# COMANDO DA AERONÁUTICA

## CENTRO DE INVESTIGAÇÃO E PREVENÇÃO DE ACIDENTES AERONÁUTICOS

# FINAL REPORT
# A - 104/CENIPA/2016

| | |
|---|---|
| **OCCURRENCE:** | **ACCIDENT** |
| **AIRCRAFT:** | **PT-YZK** |
| **MODEL:** | **407** |
| **DATE:** | **29JUL2016** |

# 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 29JUL2016 accident with the 407 aircraft model, registration PT-YZK. The accident was classified as “[LOC-I] Loss of Control in Flight and [ARC] Abnormal Runway Contact”.

During the final approach, the tail rotor touched a wall still out of the landing area. Subsequently, the aircraft made a sudden landing and continued forward until it collided with another wall, where it stopped.

The aircraft had substantial damage.

Two crewmembers suffered minor injuries, and a third one left unharmed.

An Accredited Representative of the Transportation Safety Board (TSB) - Canada, (State where the aircraft was designed/registered) was designated for participation in the investigation.

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## GLOSSARY OF TECHNICAL TERMS AND ABBREVIATIONS

| | |
|---|---|
| ADF | Federal Direct Administration Aircraft Registration Category |
| ANAC | Brazil's National Civil Aviation Agency |
| BKN | Broken (5 and 7 oktas) |
| CA | Airworthiness Certificate |
| CENIPA | Aeronautical Accident Investigation and Prevention Center |
| CMA | Aeronautical Medical Certificate |
| CRM | Crew Resource Management |
| FAA | Federal Aviation Administration |
| FEW | Few (1 and 2 oktas) |
| HMNT | Single-Engine Turbine Rating - Helicopter |
| METAR | Meteorological Aerodrome Report |
| MGSO | Safety Management Manual |
| MOP | Operations Manual |
| NSCA | Aeronautics Command System Standard |
| OEE | Special Equipment Operator |
| OM | Maintenance Organization |
| PCH | Commercial Pilot License – Helicopter |
| PIC | Pilot in Command |
| PPH | Private Pilot License – Helicopter |
| PRF | Federal Highway Police |
| RBAC | Brazilian Civil Aviation Regulation |
| RBHA | Brazilian Aeronautical Certification Regulation |
| RPM | Rotations Per Minute |
| SBRJ | ICAO Location Designator - Santos Dumont Aerodrome, Rio de Janeiro - RJ |
| SDPG | ICAO Location Designator - Guanabara Palace Helipad, Rio de Janeiro - RJ |
| SERIPA III | Third Regional Aeronautical Accident Investigation and Prevention Service |
| SGSO | Safety Management System |
| SIC | Second in Command |
| SIPAER | Aeronautical Accident Investigation and Prevention System |
| SN | Serial Number |
| SOP | Standard Operational Procedures |
| UAP | Public Air Unit |
| UTC | Universal Time Coordinated |
| VFR | Visual Flight Rules |
| VRS | Vortex Ring State |

# 1. FACTUAL INFORMATION.

| | | |
|---|---|---|
| **Aircraft** | **Model:** 407<br>**Registration:** PT-YZK<br>**Manufacturer:** Bell Helicopter | **Operator:**<br>Federal Highway Police – PRF |
| **Occurrence** | **Date/Time:** 29JUL2016 - 1905 UTC<br>**Location:** Guanabara Palace Helipad (SDPG)<br>**Lat.** 22°56'23" S **Long.** 043°11'16" W<br>**Municipality – State:** Rio de Janeiro – RJ | **Type(s):**<br>"[LOC-I] Loss of Control in Flight and [ARC] Abnormal Runway Contact"<br>**Subtype(s):**<br>NIL |

## 1.1 History of the flight.

The aircraft took off from the PRF facilities, located at *Trevo das Margaridas*, at around 1905 (UTC) to the *Guanabara* Palace Helipad (SDPG), both located in Rio de Janeiro - RJ, for a transfer flight, with two pilots and an OEE on board.

During the final approach, the helicopter experienced strong vibration. The PIC decided to proceed to land. According to the PIC, already close to the ground, the vibration became uncontrollable. Then, the tail rotor touched a wall still out of the landing area.

Subsequently, the aircraft made a sudden landing and continued forward, with vibration and without control, until it collided with a wall located after the landing area, where it stopped.

Figure 1 - View of the PT-YZK at the accident site.

The aircraft had substantial damage. Two crewmembers suffered minor injuries and a third one left unharmed.

## 1.2 Injuries to persons.

| Injuries | Crew | Passengers | Others |
|---|---|---|---|
| Fatal | - | - | - |
| Serious | - | - | - |
| Minor | 2 | - | - |
| None | 1 | - | - |

**1.3 Damage to the aircraft.**

The aircraft suffered substantial damage along its entire length, including the main rotor, cabin, fuselage, tail cone, tail rotor, and skis.

**1.4 Other damage.**

None.

**1.5 Personnel information.**

**1.5.1 Crew's flight experience.**

| Flight Hours | | |
|---|---|---|
| | PIC | SIC |
| Total | 3.000:00 | 800:00 |
| Total in the last 30 days | 40:00 | 01:00 |
| Total in the last 24 hours | 01:00 | 01:00 |
| In this type of aircraft | 1.500:00 | 200:00 |
| In this type in the last 30 days | 40:00 | 01:00 |
| In this type in the last 24 hours | 01:00 | 01:00 |

**N.B.:** The data relating to the flown hours were obtained through interviews with the pilots.

**1.5.2 Personnel training.**

The PIC took the PPH course, at *EDRA Aeronáutica* Ltd., SP, in 2005.

The SIC took the PPH course, at *EDRA Aeronáutica* Ltd., SP, in 1990.

The OEE took the training course at PRF, in 2014.

**1.5.3 Category of licenses and validity of certificates.**

Both pilots had PCH Licenses and valid HMNT Ratings.

**1.5.4 Qualification and flight experience.**

The crew were qualified and had experience in the type of flight.

**1.5.5 Validity of medical certificate.**

The pilots and the OEE had valid CMAs.

**1.6 Aircraft information.**

The aircraft, Model 407, SN 53335, was manufactured by Bell Helicopter in 1999 and was enrolled in the ADF Category.

The aircraft`s CA was valid.

The airframe and engine logbook records were updated.

The last aircraft inspection, the "300 hours/12 months" type, was carried out on 13JUL2016, by the OM Helisul Air Taxi Ltd., in Curitiba - PR, with 2 hours and 42 minutes flown after the inspection.

**1.7 Meteorological information.**

The METAR from the Santos Dumont Aerodrome (SBRJ), 2.16 NM away from the accident site, provided the following information:

SBRJ 291800Z 17008KT 9999 FEW020 BKN080 23/17 Q1022=

SBRJ 291900Z 17008KT 9999 FEW020 BKN080 22/16 Q1022=

Thus, it was verified that the conditions at the destination were favorable for the visual flight, with visibility above 10 km, few clouds at 2,000 ft, and cloudy at 8,000 ft. The wind had a direction of 170º with an intensity of 8 kt.

**1.8 Aids to navigation.**

Nil.

**1.9 Communications.**

Nil.

**1.10 Aerodrome information.**

The *Guanabara* Palace Helipad (SDPG) was private, managed by the Rio de Janeiro Government, and operated under VFR, day and night.

The surface was made of concrete, dimensions 21 x 21 m, ramps 02/20, with an elevation of 341 ft.

The landing site was operating under the legislation in force at the time and had the demarcations and limits established for the type of intended operation.

**1.11 Flight recorders.**

Neither required nor installed.

**1.12 Wreckage and impact information.**

The first impact of the aircraft against the wall occurred in a descending profile of approach to land on the helipad. The tail rotor touchdown occurred out of the touchdown area, about 2 meters before the beginning of the landing area.

Subsequently, the aircraft made a sudden landing, continued moving forward without control and in the direction of approach until it collided with a wall ahead, where it stopped.

The wreckage was concentrated, with the tail cone separated from the helicopter's central structure.

**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.**

According to data collection, the pilots and the OEE were considered experienced to perform the type of flight.

Both pilots were qualified to exercise the role of commander. However, according to the mission order, the less experienced pilot was assigned to the PIC`s role.

The crewmembers were in Rio de Janeiro to participate in missions to support the Olympics. The PIC and the OEE served in Campo Grande, and the SIC served in Natal.

According to information gathered, the PIC showed difficulty in adhering to the procedures foreseen for the operation.

It was also noted that the SIC, during the flight, remained most of the time with its attention focused on a tablet.

All crewmembers reported that the aircraft presented excessive vibration before the collision with the ground. According to reports, upon observing the excessive vibration, the SIC guided the PIC to perform a go-around procedure. However, the procedure was not adopted. The PIC stated that he had not heard this guidance.

**1.14 Fire.**

There was no fire.

There was, on site, a firefighting team available, however, there was no need for it to be called.

**1.15 Survival aspects.**

After the aircraft came to a complete stop, the crew left through the main doors by their own means.

**1.16 Tests and research.**

The PT-YZK wreckage was analyzed in order to investigate the abnormal vibration reported by the crew.

The damping system in the main rotor star did not show component failures or fractures. The springs were in normal conditions of use (Figure 2).

Figure 2 - View of the vibration damping system in the main rotor star, without failure in the springs.

The failures and fractures in the set of blades and in the main rotor control link system were consistent with the impact of the helicopter against the ground (Figure 3).

Figure 3 - Main rotor blade links. Deformation fractures caused by overload.

The damage observed in the tail rotor also occurred as a result of the collision, and no aspects were observed in the component that could have caused abnormal vibration.

Tests and analyzes were performed on the Corner Mounts due to the possible contribution of this element to the vibration observed by the crew (Figure 4).

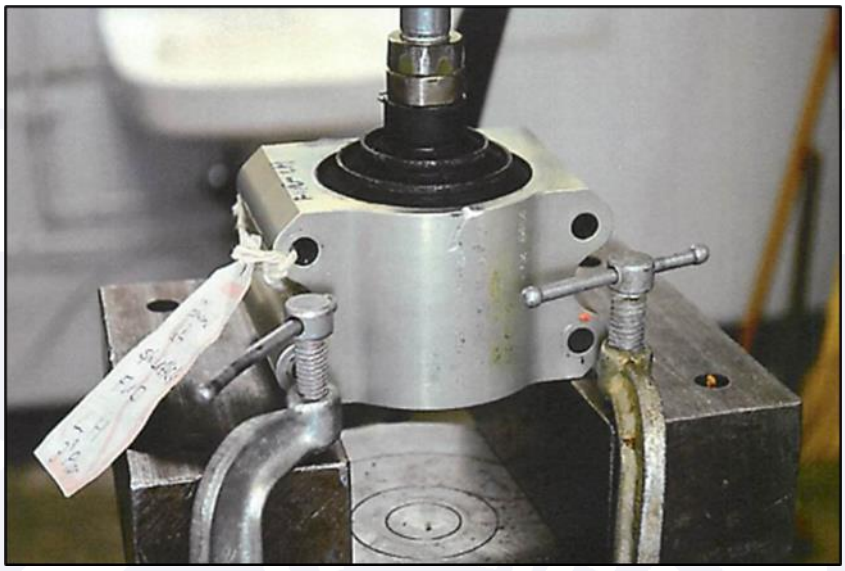

Figure 4 - Dynamic test on the Corner Mounts.

The results obtained indicated that the Corner Mounts were within acceptable parameters for service, even after the accident.

Some damage was caused during impact with the ground, some was caused by impact with other structures of the aircraft, and some was caused only by stresses greater than those resisted by the structure. The damage found was consistent with the impact with the ground and other objects. No signs of fatigue were observed.

The Corner Mounts showed behavior and parameters within the acceptable range for use. The analyses of the Corner Mounts revealed that they were in acceptable condition for use and operation even after the accident, ruling out failure or incorrect functioning.

The tests performed on the powerplant parts showed that the engine was functioning normally for the flight phase and was producing power at the moment of impact. It was not evident in the bench tests any change in the components that could have produced the vibration effect described by the crew during the landing approach.

**1.17 Organizational and management information.**

The organization did not have manuals or other documents that formalized the procedures to be used by the crewmembers in the air operations performed. The operator had several informal procedures adopted by the crewmembers.

Also, at the time of the accident, the organization did not have an MGSO duly accepted by the ANAC.

The training provided by the organization did not include CRM training, so there was no requirement to take this course to crew the aircraft.

At the time of the accident, there were crewmembers who had never taken CRM training. The professionals that had already taken this training had done so approximately 04 years before the accident.

The development of different operation profiles was considered acceptable and common. In addition, there was no reporting culture to assist the organization in identifying and managing the risks present in the context of operations.

At the date of the occurrence, 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 with respect to public security and/or civil defense operations specified in paragraph 91.953(b) of this regulation.
>
> [...]

Likewise, section 91.961, Special Conditions of Operation, defined that the organization should establish training programs and standard operating and flight safety procedures in order to guide the conduct of crews in such special conditions.

**1.18 Operational information.**

The aircraft was within the weight and balance limits specified by the manufacturer at the time of the occurrence.

It was a transfer flight between the PRF facilities at *Trevo das Margaridas* and the *Guanabara* Palace Helipad (SDPG).

During the final approach, the helicopter experienced strong vibration. The PIC decided to proceed to landing. According to the PIC, close to the ground, the vibration became uncontrollable, and the tail rotor touched a wall out of the landing area (Figure 5).

Figure 5 - Point of impact of the tail rotor against the wall.

After this impact, the skis collided sharply against the surface of the outer edge of the landing area, and the PT-YZK continued its uncontrolled forward movement in the approach direction until it passed the rear edge of the helipad and crashed into a wall located about 2 meters from the landing and takeoff area (Figure 6).


Figure 6 - Trajectory taken by the aircraft over the helipad.

## 1.19 Additional information.

A vortex stall occurred when the helicopter was at a speed below the translational lift, with a descent ratio equal to approximately ¼ of the downwash speed and collective pitch command partially applied.

The vortex effects 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, which could lead to loss of aircraft control.

On the subject, the FAA published the Rotorcraft Flying Handbook in 2000, in which it was described that VRS or Settling With Power is an aerodynamic condition in which a helicopter exhibits a vertical descent, even with maximum power applied, with little or no cyclic command remaining.

The term Settling With Power comes from the fact that the helicopter continues to sink even with engine power applied.

A fully developed VRS is characterized by an unstable condition in which the helicopter experiences uncommanded pitch and roll oscillations with little or no cyclic command authority and can reach a rate of descent of up to 6,000 ft/min if recovery maneuvers are not taken.

In this condition, rotor efficiency is lost even though power is still being supplied by the engine.

The helicopter reaches a point where most of the power developed by the engine is wasted, accelerating through the air in a "nut" pattern. In effect, the helicopter is flying in its own disturbed airflow (Figure 7).

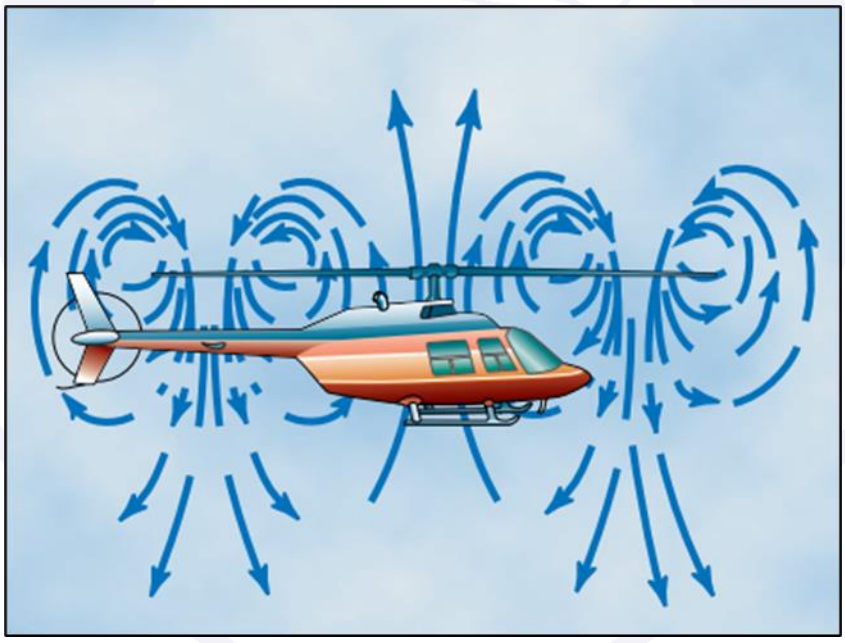

Figure 7 - Vortex Ring State. Source: Rotorcraft Flying Handbook (FAA).

According to the FAA manual, the VRS comes accompanied by high levels of vibration and can occur during any maneuver that places the main rotor in a condition of high upward airflow and low forward speed.

A combination of the following conditions can contribute to the development of the VRS:

- vertical or near-vertical descent rate of at least 300 ft/min. (The actual critical rate depends on gross weight, RPM, altitude density, and other pertinent factors);

- The main rotor system must be employing some of the available engine power (from 20 to 100%); and

- horizontal displacement speed is less than translational lift.

Some of the following situations can also lead to Settling With Power:

- attempting to hover out of ground effect at a height greater than the hover ceiling of the helicopter;

- attempting to hover out of ground effect without maintaining precise height control; or with a tailwind; and

- High-angle approaches with power, in which the airspeed drops to near zero.

When the helicopter begins to vibrate, further application of the collective increases both the vibration level and the sinking ratio. In this regard, recovery should be initiated at the first VRS signal by applying the cyclic ahead to increase speed while simultaneously reducing the collective.

The recovery will only be complete when the aircraft passes the translational lift speed and reaches a stabilized climb ratio.

### 1.20 Useful or effective investigation techniques.

Nil.

## 2. ANALYSIS.

It was a transfer flight between the Federal Highway Police facilities, located at Trevo das Margaridas and the Guanabara Palace Helipad (SDPG), with two pilots and a third crewmember on board.

The crewmembers were qualified and experienced in the type of flight.

The aircraft had a valid CA and was within the weight and balance limits established by the manufacturer. The airframe and engine logbooks were updated, with no discrepancies found that could have been associated with the occurrence.

Although the helicopter showed strong vibration during the final approach, the PIC decided to proceed to the landing. When near the ground, according to the PIC, the vibration became uncontrollable and the tail rotor touched a wall, still outside the landing area. After that, the aircraft made an abrupt landing and continued forward, with vibration and without control, until it crashed into the wall located after the landing area, where it came to a stop.

The tests performed on the parts of the powerplant during the investigation process showed that the engine was operating normally for the flight phase and was producing power at the moment of impact. The bench tests did not reveal any change in the components that could have produced the vibration effect described by the crewmembers during the landing approach.

The failures and fractures in the blades assembly and the main rotor control link system were consistent with the helicopter's impact against the ground.

The damage observed to the tail rotor also occurred as a result of the collision, and no aspects of the component were observed that could have caused abnormal vibration.

The Corner Mounts were within acceptable parameters for service, even after the accident, being discarded the failure or malfunction of these components as the cause of the reported abnormal vibration.

The analysis of the wreckage showed that some damage was caused by the impact with the ground, others by the impact with other structures of the aircraft, and others only by

the effort higher than that resisted by the structure. Furthermore, no signs of fatigue were observed in the material analyzed.

The vibration damping system in the main rotor star had its springs intact, without any indication of failure or malfunction, which excluded the possibility that this system had contributed to the strong vibration reported by the crew.

Thus, considering the exams and research carried out, it was not possible to point out any type of mechanical failure that would justify the strong vibration reported, and there is no evidence that a failure in the helicopter's systems contributed to the accident.

Regarding the dynamics of the event, the investigation identified that the first impact occurred in a descending profile of approach to land on the helipad.

The wreckage was concentrated, with the tail cone separated from the helicopter's central structure.

The landing site was operating under the legislation in force at the time and had the demarcations and limits established for the type of operation intended, with no evidence of irregularities that could compromise the operation at that helipad.

The weather conditions at the time of the occurrence did not compromise the visual operation for the type of mission performed and the wind direction in the region favored the approach and landing in the adopted direction.

Thus, considering the aforementioned aspects and the fact that vibration was reported, which became uncontrollable in the final approach for landing, it was hypothesized that there may have been an aerodynamic condition known as Vortex Ring State or Settling With Power.

In this phenomenon, the helicopter exhibits a vertical descent, even with maximum power applied. With this, a sink occurs, without control and with uncontrolled pitch and roll oscillations.

In this case, the main rotor efficiency is lost even though power is still being supplied by the engine, since most of this power is wasted, causing the helicopter to fly in its own disturbed airflow, in a context of high upward airflow and low forward speed.

To ratify the validity of this hypothesis, it was observed that the helicopter fit a flight profile that could favor the development of VRS namely: at a speed below the translational lift, with a downwash ratio equal to approximately ¼ of the downwash speed and collective pitch command partially applied.

Furthermore, the type of approach executed, with power and a steep ramp, in which a possible reduction of the horizontal speed to near zero could occur, could also contribute to the sink with power as observed in this occurrence.

That said, it is important to highlight that, according to the information gathered, the SIC instructed the PIC to perform a go-around procedure when he noticed the excessive vibration. However, such a procedure was not adopted. The PIC stated that he had not heard this guidance. This fact reveals flaws in the communication process between the pilots.

In this aspect, the training provided by the organization did not include CRM, which would be essential for the development of social and cognitive skills required in the exercise of flying, including communication. There was no regularity in the offer of this training or requirement to take this course in order to crew the aircraft.

In addition, there was no reporting culture to help the organization identify and manage the risks present in the context of its operations.

In this respect, at the time of the accident, the Public Security air operations met the requirements established in Subpart K of RBHA No. 91, which defined that it was the organization's responsibility to establish training programs and standard operating and flight safety procedures to guide the conduct of crews under such special conditions.

Despite this, the organization did not have manuals and other documents that formalized the procedures to be used by the crewmembers in air operations.

It was reported that the SIC kept most of the flight with his attention focused on the tablet, so he was not adequately monitoring the flight to better assist the PIC in decision-making.

However, the fact that the PIC proceeded to land in a non-stabilized approach profile, characterized by excessive vibration and uncommanded ditching, revealed losses in his ability to recognize and project the risks arising from an operation. A condition that led to reduced situational awareness.

These factors impaired the PIC's judgment that he would be able to land safely despite experiencing excessive vibration.

The succession of this chain of events contributed to the loss of control of the helicopter and the resulting collision of the tail rotor against the wall, which led to the undesirable consequences of this occurrence.

## 3. CONCLUSIONS.

### 3.1 Facts.

a) the crewmembers had valid CMAs;

b) the crew was qualified and had experience in the type of flight;

c) the pilots had valid HMNT Ratings;

d) the aircraft had a valid CA;

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

f) maintenance records were updated;

g) the weather conditions were favorable for the flight;

h) the helipad was operating in accordance with the legislation in force at the time and had the demarcations and limits established for the type of intended operation;

i) the helicopter presented excessive vibration, on the final approach, before the collision with the ground;

j) the PIC decided to proceed to the landing;

k) after the impact of the tail rotor, the aircraft made a sudden landing and continued moving forward, with vibration and without control, until it collided with a wall located after the landing area, where it came to a stop;

l) the examinations performed on the helicopter systems did not reveal problems that could have caused the abnormal vibration;

m) the tests showed that the engine was operating normally for the phase of flight and was producing power at the moment of impact;

n) the aircraft had substantial damage to its entire structure;

o) the PIC left unharmed; and

p) the SIC and the OEE suffered minor injuries.

### 3.2 Contributing factors.

- **Training – a contributor.**

The lack of training programs, standard operation, and flight safety procedures to guide the crews' conduct under special conditions, contributed to the crewmembers' failure to adopt more assertive and safer actions and decisions when facing the abnormal situation experienced in flight.

- **Communication – a contributor.**

At the time of the abnormal in-flight condition, although the SIC demonstrated an initiative to assist the PIC in the decision to perform a go-around procedure. There was a failure in the process of passing this guidance, as the message was not properly received by the receptor, who claimed not to have listened.

- **Crew Resource Management – a contributor.**

The SIC directed the PIC to perform a go-around procedure when he noticed the excessive vibration. However, such a procedure was not adopted. The PIC stated that he had not heard this guidance, which revealed inefficiency in the utilization of the human resources available for the operation of the aircraft, due to a failure in communication between the pilots.

- **Team dynamics – undetermined.**

The involvement of the SIC with the electronic equipment throughout the flight, the possibility of the aircraft touching an obstacle before landing, and the losses in the communication established during the critical situation in flight indicated a possible compromise in the team dynamics. The low interaction of the crew members may have contributed to lowering the level of situational awareness during the operation.

**Piloting judgment – a contributor / undetermined.**

The fact that the PIC failed to perform a go-around procedure, even in an unstabilized approach profile, characterized by excessive vibration and uncommanded sink, revealed inadequate evaluation of parameters related to the aircraft operation.

- **Perception – a contributor.**

The failure to identify the conditions that affected the safest way to carry out the operation demonstrated a lowering of situational awareness, which culminated in the decision to land under unfavorable conditions.

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

The decision to proceed to land, in a non-stabilized approach profile, characterized by excessive vibration and uncommanded sink, revealed a difficulty to perceive, analyze and choose the appropriate alternative, which would be to perform a go-around for another landing procedure.

- **Support systems – a contributor.**

The operator did not have manuals and other documents that formalized and standardized the procedures to be used by the crewmembers in airline operations.

## 4. SAFETY RECOMMENDATION.

***A proposal of an accident investigation authority based on information derived from an investigation intended to prevent accidents or incidents and 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):**

**A-104/CENIPA/2016 - 01** **Issued on 09/22/2023**

Disseminate the lessons learned in this investigation to the Federal Highway Police Department, so that this organization intensifies risk management actions and uses the information obtained in the events to promote operational safety, aiming to adopt an organizational culture capable of raising the collective perception of the risks inherent to the operation.

## 5. CORRECTIVE OR PREVENTATIVE ACTION ALREADY TAKEN.

From 12APR2019 on, with the publication of the RBAC No. 90, entitled "Requirements for special public aviation operations", it was established, in Subpart I, the requirement for the operator to have a MOP, providing the policy, procedures, instructions, guidance, and doctrine for the development of the air operations of the UAP, containing the following general requirements:

> (a) The MOP shall:
>
> (1) be a standardization mechanism for achieving operational safety performance of the UAP;
>
> (2) be approved by the UAP manager;
>
> (3) Provide detailed instructions for the UAP's activities, with guidance on operational safety;
>
> (4) be applied with consistency and uniformity within the UAP;
>
> (5) encourage the reporting of discrepancies, improvements, updates, and best practices for the implementation and revision of this publication;
>
> (6) be integrated with the SGSO of the public agency or entity; and
>
> (7) be used during training.
>
> (b) Actions or operations foreseen in other UAP publications may integrate a MOP.
>
> (c) The content of the MOP must observe the operational specificities, attributions of the organ or public entity, the type of personnel involved, and the characteristic of the UAP fleet.
>
> (d) The MOP shall be reviewed by the UAP whenever necessary, even after its implementation, to preserve the operational safety performance of the referred UAP.

Similarly, Subpart J - Standard Operating Procedures (SOP) recorded its respective general requirements, as follows:

> (a) SOPs shall:
>
> [...]
>
> (6) **be based on CRM core concepts aimed at effective cabin coordination coupled with the performance of the crew and other persons with a role on board for the activities related to each role. (our emphasis)**

On September 22th, de 2023.