary approach of the aircraft against the wires.

Considering the data above, it can be inferred that there was a context of greater demand for piloting skills to control the aircraft, as well as specific management measures at the most critical moments.

Based on the factors discussed above, it can be inferred that the crewmember, given his total experience in the air activity, ended up showing an attitude of overconfidence in his operational capacity, to the detriment of the risks inherent to the type of flight.

This fact may have influenced his decision to perform a hover with tailwind, close to the electric power transmission line.

Thus, it was found that the use of inappropriate references did not allow the commander to efficiently perceive the risks of carrying out a hovering OGE with tailwind, disregarding relevant information for a safer decision.

In the organizational scope, in line with the data above, it was identified that the company's risk management processes did not reach the pilot based in the North region.

Also, it was understood that the lack of documented operational procedures of the company, defining the processes for the execution of the overhead inspection, such as the establishment of a minimum approach height for the hovering OGE above the obstacles, among others, may have contributed so that the pilot could approach for 3 meters over the wiring, a situation in which there was little scope for errors or variations.

Therefore, it is possible to infer that the absence of support systems and supervision of aerial operations, on the part of the company's Operational Safety sector, evidenced the presence of a low culture of flight safety.

Among other factors that evidenced the risks present in the operation, we highlight the slow flight, hovered OGE, jungle region and electric power transmission line. In addition, there was an expectation of interrupting the mission to identify any abnormalities in the transmission line.

At another point, the possibility that the yaw that triggered the collision may have been generated by a phenomenon known as loss of tail rotor effectiveness (LTE) was verified.

The PT-HYV, aircraft model AS 350 BA, rotates the blades clockwise, so the loss of efficiency of the tail rotor would generate a turn of the nose to the left, different from what happened in this accident, when there was a turn of nose to the right, thus, it is inferred that there was no loss of effectiveness of the tail rotor.

Furthermore, even if there was a tailwind with intensity capable of leading the aircraft to try to align with the wind, turning the nose to the right, this turn would be slow and possible to be counteracted by the pilot acting on the aircraft pedals.

The turn of the nose to the right with sinking could be related to a compressor stall or even an engine failure. However, the report that the aircraft's engine behaved normally throughout the flight and the absence of evidence that such a condition has arisen led investigators to disregard this possibility.

Corroborating this point, it was verified that, after the collision of the tail cone against the wires, the aircraft kept the flight hovered for a few moments until there was an attempt to shift to the right, with the objective of getting out of that situation. In addition, after the fall and abandonment of the occupants, the pilot had to return to the cabin to turn off the engine that had remained on even after the impact.

Initially, the pilot mentioned only the presence of turbulence and sinking during the establishment of the hover, without making reference to the turn of the nose to the right.

However, a few days later, during an oral interview, the turn of the nose to the right was reported, with no time to use the pedal control to counter this turn. Due to the divergence between the reports, it is possible that some memory lapse occurred in relation to this phase of the accident.

However, in view of the dynamics presented, the conditions existing at the time of the accident and the characteristics of the equipment, it appears that the sinking and the turn of the nose to the right were caused by the inadequacy in the use of the controls.

Thus, when trying to perform a hover flight with tailwind, with a short distance from the wiring, without considering the intensity and tailwind limit, the pilot inadequately assessed certain parameters related to the operation of the aircraft, accepting a high risk to perform that maneuver.

The pilot's decision to make a hover out of ground effect, with tailwind and close to an obstacle, as well as the inadequate analysis of the operational environment and the possible consequences of the situation he was in, possibly contributed to the accident, denoting low situational awareness.

In addition, the flight hovered 3 meters from the transmission line, with the visualization possibly impaired by the aircraft's position in relation to the wires, added to a probable difficulty in controlling the aircraft, due to the presence of tail wind with unknown intensity, may have caused the helicopter to inadvertently approach the power grid, causing the tail cone to touch the wiring and, ultimately, resulting in the accident.

3. CONCLUSIONS.

3.1 Facts.

a) the pilot had valid CMA;

b) the pilot had valid HMNT Rating;

c) the pilot had about 250 flight hours on the aircraft’s model;

d) the company has not proven that special training has been performed for the type of mission proposed;

e) the aircraft had 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) according to the pilot's report, there was a tailwind component at the time of the occurrence;

j) the pilot approached for the hovered OGE flight, about 3 meters above the transmission line and with a tailwind component;

k) sinking and turning of the nose to the right has been reported;

l) the tail cone got stuck in the wiring;

m) in an attempt to get out of this situation, the aircraft was commanded to the right, with the tail rotor colliding against the wiring, causing the component to rupture and the aircraft to fall;

n) the aircraft had substantial damage; and

o) the pilot and passengers suffered minor injuries.

3.2 Contributing factors.

- **Control skills – a contributor.**

During the attempt to correct the sinking and turning of the nose to the right, there was an inadequacy in the use of the controls.

- **Attitude – undetermined.**

The level of total experience in aerial activity may have resulted in an excess of self-confidence on the part of the pilot, which possibly influenced his decision to execute a hover with tailwind, close to the electric transmission line.

- **Training – undetermined.**

The operator has not proven that the pilot has undergone training, as provided for in the PTO for operations to inspect transmission lines.

- **Tasks characteristics – a contributor.**

The complex context of operation in the region, associated with the characteristics of the transmission line inspection mission, showed risks present in the flight, which demanded from the commander a greater individual capacity to meet the requirements and specificities inherent to the operation management.

- **Organizational culture – undetermined.**

The flight safety culture adopted by the company did not reach the pilot based in the North region, showing a favorable environment for the use of informal practices that, associated with the excess of self-confidence in his psychomotor ability, may have compromised the maintenance of safe levels of operation.

- **Piloting judgment – a contributor.**

The pilot's decision to hover out of ground effect, with tailwind, with the helicopter positioned to the right of the transmission line cables and about 3 meters from an obstacle, showed an inadequate evaluation by the pilot, of the parameters related to the operation of the aircraft.

- **Insufficient pilot's experience – undetermined.**

The pilot's experience on the AS 350 BA aircraft may have contributed to an inadequate assessment of his operational environment and inadequate application of commands.

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

The defined flight profile did not take into account adequate references, not being effectively analyzed factors related to the characteristics of the transmission line inspection operation.

- **Support systems – undetermined.**

The lack of documented operational procedures of the company, defining the processes for the execution of the aerial line inspection, such as the definition of a minimum approach height for the hovering OGE above the obstacles, among others, may have contributed for the pilot to make an approach 3 meters above the wiring, a situation in which there was little scope for errors or variations.

- **Managerial oversight – undetermined.**

The pilot did not participate, since the period in which he completed the initial training, in any flight safety event promoted by the company in Rio de Janeiro - RJ, nor did he receive any information that could contribute to the risk management of the operations.

Likewise, the company has not provided evidence that the pilot has undergone specific training to carry out transmission line inspection operations, thus demonstrating inadequate supervision of operational activities for pilots.

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-047/CENIPA/2018 - 01 **Issued on 07/08/2021**

Work with the company Maricá Air Taxi Ltd., so that the procedures adopted, during the transmission line inspection operation, are formalized, including the aspects involved in performing a hovering OGE, especially regarding the direction and the intensity of the wind, and the positioning of the helicopter in relation to the power grid.

A-047/CENIPA/2018 - 02 **Issued on 07/08/2021**

Work with the company Maricá Air Taxi Ltd., in order to verify the fulfillment of the special training prevised in the PTO, for the accomplishment of the flights on part ofy the crewmembers.

5. CORRECTIVE OR PREVENTATIVE ACTION ALREADY TAKEN.

None.

On July 8th, 2021.