COMANDO DA AERONÁUTICA

CENTRO DE INVESTIGAÇÃO E PREVENÇÃO DE ACIDENTES AERONÁUTICOS

FINAL REPORT
A-157/CENIPA/2018

OCCURRENCE:	ACCIDENT
AIRCRAFT:	PR-PMT
MODEL:	A109E
DATE:	11OUT2018

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 considering 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 distinct 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 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. Considering 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 11Oct2018 accident involving the A109E aircraft, registration PR-PMT. The occurrence was typified as "[LOC-I] Loss of control in flight" and "[ARC] Abnormal contact with the runway".

The helicopter was about to complete the approach for landing in SJNN (*Iporanga-Guarujá* Helipad, municipality of *Guarujá*, SP), when it lost height in an abnormal fashion, and ended up colliding with the ground.

The aircraft sustained substantial damage.

None of the aircraft occupants was injured.

Canada (State of engine manufacture) and Italy (State of aircraft manufacture) designated accredited representatives, respectively from the Transportation Safety Board (TSB) and *Agenzia Nazionale per* la *Sicurezza del Volo* (ANSV), for participation in the investigation of the accident.

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GLOSSARY OF TECHNICAL TERMS AND ABBREVIATIONS

ANAC	Brazil's National Civil Aviation Agency
ANSV	Italy's *Agenzia Nazionale per la Sicurezza del Volo*
BKN	Broken clouds (5 to 7 oktas)
BR	Mist
CG	Center of Gravity
CIV	Pilot Logbook
CMA	Aeronautical Medical Certificate
CVR	Cockpit Voice Recorder
CTP	Main Gear Box
DB	Aircraft Logbook
DZ	Drizzle
EASA	European Union Aviation Safety Agency
FAA	Federal Aviation Administration (USA)
FEW	Few clouds (1 and 2 oktas)
FL	Flight Level
HOGE	Hover Out of Ground Effect
IAE	Brazil's Institute of Aeronautics and Space
IAM	Annual Maintenance Inspection
IAS	Indicated Air Speed
IFRH	IFR Flight Rating – Helicopter category
IMC	Instrument Meteorological Conditions
INVH	Flight Instructor License – Helicopter category
MCA	Manual of the Command of Aeronautics (Brazil)
METAR	Meteorological Aerodrome Report
MTOW	Maximum Takeoff Weight
HMLT	Multi-Engine Turbine Helicopter Rating
IGE	In Ground Effect
OGE	Out Of Ground Effect
OM	Maintenance Organization
OVC	Overcast (8 oktas)
P&WC	Pratt & Whitney Canada
PIC	Pilot in Command
PCH	Commercial Pilot License – Helicopter category
PLH	Airline Transport Pilot License – Helicopter category
PPH	Private Pilot License – Helicopter category

RA	Rain
RBAC	Brazilian Civil Aviation Regulation
RBHA	Brazilian Aeronautical Certification Regulation
RFM	Rotorcraft Flight Manual
SBST	ICAO Location designator – *Santos* aerodrome, State of *São Paulo*
SC	Stratocumulus cloud
SCT	Scattered clouds (3 and 4 oktas)
SDPT	ICAO Location designator – *Parque Paulista* Helipad, *São Paulo*, SP
SGSO	Operational Safety Management System
SH	Showers
SIAV	ICAO Location designator – *Helipark* Helipad, *Carapicuíba*, SP
SIC	Second in Command
SIGWX	Significant-Weather Chart
SJNN	ICAO Location designator – *Iporanga-Guarujá* Helipad, SP
SN	Serial Number
ST	Stratus cloud
TCU	Towering-Cumulus cloud
TPP	Private Aircraft Registration – Private Air Services
TSB	Transportation Safety Board - Canada
UTC	Universal Time Coordinated
VFR	Visual Flight Rules
VMC	Visual Meteorological Conditions
VRS	Vortex Ring State

1. FACTUAL INFORMATION.

Aircraft	**Model:** A109E **Registration:** PR-PMT **Manufacturer:** *Agusta Westland*	**Operator:** *Band Participações e Gestão Ltda.*
Occurrence	**Date/time**: 11OUT2018 - 21:00 (UTC) **Location:** SJNN (*Iporanga-Guarujá* Helipad) **Lat.** 23°53’17”S **Long.** 046°10’18”W **Municipality – State:** Guarujá - SP	**Type(s):** [LOC-I] Loss of control - inflight [ARC] Abnormal runway contact

1.1. History of the flight.

At about 20:30 UTC, the aircraft took off from SDPT (*Parque Paulista* Helipad, *São Paulo*, SP), destined to SJNN (*Iporanga-Guarujá* Helipad, *Guarujá*, SP) on a private flight for passenger transport, with two crew and five passengers on board.

At the final phase of the approach maneuver to land on the helipad, the helicopter lost height in an abnormal way, and crashed into the ground.

Figure 1 - View of the PR-PMT at the accident site.

The aircraft sustained substantial damage. Neither the crew nor the passengers were injured.

1.2. Injuries to persons.

Injuries	Crew	Passengers	Others
Fatal	-	-	-
Serious	-	-	-
Minor	-	-	-
None	2	5	-

1.3. Damage to the aircraft.

The main rotor blades hit the ground, resulting in breakage of the blade connections close to the rotor head.

In addition, the left main landing gear broke up, the fuselage sustained damage, especially to its underside, and the tail boom suffered perforation.

1.4. Other damage.

There was damage to the helipad's beaconing system (Figure 2).

Figure 2 - Damage to the helipad beaconing.

1.5. Personnel information.

1.5.1. Crew's flight experience.

Flight Experience		
	PIC	SIC
Total	6.000:00	495:00
Total in the last 30 days	02:30	02:30
Total in the last 24 hours	00:40	00:40
In this type of aircraft	2.000:00	200:00
In this type in the last 30 days	02:30	02:30
In this type in the last 24 hours	00:40	00:40

NB.: Information on the hours flown by the crew was obtained by means of the pilots' Individual Digital Logbook (CIV). The total flight-hour information was gathered through reports from the crew.

1.5.2. Personnel training.

The PIC (Pilot-in-Command) did the Private Pilot - Helicopter (PPH) course in 1984, at the *Escola Santana de Pilotagem*, a flying school located in *São Paulo*, State of *São Paulo*.

The Second in Command (SIC) did his PPH course in 2011, at the Unifly *Escola de Pilotagem*, a flying school located in the municipality of *Arujá*, SP.

1.5.3. Category of licenses and validity of certificates.

The PIC held a PLH license (Airline Transport Pilot - Helicopter category), besides valid ratings for HMLT (Multi-Engine Turbine Helicopter), IFRH (IFR Flight – Helicopter category), and INVH (Flight Instructor - Helicopter category).

The SIC held a PCH (Commercial Pilot license - Helicopter category) and also a valid HMLT license.

1.5.4. Qualification and flight experience.

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

1.5.5. Validity of medical certificate.

The pilots held valid Aeronautical Medical Certificates (CMA).

1.6. Aircraft information.

The Serial Number 11101 A109E aircraft, equipped with an articulated rotor, was manufactured in 2000 by Agusta Westland, and was registered in the Private Registration Category - Private Air Services (TPP).

The Airworthiness Certificate (CA) was valid.

The records of the airframe and engine logbooks were up to date.

The last inspections of the aircraft, types "Annual Maintenance Inspection (IAM)" and "200 hours / 12 months of airframe", were completed on 10Oct2018, on the day before the occurrence. The inspections were performed by the *Helipark Táxi Aéreo e Importação Aeronáutica Ltda.* Maintenance Organization (OM), located in the municipality of *Carapicuíba*, SP. The aircraft flew 40 minutes after the inspections.

Among the services performed by the OM, was the replacement of the aircraft fuel tanks cells, after a complaint presented by the owner regarding the presence of fuel odor in the passenger cabin. According to the OM, that was due to a natural process of wear of the aircraft tanks, which allowed fuel vapor to escape.

Two test flights were performed after the inspection for verification of whether the aircraft could be released for return to flight. Both tests flights were flown by the same crew of the occurrence flight.

On the first test flight, the crew reported a pitch-control discrepancy. According to their report, there was "some looseness in the cyclic", something that had been reported previously to the maintenance inspection team. After the flight, the OM worked to solve the problem, and released the aircraft for a new verification.

On the other hand, in the parts I and II of the airframe logbook, there were records of all the repairs and replacements performed during the inspection, including those related to the aircraft pitch-control system. Even so, no details were given of such interventions capable of clarifying whether they were made before or after the pilots complained on the occasion of the first test flight (looseness in the cyclic).

1.7. Meteorological information.

The location of the occurrence had no meteorological services available.

The sunset time in Santos was 21:10 UTC.

The 21:02 UTC SIGWX (Significant-Weather Chart) of 11Oct2018 (approximately the same time of the occurrence, and valid until 12:00 UTC of 12Oct2018) indicated the presence of a frontal system over the ocean.

This system indicated the possibility of the occurrence of the following meteorological phenomena at the destination:

- Stratus cloud layer (ST) with coverage of 5 to 7 oktas (BKN), between levels FL010 and FL015;
- Stratocumulus cloud layer (SC) with coverage of 5 to 7 oktas (BKN), between FL015 and FL060;
- Towering-Cumulus clouds (TCU) with coverage of 1 to 2 oktas (FEW), and developing between levels FL025 and FL210;
- Rain (RA) and Showers (SHRA), among other phenomena (Figure 3).

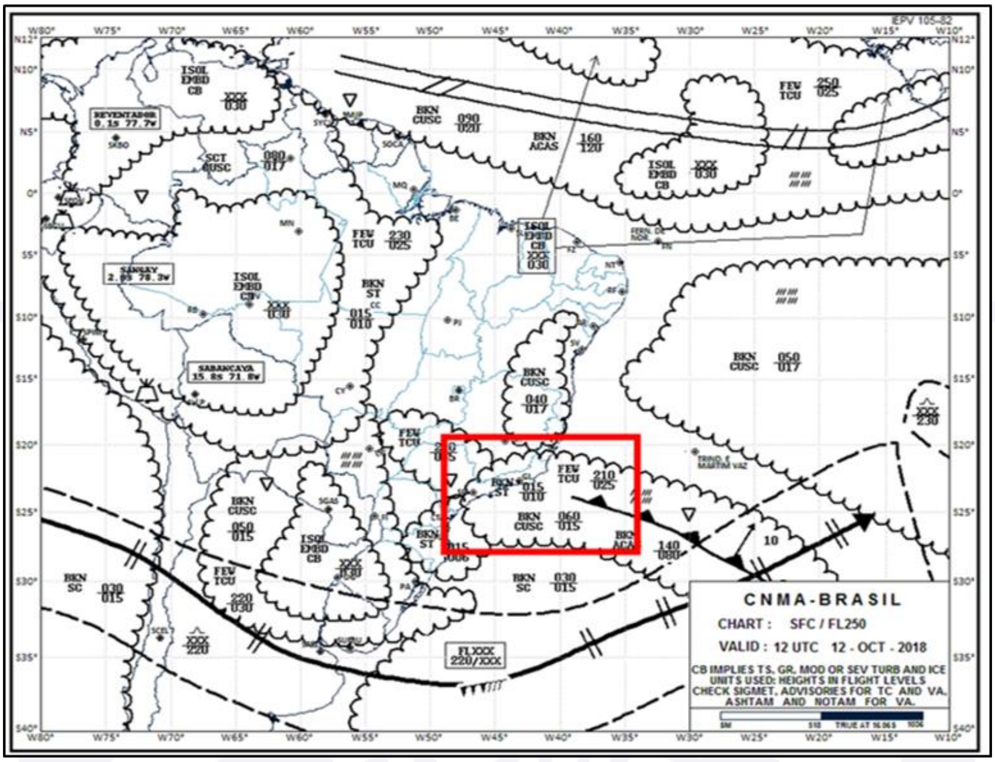

Figure 3 - SIGWX chart valid until 12 Oct 2018 (12:00 UTC). Source: REDEMET.

The 11Oct2018 21:00UTC METAR of SBST* (*located in Guarujá, at a distance of 7NM from the landing site of the occurrence), contained the following information:

METAR SBST 112100Z 19007KT 2000 - DZ BR BKN007 OVC009 20/20 Q1018.

Wind direction 190°, wind speed 7 kt., visibility 2,000 meters, drizzle (DZ), mist (BR), cloud cover (BKN) at 700 ft. AGL, and overcast (OVC) at 900 ft. AGL.

The crew reported the presence of rain in the vertical of SJNN, cloud cover below the height of the hills forming the valley, moderate turbulence and zero-knot landing wind (estimated).

The region around the destination helipad was conducive to the formation of orographic turbulence.

About the subject, the Chapter 12 - Weather Theory of the Federal Aviation Administration (FAA), stated that while the wind flows smoothly through the windward side of the mountain, and the updrafts help to carry an aircraft above the mountain peak, the leeward wind doesn't work the same way. As the air flows to the leeward side of the mountain, the air following the contour of the land is increasingly turbulent. This tends to push an aircraft down. The stronger the wind, the greater the descending rate and the intensity of the turbulence (Figure 4).

Figure 4 - Turbulence in a mountainous region.
Source: adapted from Chapter 12 - Weather Theory - FAA.

Due to the effect that terrain has on the wind in valleys or canyons, downdrafts can be severe. Before performing a flight in or near mountainous terrain, it is recommended that a pilot, unfamiliar with operation in a mountainous area, perform an instructional flight with a qualified flight instructor.

The Instruction of the Command of Aeronautics (ICA) 100-4, Special Air Traffic Rules and Procedures for Helicopters, in effect at the time, established that:

> 3 VISUAL FLIGHT RULES
>
> 3.1 GENERAL CRITERIA
>
> 3.1.1 Within controlled airspace, a VFR helicopter flight will only take place when, simultaneously and continuously, the following conditions are met:
>
> a) Remain in flight visibility conditions equal to, or greater than, 3,000 meters;
>
> b) Remain at least 1,500 meters horizontally and 500 ft. vertically from clouds or any other meteorological formation of equivalent opacity; and
>
> c) Maintain reference with ground or water, so that meteorological formations, below the flight level, do not obstruct more than half of the pilot's vision area.
>
> 3.1.2 Outside controlled airspace, above 3,000 ft. of altitude or 1,000 ft. of height above the terrain, whichever is greater, the helicopter VFR flight will only be conducted when, simultaneously and continuously, the following conditions can be met:
>
> a) Remain in flight visibility conditions equal to, or greater than, 3,000 meters;
>
> b) Remain at least 1,500 meters horizontally and 500 ft. vertically from clouds or any other meteorological formation of equivalent opacity; and
>
> c) Maintain reference with ground or water, so that meteorological formations, below the flight level, do not obstruct more than half of the pilot's vision area.
>
> 3.1.3 Outside controlled airspace, below 3,000 ft. of altitude or 1,000 ft. of height above the terrain, whichever is greater, the helicopter VFR flight by will only conducted when, simultaneously and continuously, the following conditions can be met:
>
> a) Remain in flight visibility conditions equal to or greater than 1000 m, provided that the flight speed is sufficient to be seen and avoid traffic or any obstacle with enough time to prevent a collision; and
>
> . b) Stay clear of clouds and maintain reference to ground or water.

1.8. Aids to navigation.

NIL.

1.9. Communications.

There were no technical abnormalities in the communication equipment during the flight.

1.10. Aerodrome information.

SJNN is a private Helipad, with dimensions of 21 m x 21 m, at an elevation of 30 ft., operated under Visual Flight Rules (VFR), during daytime and night-time.

The geographic characteristics around the helipad pose restrictions to the direction of the approach axis, making it difficult to go around, on account of elevations in the terrain. The approach was to be conducted, as a priority, via the southwest sector.

Around the helipad, there were the following features: a canal in front of the landing area, a road in the background, a row of trees on the left side, and a helicopter parking area on the right.

After the road (rear limit), in the extension of the approach axis, there was an elevation approximately 200 meters high (a hill between the helipad and the coastline) (Figure 5).

Figure 5 - View of the obstacles around the helipad, in the direction of approach
Source: adapted from Google Earth.

Preceding the canal in the direction of approach, there was high terrain (part of the *Serra do Mar* mountain range), demanding that the approach for landing be carried out from the inside of the valley, but in a direction perpendicular to it (Figure 6).

Figure 6 - Side view of the approach performed by the PR-PMT.
Source: adapted from Google Earth.

1.11. Flight recorders.

Neither required nor installed.

1.12. Wreckage and impact information.

The aircraft was approaching the helipad at a rather high rate of descent, with the fuselage slightly banked to the right relatively to the direction of landing. Its first contact of the aircraft with the ground occurred when, close to the landing spot, its left main landing gear hit a grassy area slightly higher than the level of the canal.

The left landing gear broke, and there was contact of the main rotor with the ground. The aircraft rotated around its vertical axis in a counterclockwise direction while maintaining a short forward displacement, until coming to a stop on the left side of the helipad. In this process, there was a heading variation of approximately 135° in relation to the direction of approach.

All main rotor blades were severely damaged, and there was significant twisting of the airframe, evidenced by misalignment of the doors. The tail boom suffered a perforation caused by material detached from the main rotor (Figure 7).

Figure 7 - View of the damage to the main rotor blades.

1.13. Medical and pathological information.

1.13.1. Medical aspects.

There was no evidence that physiological or disability issues might have affected the crew's performance.

1.13.2. Ergonomic information.

NIL.

1.13.3. Psychological aspects.

The PIC had been in the aviation industry for 26 years, and had extensive experience on the accident aircraft and on the flight route. He considered himself a professional who valued flight safety.

For a year and two months, he had been working for the aircraft owner. He said that, before the flight, he had told the owner that the moment chosen for the flight was not the best on account of weather along the route. However, the owner called several times saying that the flight would have to take place because of the flight hours that he owed to the company managing the fleet-sharing program (as detailed in item 1.17 - Organizational and management information).

According to the PIC, that type of service, namely, flying in degraded weather, was frequent in the executive aviation. Even though feeling uncomfortable, he decided to conduct the flight for fear of losing his job.

The pilots participated in all the operational tasks before the flight, including the test flight for the aircraft to be released by the maintenance organization, where it remained for two months. Throughout that process, the owner stressed that the flight had to take place.

The PIC declared that he was not experiencing any personal, family and/or social problems, and that he had not faced anything related to his physical or mental health in recent months. He informed that he had not flown for more than a month. However, he was happy to have returned that day. In his routine, he didn't use to fly every day.

The SIC, who had 200 flight hours on the aircraft model, reported having good cockpit management with the PIC, and that, as a pilot, he valued flight safety. He reported to be doing well with his family, and was not experiencing any personal or family conflicts.

1.14. Fire.

There was no fire.

1.15. Survival aspects.

The crew and passengers managed to leave the aircraft on their own.

1.16. Tests and research.

After the accident, two samples of aviation kerosene and lubricating oil were sent to the Aeronautical Propulsion Subdivision (APR-A), of the Institute of Aeronautics and Space (IAE).

The results obtained in the physicochemical tests of the two aviation kerosene samples were compatible with their specification, and did not show any signs of contamination. The results obtained in the viscosity test at 100ºC of the “oil sample-2” revealed that it was slightly above its specification. The analysis did not indicate any contribution of that factor to the occurrence in question.

The aircraft fuel system was also tested for detection of any interruption in the flow of fuel to the engines. The investigation committee did not find out any abnormalities with the fuel lines and fuel flow.

In the same way, at the *Leonardo* Company, in *Osasco*, SP, the Main Gear Box (CTP) equipping the aircraft was disassembled, and its components were analyzed internally for detection of malfunctions that could have interfered in the transmission of engine rotation to the main rotor.

The internal parts of the CTP seemed to be in good condition, with no visual damage. The component had oil without apparent degradation, and the O-rings were intact. No filings were found in the detectors. There were no aspects present in the CTP that might have contributed to the occurrence.

The PW206C engines (SN: PCE-BC0212 and SN PCE-BC0211) of the PR-PMT were removed and shipped to the P&WC Service Center in Saint-Hubert, Quebec, Canada, where they were inspected and tested in the presence of representatives of the engine manufacturer and of the TSB.

Visual and borescope inspections of both engines, BC0211 and BC0212, showed no anomalies. There was no evidence of damage to the engines inspected.

In the test bench analysis, the engines did not show abnormalities in the various power regimes to which they were submitted.

Therefore, the results of the tests, research and exams led the investigators to conclude that there was no evidence of any problems or abnormalities during the flight being analyzed in this investigation.

1.17. Organizational and management information.

The aircraft operated under the rules of the Private Air Services category. Most flights were engaged in trips of the owner or people close to him. The profile of flights prior to the accident had been almost always the same: few passengers (two or three), with the aircraft operating within its weight and balance limits.

The aircraft remained not available for a period of approximately seventy days for replacement of the fuel tanks and provision of scheduled maintenance.

During the period of unavailability, the owner of the aircraft joined a fleet-sharing program, and started making his trips on other aircraft.

At the end of that time interval, the owner would reimburse the sharing program for the hours eventually flown by him on other aircraft of the program.

At the time of the accident, there were no requirements established by the Regulatory Agency for shared-ownership aircraft operations. Only on 11Feb2021, through the Resolution nº 606, was the subject included in the Brazilian Civil Aviation Regulation (RBAC) nº 91, Subpart K, which established the requirements for this type of operation:

> 91.1009 Clarification on operational control
>
> (a) The operational control is always exercised by the program manager, who must be listed as operator of the aircraft included in the program before the RAB, even when the flight is being conducted for the benefit of a shareholder.

The Subpart K also defined the requirements for the implementation of the Operational Safety Management System (SGSO) in companies conducting that type of operation, increasing the operational safety of flights with shared-ownership aircraft.

Thus, within the fleet-sharing program, the first flight was scheduled for a holiday eve (extended weekend). In view of that flight, it was necessary for the aircraft to be released by the OM, a condition that included being approved in the test flight.

It was reported that the owner of the aircraft was committed to ensuring that the final stages of the maintenance process would not extend beyond schedule, so as not to disrupt the scheduled flight.

The aircraft was approved in the last of the test flights, and completed the maintenance process one day before the date of the scheduled flight.

According to the PIC, the great emphasis given by the aircraft owner to the importance of accomplishing the compensation flight for the benefit of the sharing program may have contributed to the acceptance of the aircraft on the test flight, without, in his opinion, completely solving the pitch-control issue.

On the following day, the aircraft took off from SIAV bound for SDPT, where passengers embarked for the occurrence flight: a family of five people and two medium-sized pets.

Again, it was reported that the aircraft owner constantly expressed his desire that the flight in question, the first one for the benefit of other participants in the fleet-sharing program, not suffer any delay/cancellation capable of jeopardizing his (the owner's) commitment with the company in charge of the program management.

All the planning and operational demands concerning the flight were transmitted by the aircraft owner directly to the pilots. The crew only became aware of the exact number of passengers at the boarding for the flight.

1.18. Operational information.

The aircraft performed a VFR flight of approximately thirty minutes between the cities of São Paulo and Guarujá, along helicopter flight routes between the two locations. A portion of the flight was flown under Instrument Meteorological Conditions (IMC). While the helicopter was descending to the destination and flying over the sea, Visual Meteorological Conditions (VMC) were reestablished.

The aircraft entered the region of the valley flying along the course of the canal at the prescribed height of the traffic circuit (500 ft. AGL) until getting to the helipad.

The approach was flown in the approximate azimuth of 200° at a speed lower than the one prescribed (about 30 kt), on account of the light rain that was falling at the time. The crew performed all the necessary checks before landing.

On the short final for landing, the crew noticed an abnormal control condition, along with a reduction of the noise generated by the rotor, and an abrupt descent of the aircraft.

The PIC reported his feeling that, at that moment, the forward speed of the aircraft had decreased, and the controls were “slow” (with a delayed response when compared with a normal flight condition). His reaction was to maintain the position of the collective, and to move the cyclic forward to increase speed and manage to reach the helipad, as he was still flying over the canal. When contact of the aircraft with the ground became imminent, he pulled the collective to its maximum amplitude, in an attempt to reduce the rate of descent.

The SIC reported having quickly checked the aircraft instruments, as well as the alarm panel, but did not notice any announced messages.

The aircraft struck the ground with its left main landing gear in a grassy area short of the helipad pavement, at a high rate of descent, with the fuselage slightly misaligned to the right, in relation to the direction of landing.

After the aircraft came to a stop, the instruments were checked anew, including the engine instruments. However, no abnormalities were noticed in the checked parameters, and there were no messages announced on the alarm and warning panels.

The crew performed the engine shutdown procedure, and evacuated the passengers from the aircraft.

According to the calculations made by the investigation committee (based on the data provided by the crew), the estimated aircraft takeoff-weight at the departure from SDPT was 2,966 kg, i.e. 116 kg above the Maximum Takeoff Weight (MTOW) of 2,850 kg, and outside of the Center of Gravity (CG) longitudinal limits.

Based on the fuel remaining in the tanks (248 kg), it was calculated that, at the time of the accident, the helicopter had a weight of 2,864 kg, that is, 14 kg above the weight limit, and still outside the longitudinal limits of the CG (Figure 8).

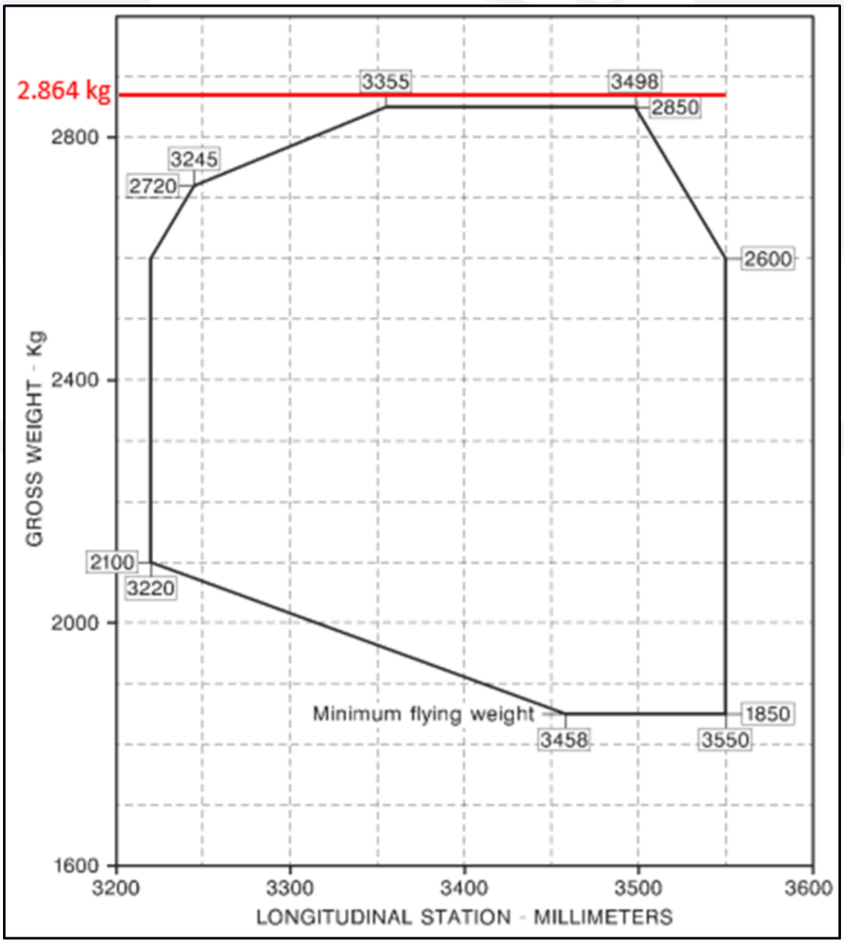

Figure 8 - A109E CG longitudinal limits.
Source: A109E Rotorcraft Flight Manual (RFM).

Therefore, the aircraft was above the weight limits, and outside the center of gravity limits both at the takeoff from SDPT and at the landing in SJNN.

By using the *Hovering ceiling - out of ground effect - take-off power* diagram, available on the page 4-14, Section 4 - Performance Data, of the Agusta-A109E-RFM, one concluded that the calculated weight of 2,864 kg at the time of landing, would be an indication that the PR-PMT performed the approach with 14 kg above the maximum landing weight limit.

For that purpose, the following parameters were considered: aircraft hovering outside of ground effect (OGE), pressure altitude of 90 ft., at an elevation of 30 ft. for SJNN, temperature 20° C, aircraft weight 2,864 kg , takeoff power, 102% rotor RPM, and zero wind (Figure 9).

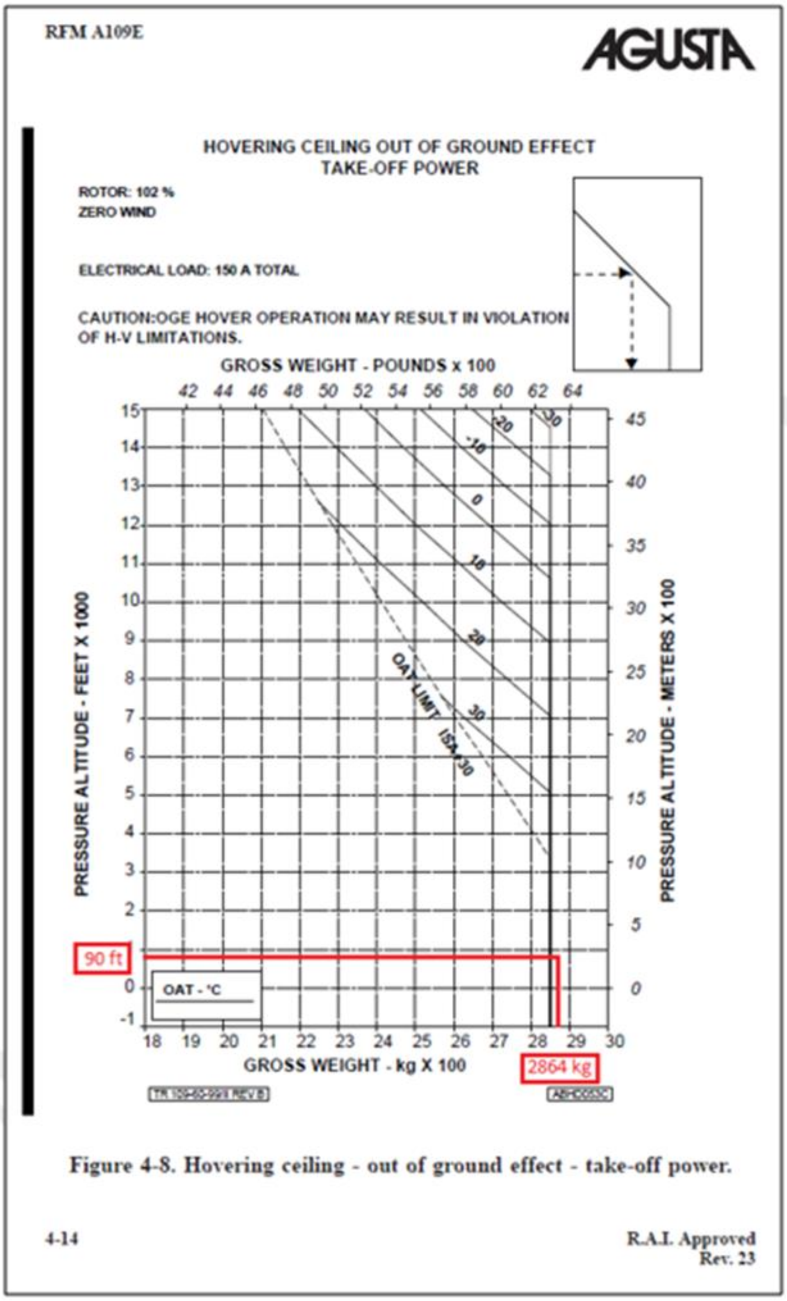

Figure 9 - PR-PMT OGE-Hovering Calculation for the time of occurrence.
Source: RFM A109E.

The analysis of the *Hovering ceiling - in ground effect - take-off power* diagram as per page 4-11 of Section 4 - Performance Data, for the Agusta-A109E-RFM, for a Hover Height Into Ground Effect (IGE) of 3 ft., considering a field elevation of 30 ft., also revealed that the landing attempt with aircraft weighing 2,864 kg, was performed in excess of the prescribed maximum landing weight (Figure 10).

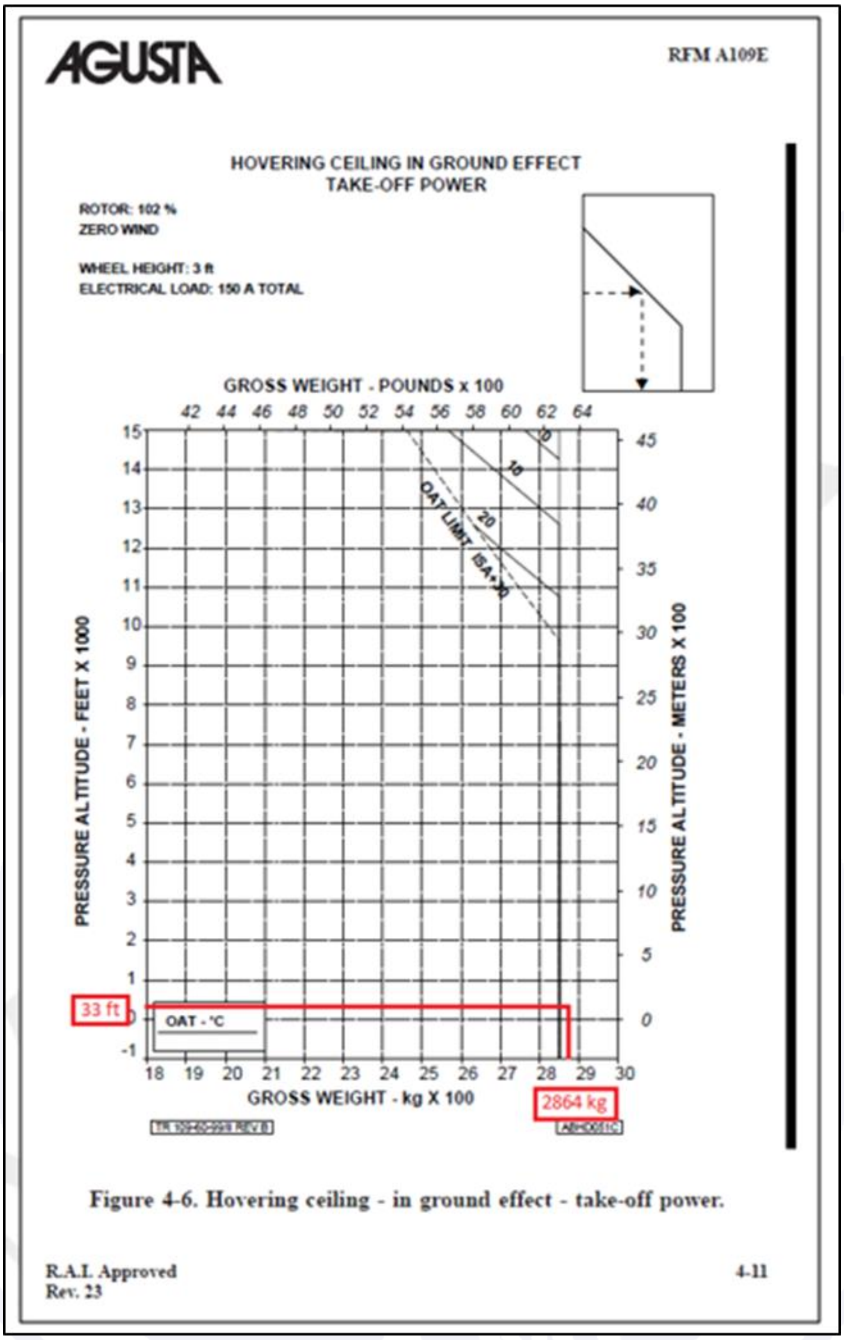

Figure 10 - PR-PMT IGE-hovering calculation for the time of occurrence.
Source: RFM A109E.

1.19. Additional information.

The Brazilian Aeronautical Homologation Regulation (RBHA) nº 91 - General Operating Rules for Civil Aircraft, in force on the date of the accident, established that:

> 91.7 - CIVIL AIRCRAFT AIRWORTHINESS
>
> (a) No person may operate a civil aircraft unless it is in an airworthy condition.
>
> (b) The pilot-in-command of a civil aircraft is responsible for checking the condition of the aircraft for a safe flight. He must discontinue the flight when maintenance or structural problems degrade the aircraft's airworthiness.

The Manual of the Command of Aeronautics (MCA) 3-6 - SIPAER Investigation Manual, 2017, in item 9.6.11.1.13 - Center of Gravity - CG stated that:

[...]

> Operating above the maximum weight compromises the structural integrity, and affects helicopter performance. Under certain flight conditions, the helicopter may not be able to fly with the maximum takeoff weight described in the manual. A few centimeters in the load distribution can cause significant changes in the aircraft's CG, with influence on the piloting. Helicopters have a maximum weight per floor area, which is limited by the aircraft structure, and some have the ability to operate with external loads, increasing the maximum operating weight.

Elsewhere, the Manual stated that:

[...]

> In fully-articulated-rotor helicopters, the CG shift is more limited, but not as restricted as in semi-rigid rotors, which have a very small CG shift. These rotors have a longitudinal CG shift longer than the lateral CG shift, and the CG is affected by the distribution of crew, passengers, cargo and fuel consumption during flight.

[...]

. The MCA warned that operating above the maximum weight could result in structural deformation or failure, as well as subjecting the helicopter to excessive load factors. Wind gusts and turbulence can also cause structural damage.

Also, according to the publication:

[...]

> Inappropriate or poorly distributed loading also decreases aircraft maneuverability. The cyclic control is less effective in the opposite direction of the CG position. When the CG is exactly vertical to the mast, the helicopter tends to keep the nose in a horizontal position.

Finally, the manual made considerations about the CG shift, and its implications in the operation of the helicopter:

> If the CG moves forward from the mast, the nose of the aircraft tends to lower. A very heavy pilot, or lack of weight in the region behind the mast, can push the CG forward. At high speeds, this situation can be undesirable, leading the helicopter to increase its speed more and more.
>
> If the fuel tanks are located behind the mast, the weight in the rear region of the aircraft will decrease as fuel is consumed, moving the CG further forward and further restricting rearward cyclic control authority.
>
> The forward CG can reach such a high value that, even moving the cyclic fully backwards, it is impossible to stop the aircraft. If this situation occurs during an autorotation, the pilot may not have sufficient cyclic control authority to safely flare, which would limit the position of the longitudinal CG during the certification process. Strong winds can mask a forward CG situation, so it is essential to assess the wind direction and intensity and its relationship to aft cyclic control authority.
>
> If the CG is too far behind the mast, the nose will tend to rise. An exaggerated astern CG condition may make it impossible to maintain a given forward speed due to restrictions on the cyclic control authority to maintain a nose down attitude.

With regard to weight and balance, it should be noted that the control thereof is the responsibility of the operator.

Operating a helicopter above the maximum weight can compromise its performance, in the same way that changes in the load distribution can cause significant changes in the aircraft's CG, directly influencing aircraft piloting.

The CG is affected by the distribution of crew, passengers, cargo and fuel consumption during the flight.

If the fuel tanks are located behind the mast, the weight in the rear region of the aircraft will decrease as fuel is consumed.

The MCA 3-6/2017 also highlighted that the vortex stall was the flight descent phase characterized by unstable air flowing through the rotor blades.

It would occur with the helicopter being at a speed below the translational lift speed, at a rate of descent equal to approximately ¼ of the downwash speed, and with the collective pitch-control partially applied.

The vortex effects would reach their peak when the rate of descent reached values approximately equal to ¾ of the induced speed, causing strong vibrations and inadvertent pitch and roll oscillations, capable of leading to loss of aircraft control.

Relatively to this subject, in the year 2000 the FAA published the Rotorcraft Flying Handbook, which described that Vortex Ring State (VRS) or Settling With Power is an aerodynamic condition, in which a helicopter experiences a vertical descent, even with maximum power applied, leaving little or no cyclic control.

The term *Settling With Power* comes from the fact that the helicopter continues sinking even with the application of engine power.

In a normal out-of-ground-effect hover, the helicopter is able to remain stationary by pushing a large mass of air down through the main rotor. Some of the air is recirculated near the blade tips, forming spiral-shaped vortex rings. This phenomenon is common to all airfoils, and is known as blade tip vortices. They consume engine power but are not capable of producing lift.

As long as the blade tip vortices are small, their only effect is to generate a small loss in rotor efficiency. However, when the helicopter begins to descend vertically at a higher rate of descent, it settles into its own turbulent air, which greatly increases the blade tip vortices.

In such condition, most of the energy developed by the engine is wasted in accelerating the air in a “thread pattern” around the rotor. This causes instability of the airflow over a large area of the rotor disk, causing the rotor efficiency to be lost, even though power is still being supplied by the engine (Figure 11).

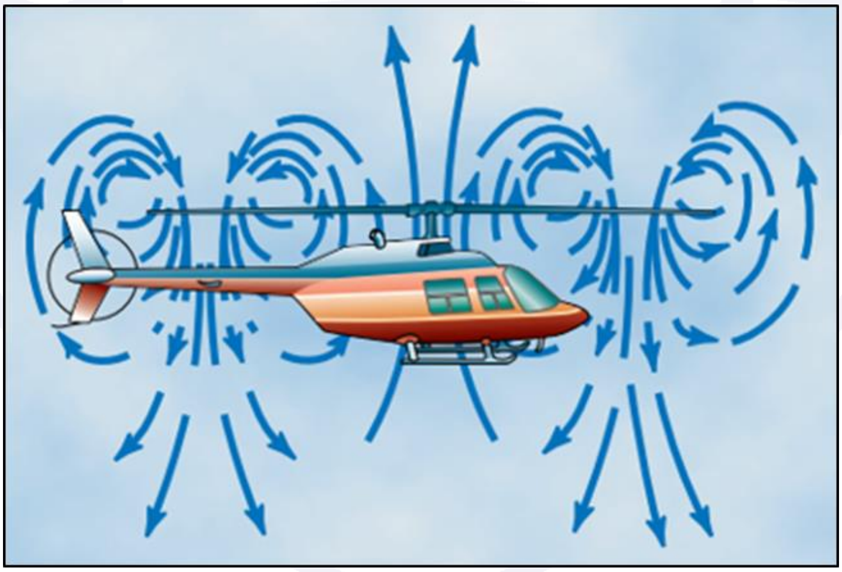

Figure 11 - Vortex Ring State.
Source: Rotorcraft Flying Handbook (FAA).

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

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

- Rate of vertical descent, or near-vertical descent, of at least 300 ft. per minute. (Actual critical rate depends on gross weight, RPM, density altitude, and other pertinent factors);
- The main rotor system must be using part of the available engine power (from 20% to 100%); and
- Horizontal displacement speed slower than the translational lift.

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

- Attempt to hover out of ground effect at a height higher than the helicopter's hovering ceiling;
- Attempt to hover out of ground effect without maintaining precise height control, or in tailwind; and
- powered wide-angle approaches, in which the airspeed drops to close to zero.

When the helicopter begins to vibrate, an additional application of the collective increases both the vibration level and the sink rate. In this sense, the recovery must be started at the first sign of VRS, by moving the cyclic forward to increase the speed, and, simultaneously, reducing the collective.

Recovery will only be accomplished when the aircraft passes through the translational lift speed and reaches a stabilized rate of climb.

In turn, on 07Feb2011, the *Eurocopter An Eads Company* published the Safety Information Notice No. 2335-S-00, which, among other topics, addressed the issue of VRS.

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

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

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

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

Among the effects caused by the vortex stall, the following ones stand out:

- Vibrations when the vortices leave the ends of the blades;
- Diminished smoothness of the pitch and roll controls on account of unstable airflow that constantly changes the impulse and moment of the control application.
- Fluctuations in the power demand resulting from the fact that significant changes in drag cause variations in thrust; and
- Abnormally high rate of descent (may exceed 3,000 ft. /min.) when the vortex is developing.

Recovery of helicopter control, according to the Safety Information Notice No. 2335-S-00, could be achieved by acting on the cyclic and/or collective. However, depending on the rotor system, an action only on the cyclic could be insufficient to modify the helicopter's attitude and increase the speed. Thus, to regain control of the helicopter, the collective had to be reduced to the minimum pitch. However, the loss of height during recovery of control by reducing the collective pace could be greater than the corresponding loss of height by the action in the cyclic, due to the fact that the rate of descent in autorotation at low speed was very high.

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

- move the cyclic forward effectively to obtain an attitude of acceleration and to increase speed;
- regain control of the helicopter when the Indicated Speed (IAS) reaches 40 kt; and
- if speed does not increase, reduce collective to enter autorotation, and then move the cyclic stick forward as necessary to increase speed.

Basically, such maneuvers (defined by the manufacturer as “classical techniques”) recommended that, to escape VRS, the collective had to be lowered (if necessary), and the cyclic moved forward to get out of the column of swirling air.

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

The publication concluded by stating that crews should exercise extreme caution when carrying out some operations, among which the *hovering flight outside of ground effect* and the *approach with tailwind* have prominence.

Still on the VRS subject, in 2022, the *European Union Aviation Safety Agency (EASA)* published the fourth edition of the Helicopter Flight Instructor Guide, Together4safety, in which the item 18b *HOGE HAZARDS: VORTEX RING* warned of the need to recognize early conditions leading to VRS to prevent the inadvertent entry of the helicopter in such condition.

Among the aspects addressed, the publication described that one of the characteristic symptoms was the sensation of floatation experienced in the case of a negative “G” force. Even with the application of the collective, there is no indication of positive “G” force. Changes in the helicopter's vibration and an increase in the rate of descent are also observed even with application of the collective.

Thus, Together4safety listed the following situations in which the helicopter could be led to a VRS condition:

- hovering out of ground effect (HOGE) with inadvertent vertical descent;
- Wide-angle approach;
- Approach with tailwind;
- Transition from approach to hover;
- Orbit at low speed (e.g. during photo flight);
- Recovery from an autorotation; and
- Fast deceleration and flare (with tailwind and in turns).

The publication clarified that there were two techniques widely used to enable recovery from VRS.

The first one, known as the standard technique, recommended the following actions:

- Reduce the collective;

- Move the cyclic forward smoothly, adopting a nose pitch-down attitude;
- Maintain heading by means of the pedals; and
- When above the translational lift speed, apply maximum continuous power during the climb.

The second one, known as the *Vuichard* Recovery Technique, indicated the following:

- Apply the collective;
- Maintain heading by means of the pedals;
- Apply the cyclic laterally in the direction of the tail rotor thrust; and
- As soon as the descent ceases, apply the cyclic smoothly forward to regain speed.

In the case of the A109E, it would be advisable to move the cyclic to the side of the advancing blade, that is, to the right. In this condition, maintenance of the heading would be achieved by applying the left anti-torque pedal, generating traction to the right.

Thus, such technique was designed to enable the recovery from the VRS, by means of a lateral movement of the helicopter.

It could be applied in the case of a fully developed VRS under specific operational conditions, such as the helicopter facing an obstacle in flight.

The document warned that not all manufacturers were in accordance as to the best way to recover from vortex ring states, be they incipient or developed.

For this reason, the Instructor Guide recommended that the instructor check, in the official documentation of the manufacturers of the helicopter model used for training, if both techniques could be applied, or if there were any restrictions.

The A109E RFM (Ref. doc 502052121B, page 2-47) approved by ANAC includes a recommendation regarding steep approaches and vertical descent manoeuvers in the Flight Handling Characteristics subchapter.

> FLIGHT HANDLING CHARACTERISTICS
>
> STEEP APPROACHES AND VERTICAL DESCENT MANOEUVRES
>
> Low speed steep approaches (up to 20 kts) and vertical descent manoeuvres should be performed with a rate of descent not exceeding 900 ft/min.

1.20. Useful or effective investigation techniques.

NIL.

2. ANALYSIS.

It was a private passenger transport flight between the helipads of SDPT and SJNN.

Prior to the accident, the aircraft had remained unavailable for a period of approximately seventy days for replacement of the fuel tanks and provision of scheduled maintenance.

During that period of time, the PR-PMT owner joined a fleet-sharing program, and started making his trips in other aircraft of the said program. At the end of the scheduled maintenance period, the owner would reimburse the fleet-sharing program for the hours flown by him in other participating aircraft.

Therefore, the owner expressed his concern for the maintenance services to be finished within the expected period, so that his aircraft would be available for the first flight in favor of the fleet-sharing program, which had already been scheduled for the week of the flight in question.

At the time of the occurrence, there were no requirements established by ANAC concerning shared-ownership aircraft operations. Therefore, the responsibility for the operational control of the flight was not clear, and was only implemented in 2021, with the inclusion of Subpart K in the RBAC 91.

The Subpart K also defined the requirements for implementing SMS in companies conducting that type of operation, aiming at improving the operational safety of flights with shared-ownership aircraft.

The day before the occurrence flight, the aircraft had completed a number of maintenance services, including the *IAM* and the *200-hour/12-month* inspection. In view of the aircraft availability, two test flights were performed by the same crew of the occurrence flight.

On the first test flight, a slight play in the cyclic controls was reported. However, there were no records regarding the issue in the aircraft logbook.

After the maintenance organization acted on the alleged problem, the aircraft was released for a new verification. On this second test flight, the crew became satisfied, the maintenance process was concluded, and the aircraft released for return to flight.

In the PIC's opinion, the great emphasis given by the owner on the importance of fulfilling the compensation flight may have contributed to the acceptance of the aircraft on the test flight without the pitch-control problem being fully resolved.

Regarding the subject, the RBHA nº 91 - General Operating Rules for Civil Aircraft, in force on the date of the accident, established that the PIC of a civil aircraft was responsible for verifying the condition of the aircraft in relation to flight safety.

However, the absence of records related to the discrepancy both in the aircraft and maintenance logbooks was an indication that the helicopter did not have any problems with the flight controls that could prevent it from returning to the air activity. The lack of such records made it impossible to track possible maintenance actions performed in response to the reported "looseness", negating the possibility of verification of the evidence.

As far as the occurrence flight is concerned, the dynamic of the flight planning changed relatively to what used to be usual before the aircraft joined the fleet-sharing management program.

Prior to the adherence to the shared-fleet program, flights would typically receive up to 3 passengers. In the flight leg related to the occurrence, 5 passengers and two medium-sized animals were transported, without previous pilots' knowledge of neither the exact number of passengers nor their respective weights, a piece of information that was only transmitted to them at the time of passenger boarding, in contrast with the routine adopted in earlier times, when the flights carried the aircraft owner.

Thus, based on information provided by the crew, it was verified that the aircraft took off with excess weight in the order of 116 kg, and outside of its CG longitudinal limits.

Based on the fuel remaining in the tanks (248 kg), calculation revealed that, at the time of the accident, the helicopter had an estimate weight of 2,864 kg, i.e. 14 kg above the maximum landing weight prescribed.

Operating a helicopter above its maximum weight can compromise its performance. Likewise, changes in the load distribution can cause significant alterations in the aircraft's CG, directly influencing the piloting procedures.

Inappropriate or poorly distributed loading also degrades aircraft maneuverability. The cyclic control becomes less effective in the opposite direction of the CG position. When the CG is exactly vertical to the mast, the helicopter tends to keep the nose in a horizontal position.

There was a complacent attitude towards taking off with a weight that was higher than the one prescribed, on account of the great importance given by the helicopter owner (pilots' employer) to the accomplishment of that flight, in accordance with the conditions agreed upon with the company managing the fleet-sharing program.

Indications of external pressure on the part of the operator favored the non-observance of the helicopter's operating limits by the PIC, leading him to operate the aircraft with excessive take-off weight, overestimating the operational capability of the equipment.

The PIC reported that, before the flight, he had informed the owner that the moment chosen for the flight was not the ideal one on account of the weather conditions on the route. However, for fear of losing his job, even though feeling uneasy, the pilot decided to fly.

Since the helipad was located in a valley and there was a cloud cover, it is possible that, at the time of landing, a decrease in the natural luminosity was taking place, as the landing was made about 10 minutes before sunset.

Besides, the crew reported the presence of rain in the vertical of SJNN, with cloud cover below the height of the hills surrounding the valley, moderate turbulence, and wind estimated at zero kt. for landing.

The METAR of SBST* (* at a distance of approximately 7 NM) reported wind of 190° at 7 kt., visibility 2,000 m, drizzle, mist, broken clouds at 700 ft., and sky overcast at 900 ft.

The 11Oct2018 SIGWX chart produced at 21:02 UTC (close to the time of occurrence), indicated the presence of a frontal system over the ocean, with the possibility of rain and showers.

At the same time, the characteristics of the relief around the helipad, on the leeward side of the mountain, in addition to limiting the approach direction options, made the region favorable to the emergence of orographic turbulence. In fact, the crew reported experiencing moderate turbulence while still in the traffic pattern for landing. On account of the effect that terrain has on the wind in valleys or canyons, downdrafts can be severe with implications for helicopter control.

About that subject, the *Chapter 12 - Weather Theory* of the FAA, reads that while the wind flows smoothly through the windward side of the mountain, and the updrafts help to carry an aircraft above the mountain peak, the leeward wind does not act in the same way. As air flows to the leeward side of the mountain, the air following the contour of the land becomes increasingly turbulent. This tends to push an aircraft down. The stronger the wind, the greater the descent rate and the intensity of the turbulence.

Therefore, the contribution of a possible orographic turbulence to the outcome of the flight in question cannot be ruled out.

However, one must also consider the hypothesis that the PR-PMT encountered an aerodynamic condition known as *Vortex Ring State* (VRS), in which a helicopter experiences a vertical descent, even with application of maximum power, leaving little or no cyclic control at all.

In such condition, most of the power developed by the engine is wasted in accelerating the air in a "thread pattern" around the rotor. This causes instability of the airflow over a large area of the rotor disk, causing the rotor efficiency to be lost even though power is still being supplied by the engine.

As a matter of fact, the type of approach performed, the symptoms perceived by the crew, as well as some of the circumstances present at the time of landing, showed great similarities with the characteristics of the phenomenon described in the literature on the subject, namely:

- Rate of vertical or near-vertical descent of at least 300 ft. per minute;

- Main rotor system employing part of the available engine power (from 20% to 100%);
- Horizontal displacement speed lower than the translational lift; and
- Loss of effectiveness of the cyclic and yaw control.

According to the PIC, the approach was conducted in the approximate azimuth of 200°, with the aircraft flying at a speed that was lower than the one prescribed (about 30 kt), due to the light rain that was falling at the time.

In this way, it is possible that, due to the meteorological conditions encountered (degraded visibility), the approach was conducted at a high angle, at low speed, and with a high rate of descent. With the possible low luminosity at the landing site, it is also likely that the perception of aircraft sinking was impaired.

On the short final for landing, the crew noticed an abnormal condition of aircraft control, along with a reduction of the noise made by the rotor, and an abrupt sinking of the aircraft.

The PIC reported that, at the moment, his feeling of the forward speed of the aircraft diminished, and the controls had a delayed response in relation to a normal flight condition.

The aircraft symptoms perceived by the crew were consistent with the description of the phenomenon: sudden sinking (increased rate of descent), “slow” controls (lack-of-control feeling), and airspeed decrease.

In response, the PIC’s reaction was to maintain the position of the collective, and move the cyclic forward to increase speed, in an attempt to reach the helipad. Still according to the PIC, when contact with the ground became imminent, he pulled the collective to its maximum amplitude, in an attempt to reduce the rate of descent.

On the subject, all publications related to VRS phenomena are emphatic in stating that an additional application of the collective increases both the level of vibration and the sink rate. If there is sufficient height, the recovery must be started at the first sign of a VRS, with application of the cyclic forward to increase the speed, while, simultaneously, reducing the collective.

Recovery of helicopter control is achieved when the IAS reaches 40 kt.

In addition to that technique, there was another possibility of trying to recover from the phenomenon, using the *Vuichard* Recovery Technique, which consisted in using the collective, while applying a lateral movement to the cyclic, maintaining control of the steering by means of the pedals. Thus, the procedure was designed to enable the pilot to recover from the VRS by moving the helicopter sideways.

In the case of the A109E aircraft, it would be advisable to move the cyclic to the side of the advancing blade, that is, to the right. In this condition, the heading would be maintained with application of the left pedal (anti-torque), generating traction to the right.

It is worth pointing out that, for the use of the *Vuichard* Recovery Technique, one must consult the documentation of the manufacturer specific for the helicopter model.

That said, it should be noted that early detection and prevention of VRS are essential aspects for the avoidance of the phenomenon. Pilots must understand the importance of timely recovery, and be trained to identify a VRS in its early stages by recognizing early warning symptoms.

Therefore, it was inferred that the pilot made use of a wide-angle approach influenced by the degraded weather conditions. Then, the PIC allowed a high rate of descent. It is important pointing out that, according to calculations, the PR-PMT was outside of its weight and balance limits.

When performing the transition to the last third of the approach, it was necessary for the pilot to slow down the helicopter. To do so, the pilot had to increase the pitch of the collective control, in order to generate more lift on the main rotor, and act on the cyclic control in a pitch-up direction.

By pulling the collective control to reduce approach speed towards the ground and moving the cyclic, it is possible that the helicopter started a descent involved in its own turbulent air, greatly increasing the blade tip vortices.

In that condition, most of the power developed by the engine was wasted in accelerating the air in a "thread pattern" downwards from the helicopter, compromising the efficiency of the main rotor, even with the power being supplied by the engines.

The PIC, in an attempt to perform a maneuver that would make it possible to recover from the sinking condition and avoid impact with the ground, pulled the collective in all its amplitude. This movement did not have the desired effect, as it only aggravated the vortex stall situation. Thus, the PR-PMT collided with the ground in a loss-of-control condition.

In the P&WC's test bench analysis, the engines were put in operation, having achieved all the test parameters for all the speeds to which they were subjected.

There was no indication on the aircraft instruments or on the alarm panel denoting any failure in the propulsion or transmission of rotation to the aircraft's main rotor.

No contributing factors related to aircraft maintenance were observed in the case of the PR-PMT accident. The replacement of the fuel tank, as well as the cyclic looseness reported by the crew did not show any connection with the accident. Technical analyses of the engine, transmission, fuel system, fuel and lubricants revealed no contribution to the accident in question.

3. CONCLUSIONS.

3.1. Findings.

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

b) the PIC held a valid PLH license (Airline Transport Pilot – Helicopter), a valid HMLT license (Multi-Engine Turbine Helicopter), a valid IFRH rating (IFR Flight - Helicopter), and a valid INVH rating (Flight Instructor – Helicopter);

c) the SIC held a valid PCH license (Commercial Pilot - Helicopter), and had a valid HMLT license (Multi-Engine Turbine Helicopter);

d) the pilots were qualified and had experience in the type of flight;

e) the aircraft had a valid Airworthiness Certificate (CA);

f) the aircraft was outside the prescribed weight and balance limits;

g) the records of the airframe and engine logbooks were up to date;

h) before the accident, the aircraft stayed unavailable for approximately 70 days on account of maintenance services;

i) the crew conducted two test flights of the PR-PMT after the maintenance services were finished;

j) the exams, tests and research performed did not reveal contribution of the aircraft systems to the accident;

k) the weather conditions at the destination helipad, despite being compatible with VFR flights in helicopters, had low ceiling, restricted visibility, light rain, and moderate turbulence;

l) the geographical characteristics around the helipad limited the direction of the approach axis, and hindered the possibility of a missed-approach procedure due to elevations in the terrain;

m) the approach to the helipad was flown in the approximate azimuth of 200° at a speed that was lower than the one prescribed (about 30 kt), on account of the light rain falling at the time;

n) while on the short final toward the helipad, the aircraft lost lift, and, at a high rate of descent, collided with the ground in a grassy area short of the paved landing surface.

o) the aircraft sustained substantial damage; and

p) none of the aircraft occupants was injured.

3.2. Contributing factors.

Attitude – a contributor.

Despite showing discomfort with the weather conditions and with the fact that the aircraft was above the weight and balance limits, the crew displayed non-compliance with the helicopter operational limits, by taking off and trying to land in a location that featured moderate turbulence and restrictions of ceiling and visibility.

Training – undetermined.

The corrective action of increasing the engine power by means of the collective to reverse the sinking situation on the final for landing revealed that the PIC did not have the necessary knowledge and training to correct and prevent a possible VRS.

Adverse meteorological conditions – undetermined.

One cannot rule out the possibility that the moderate turbulence reported by the pilot, as well as the ceiling and visibility conditions on account of the rain and lighting conditions in SJNN, contributed to compromise the ideal approach profile for landing at the destination.

Emotional state – a contributor.

According to PIC’s accounts, there was fear of losing their job if the flight was not accomplished. Thus, although the crew concluded that the weather conditions were unfavorable for the operation, the flight was conducted in a close relationship between the emotional state of the crew and the actions that contributed to the occurrence in question.

Handling of aircraft flight controls – undetermined.

On the final approach, the PIC possibly reduced the helicopter speed to a value below 30 kt., and performed a powered wide-angle approach with zero wind in a region of moderate turbulence. The use of this approach profile possibly contributed to the helicopter experiencing the VRS aerodynamic phenomenon.

Piloting judgment – a contributor.

Inappropriate evaluation on the part of the pilot of certain parameters related to the operation of the aircraft, such as flying with the aircraft above the weight limits for landing and outside the center of gravity, in a place subject to orographic turbulence and with degraded meteorology, contributed to the accident.

Motivation – a contributor.

According to the PIC report, flights with degraded meteorology took place frequently. Motivated by the fear of losing his job, even though feeling uncomfortable, the PIC decided to fly. In addition, the aircraft had been sent for maintenance and, during the process, the owner stressed that the flight had to take place, strongly influencing the pilots to release the aircraft within the period agreed with the shared-fleet managing company. As reported by the pilots, they felt pressure in the owner's attitude.

Perception – undetermined.

In view of the need to accomplish the mission, there were losses in the crew's ability to properly assess the dangers and risks associated with operating in a region that had restrictions of ceiling, visibility, and turbulence. This condition may have led to a decrease of the situational awareness of the operational environment at the time of landing.

Air traffic planning – a contributor.

All planning and operational demands for this flight were transmitted by the aircraft owner directly to the pilots. The crew only became aware of the exact number of passengers and their respective weights at the time of boarding, something that never occurred when the flights were conducted under the management of the aircraft owner. Such fact contributed to the PR-PMT taking off in incompliance of the weight and balance limits. At the time of the occurrence, there were no requirements established by ANAC for shared ownership aircraft operations.

Decision-making process – a contributor.

The profile of the approach employed revealed difficulties in the crew's perception and analysis of the risks involved in the operation. These difficulties resulted in an inadequate judgment that, consequently, turned into a mistaken decision of trying to land with the aircraft above the maximum weight, in a region that presented restrictions of ceiling, visibility, and moderate turbulence.

4. SAFETY RECOMMENDATIONS

NIL.

5. CORRECTIVE OR PREVENTATIVE ACTION ALREADY TAKEN.

Relatively to the legislation, the RBAC 91, in Section 91.1021 of Subpart K - “Operations of Shared-Ownership Aircraft”, established the requirements for the implementation of the Operational Safety Management System (SGSO) in companies conducting such this type of shared operation, as follows:

> 91.1021 RBAC (SGSO)
>
> (a) The program manager must establish, implement and maintain an SMS, acceptable to ANAC, capable of guaranteeing the safety conditions of operations and compliance with the requirements established in this Regulation. The SMS required by ANAC must:
>
> (1) establish the organization's policy and objectives for operational safety;
>
> (2) establish operational safety goals and performance indicators that allow assessing the achievement of operational safety objectives;
>
> (3) establish the organizational structure and the personnel responsible for the implementation, maintenance and continuous improvement of the system;
>
> (4) identify hazards and assess the respective associated operational risks;
>
> (5) apply corrective and preventative actions developed from the evaluated operational risks, as well as evaluate the effectiveness of such actions;
>
> (6) perform permanent supervision of the organization's activities, in order to guarantee the required operational safety;
>
> (7) periodically plan and conduct internal evaluations or audits of the SGSO, aiming at its adequacy to the operational context of the organization and the continuous improvement of operational safety performance levels;

(8) ensure that the personnel involved with sensitive activities with regards to operational safety possess the necessary skills and are cognizant of their responsibilities;

(9) communicate the results related to operational safety performance, as well as disseminate information conducive to the improvement of the organization's operational safety culture;

(10) generate and organize documents and records that provide evidence of the development, operation, maintenance and continuous improvement of the SMS; and

(11) meet any other specific SMS requirements established in normative instruments applicable to PSAC.

On August 15th, 2023.