COMANDO DA AERONÁUTICA

CENTRO DE INVESTIGAÇÃO E PREVENÇÃO DE ACIDENTES AERONÁUTICOS

FINAL REPORT
A-047/CENIPA/2016

OCCURRENCE:	**ACCIDENT**
AIRCRAFT:	**PR-HCT**
MODEL:	**AS 350 B2**
DATE:	**18MAR2016**

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 18MAR2016 accident with the AS 350 B2 aircraft, registration PR-HCT. It was classified as “Collision with Obstacle In-Flight”.

During the burnout operation, during the final approach to landing in a support area, the aircraft inadvertently went down and collided the main and tail rotors against the local vegetation.

The aircraft had substantial damage.

The three crewmembers and the three firemen on board left unharmed.

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

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GLOSSARY OF TECHNICAL TERMS AND ABBREVIATIONS

AIF	Registration Category - Private of Indirect Federal Administration
ANAC	National Civil Aviation Agency
BEA	Bureau d'Enquêtes et d'Analyses pour la Sécurité de l'Aviation Civile
CA	Airworthiness Certificate
CENIPA	Aeronautical Accident Investigation and Prevention Center
CMA	Aeronautical Medical Certificate
CPAR	Rotorcraft Pilot Course
COAer	Coordination of Monitoring and Air Operations
CRM	Crew Resource Management
GSO	Operational Safety Manager
IAM	Annual Maintenance Inspection
IBAMA	Brazilian Institute of Environment and Renewable Natural Resources
IGE	In Ground Effect
MGO	General Operations Manual
MGSO	Operational Safety Management Manual
NOA	Air Operations Center
NSCA	Aeronautics Command System Rule
OGE	Out Ground Effect
PCH	Commercial Pilot License - Helicopter
PPH	Private Pilot License - Helicopter
RBAC	Brazilian Civil Aviation Regulation
RBHA	Brazilian Regulation of Aeronautical Homologation
SBBV	ICAO location designator – Boa Vista Aerodrome - RR
SGSO	Operational Safety Management System
SIPAER	Aeronautical Accidents Investigation and Prevention System
SWQI	ICAO location designator – Caracaraí Aerodrome - RR
UTC	Universal Time Coordinated
VEMD	Vehicle and Engine Multi-function Display

1. FACTUAL INFORMATION.

Aircraft	**Model:** AS 350 B2 **Registration:** PR-HCT **Manufacturer:** HELIBRAS	**Operator:** IBAMA
Occurrence	**Date/time:** 18MAR2016 - 1830 UTC **Location:** Southwest Sector of Caracaraí, RR **Lat.** 01º22'37"N **Long.** 061º09'09"W **Municipality – State:** Caracaraí, RR	**Type(s):** "Collision with Obstacle In-Flight" **Subtype(s):** Nil.

1.1 History of the flight.

The aircraft took off from the Caracaraí - RR (SWQI) Aerodrome for a local flight, at 1805 (UTC), to conduct a firefighting operation in an area around 27NM southwest of the city, with three crewmembers and three passengers on board.

When proceeding to a second landing in a restricted area, in order to leave more firemen to fight fire in a nearby location, the crew observed an inadvertent go down movement of the aircraft in the final third of the approach, leading to the collision of the main rotor and the tail rotor against the vegetation of the area.

After the collision, the crew noticed a slight right turn. The pilot was able to control the aircraft and make the landing in the restricted area, approximately fifteen meters from the impact site.

Figure 1 - Aircraft landing site after collision.

All occupants left the aircraft after full stop.

The aircraft suffered substantial damage. The three crewmembers and the three firemen were unharmed.

1.2 Injuries to persons.

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

1.3 Damage to the aircraft.

The aircraft had substantial damage to the blades of the main rotor and tail rotor assemblies with dents on their surfaces (Figures 2 and 3).

Figure 2 - Overview of the aircraft and damage to the tip of the main rotor blade.

Figure 3 - Extension of damage to the main rotor blade.

1.4 Other damage.

Nil.

1.5 Personnel information.

1.5.1 Crew's flight experience.

Hours Flown		
	Pilot	Copilot
Total	3.500:00	420:00
Total in the last 30 days	12:00	10:10
Total in the last 24 hours	03:40	03:40
In this type of aircraft	3.000:00	405:00
In this type in the last 30 days	10:10	10:10
In this type in the last 24 hours	03:40	03:40

N.B.: The Data on flown hours were obtained from the pilots.

1.5.2 Personnel training.

The pilot took the Helicopter Pilot course (CPAR) on the 1ST Squadron of the 11ST Aviation Group (1º/11º GAV), SP, in 1989.

The copilot took the Private Pilot course – Helicopter (PPH), at EDRA Aeronautics, SP, in 2009.

1.5.3 Category of licenses and validity of certificates.

The pilot had the Commercial Pilot License – Helicopter (PCH) and had valid Technical Qualification for the H350 aircraft.

The copilot had the Commercial Pilot License – Helicopter (PCH) and had valid Technical Qualification for the H350 aircraft.

1.5.4 Qualification and flight experience.

The pilots were qualified and had experience in that kind of flight.

1.5.5 Validity of medical certificate.

The pilots had valid Aeronautical Medical Certificates (CMA).

1.6 Aircraft information.

The aircraft, serial number 7432, was manufactured by HELIBRAS, in 2012 and was registered in the AIF category.

The aircraft had valid Certificate of Airworthiness (CA).

The airframe and engine logbook records were updated.

The last inspection of the aircraft, the "100 hour-type" on 13MAR2016 was performed by Helisul Air Taxi Ltd., in Boa Vista – RR, having flown 04 hours and 10 min after the inspection.

The last inspection of the aircraft, the "Annual Maintenance Inspection (IAM)" type, was performed on 28SEPT2015 by the Helisul Air Taxi Ltd. shop, in Boa Vista - RR, having flown 273 hours and 20 min after the inspection.

1.7 Meteorological information.

The accident occurred in the daytime.

There was no ceiling restriction and visibility in the area, according to reports from the crew and witnesses.

During the interviews, the pilot suggested the possibility that the go down movement was caused by a windshear, which can be defined as a rapid change in direction and / or wind speed over a given distance.

The wind shear can have several origins, such as: thunderstorms, presence of cumulonimbus (CB), virga (type of precipitation that occurs in the base of certain clouds and that does not reach the ground), frontal systems, low level jet streams , surface strong winds, sea and land breezes, mountain waves, instability lines and strong temperature inversions.

Due to the fact that the meteorological site closest to the scene was 90NM away (SBBV), it was not possible to specify the direction and intensity of the wind in the area of the accident.

1.8 Aids to navigation.

Nil.

1.9 Communications.

Nil.

1.10 Aerodrome information.

The occurrence took place outside the Aerodrome.

1.11 Flight recorders.

The aircraft was not equipped with flight recorders, which were not required by current regulations.

It was possible to identify, by analyzing the Vehicle and Engine Multi-function Display (VEMD) maintenance page that the engine torque limit was exceeded (OVER LIMIT) about 19 seconds before the cutting procedure.

At the request of the investigation team, the maintenance company hired by the operator performed a verification on the aircraft's VEMD, identifying that, on the maintenance page; there was only OVER LIMIT, caused by the excessive application of torque, moments after the first collision of the main rotor assembly against the vegetation of the site.

1.12 Wreckage and impact information.

The place chosen for the landing was considered an occasional, restricted landing area in which a normal or wide-angle approach was possible.

The terrain was flat and steady, with an approximate size of 900m² (30m x 30m) of area, and it was perfectly possible to land the aircraft on the spot.

In the final approach, the aircraft's course was 253º, and the collision occurred in a tree approximately 15m high (Figure 4), located in the approach sector.

Figure 4 - View of the location of the first impact (tree) of the aircraft during the final approach to the landing point.

After the collision, the aircraft was controlled and proceeded to the landing in the restricted area, coming to a stop with the bow on 284th.

The aircraft had substantial damage on two main rotor blades and minor damage on the other blade, in addition to minor damage to the two blades of the tail rotor.

1.13 Medical and pathological information.

1.13.1 Medical aspects.

Not Investigated.

1.13.2 Ergonomic information.

Nil.

1.13.3 Psychological aspects.

Not Investigated

1.14 Fire.

There was no fire.

1.15 Survival aspects.

Nil.

1.16 Tests and research.

Nil.

1.17 Organizational and management information.

The aircraft operator was the Brazilian Institute of Environment and Renewable Natural Resources (IBAMA), a federal agency of special regime linked to the Ministry of Environment.

The regulative structure of IBAMA, approved by Decree 6,099, of 26APR2007, listed among its purposes the following actions: to exercise the power of environmental police; execute enforcement actions, monitoring and environmental control; assistance and

operational support to public institutions and society in matters of environmental accidents and emergencies and of relevant environmental interest.

IBAMA's air operation was classified as "private of federal indirect administration", but its main characteristic was the carrying out of typical public safety aviation missions. Including exposure to armed confrontation and operation in restricted areas, as recommended by Subpart K of Brazilian Regulation of Aeronautical Homologation (RBHA) 91, which dealt with the activities of public safety and / or civil defense air operations.

> 91.951 - APPLICABILITY
>
> [In view of the peculiarities of public safety and / or civil defense air activities, this subpart establishes standards and procedures applicable to such activities, including crew training and aircraft maintenance.]
>
> 91.953 - CONCEPT
>
> (a) For the purposes of this regulation:
>
> (1) ["Public safety and / or civil defense air operations" is an activity carried out with aircraft and conducted by a public safety or civil defense body.
>
> (2) "Public Security Agency" and "Civil Defense Agency" are bodies of the Federal, State, Municipal and Federal District direct public administration, designed to ensure the preservation of public order, the safety of persons and property.
>
> (b) Public security and / or civil defense air operations comprise typical administrative, judicial, fire and civil defense police activities, such as ostensive and investigative policing; intelligence actions; support for compliance with court orders; control of riots, disturbances and mutinies. Escort and transport of dignitaries, prisoners, values, charges; aeromedical, transport of patients, human organs and rescue; search, land and water rescue; control of road, rail and urban traffic; prevention and firefighting; urban, rural, environmental, coastal and border patrols; and other operations authorized by the DAC.

In 2016, the total number of hours flown to the occurrence site was 1,031 hours, with about 337 hours on inspection flights, 129 hours on transfer and the rest on flights of policing, support, monitoring and firemen and cargo transportation.

In that year, through a lease agreement with an air taxi company, IBAMA operated six helicopters, one being a Silla AS350 B2H-50 and five Bell Long Ranger BH06.

The rental company was responsible for the maintenance of the aircraft and for the provision of a mechanic for accompanying each helicopter during their operations.

The helicopter crew consisted of 28 pilots from various organizations, such as military police, military fire brigades and aircraft rental companies. In 2016, a pilot from IBAMA was incorporated into the existing group.

Regarding the pilots hired, there was no appropriate system of selection and hiring for inclusion in the Institute's crew, since they operated (within the company) under the auspices of Law 7.183 and in accordance with the collective agreement of the category, in a restricted context to the environmental, social and operational conditions established for airlines. This condition ended up causing restrictions on the crew's own operation.

The structure of the Institute had the Coordination of Monitoring and Air Operations (COAer), located in Brasília, which was responsible for planning, coordinating and executing the air operation, as well as for the management of air support for the accomplishment of IBAMA’s institutional missions.

In the Coordination, the Operational Safety Manager (GSO) managed the accident prevention activity, a position held by an IBAMA employee who was not part of the Institute's crew.

There was also in that COAer, the figure of a Coordinator, who was in the place where the mission would be performed.

The crew, arriving at the city designated as the base of the mission, received a briefing from that Coordinator, addressing the objectives to be achieved and the peculiarities of the air activity. The aircraft's Commander, who should report to COAer any discrepancies and abnormalities that might be encountered performed Monitoring and supervision of the flight.

Among the documents that guided the Institute's air activity, were identified: the General Operations Manual (MGO), the Operational Safety Management Manual (MGSO) and the External Cargo Manual.

The MGO, approved and dated of June 2006, established:

> "1.1 PURPOSE
>
> This General Operations Manual (MGO) aims to describe the procedures and systems related to air operations in IBAMA, being used as an administrative and operational tool to control and direct the activities of the AIR OPERATIONS CENTER.
>
> 1.2 CONFORMITY
>
> This General Operations Manual (MGO) was elaborated, observing the precepts established in Law n. 7.565 (Brazilian Aeronautical Code - CBAer), and in accordance with the applicable Brazilian Aeronautical Certification Regulations (RBHA). Its purpose is to describe the policies and standards for decision-making and procedures for conducting the Air Operations Center, as an aeronautical advisory body of the IBAMA's Environmental Protection Directorate for airplanes and helicopters operations and directly correlated activities.
>
> In addition, this manual is kept up-to-date with the rest of the applicable aeronautical regulations, in particular the Brazilian Aeronautical Certification Regulation - RBHA 61, Brazilian Aeronautical Certification Regulation - RBHA 91 - Subpart K, and IAC 3535, 3203, 3252, 2225, 2308 and others. This General Operations Manual (MGO) is permanently in the Technical Library, located at the operational headquarters of the AIR OPERATIONS CENTER - NOA, available to all personnel involved in NOA operations, as well as the Aeronautical Authorities.
>
> 1.3 COMMITMENT
>
> The AIR OPERATIONS CENTER, through its Coordination, NOA-filled servers, consultants and employees, and persons connected to the Air Operations Nucleus - NOA who is responsible for making decisions, compromise to disclose, comply with and enforce the guidelines of this General Operations Manual, when approved by the Brazilian Aeronautical Authority. They also commit to seek the highest levels of safety quality in their air and ground operations, to encourage and support good aeronautical practices and to consider all suggestions and recommendations issued by any of its professionals, partners, and suppliers and by authorities, in order to be permanently improving in the conduct of aeronautical activities.
>
> This manual is mandatory for all flight, ground and maintenance personnel of the AIR OPERATING CENTER - NOA and people related to air operations, and it is the responsibility of the Coordinator and the Operations Chief to determine the levels of knowledge required for the operation. Good performance in relation to the contents of this manual, according to the tasks and positions occupied by the various professionals involved, as well as their areas of operation.
>
> At the administrative and operational headquarters, there is a copy of this manual, together with the collection of applicable legislation, which are under the responsibility of all Heads of the Air Operations Center - NOA sections. Also, in each aircraft, there is a copy of this General Manual of Operations for consultation and for the faithful fulfillment by the crews.
>
> Each holder of this manual is responsible for complying with and enforcing the standards and procedures set forth therein. The holders are also responsible for

> their conservation and updating, and must return it to the Air Operations Center - NOA in case of definitive removal. "

It is important to note that the MGO was not available on the aircraft for consultation on the occasion of the mission, and that the crew was not aware of its content or even of its existence, despite the fact that it foresees the need for full knowledge of the guidelines and standards established.

Further on, the manual provided:

> "6.4 OBLIGATIONS OF THE CREW DURING THE FLIGHT CRITICAL PHASES
>
> NOA cannot determine, nor can any crewmember perform, any service during critical phases of flight, except those services required for the safe operation of the aircraft.
>
> No crewmember may perform and no Commander may permit any activity during the critical phases of the flight that may divert any flight crewmember from the performance of his or her duties or that may interfere in any way with the proper performance of those obligations. Activities such as eating, engaging in non-essential conversations, making unnecessary communications, or reading publications unrelated to the conduct of the flight are not activities required for the safe operation of the aircraft.
>
> These are critical phases of flight:
>
> Soil operations involving rolling, running and takeoff;
>
> The land and landings in restricted areas;
>
> Other flight operations conducted below the altitude of 1000 feet (airplane) and 500 feet (helicopter) except cruise.
>
> 6.5...
>
> 6.6 ACCOMPANYING THE FLIGHT
>
> All personnel responsible for the operational control of NOA flights including: Chief of Operations, Chief Pilots, Commanders and other NOA pilots shall follow established procedures and standards for flight monitoring to coordinate efforts and contribute to timeliness, economy and safety in operations. "

Regarding the MGSO, approved and dated of August 2015, item 2.5

> "2.5. MGSO DO IBAMA
>
> This Operational Safety Management Manual (MGSO) is regulated by the National Civil Aviation Agency (ANAC) as one of the requirements of Resolution No. 106, of June 30, 2009, whose implementation allows the adoption of preventive and predictive approaches to the operational safety.
>
> The MGSO describes the characteristics of the Operational Safety Management System (OSMS) as a set of integrated measures, procedures and practices and tasks of the personnel involved in the OSMS.
>
> The purpose of the MGSO is to consolidate and integrate information and documentation regarding the policy, objectives, strategies, goals, indicators, programs, procedures and responsibilities pertaining to IBAMA's GSO, as well as the structure, organization, planning and programming of its implementation. "

Still regarding the MGSO, it is highlighted the one foreseen in item 12, dedicated to the management of crew resources:

> "12 CORPORATE & CREW RESOURCE MANAGEMENT PROGRAM
>
> 12.1 HISTORY
>
> 12.2. TRAINING CHARACTERISTICS
>
> CRM training has the following characteristics:
>
> ...

- It includes all the personnel involved with the aerial activity;

- It's part of the flight training;

...

- It requires the participation of all; and

...

12.4. CONTENTS OF IBAMA'S CRM

The CRM training given at IBAMA addresses the following topics:

12.4.2. CRM WITH OPERATIONAL APPROACH (INITIAL):

...

- Sterile Cabin

...

12.5 SPECIFIC ATTRIBUTIONS

From the President of IBAMA (or Director of Environmental Protection for his delegation)

- To approve the accomplishment of the events involving financial resources of displacement of the members and facilitators.

From the Air Operations Coordinator

- Approve the programming of the CRM Courses for the crew and the annual periodicity for their recycling.

- Participate in all CRM events held at IBAMA; and

- Invite the president of IBAMA and the Director of Environmental Protection to participate in the CRM event for management levels.

From the Operational Security Manager

- Prepare, together with the Air Operations Coordinator, the annual and exceptional schedules for conducting the CRM events.

- Participate in all CRM events held at IBAMA.

- Define the approaches to CRM events according to the target audience for which it is intended.

- Evaluate the results obtained in the CRM events carried out and present the respective report to the Coordinator of Air Operations. "

According to a consultation carried out with COAer, despite initial training in CRM and annual recycling for the crew, IBAMA promoted only one training, which took place in 2011.

It should be noted that the crew involved in the event had entered the crew after the year of 2011, not having performed the training provided in the Manual.

The External Cargo Manual, prepared in accordance with the Brazilian Civil Aviation Regulation (RBAC) 133, provided for the special operations of IBAMA with external cargo, which was approved and dated in August 2015.

That Manual prevised a course of leveling that the crewmember should perform to start the operation in the organ. This course covered the theoretical and practical parts of the Institute's operations. The practical part was programmed only for the pilots and mechanics of the hired company. The co-pilots and other crewmembers (called "fiéis") performed only the theoretical course.

Also regarding the training of external cargo, there was an estimated recycling in the techniques applicable to that type of operation, but only for pilots and mechanics who had

already passed the practical leveling. The Manual did not include theoretical recycling for the “fiéis” and co-pilots.

1.18 Operational information.

Routinely, the schedule of the helicopter crews was made jointly by IBAMA (operator), which indicated the co-pilots, and the contracted company, which indicated the Commanders.

At the time of the occurrence, the crew consisted of a retired military man from the Rio de Janeiro Military Fire Brigade, as Commander, a military police officer from Rio Grande do Norte, as a copilot, and another military police officer, also from Rio Grande do Norte , as “fiel”.

The crew performed an IBAMA’s mission, in the region of Caracaraí, with a 15 days exchange period. At the time, the Commander was going to his second mission in the region. The co-pilot and the “fiel” had not been on an operator’s mission for more than a year.

The arrival of the crew took place on 10MAR2016, in Boa Vista - RR, where the aircraft was based due to the programmed maintenance inspection, the "100 hours" type, performed by the contracted company.

At the end of 15MAR2016, the aircraft was released for the flight and transferred to Caracaraí (SWQI) in the morning of 16MAR2016, when the flights got started in the area near the place of occurrence.

These flights consisted of transporting brigades to firefighting areas, already predefined and known to the crews and the IBAMA support team, with an average air effort of 4 hours per day.

On the incident’s eve, a reconnaissance flight of the affected area was performed to verify the conditions of the landing sites and the pertinence of using the bambi bucket (a bucket to pour water in a spot with fire outbreak or forest fire) in the mission.

According to the Commander, a request was made for the IBAMA support team to expand the area that would be used for landing, eliminating vegetation that could hamper landings and maneuvers close to the ground.

The expansion of the area was also intended to remove vegetation around the aircraft in order to prevent further fire propagation that could interfere with the safety of operations.

On 18MAR2016, the crew took off from SWQI, around 01:00 p.m. (local time), for a new overfly to check the conditions of the proposed landing site. He then went on to where the brigade and the fire-fighting equipment were, about ten minutes' flight away from that point of disembarkation.

Due to the low availability for passengers, due to the aircraft’s weight limit, there would be four transfers between the support site and the point of disembarkation.

In the first transfer, three firemen and the support material to be used to reduce the vegetation of the landing area were transported.

According to the crew, the wind was constant at that moment, coming from the right quadrant of the aircraft in relation to the axis of the final approach. The Commander

judged that the right wind for that type of aircraft, with a clockwise rotation of the main rotor, would lead to a power gain, with no problems with that wind direction.

The final approach was performed without abnormalities related to the turbulence, obstacles and controllability of the helicopter.

The three firemen disembarked and, following the plan, the aircraft returned to the IBAMA support site. It would only return to the landing point thirty minutes later, long enough to reduce vegetation in the area and make operation safer.

At about 14:30 (local time), the aircraft took off from the point of support with six people on board, three crewmembers and three firemen.

As the site was familiar and a landing had been made a short time ago, the Commander informed that he decided to proceed straight to the final, without re-evaluating the wind, which, according to the interviews with the crew and firemen in the ground, had increased in intensity and changed direction to a tail quadrant.

According to the Commander, the approach was made by the co-pilot, as in an "informal instruction", in order to enable him to increase his flight experience, leaving the Commander responsible for verbal accompaniment and monitoring of cyclic and collective commands.

According to the Commander's perception, the final approach ramp was lower than the previous landing (thirty minutes earlier).

At 60kt of speed indicated, the door was opened for the “fiel” to act in the approaching aid. The rate of descent was approximately 300ft / min.

With speed between 30kt and 20kt, the crew noticed an inadvertent movement of the aircraft going down, colliding the main rotor against a tree, to the right of the approach axis, followed by a right tail yaw and new collisions against the vegetation.

The commander decided to eliminate the tail-turning tendency and the going down movement, applying the residual torque, mainly because the aircraft was no longer with speed of displacement, being lifted exclusively by the engine. At that time, pilots identified the OVER LIMIT engine sound warning from the VEMD.

After stabilizing the tail turning and eliminating the going down movement, the Commander decided to proceed cautiously to the point proposed for the landing, observing an abnormal vibration of the aircraft, due to the collision of the rotor against the vegetation. The landing, the engine cut-off and the abandonment of the aircraft occurred without any abnormality.

Meteorological conditions were favorable for the visual flight, with no cloudiness or strong winds that could have impaired the pilots’ judgment, or made it difficult to maintain control of the aircraft during approach and landing.

Regarding the aircraft operation, at the time of occurrence, the temperature was approximately 34 ° C, the altitude of the terrain was 300ft, altitude density (calculated) was 2,300ft, atmospheric pressure was 1,010mbar and the aircraft weight was 1,950 kg.

Considering that, the aircraft had a PMD of 2,250 kg, relying on the weight, and balancing chart, it was concluded that the helicopter was within the prescribed limits.

Regarding performance, the analysis of the parameters above, in face of the In Ground Effect (IGE) and Out Ground Effect (OGE) graphs, showed that the aircraft was within the limits of operation.

Also, regarding the operation of the aircraft, the final approach was performed in the bow 253º, and the pilots observed a component of tail wind, estimated at around 10kt, varying from 090º to 080º.

Both the crew and the passengers stated that there was no light on the aircraft dashboard or any other indication of a possible engine failure that might have contributed to the occurrence.

1.19 Additional information.

Nil.

1.20 Useful or effective investigation techniques.

Nil.

2. ANALYSIS.

The crew had a mission to support the fight against fires in the vegetation located in the southwest sector of the city of Caracaraí - RR, which consisted of transporting firemen and equipment to a landing site located near the fire to be fought.

On the day of its occurrence, on the first landing at the landing site, personnel had been left to cut vegetation in the landing area and in the approaching sector, in order to increase the mission safety.

The occurrence happened during the second flight, which aimed to transport the members of a brigade to fight against the fire nearby. During the final third of the approach to landing, the crew noticed an inadvertent going down movement of the aircraft, colliding the main rotor assembly and tail against vegetation in the area.

After the collision, the crew noticed a slight tail yaw to the right, possibly caused by excessive torque application, ratified by the OVER LIMIT (OVER LIMIT) audible warning.

The Commander controlled the helicopter and proceeded cautiously on the approach to the landing site, about 15 meters ahead, where he successfully landed.

Both pilots were from state military corporations, with experience in public safety and civil defense operations, under the rules of Subpart K of RBHA 91, including risky situations, such as landings and take-offs at unlicensed or registered locations and emergencies.

In addition, it should be pointed out that the crew had operated on the IBAMA missions for at least two years, and that the Commander already knew the area of operation, since he had been engaged in the same mission days before the occurrence.

In the organizational aspect, although IBAMA's aims, in its regimental structure (Decree 6.099 / 2007), involved actions that were similar to those of public security and civil defense, it was an autarchy (a body belonging to the federal administration indirectly) and it is therefore not subject to the rules of Subpart K of RBHA 91.

As a direct consequence, IBAMA was not required to establish minimum training standards for its missions, in the manner required by public organizations of direct administration by the Civil Aviation Authority.

Nevertheless, despite the lack of obligatoriness, the Institute developed manuals (MGSO, MGO, External Cargo, etc.) and implemented specific theoretical training for all its crewmembers, as well as practical training for pilots hired by the aircraft's company.

However, this situation, since it does not cover homogeneous training for all crew, may have generated a lack of standardization in the execution of the missions, creating a conducive atmosphere to divergent procedures among the crew.

After all, the training program of a company, when guiding the training of the crew and the maintenance of their operations, ends up serving as a basis for the implementation and strengthening of a standard of action common to all.

In this context, the lack of prediction of practical training for co-pilots may have favored initiatives such as the "informal instruction" given by the Commander during the final approach of the occurrence.

As for the conditions of the aircraft, the documentation was up to date, with no evidence of discrepancies that might have impaired its operation and contributed to the occurrence. Still, it did not show signs of mechanical problems that could compromise its control or its operation.

It was also found that, at the time of the occurrence, the aircraft was operating within the envelope of operation under In Ground Effect (IGE) and Out Ground Effect (OGE) conditions.

During the first action, it was possible to access the engine's operation database by analyzing the maintenance page of the VEMD. It was observed that the torque limits (OVER LIMIT) were extrapolated 19 seconds before the engine cut-off procedure.

According to the Commander, the extrapolation occurred after the first impact of the rotors against a tree, at a time when the aircraft had lost its lift, tending to go down.

The Commander reported that it was necessary to apply torque to maintain stabilization of the aircraft in the hovering and subsequent controlled movement of the aircraft to the proposed landing site.

It was possible to rule out a failure of the engine as a contributing factor to the go down movement, since, in addition to having responded promptly to the new demand of power made by the Commander, guaranteeing the hovering flight and displacement to the landing, there was no report (or registration) of loss of power warning.

The Commander's action, even if he extrapolated the engine torque limits (OVER LIMIT), ended up avoiding the aircraft to go down in an area of dense vegetation, which would have certainly generated consequences of greater gravity to the occurrence.

Considering the absence of convective systems near the place of occurrence, as well as of reliable indicators of direction and wind intensity, which could characterize the area as propitious to the occurrence of windshear, it was not possible to support the hypothesis presented by the Commander, that the sudden sinking of the aircraft was due to this meteorological phenomenon.

Through the report of the crew, it is estimated that at the time of the occurrence, the wind was constant, with intensity around 10kt and direction of 080º.

For a better understanding of the influence of tailwind on the aircraft trajectory, it is important to remember that, in the case of the helicopter; the lift is obtained from the displacement of the mass of air (induced airflow) down, caused by the rotation of the rotor. This mass of air becomes turbulent by the action of the blades.

Because the induced airflow is lower in the central region of the rotor disc relative to its end, when the helicopter begins to descend rapidly and with little forward displacement, the reverse airflow - from below the rotor - overcomes the induced airflow in that central region.

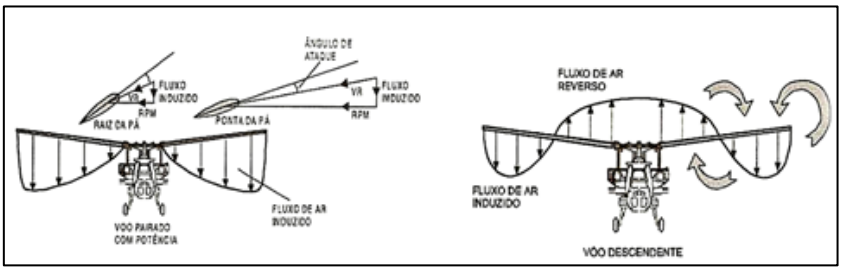

Figure 5 - Characteristics of air flow induced during hovering flight with power and descending flight.

This causes the reverse airflow to return through the central part of the blades where there is still induced airflow (Figure 5). Depending on the intensity of the central vortices and blade tip, the turbulence generated may involve the entire rotor and cause vortex stalls. Such condition is more frequent during tailwind approaches or in areas of turbulence.

The first symptom of the vortex stall may be a low frequency vibration, similar to that normally experienced upon transition to hovering.

The second symptom is the involuntary movement of the aircraft around one or more than one of its three axes.

If the pilot does not intervene actively in the flight controls, that is, leaving the whirling zone, commanding the cyclic effectively ahead and reducing the rotor load, reducing the collective pitch, the helicopter will randomly change the bow, the inclination and attitude, as well as tend to increase the reason for going down.

The analysis of the circumstances in which the occurrence happened, points to a damaging and decisive action of the tail wind.

On that day, two approaches were made to the landing site, both with tailwind, but with different intensities, according to witnesses who were in the place.

The second approach, which culminated in the occurrence, besides having a tailwind, also had a ramp profile lower than the first approach, and was also carried out in the middle of an "informal instruction" given by the Commander to the co-pilot.

Thus, with the gradual reduction of speed during approach and under the action of the tail wind, was with a considerable intensity at the moment, about 10 kt. The aircraft reached a condition in which the reverse airflow, passing through the central part of the main rotor, already turbulent because of the action of the induced airflow, began to envelop the entire rotor, causing a vortex stall.

At this point, there was an abrupt loss of altitude, with the consequent collision of the main rotor assembly against a tree to the right of the final axis, culminating in the following events.

Since the final approach was made in the midst of an "informal instruction", it is possible that a more aggressive pitching by the co-pilot contributed to aggravate the situation by throwing turbulent air ahead of the aircraft's trajectory, favoring the entry in vortex stall.

In addition, the adoption of a lower approach ramp, in the event of the occurrence, reduced the distance between the aircraft and the obstacles. It reduced the time available for the recognition of the vortex stall condition and, consequently, for the application of the corrective action (command of the cyclical ahead and lowering the collective) on the part of the pilots, favoring the collision.

On the other hand, the strict observance of the provisions of item 6.4 of the MGO could have prevented the occurrence, since it established that:

> "No crewmember may perform and no commander may permit any activity during the critical phases of the flight which may divert any flight crewmember from the performance of his or her duties or that may interfere in any way with the proper performance of those duties."

Adhesion to this item would inhibit the practice of "informal instruction," which certainly consumed some of the Commander's attention.

The fact that the MGO was not available in the aircraft and those who participated in the air activity did not know its content, presented as a latent condition involving risk to the air activity.

Another point worth noting is the fact that none of the pilots had performed the CRM training, previsied in the MGSO. This training was of enormous importance, since it would add synergy to the crew's performance, increasing situational awareness, which could have favored the perception that the influence of the tail wind was significant and that the low ramp would merit correction.

In addition, it is concluded that "informal instruction", inopportune and inadequate, as well as not scheduled, contributed to diverting the attention of the crew in the most critical moments of the flight.

It should be noted that adequate operational supervision of its pilots during the flight planning and execution phase could represent another defense against the accident, avoiding that informal and isolated procedures could contribute to the distortion of practices and doctrinal standardizations inherent to the operation of the aircraft. At the time, however, flight supervision was the responsibility of the Aircraft Commander himself.

3. CONCLUSIONS.

3.1 Facts.

a) the pilots had valid Aeronautical Medical Certificates (CMA);

b) the pilots had valid Technical Qualification for H350 aircrft;

c) the pilots were qualified and had experience in that kind of flight;

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

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

f) the airframe and engine logbook records were updated;

g) there was no ceiling and visibility restriction in the area of the occurrence;

h) the final approach was performed with tailwind;

i) the aircraft was operating within the operating envelope under In Ground Effect (IGE) and Out Ground Effect (OGE) conditions;

j) the engine torque limit was extrapolated (OVER LIMIT), about 19 seconds before the cutting procedure;

k) the aircraft had substantial damage; and

l) the occupants were unharmed.

3.2 Contributing factors.

- **Handling of aircraft flight controls - undetermined.**

It is possible that the use of flight commands improperly, during the final approach, with a possible climbing attitude induced by the "informal instruction" given by the Commander to the co-pilot, has contributed to the occurrence of the vortex stall.

- **Cabin Coordination - a contributor.**

The "informal instruction", at the most critical moment of the flight, generated inefficiency in the use of the human resources available for the operation of the aircraft, due to the inadequate management of the tasks assigned to each crewmember during the execution of an activity not previously scheduled.

- **Training - undetermined.**

The lack of CRM training for crewmembers may have contributed to the lack of effective use of available resources to ensure the safety and efficiency of the operation. The CRM seeks to elevate situational awareness so that one has a precise perception of the facts and conditions that affect the aircraft and its crew.

In this way, the lack of perception of the operational parameters in the final approach can represent a consequence of this training gap, since there was not an adequate identification of the conditions that required better management of the crew and its future consequences.

- **Piloting judgment - a contributor.**

By choosing to proceed directly to land at the disembarkation site, with tail wind component and approach ramp below that considered ideal, the crew failed to observe relevant aspects to the safe operation of the aircraft.

- **Management planning - undetermined.**

Although IBAMAS' MGSO talked about conducting CRM training, material and human resources were not allocated for the development of the activity

- **Organizational processes - a contributor.**

The helicopter crew consisted of 28 pilots from various organizations, which caused restrictions on the operation of the Institute, as there was no adequate selection and monitoring system for its crew, favoring the practice of informal activities in flight.

- **Support System - undetermined.**

The fact that the MGO was not available on the aircraft demonstrated a fragility regarding the operational support offered to the crew. The presence of this on-board Manual could help them perform their functions with a technical foundation and support the practical performance with safety.

- **Managerial oversight - a contributor.**

There was inadequate oversight of operational planning and execution activities by the operator's management, as the Commandant was given "informal instruction" for which there was no previous schedule.

- **Other (Legislation) - a contributor.**

IBAMA's air operation was classified as "private of federal indirect administration", but had as its main characteristic typical missions of public safety aviation, including exposure to armed confrontation and operation in restricted areas.

As a result, some of the air operations carried out by the Institute were not endorsed by Subpart K of the Brazilian Aeronautical Certification Regulation (RBHA) 91, despite being necessary for the fulfillment of its institutional mission. Accordingly, existing legislation did not require the operator to establish clear standards for its operations.

4. SAFETY RECOMMENDATION.

A measure of preventative/corrective nature issued by a SIPAER Investigation Authority or by a SIPAER-Link within respective area of jurisdiction, aimed at eliminating or mitigating the risk brought about by either a latent condition or an active failure. It results from the investigation of an aeronautical occurrence or from a preventative action, and shall never be used for purposes of blame presumption or apportion of civil, criminal, or administrative liability.

In consonance with the Law n°7565/1986, recommendations are made solely for the benefit of the air activity operational safety, and shall be treated as established in the NSCA 3-13 "Protocols for the Investigation of Civil Aviation Aeronautical Occurrences conducted by the Brazilian State".

Recommendations issued at the publication of this report:

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

A-047/CENIPA/2016 - 01 Issued on 25/06/2018

Work with the Brazilian Institute for the Environment and Renewable Natural Resources so that, despite this condition not being mandatory, the MGO and the MGSO of that operator are available in each of the aircraft operated by IBAMA and that its contents are known of all those involved in the Institute's air activity.

5. CORRECTIVE OR PREVENTATIVE ACTION ALREADY TAKEN.

In order to establish requirements for Brazilian public aviation special operations, ANAC started the production process of the BRAZILIAN CIVIL AVIATION REGULATION 90 (RBAC 90). This document applies to the conduct of special public aviation operations of the bodies and entities of the public administration, in the exercise of its specific attributions.

Upon entry into force, this Regulation will make mandatory several procedures and measures directed to Operational Safety in the air activity of public agencies, as it is the case of IBAMA. Thus, it is understood that the creation of this regulatory framework will mitigate risks to the maintenance of operational safety in public civil aviation operations, as far as it will establish standardization criteria for such activity.

On June 25th, 2018.

Major Brigadier FREDERICO ALBERTO MARCONDES FELIPE
Head of CENIPA