COMMAND OF AERONAUTICS

AERONAUTICAL ACCIDENT INVESTIGATION AND PREVENTION CENTER

FINAL REPORT
A - 010/CENIPA/2013

OCCURRENCE: ACCIDENT

AIRCRAFT: PR-JBN

MODEL: BELL 206B

DATE: 21 January 2013

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 item 3.1, 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.

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SYNOPSIS

This is the Final Report of the 21 January 2013 accident with the Bell 206B helicopter, registration PR-JBN. The accident was classified as loss of control in flight.

During a low altitude flight over a residential area, the aircraft collided with electric wires, and then with the roofs and concrete slabs of three houses.

The pilot perished in the crash. Two passengers were seriously injured, while the third one sustained only minor injuries.

The aircraft was substantially damaged.

Accredited representatives (one from the National Transportation Safety Board of the United States of America, and one from the Transportation Safety Board of Canada) were designated for participation in the investigation.

GLOSSARY OF TECHNICAL TERMS AND ABBREVIATIONS

ABRAPHE	Brazilian Helicopter Pilots Association
ANAC	National Civil Aviation Agency
ATS	Air Traffic Services
CENIPA	Aeronautical Accident Investigation and Prevention Center
CG	Center of Gravity
CHT	Technical Qualification Certificate
CMA	Aeronautical Medical Certificate
FAA	Federal Aviation Administration
GPS	Global Positioning System
IAE	Institute of Aeronautics and Space
IAM	Annual Maintenance Inspection
ICA	Instruction of the Command of Aeronautics
IFR	Instrument Flight Rules
IGE	In Ground Effect
Kg	Kilogram
Lat	Latitude
Long	Longitude
METAR	Routine Aerodrome Weather Report
NTSB	National Transportation Safety Board
OGE	Out of Ground Effect
PCH	Commercial Pilot (Helicopter category)
PPH	Private Pilot (Helicopter category)
SBMT	ICAO Location Designator (*Campo de Marte* Aerodrome)
SDNP	ICAO Location Designator – *Edifício BANESPA* Helipad
SERIPA	Regional Aeronautical Accident Investigation and Prevention Service
SIPAER	Aeronautical Accident Investigation and Prevention System
TSB	Transportation Safety Board of Canada
UTC	Coordinated Universal Time
VFR	Visual Flight Rules

AIRCRAFT	**Model:** BELL 206B **Registration:** PR-JBN **Manufacturer:** *Bell Helicopter Co.*	**Operator:** *Helimarte Táxi-Aéreo Ltda.*
OCCURRENCE	**Date/time:** 21 Jan 2013 / 14:48 UTC **Location:** *Comunidade Jardim Rincão* **Lat.** 23°26'11"S – **Long.** 046°43'55"W **Municipality – State:** São Paulo – SP	**Type:** Loss of control in flight

1 FACTUAL INFORMATION

1.1 History of the occurrence

The aircraft departed from SDNP with the pilot and three passengers on board, destined for the northwest sector of SBMT, with the objective of overflying stretches of terrain located at approximately six nautical miles from the *Campo de Marte* Aerodrome (SBMT).

Approximately 40 minutes into the flight, while flying at low altitude over a residential area, the aircraft collided with electric wires and then with the roofs and concrete slabs of three houses.

1.2 Injuries to persons

Injuries	Crew	Passengers	Third parties
Fatal	01	-	-
Serious	-	02	-
Minor	-	01	-
Uninjured	-	-	-

1.3 Damage to the aircraft

The crash resulted in fracture of the two main rotor blades, fracture of the tail rotor transmission, and substantial damage to the main transmission, cabin and landing gear (skis) structures, and bending of the tail boom.

1.4 Other damage

Low tension electric wires, concrete slabs and walls of three houses.

1.5 Personnel information

1.5.1 Information on the crew

HOURS FLOWN	
	PILOT
Total	595:00
Total in the last 30 days	18:25
Total in the last 24 hours	00:40
In this type of aircraft	103:35
In this type in the last 30 days	18:25
In this type in the last 24 hours	00:40

NB.: Flying time data obtained by means of records provided by the operating company.

1.5.1.1 Professional formation

The pilot did his Private Pilot Course (Helicopter category) at the *EDRA Escola Aeronáutica* in 2002.

1.5.1.2 Validity and category of licenses and certificates

The pilot had a Commercial Pilot license (Helicopter category) and a valid technical qualification certificate for BH06 aircraft.

1.5.1.3 Qualification and flight experience

The pilot had qualification and enough experience for the type of flight.

1.5.1.4 Validity of the medical certificate

The pilot had a valid Aeronautical Medical Certificate.

1.6 Aircraft information

The SN4661 aircraft was manufactured by Bell Helicopter Co. in 2008.

It had a valid airworthiness certificate.

The airframe, engine and propeller logbooks contained up-to-date records.

The last aircraft inspection (Annual Maintenance Inspection) was made simultaneously with the inspection of 1,200 hours by the *WM Manutenção Aeronáutica Ltda.* company in São Paulo, State of São Paulo. After the inspection, the aircraft flew a total of 103 hours and 8 minutes.

The Bell 206 Maintenance Manual (section 5-6) allows a 10%-tolerance in relation to the 1.200 hours maintenance inspection.

1.7 Meteorological information

The weather conditions were VMC.

According to weather information of SBMT, located at a distance of 6.5 nautical miles from the crash site, there were winds coming from 210º at 7kt.

1.8 Navigational aids

Navigation was being done according to visual references, with the use of portable GPS equipment.

1.9 Communications

Nil.

1.10 Aerodrome information

Not applicable.

1.11 Flight recorders

Neither required nor installed.

1.12 Wreckage and impact information

The impact of the aircraft resulted in great deceleration of the cabin, with a horizontal component that was bigger than its vertical counterpart.

The aircraft first collided with a secondary low tension electric wiring.

The wiring twined around the main transmission, and the helicopter precipitated onto the roofs and concrete slabs of two houses, fracturing the two main rotor blades, while the tail boom collided with a lamp post and the structure of another house.

The wire-cutting system on the front part of the helicopter fuselage did not have marks indicative of the cutting of wires prior to the crash.

Figure 1 – Situation of the aircraft after the collision.

1.13 Medical and pathological information

1.13.1 Medical aspects

The necropsy report of the São Paulo Forensic Medical Institute determined traumatic brain injury as the *causa mortis* of the pilot.

Other exams conducted by the Institute presented a negative result for ethyl alcohol and toxic agents.

1.13.2 Ergonomic information

Nil.

1.13.3 Psychological aspects

1.13.3.1 Individual information

Nil.

1.13.3.2 Psychosocial information

From interviews, the investigation commission obtained information that the interpersonal relationship with workmates in the company was very good.

1.13.3.3 Organizational information

Nil.

1.14 Fire

There was no fire.

1.15 Survival aspects

According to information provided by locals and from videos recorded by mobile phones, people from the region had immediate access to the cabin, and attempted to shut down the engine and remove the victims.

The firefighters and paramedics arrived at the site a few minutes after the helicopter had crashed. The three passengers were removed by locals, and were later assisted by the firefighters' rescue team.

The pilot was removed by the rescue team since he had gotten stuck in the midst of the aircraft wreckage and the rubble of the houses hit by the helicopter.

1.16 Tests and research

According to the Technical Report RI APA 04/2013 of 12 April 2013 issued by the Aeronautical Propulsion Division of the Aeronautics and Space Institute, the engine had integrity, with normality of the ignition, feeding and lubrication systems.

There was ingestion of rubbles at the moment of the impact between the engine (still running) and the obstacles. Thus, there was damage to the compressor, requiring its replacement for the tests.

After the replacement, the engine developed power on the test bench, and its normal functioning was verified in different regimes.

Samples of fuel and hydraulic fluid were sent to the IAE for analysis. The Technical Report RE APA 17/2013 of 11 June 2013 concluded that both fluids met the prescribed specifications.

The analysis of the multiple-alert panel of the helicopter concluded that the filaments were functioning normally, and no evidence was found of illumination of any warning lights before the impact.

The Technical Report 22/AMR/2013 of 01 July 2013 following the analysis of three components of the tail rotor transmission (Disk Assy, Adapter and Driveshaft) concluded that the fracture resulted from the impact of the tail rotor shaft assembly.

The aircraft manufacturer technical report (*Accident Investigation Factual Information Bell* 206B3 SN 4661 of 05 April 2013) concluded that there was no evidence of malfunctioning on the part either of the aircraft or its components.

The cameras used by the passengers were picked up, as well as annotations about the flight (list of points of interest) that had been passed to the pilot.

The pictures taken by the aircraft occupants show that the flight was being conducted at an altitude of approximately 200ft above the terrain.

1.17 Organizational and management information

There was neither a coordination meeting nor a briefing between the pilot and the passengers, concerning details of the flight or safety-related aspects.

1.18 Operational aspects

On that day, the pilot had already made a local flight of short duration before the one that resulted in the accident.

After departing from SBMT (only the pilot on board), the aircraft landed in SDNP (*Banespa* Helipad) to pick up the passengers.

Three government officials (from the São Paulo City Hall and Green & Environment Secretariat) embarked on the helicopter. The aircraft departed for the northwest sector of SBMT in order to fly over some areas of land located at approximately 6 miles from SBMT for purposes of inspection and registration of green areas.

Prevailing weather was VMC, and the forecast flight time was one hour and thirty minutes.

For the inspection of the selected areas, the pilot was flying at low altitude.

According to accounts provided by the helicopter occupants, the helicopter flew backwards for some distance during the inspection of the area, and presented a high angle of attack in a “nose-up” attitude.

Then, a loss of lift was noticed, as well as a descending maneuver, as a way to gain airspeed.

A few seconds later, a new nose-up attitude and a descending maneuver occurred, this time with the pilot warning that a collision was imminent.

The first impact of the aircraft was with low tension electric wires, and then with the roofs and concrete slabs of three houses.

The passengers and pilot in the helicopter were occupying the seats as follows:

1) The pilot (83Kg) was on the front right hand side seat. A passenger (75Kg) was on the front left hand side seat.

2) As for the back seat row, a female passenger (67Kg) was occupying the right hand side window seat, and a male passenger (82Kg) was sitting on the left hand side window seat.

Considering the amount of fuel in the PR-JBN and the weight of the occupants, it is possible to conclude that the aircraft was within its weight and balance limits.

In these inspection flights, covering more than thirty areas, it was necessary to take pictures while the aircraft was flying over them and, therefore, the speed of the helicopter had to be reduced, so coordination was necessary between the passengers and the pilot.

Local people informed that they had seen the helicopter moving “from one side to the other” in a falling trajectory.

The passengers and the interviewed witnesses were lay people as far as aviation was concerned.

The passenger that had occupied the left front seat described that the aircraft assumed a nose-up attitude just after flying backwards in the pilot’s attempt to obtain a better sighting of the area, which was to the left of the aircraft.

This backward movement lasted a maximum of five seconds, according to the passenger. It was also reported that the pilot would have gotten frightened with the helicopter abrupt nose-up attitude.

Soon after the helicopter assumed a nose-down position, a new nose-up attitude followed, with a new descending attitude and with the pilot warning that collision was imminent.

The back-seat passengers later informed that they did no notice any sound warning in the aircraft, while the front seat passenger reported having heard an alert, although he was not able to describe it accurately.

The analysis of photographs and videos recovered from the camera used by the front seat passenger revealed that the altitude of the flight was approximately 200ft above the ground.

Figure 2 – Photograph taken by the passenger sitting on the front left seat aboard the PR-JBN, moments before the impact.

In the BELL 206 flight manual, the manufacturer warns of a critical wind quadrant relative to the plane of the main rotor.

According to the manual, the drag induced by the main rotor should be observed in relation to the prevailing wind, which would turn out to be a relevant circumstance if one considered a hover flight.

With the main rotor rotating in a counterclockwise direction, such quadrant was to the right of the aircraft, from the bearing 050º (relative to the aircraft heading) to the bearing 210º.

According to the passengers, in the last segment of the flight moments before the accident, the aircraft was flying in a northerly direction, and the pilot was asked by the team of passengers about the possibility of a better sighting of the terrain that had just been left behind and to the left. That was when the backward flight was executed.

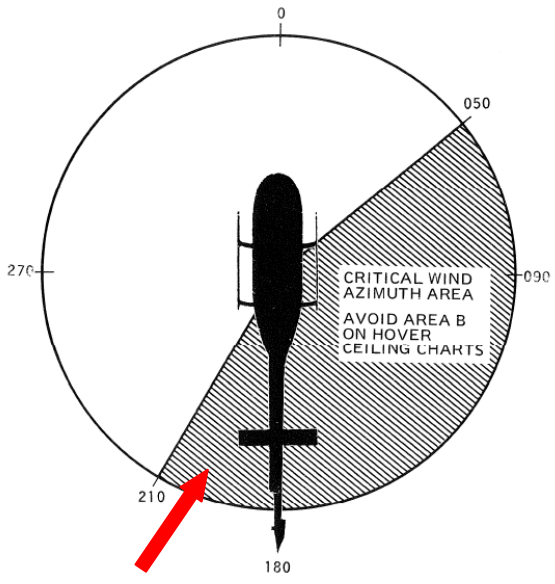

Figure 3 - Bell 206B Flight Manual, with the critical wind quadrant.

In this type of flight, one has to consider the ground effect issue since the aircraft was flying and would sometimes hover at an altitude of approximately 200ft, that is, outside the ground effect.

Therefore, the graphics to be consulted for the analysis of the helicopter performance are related to the out-of-ground-effect flight, in which lift tends to deteriorate if compared with a hover in-ground-effect flight.

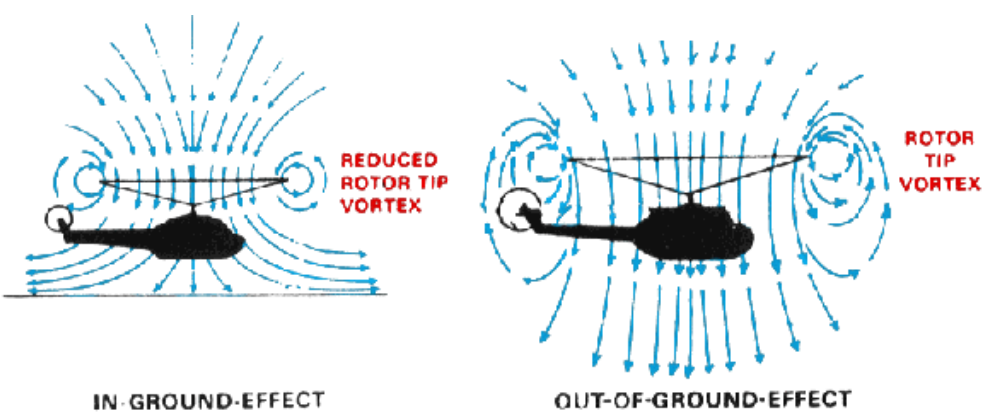

Figure 4 – Helicopter in- and out-of-ground-effect.

In hover flights with that profile, the following parameters would be observed at the time of the occurrence:

1) Estimate helicopter weight: 1,320kg (2,910lb);

2) Pressure altitude: approximately 2,500ft;

3) Outside air temperature: approximately 22ºC.

By referring to the Flight Manual graph *Hover Ceiling – Out of Ground Effect*, it is possible to observe that the helicopter (weight of 2,910lb) was at its operational limit for a hover flight in those circumstances.

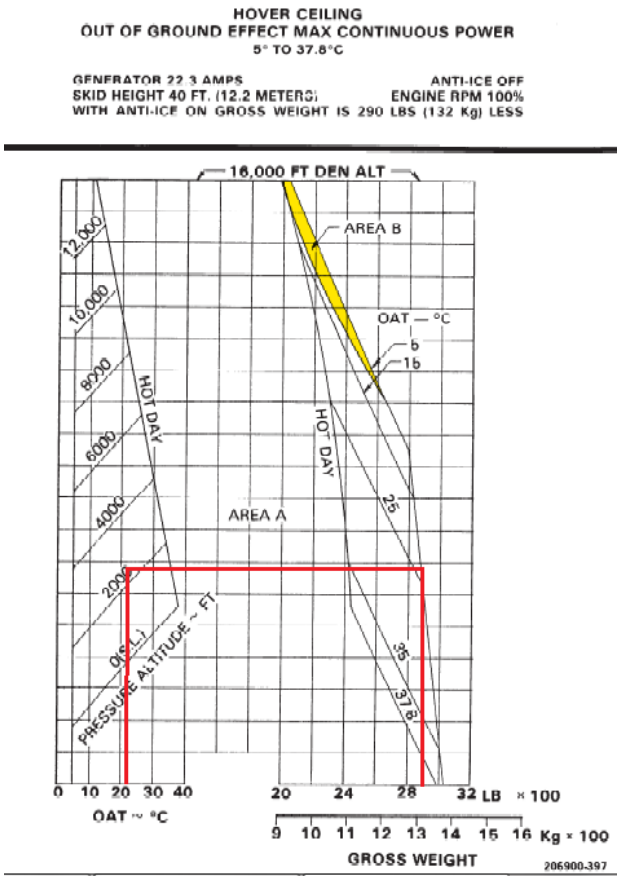

Figure 5 – Graph of a hover flight out of ground effect, with red lines indicating the situation of the PR-JBN.

The Federal Aviation Administration (FAA) Helicopter Flying Handbook, a recognized publication of helicopter operation techniques, had the following recommendation relative to a backward flight:

Pilots must do a thorough scan of the area before attempting to hover rearward, looking for obstacles and terrain changes. Slower airspeeds can help mitigate risk (…).

The pilot had a total of 600 flight hours, with approximately 100 hours in this type of helicopter. He had previously flown conventional reciprocating-engine helicopters (Robinson R-22 and R-44).

His transition for the Bell 206 helicopter was made approximately eleven months before the accident, between the days 6 and 14 of February 2012.

The pilot had been flying this type of helicopter since November 2013 on a daily basis, together with a Robinson R-44 model.

1.19 Additional information

The RBHA 91 (General Rules for the Operation of Civil Aircraft), section 91.119 prescribes the following minimum altitude for overflights:

91.119 – MINIMUM SAFE ALTITUDES; GENERAL

Except when necessary for takeoffs or landings, no person is allowed to operate an aircraft below the following altitudes:

(a) An altitude that permits, in case of engine failure, the aircraft to make an emergency landing without undue risks to persons and property on the ground.

(b) Over a densely populated area. Over any densely populated area of a city or over any group of people gathered out of doors, an altitude of 1,000ft (300m) above the highest obstacle within a horizontal radius of 2,000ft (600m) around the aircraft.

(c) Over areas not densely populated. An altitude of 500ft (150m) above the ground, except over open water surfaces or over scarcely populated areas. In these latter cases, the aircraft cannot be operated at a distance of less than 500ft (150m) from any person, boat, vehicle or structure.

(d) Helicopters are allowed to be operated below the minima established in the paragraphs (b) and (c) of this section if the operation is conducted without risk for people and property on the ground. Additionally, any person operating a helicopter must comply with any routes or altitudes specifically established by the aeronautical authority having jurisdiction over the area of operation."

The Ordinance nº 18/GM5 of 14 February 1974, listed the provisions established for the operation of helicopters. This publication, as well as the one described previously, had coherence with the ICA 1-12 (Rules of the Air and Air Traffic Services).

Part III Special Air Traffic Rules for Helicopters

2.0 – VISUAL FLIGHT RULES

The operation of a helicopter shall obey the following visual flight rules:

a – fly during daytime or, if during nighttime, fly within specified airspace;

b – Maintain inflight visibility conditions equal to or higher than 5Km, or according to prescriptions for the airspace specified;

c - Maintain visual reference with the ground or water, so that meteorological formations below the flight altitude do not obstruct more than 50% of the pilot's sight of the surface;

d - Maintain a distance of at least 1,500m horizontally and 150m vertically from clouds or meteorological formations of equivalent opacity (...)

7.0 – MINIMUM HEIGHT FOR LOCAL OR ENROUTE FLIGHTS

7.1 - Except for takeoff and landing operations, or when explicitly authorized, the minimum safe heights for helicopter flights are the following:

a – Over cities, villages, settlements, and groups of people out of doors: 300m above the highest obstacle within a radius of 600m around the aircraft;

b - Over areas other than the ones mentioned in "a": at a height equal to 150m or more above the ground or water.

7.2 - For flying below the minima established in this item, the pilot must be authorized by one of the following authorities:

a – Military helicopters:

Commanders of Brazilian Air Force Units to which they are subordinate;

b – Civil helicopters:

Directorate of Electronics and Flight Protection, for operations authorized by the DAC, or local ATS agency for contingent operations.

NB.: Such authorizations shall be preceded by consultation of the ATS Unit responsible for the airspace involved with the flights."

1.20 Utilization of other investigation techniques

Nil.

2 ANALYSIS

According to the 12 April 2013 Technical Report (RI APA 04/2013) issued by the Division of Aeronautical Propulsion of the Institute of Aeronautics and Space (IAE), the engine had integrity, and the ignition, feeding and lubrication systems were operating normally.

Samples of the fuel and hydraulic fluid were sent to the IAE for analysis. The Technical Report RE APA 17/2013 of 11 June 2013 concluded that both fluids met the prescribed specifications.

The analysis of the multiple-alert panel showed that the filaments were functioning normally with no indication of the illumination of any warning lights before the impact.

The Technical Report 22/AMR/2013 of 01 July 2013, relative to the analysis of three components of the tail rotor transmission (Disk Assy, Adapter and Driveshaft) concluded that the fracture occurred due to impact of the tail rotor shaft assembly, discarding the possibility of a transmission failure or even a tail rotor failure.

The integrity of the tail boom and tail rotor blades ruled out the possibility of a previous impact with obstacles.

According to the passengers, in the last segment of the flight, moments before the impact, the aircraft was flying in a northerly direction, and the pilot was consulted by the passengers on the possibility of a better sighting of the terrain that had just been left behind and to the left.

In that situation, the pilot did not consider the possibility of turning to the left (which would be the safest and most adequate maneuver) and chose to fly backwards in order to reach the new position more quickly, thus facilitating the work to be done by the technical team aboard the aircraft.

Upon consultation to the Flight Manual graph *Hover Ceiling – Out of Ground Effect*, it was possible to observe that the helicopter was at the operational limit for a hover flight out of ground effect in those circumstances, if one considered the helicopter weight of 2,910lb on the occasion.

The weather information relative to SBMT (located at a distance of 6.5 miles southeast), had winds from 210º (red arrow in Figure 3) at 7kt.

With the counterclockwise rotation of the main rotor, such quadrant was to the right hand side of the aircraft, from a bearing 050º up to 210º.

Flying backwards while facing a northerly direction, with a predominant wind coming from 210º, put the aircraft in a critical wind quadrant, a situation that had to be avoided, according to the aircraft manufacturer.

These combined factors during the backward flying left the aircraft in a critical aerodynamic condition, which resulted in loss of lift.

The pilot, in turn, in an attempt to recover, applied the cyclic forward and the collective downward in order to regain speed and lift.

Since the pilot did not succeed in the maneuver, and due to his loss of altitude and ground proximity, he once more applied the cyclic backwards in order to reduce the rate of descent. Because his altitude was not sufficient, the aircraft collided with obstacles.

It is possible that his non-compliance with the safety parameters concerning the maintenance of a minimum altitude while flying over areas of high and low demographic density made it difficult for him to adopt an appropriate maneuver aimed at the reestablishment of a sustained flight.

3 CONCLUSIONS

3.1 Facts

a) the pilot had a valid aeronautical medical certificate;

b) the pilot had a valid technical qualification certificate;

c) the pilot had proper qualification and experience for the flight;

d) the aircraft had a valid airworthiness certificate;

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

f) the aircraft departed from SDNP, with a pilot and three passengers on board, destined for the northwest sector of SBMT, with the objective of flying over an area located at a distance of approximately six nautical miles from SBMT;

g) the prevailing weather conditions were VMC, and the forecast time of flight was one hour and thirty minutes;

h) according to the results of technical analyses, all aircraft systems were operating normally at the moment of the accident;

i) the pilot was flying at low altitude in order to inspect the selected areas of land;

j) in the last segment of the flight, with the aircraft traveling in a northerly direction, the pilot was consulted by the team of passengers on the possibility of a better sighting of the terrain that had just been left behind and to the left;

k) in order to have the area of land in sight again, the pilot flew backwards for some distance, with the helicopter presenting a high angle of attack, in a pitch-up attitude;

l) subsequently, a loss of lift was perceived, together with a descending maneuver, as a way to regain airspeed;

m) a few seconds later, there was a new nose-up attitude and a new descending maneuver, followed by a warning by the pilot that collision was imminent.

n) the first impact of the aircraft was with low tension electric wires and, shortly after, with the roofs and concrete slabs of three houses;

o) the aircraft was substantially damaged; and

p) The pilot perished in the crash. Two passengers sustained serious, and the third one received minor injuries.

3.2 Contributing factors

3.2.1 Human Factor

3.2.1.1 Medical Aspect

Not a contributor.

3.2.1.2 Psychological Aspect

3.2.1.2.1 Individual information

Not a contributor.

3.2.1.2.2 Psychosocial information

Not a contributor.

3.2.1.2.3 Organizational information

Not a contributor.

3.2.2 Operational Factor

3.2.2.1 Concerning the operation of the aircraft

a) Pilot judgment – a contributor

The pilot disregarded the possibility of turning to the left, a maneuver that would be safest and most adequate, and chose to fly backwards without taking into account the wind coming from 210º, thus placing the aircraft in a critical quadrant (a situation to be avoided, according to the aircraft manufacturer).

b) Flight planning – a contributor

Before the flight, there was neither a coordination meeting nor a briefing with the passengers for detailing the flight and safety-related aspects.

3.2.2.2 Concerning ATS units

Not a contributor.

3.2.3 Material Factor

3.2.3.1 Concerning the aircraft

Not a contributor.

3.2.3.2 Concerning ATS technology systems and equipment

Not a contributor.

4 SAFETY RECOMMENDATION

A safety recommendation is the establishment of an action which the Aeronautical Authority or SIPAER-Link issues to their respective area of responsibility, aiming at eliminating or mitigating the risk of a latent condition or the consequence of an active failure.

From a SIPAER perspective, a safety recommendation is essential for the safety of flight, refers to a specific hazard, and has to be complied with by a certain deadline.

Safety Recommendations made by the CENIPA:

To the National Civil Aviation Agency (ANAC):

A-010/CENIPA/2013 – 001 **Issued on 26/05/2014**

Publicize the contents of this report at seminars, lectures and like activities prepared for rotary-wing aircraft owners, operators and explorers.

5 CORRECTIVE/PREVENTATIVE ACTION ALREADY TAKEN

Nil.

6 DISSEMINATION

- National Transportation Safety Board (NTSB)
- Transportation Safety Board of Canada (TSB)
- National Civil Aviation Agency (ANAC)
- Brazilian Helicopter Pilots Association (ABRAPHE)
- *Helimarte Táxi-Aéreo Ltda*.
- SERIPA IV

7 APPENDICES

Nil.

On 26 / May / 2014.