COMANDO DA AERONÁUTICA

CENTRO DE INVESTIGAÇÃO E PREVENÇÃO DE ACIDENTES AERONÁUTICOS

FINAL REPORT
A - 165/CENIPA/2018

OCCURRENCE:	**ACCIDENT**
AIRCRAFT:	**PP-MTX**
MODEL:	**A109E**
DATE:	**03NOV2018**

NOTICE

According to the Law nº 7565, dated 19 December 1986, the Aeronautical Accident Investigation and Prevention System – SIPAER – is responsible for the planning, guidance, coordination and execution of the activities of investigation and prevention of aeronautical accidents.

The elaboration of this Final Report was conducted taking into account the contributing factors and hypotheses raised. The report is, therefore, a technical document which reflects the result obtained by SIPAER regarding the circumstances that contributed or may have contributed to triggering this occurrence.

The document does not focus on quantifying the degree of contribution of the different factors, including the individual, psychosocial or organizational variables that conditioned the human performance and interacted to create a scenario favorable to the accident.

The exclusive objective of this work is to recommend the study and the adoption of provisions of preventative nature, and the decision as to whether they should be applied belongs to the President, Director, Chief or the one corresponding to the highest level in the hierarchy of the organization to which they are being forwarded.

This Report does not resort to any proof production procedure for the determination of civil or criminal liability, and is in accordance with Appendix 2, Annex 13 to the 1944 Chicago Convention, which was incorporated in the Brazilian legal system by virtue of the Decree nº 21713, dated 27 August 1946.

Thus, it is worth highlighting the importance of protecting the persons who provide information regarding an aeronautical accident. The utilization of this report for punitive purposes maculates the principle of "non-self-incrimination" derived from the "right to remain silent" sheltered by the Federal Constitution.

Consequently, the use of this report for any purpose other than that of preventing future accidents, may induce to erroneous interpretations and conclusions.

N.B.: This English version of the report has been written and published by the CENIPA with the intention of making it easier to be read by English speaking people. Taking into account the nuances of a foreign language, no matter how accurate this translation may be, readers are advised that the original Portuguese version is the work of reference.

SYNOPSIS

This is the Final Report of the 03NOV2018 accident with the A109E aircraft model, registration PP-MTX. The accident was classified as "[UIMC] Unintended flight in IMC [LOC-I] Loss of Control in Flight".

During an en-route flight, the aircraft entered a region under adverse weather conditions, which caused the pilot to lose control of the aircraft, causing a collision with a forest area, near the municipality of Mogi das Cruzes - SP.

The aircraft was destroyed.

The pilot and four passengers died.

An Accredited Representative of the *Agenzia Nazionale per la Sicurezza del Volo* (ANSV) – Italy, (State where the aircraft was manufactured and designed) and an Accredited Representative of the Transportation Safety Board (TSB) - Canada, (State where the engine was manufactured and designed) were designated for participation in the investigation.

CONTENTS

GLOSSARY OF TECHNICAL TERMS AND ABBREVIATIONS 5

1. FACTUAL INFORMATION. 8

1.1 History of the flight. 8
1.2 Injuries to persons. 8
1.3 Damage to the aircraft. 8
1.4 Other damage. 8
1.5 Personnel information. 8
1.5.1 Crew's flight experience. 9
1.5.2 Personnel training. 9
1.5.3 Category of licenses and validity of certificates. 12
1.5.4 Qualification and flight experience. 12
1.5.5 Validity of medical certificate. 13
1.6 Aircraft information. 13
1.7 Meteorological information. 16
1.8 Aids to navigation. 18
1.9 Communications. 18
1.10 Aerodrome information. 19
1.11 Flight recorders. 19
1.12 Wreckage and impact information. 21
1.13 Medical and pathological information. 23
1.13.1 Medical aspects. 23
1.13.2 Ergonomic information. 23
1.13.3 Psychological aspects. 23
1.14 Fire. 24
1.15 Survival aspects. 24
1.16 Tests and research. 24
1.17 Organizational and management information. 27
1.18 Operational information. 27
1.19 Additional information. 31
1.20 Useful or effective investigation techniques. 35

2. ANALYSIS. 35

3. CONCLUSIONS. 39

3.1 Facts. 39
3.2 Contributing factors. 40

4. SAFETY RECOMMENDATION. 41

5. CORRECTIVE OR PREVENTATIVE ACTION ALREADY TAKEN. 42

GLOSSARY OF TECHNICAL TERMS AND ABBREVIATIONS

AD WNRG	Aerodrome Warning
ADI	Attitude Director Indication
AEO	All Engine Operating
AFCS	Automatic Flight Control System
AIC	Aeronautical Information Circular
AIP	Aeronautical Information Publication
ALT	Altitude
ANAC	Brazil's National Civil Aviation Agency
APP-SP	Approach Control – São Paulo
ATC	Air Traffic Control
ATO	Approved Training Organization
ATS	Air Traffic Services
ATSB	Australian Transportation Safety Bureau
ANSV	*Agenzia Nazionale per la Sicurezza del Volo*
BKN	Broken (5-7 oktas)
BR	Mist
CA	Airworthiness Certificate
CAVOK	Ceiling and Visibility OK
CAR	Canadian Aviation Regulation
CB	Cumulonimbus Cloud
CENIPA	Aeronautical Accident Investigation and Prevention Center
CIV	Pilot`s Flight Logbook
CMA	Aeronautical Medical Certificate
CPTEC	Weather Forecast and Climate Studies Center
CVR	Cockpit Voice Recorder
DECEA	Air Space Control Department
DTO	Declared Training Organization
EASA	European Union Aviation Safety Agency
EHSI	Electronic Horizontal Situation Indicator
ENAC	*Ente Nazionale Aviazione Civile*
FAA	Federal Aviation Administration
FCA	Coordination Frequency between Aircraft
FDC	Flight Director Computer
FEW	Few Clouds (1- 2 oktas)
FIR	Flight Information Region
FAP	Pilot`s Evaluation Form
FD	Flight Director

FDC	Flight Director Computer
FDMS	Flight Director Mode Selector
FTR	Force Trimm
GAMET	General Aviation Meteorological Information
GOES	Geostationary Operational Environmental
GS	Glide Slope
HDG	Heading
HMLT	Helicopter Multi-Engine Rating
HMNT	Single Turbo Helicopter Rating
HZ	Haze
IAE	Aeronautics Space Institute
IAM	Annual Maintenance Inspection
IAS	Indicated Airspeed
ICA	Command of Aeronautics' Instruction
IFR	Instrument Flight Rules
IMC	Instrument Meteorological Conditions
INPE	National Institute for Space Research
IS	Supplementary Instruction
LABDATA	Flight Data Recorders Read-Out and Analysis Laboratory
METAR	Meteorological Aerodrome Report
MNTE	Airplane Single-Engine Land Rating
NAV	Navigation
NOTAM	Notice to Airmen
NSCA	Aeronautics Command System Standard
OM	Maintenance Organization
OVC	Overcast (8 oktas)
PMD	Maximum Take-off Weight
PN	Part Number
PPH	Private Pilot License – Helicopter
PPR	Private Pilot License – Airplane
RA	Rain
RAB	Brazilian Aeronautical Registry
RADAR	Radio Detection And Ranging
RBAC	Brazilian Civil Aviation Regulation
RBHA	Brazilian Aeronautical Certification Regulation
REH	Helicopters Special Routes
REDEMET	Aeronautics Command Meteorology Network
RERA	Recent Rain
RETS	Recent Thunderstorm

RFM	Rotorcraft Flight Manual
ROTAER	Auxiliary Air Route Manual
SACI	Integrated Civil Aviation Information System
SAGITARIO	Advanced Air Traffic Information Management and Operational Interest Reporting System
SBGR	ICAO Location Designator - Governador André Franco Montoro Aerodrome, Guarulhos - SP
SBMT	ICAO Location Designator – Campo de Marte Aerodrome, São Paulo - SP
SBSP	ICAO Location Designator – Congonhas Aerodrome, São Paulo - SP
SBST	ICAO Location Designator - Santos Aerodrome, Guarujá - SP
SCT	Scattered (3-4 oktas)
SDJD	ICAO Location Designator - Juquehy Baleia Helipad, São Sebastião - SP
SDLA	ICAO Location Designator – *Condomínio Laranjeiras*, Paraty - RJ
SERIPA IV	Fourth Regional Aeronautical Accident Investigation and Prevention Service
SHRA	Rain Showers
SIPAER	Aeronautical Accident Investigation and Prevention System
SN	Serial Number
SPECI	Aviation Selected Special Weather Report
SRPV-SP	Regional Flight Protection Service - São Paulo
SSCVR	Solid State Cockpit Voice Recorder
SSUB	ICAO Location Designator - HBR Helipad, Osasco - SP
STEP	Simultaneous Time and Events Processing
TAF	Terminal Aerodrome Forecast
TC	Transport Canada
TCU	Towering Cumulus
TEMPO	Temporary
TMA-SP	Terminal Control Area – São Paulo
TPP	Registration Category of Private Service - Aircraft
TS	Thunderstorm
TSRA	Light to Moderate Thunderstorm with Rain
TSB	Transportation Safety Board of Canada
UTC	Universal Time Coordinated
VFR	Visual Flight Rules
VS	Vertical Speed
VCTS	Vicinity Thunderstorm
WS	Windshear

1. FACTUAL INFORMATION.

Aircraft	**Model:** A109E **Registration:** PP-MTX **Manufacturer:** Agusta	**Operator:** Filipinas *Empreendimentos Imobiliários* S.A
Occurrence	**Date/time:** 03NOV2018 - 2208 UTC **Location:** Quatinga District **Lat.** 23°42'09"S **Long.** 046°13'19"W **Municipality – State:** Mogi das Cruzes – SP	**Type(s):** "[UIMC] Unintended flight in IMC [LOC-I] Loss of Control in Flight" **Subtype(s):** NIL

1.1 History of the flight.

The aircraft took off from the Juquehy Baleia Helipad(SDJD), São Sebastião - SP, to the HBR Helipad(SSUB), Osasco - SP, around 2145 (UTC), in order to perform a private flight, with a pilot and four passengers on board.

During the en-route flight, in a region under adverse weather conditions, the aircraft collided in a forest area, near the district of Quatinga, located in the municipality of Mogi das Cruzes - SP.

Figure 1- View of the PP-MTX wreckage.

1.2 Injuries to persons.

Injuries	Crew	Passengers	Others
Fatal	1	4	-
Serious	-	-	-
Minor	-	-	-
None	-	-	-

1.3 Damage to the aircraft.

The aircraft was destroyed.

1.4 Other damage.

None.

1.5 Personnel information.

1.5.1 Crew’s flight experience.

Flight Hours	Pilot
Total	309:35
Total in the last 30 days	07:35
Total in the last 24 hours	03:00
In this type of aircraft	106:36
In this type in the last 30 days	07:35
In this type in the last 24 hours	03:00

N.B.: The data relating to the flown hours were obtained through the pilot`s CIV and the ANAC`s SACI,

1.5.2 Personnel training.

The pilot took the PPH course at Rangel *Helicópteros - Escola de Aviação Civil* - SP, obtaining this license on 13DEC2013.

On 27NOV2014, he completed the PPR course, obtaining the MNTE class Rating.

As a PPH, the pilot obtained type ratings on the R66 and H350 helicopters. With the changes made to the RBAC No. 61, Amendment 06, of 18MAR2016, these type ratings changed into an HMNT class Rating.

As of the publication of this Amendment to the RBAC 61, all Agusta A109 family aircraft (A109A, A109AII, A109C, A109K2, A109E, A109S, AW109SP) required an HMLT class Rating.

At the time of the transition from “type” to “class” Rating, there was concern about the impact of this change on the operating environment of helicopters, which have always been considered “type rating” aircraft.

This concern was included in the minutes of the ANAC Deliberative Meeting, of 18MAR2016, which approved Amendment 06 of the RBAC 61, where the following determination was recorded:

> On that occasion, the Board of Directors determined that the SPO, over the next 4 years, monitor the changes implemented by this amendment concerning the new definition of aircraft type, especially observing the category of helicopters that have migrated to class rating, annually presenting an operational safety report to the Board of Directors.

The publication of amendment 06 of the RBAC 61 essentially meant two major changes, both based on the FAA regulation No. 14 CFR Part 61:

- new parameters for aircraft requiring class or type ratings:

aircraft that have a PMD < 12,500 lbs, operate “single pilot” and are not turbojet/turbofan would be classified as “class” (including helicopters);

aircraft with PMD > 12,500 lbs that operate “multi-crew” and are turbojet/turbofan would be classified as “type”.

- the institution of the FAA endorsements:

assessments carried out by another pilot. Depending on the case, a flight instructor and, in others, a Commercial Pilot or Airline Pilot.

Thus, on 23APR2016, the IS 61-004, revision G came into force, with the new list of qualifications, among them, the HMLT Rating.

At the same time, the training programs proposed by the AgustaWestland Training Academy and approved by the EASA/ENAC were reproduced in the ANAC's Operational Assessment Report, Revision 2, of 23APR2016.

These programs contemplated two distinct scenarios, depending on the previous experience of the applicant pilot, namely:

- pilots with no previous experience in multi-engine turbine helicopter operation, where comprehensive training must be provided; and

- pilots with demonstrated experience in multi-engine turbine helicopter operation, where credit may be given.

Based on this program, the entry requirements for training A109E/S/SP models for pilots with no previous experience in multi-engine turbine helicopter operation should meet the following criteria:

- helicopter pilot license;

- single-engine piston or turbine helicopter rating;

- 70 (seventy) flight hours as Pilot in Command; and

- specific theoretical course related to multi-engine turbine helicopters.

Below, Figure 2 summarizes the other requirements of the approved training curriculum for A109E pilots with no previous experience in multi-engine turbine helicopter operation, contained in the respective Operational Assessment Report:

TREINAMENTO		*SEM EXPERIÊNCIA PRÉVIA* EM OPERAÇÃO DE HELICÓPTERO MULTIMOTOR A TURBINA			
MODELO REQUERIDO		A 109E		A 109S	A 109SP
		Helicóptero	Simulador		
VFR	Treinamento Teórico (incluindo o exame)	34h	34h	34h	48h
	Treinador Sintético	–	–	–	4h
	Simulador de Voo	–	8h	–	–
	Helicóptero	8h	2h	8h	8h
	Voo de Verificação de Proficiência	sim	sim	sim	sim

Figure 2 - Summary of the Agusta A109E Aircraft Training Program.
Source: Operational Assessment Report, Revision 2, of 23APR2016.

Regarding the theoretical exam provided for in the Operational Assessment, the ANAC applied the theoretical exam of the equipment in the past, but only for "type" equipment. There was no theory test for "class" aircraft.

This theoretical exam was replaced by the oral exam to be conducted before the proficiency exam, valid for both "type" and "class" aircraft. The oral exam was described in Section 8 of the IS 00-002, which dealt with the Standards for Conducting Pilot Proficiency Examinations:

8. ORAL EXAM

8.1 Every proficiency exam must begin with an oral exam, which aims to assess whether the candidate has the required knowledge for the role he intends to perform. This exam must be carried out completely, both in the initial exams and in the revalidation exams.

> 8.2 The content applicable to each oral exam is prevised in the FAP (Appendix A of this (IS). The examiner must prepare questions that address all the predicted content, but do not go beyond it.
>
> 8.3 The questions must be formulated by the examiner with a practical focus, that is, they must reflect real conditions encountered by the pilot in the operation of the aircraft.

In addition, there was the FAP 04.7, used for the proficiency exam, in which there was a specific field to guide the examiner in the competence items that should be included in the questions formulated for the oral exam.

Appendix B - Tables of “class” aircraft models that required specific endorsement, of the Supplementary Instruction (IS), No. 61-006, Revision C, of 20APR2017, of the ANAC, in force at the time of the proficiency exam, which dealt with the Procedures for Launching Endorsements in Pilots' Flight Records, established that the instruction required for the endorsement of the A109E, multi-engine helicopter class, would be at the discretion of the endorsing pilot.

Also, according to the IS, Appendix C guided how the tables in Appendix B should be read, which mentioned the following guidance concerning column 4:

> Column 4 indicates the instruction required before granting the endorsement. If this column indicates instruction “At discretion”, the endorsing pilot must provide the ground and flight instruction that is sufficient for the endorsing pilot to be able to demonstrate full knowledge and proficiency in the following aspects:
>
> a) Aircraft structure, systems, and limitations;
>
> b) Pre-flight procedures, including weight, balance, and verification of general airworthiness conditions;
>
> c) Normal ground and in-flight procedures;
>
> d) Abnormal and emergency ground and in-flight procedures; and
>
> e) Procedures in case of equipment and engine failures.
>
> In all cases, if there is an operational assessment published for the aircraft model, it should be used as a reference for the training provided. The Operational Assessments can be found on the page http://www.anac.gov.br/assuntos/setorregulado/profissionais-da-aviacao-civil/valiação-operacional.

As previously mentioned, the AgustaWestland AW109SP Operational Assessment Report provided the necessary training guidelines for the A109E model. However, as the guidelines were available within the AW109SP Report, there was no clarity as to the procedures to be adopted by the instructor, causing him to give the instruction “at his discretion”.

It should be noted that, on 19JUL2011, EASA had already published the Operational Evaluation Board Final Report, AgustaWestland Report, A109E, A109S & AW109SP, an operational document, which detailed a series of minimum curricula in theoretical and practical training for pilot qualification for operating variants E, S, and SP.

In that document, all curricula were detailed in terms of total and partial minimum hours directed to the various topics of the syllabus. The publication clarified that the training, although carried out in an aircraft, should necessarily cover, among others, topics related to the operation of the Autopilot and Flight Director in the navigation under VFR.

Thus, on 05JAN2018, after carrying out the training prevised in letter (e) of section 61.195 of the RBAC nº 61, in force at the time of the accident, the pilot received the instructor's endorsement and was released to take the proficiency exam to obtain the HMLT class Rating.

In this regard, letter (f) of section 61.195 of the RBAC No. 61 established that:

> (f) The instructor is responsible for declaring that the pilot is competent to safely perform all maneuvers necessary to pass the proficiency exam for the award of the required class rating. Such declaration will be valid for 30 (thirty) days, from the date of the last preparation flight for the proficiency exam.

All instruction flights, performed from 22DEC2017 to 23JAN2018, were carried out in the PP-MTX aircraft, totaling 15 hours and 56 minutes. On 27JAN2018, the proficiency exam flight was carried out in the same aircraft. The pilot was successful and passed with a satisfactory grade. The flight lasted 50 minutes, with take-off from SSUB, at 1430 (UTC), to the Campo de Marte Aerodrome (SBMT), São Paulo - SP.

His FAP 04.7 - Class Rating - HMLT contained the following observation, noted by the Examining Pilot:

> The Captain (...) performed all the procedures of this FAP 04.7 with adequate technical proficiency for what was proposed. Grade: Satisfactory.

The grade "Satisfactory" ("S") was assigned to all items of FAP 04.7, as highlighted in Figure 3.

Nº ref.	Cód. do elemento	Elemento de competência	Resultado
		Exame oral	
		Conhecimentos gerais	
1.	–	Instrumentos e equipamentos requeridos para a realização do voo	S
2.	–	Documentos requeridos para a realização do voo	S
3.	–	Conhecimentos técnicos da aeronave	S
4.	–	Procedimentos normais, anormais e de emergência da aeronave	S
5.	–	Cálculo de peso e balanceamento da aeronave	S
6.	–	Cálculos de desempenho de pouso e decolagem da aeronave	S
7.	–	Boletins ou notificações de segurança referentes à operação da aeronave, emitidos pelo fabricante, pela autoridade aeronáutica do país de origem ou pela ANAC	S
8.	–	Leitura e interpretação de mensagens e cartas meteorológicas	S
9.	–	Leitura e interpretação de publicações aeronáuticas (ROTAER, AIP, NOTAM, etc.)	S
10.	–	Planejamento de voo	S
		Exame de voo	
		Procedimentos gerais	
11.	C3.1	Operar o equipamento de rádio	S
12.	C3.2	Gerenciar panes do equipamento de rádio	S
13.	C3.3	Operar o transponder	S
14.	C4.2	Gerenciar o sistema de combustível	S
15.	C4.3	Reabastecer a aeronave	S
16.	C5.1	Gerenciar passageiros	S
17.	C5.2	Gerenciar carga e/ou bagagem	S
18.	NTS1.1	Manter uma vigilância efetiva	S
19.	NTS1.2	Manter consciência situacional	S
20.	NTS1.3	Avaliar situações e tomar decisões	S
21.	NTS1.4	Definir prioridades e gerenciar tarefas	S
22.	NTS1.5	Manter comunicações e relações interpessoais efetivas	S
23.	NTS2.1	Reconhecer e gerenciar ameaças	S
24.	NTS2.2	Reconhecer e gerenciar erros	S
25.	H5.6	Cumprir as regras de tráfego aéreo	S
		Manobras normais	
26.	C2.1	Realizar procedimentos pré-voo	S
27.	C2.2	Realizar inspeção pré-voo	S
28.	H1.1	Acionar o helicóptero	S
29.	H2.1	Decolar a aeronave e estabelecer voo pairado	S
30.	H2.2	Executar giros em torno do mastro	S
31.	H2.3	Deslocar a aeronave em todas as direções a partir do voo pairado (quadrados)	S
32.	H3.1	Taxiar o helicóptero	S
33.	H4.1	Realizar os cheques pré-decolagem	S
34.	H4.2	Realizar uma decolagem normal	S
35.	H4.3	Realizar uma aproximação normal para pouso	S
36.	H4.4	Realizar uma Decolagem Direta	S

Figure 3 - Extract from the pilot's FAP 04.7.

The following elements of competence assessed were highlighted in red in Figure 3, to further analysis: "Technical knowledge of the aircraft"; "Normal, abnormal and emergency aircraft procedures"; "Reading and interpretation of weather messages and charts"; "Reading and interpretation of aeronautical publications (ROTAER, AIP, NOTAM, etc.)"; "Flight planning"; "Keep effective surveillance"; "Keep Situational Awareness"; "Assessing Situations and Making Decisions"; and "Recognize and Manage Threats".

1.5.3 Category of licenses and validity of certificates.

The pilot had the PPH License and had a valid HMLT Rating.

1.5.4 Qualification and flight experience.

As a helicopter pilot, he had previously flown the R44, R66, H350 Esquilo, and A109E model aircraft.

His flight experience was limited to the operation of private aircraft, according to the requirements of the RBHA No. 91 - “General Operating Rules for Civil Aircraft”, in force at the time of the accident.

The A109E model was the first multi-engine helicopter operated by the pilot.

Of the total hours on the A109E, the pilot had about 8 hours performed at night, with only 4 hours and 30 minutes registered in his digital CIV. None of these recorded hours were spent on instruction or dual command flights.

The first night operation as a pilot of the PP-MTX aircraft took place on 02JUN2018, and the last night operation, before this flight, had taken place on 21FEB2016, in the aircraft model H350.

This long period without performing night operations (more than 2 years) in the same category and class of aircraft was contrary to the provisions of section 61.21 of RBAC 61:

> 61.21 Recent Experience
>
> (a) Except for the deadlines established in section 61.19 of these Regulations, a pilot may only act as pilot-in-command of an aircraft if, within the preceding 90 (ninety) days, he has performed:
>
> [...]
>
> (2) for night flight operations: at least 3 (three) take-offs and 3 (three) landings at night, during which the controls of aircraft of the same category and class/type have actually been operated;

In June, July, August, and September 2018, the pilot performed 11-night landings and take-offs, none of them under instruction. However, despite these take-offs and landings, it was not possible to state that the pilot had the recent experience to perform night operations, considering that, in section 61.21 of the RBAC 61, there was no clarification on the procedures necessary for a pilot to reacquire the recent experience qualification.

The procedures for acquiring recent experience were established only for glider-tows and parachutists launcher pilots, according to letter (d) of section 61.21 of the RBAC 61:

> (d) In the case of a glider-tow pilot and a parachutist launcher pilot, if the pilot has not performed at least one of these operations (as applicable) within the last 90 days, he must perform an operation accompanied by a qualified flight instructor.

Despite the little experience, the pilot complied with the regulations applicable to his operating environment, regarding Licenses, Ratings, CMA, training, and examinations.

The pilot was qualified but had little experience in the type of flight (Night VFR), and it was not possible to say whether he met the requirements established in section 61.21 of the RBAC 61 regarding recent experience.

The pilot was the owner of the company and the aircraft, however, there was another pilot hired to carry out the flights on business.

1.5.5 Validity of medical certificate.

The pilot had a valid CMA.

1.6 Aircraft information.

The aircraft, model A109E (commercial designation A109E Power), SN 11120, was manufactured by Agusta in 2001 and was registered in the TPP Category.

The aircraft had a valid CA.

The airframe and engine logbook records were updated.

The last inspection of the aircraft, of the “50 hours/30 days” type, was carried out on 17OCT2018 by an accredited mechanic, in São Paulo - SP, with approximately 6 hours flown after the inspection.

The last inspection of the aircraft, of the “IAM” type, was carried out on 24APR2018 by the Maintenance Organization HBR *Aviação* Ltd., in Osasco - SP, with the aircraft having flown approximately 90 hours after the inspection.

According to the RAB, the PP-MTX aircraft was certified to operate under IFR.

The PP-MTX was equipped with a Digital Weather Radar System, RDR 2000 Bendix King, Part Number (PN) 109-0811-47, which could be displayed on the EHSI screens of the two cockpits when the respective modes were selected.

Figure 4 below shows the location of the FDMS panel, the ADIs, and the two EHSIs where the RADAR could be selected and viewed, the image is an illustration of the RADAR display screen itself, taken from the equipment manual.

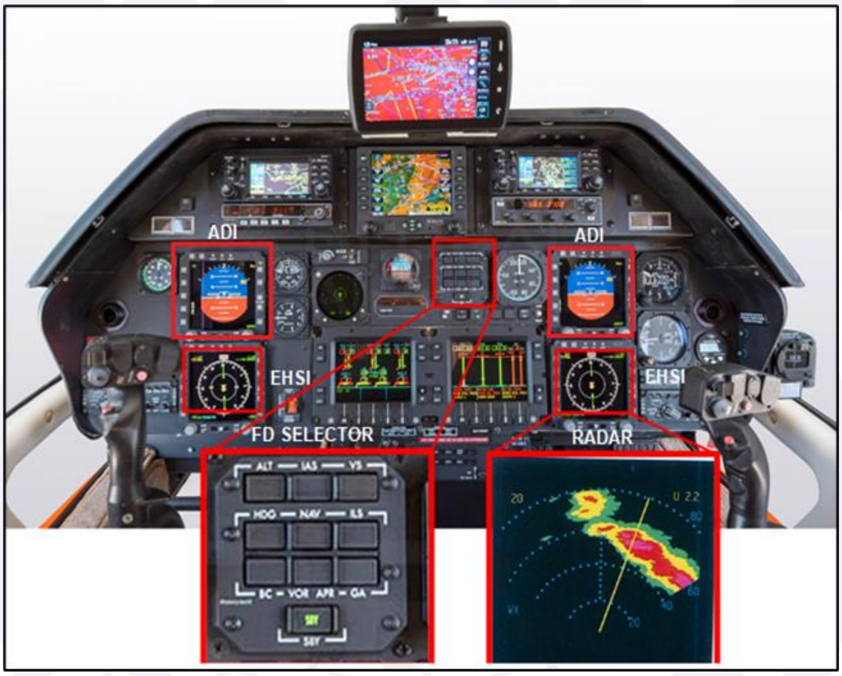


Figure 4 - A109E Panel.

Section 7, Systems Description, Heli Pilot/Flight Director, RFM 109E, indicated that the Heli Pilot Computer performed all the electronic calculations and processing necessary for the stabilization and automatic control of the trajectory of the helicopter when coupled with the FDC.

The Heli Pilot System was operated from switches located in the cockpit.

Likewise, the FDC performed all the electronic calculations and processing necessary to display FDMS commands on the ADI and to perform automatic route control functions when coupled with the Heli Pilot Computer.

Automatic control depended on the FDC and was obtained automatically after selecting a valid mode in the FDMS controller, as shown in Figure 4.

The IFR mode operated in either of two possible conditions: automatic course control or attitude maintenance.

If a valid FDMS mode was not selected on the pitch or roll axes, the respective axis would revert to the attitude hold condition. Thus, when flying in this condition, the pilot could command attitude changes in the normal way through the cyclic control. Permanent attitude changes were performed by operating the aircraft's force trim pushbutton (FTR) located on the cyclic grip (Figure 5, item 2).

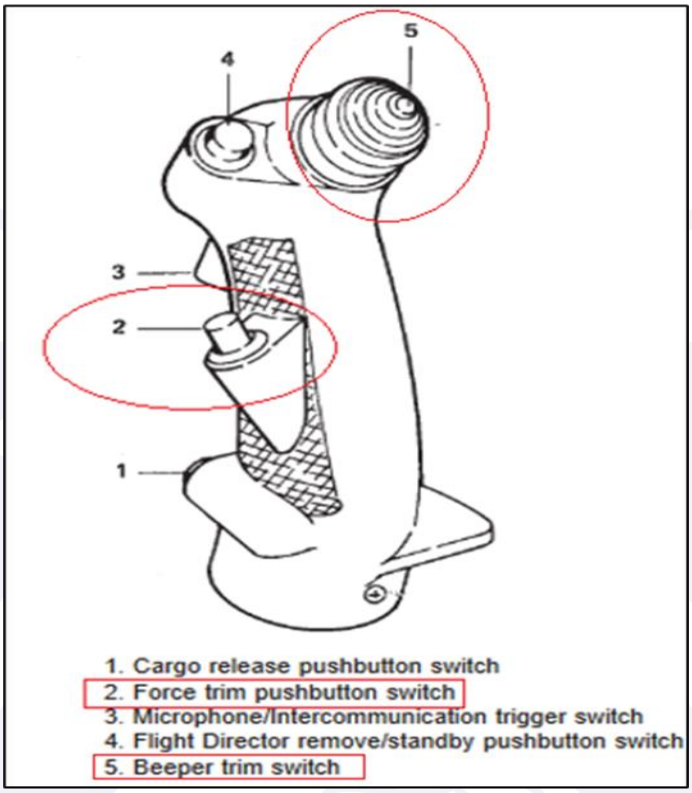


Figure 5 - Cyclic command. Source: RFM 109E.

Lateral modes available for both flight director and auto-engagement included HDG, NAV/VOR-VOR APP, and Localizer (normal and reverse course).

The vertical command bar in the ADI was automatically followed when the Heli Pilot Computer was engaged. In manual operation, the pilot flew following the command bars, performing a cross-check with the other instruments to keep the aircraft stabilized.

Longitudinal/vertical modes of operation included ALT mode, IAS maintenance mode, VS mode, and GS capture and tracking mode. The pilot could fly with one of these modes attached.

During the climb, the RFM advised that the roll axis control could be performed using either the HDG or NAV mode.

For leveling, the ALT mode could be selected, either employing automatic control or using only the FD operation. The altitude could be changed at any time by pressing ALT off and flying to a new chosen altitude and pressing ALT again.

Navigating with the IAS mode in cruise flight, a new airspeed could be selected, actuating the airspeed increase/decrease switch on the cyclic command (beeper trim switch), this would change the reference speed by approx. 2 kt per second (Figure 5, item 5).

According to Section 1 - Limitations - of the RFM A109E, the rotor speed limit for the AEO condition was 102%.

According to Section 3 - Emergency and Malfunction Procedures of the RFM A109E, an alert message (red), a voice message (Rotor High), and acoustics were issued when the rotation of the rotor exceeded the speed in 105.5% in the condition of power on and 110.5% with power off. The corrective action for this condition would be the use of the collective, reducing the potency.

1.7 Meteorological information.

Figure 6 shows the approximate distances between the accident site and the aerodromes located in the area close to the occurrence.

Figure 6 - Distances between the place of occurrence and the researched aerodromes.
Source: adapted from Google Maps.

Thus, and with the purpose of evaluating the meteorological conditions at the moment of the occurrence, the SRPV-SP analyzed the available data from the region close to the accident site.

For this purpose, Meteorological/Satellite Radar images and data from the TAF, the METAR, the SPECI, the AD WRNG of the Governor André Franco Montoro Aerodrome - Guarulhos (SBGR), Campo de Marte (SBMT), Congonhas (SBSP) and Santos Air Base (SBST) in São Paulo were used.

A SPECI message from SBGR, issued at 2230 (UTC), reported an increase in average wind speed from 4 kt to 11 kt, with gusts of up to 28 kt. The message also brought the condition of a thunderstorm with light rain (-TSRA), which evolved into a thunderstorm with moderate rain (TSRA), in a new SPECI issued at 2245 (UTC). The condition lasted until the METAR at 2300 (UTC), which reported gusts of up to 20 kt and, again, –TSRA:

METAR SBGR 032200Z 31004KT CAVOK 27/21 Q1011=

SPECI SBGR 032230Z 19011G28KT 8000 -TSRA BKN023 FEW040CB 22/18 Q1013=

SPECI SBGR 032245Z 21011G28KT 5000 +TSRA BKN023 FEW040CB 20/18 Q1014=

METAR SBGR 032300Z 22010G20KT 8000 -TSRA BKN020 FEW040CB 19/18 Q1015 RERA=

The METAR of SBMT at 2200 (UTC) showed a thunderstorm in the vicinity of the aerodrome (VCTS). A SPECI issued ten minutes later, however, highlighted the presence of a thunderstorm (TS) over the aerodrome, in addition to an increase in wind speed to 25 kt with gusts of 37 kt. The following message had a thunderstorm with light rain (-TSRA), but still with a strong wind of 25 kt and gusts of 37 kt that lasted until 23:10 (UTC):

METAR SBMT 032100Z 29008KT CAVOK 29/18 Q1010=

METAR SBMT 032200Z 26004KT 9999 VCTS FEW049CB 28/19 Q1011=

SPECI SBMT 032210Z 22025G37KT 8000 TS SCT025 FEW049CB BKN100 23/16 Q1013=

METAR SBMT 032300Z 18021G31KT 8000 -TSRA FEW017 FEW049CB BKN060 BKN100 19/16 Q1014=

SPECI SBMT 032310Z 16011KT 8000 BKN019 BKN049 BKN100 19/15 Q1015 RETS=

The METAR of SBST at 2200 (UTC) presented similar wind conditions to the SBGR and SBMT, with an intensity of up to 17 kt and gusts of 31 kt:

METAR SBST 032100Z 14003KT 9999 FEW025TCU SCT030 26/22 Q1004=

METAR SBST 032200Z 28017G31KT 5000 HZ SCT016 FEW025TCU 25/22 Q1010=

METAR SBST 032300Z 27008KT 5000 BR SCT010 OVC014 22/20 Q1013=

In SBSP, from 2200 (UTC) on, the METAR reported wind of 29 kt with gusts of 40 kt. A SPECI issued at 2210 (UTC) indicated wind of 28 kt with gusts of 40 kt and thunderstorms in the vicinity (VCTS).

Seven minutes later, a new SPECI reported a thunderstorm with heavy rain (+TSRA) and Windshear (WS) on runway 17R. At 2236 (UTC), there was a reduction in precipitation, but the thunderstorm lasted until 2300 (UTC):

METAR SBSP 032100Z 30008KT CAVOK 29/17 Q1011=

METAR SBSP 032200Z 26029G40KT 9999 SCT013 BKN080 29/18 Q1014=

SPECI SBSP 032210Z 20028G39KT 9999 VCTS BKN017 FEW040CB 21/16 Q1015=

SPECI SBSP 032217Z 20024G37KT 2000 +TSRA BR FEW009 BKN013 BKN019 FEW040CB 20/17 Q1016 WS R17=

SPECI SBSP 032236Z 21019G32KT 6000 -TSRA BKN011 BKN039 FEW045CB 19/16 Q1015 RERA=

METAR SBSP 032300Z 20020KT 8000 -RA SCT011 BKN013 OVC020 19/15 Q1016 RETSRA=

The meteorological information researched indicated, therefore, that the atmosphere in the region of the accident was unstable. This instability was characterized by the presence of thunderstorms with electrical discharge, precipitation, and strong wind.

The meteorological radars detected, between 2140 (UTC) and 2210 (UTC), a gradual increase in the intensity of precipitation in the region of the accident. The peak occurred in the image of the last hour, evidencing the degradation of weather conditions at the time of the accident, as shown in Figure 7.

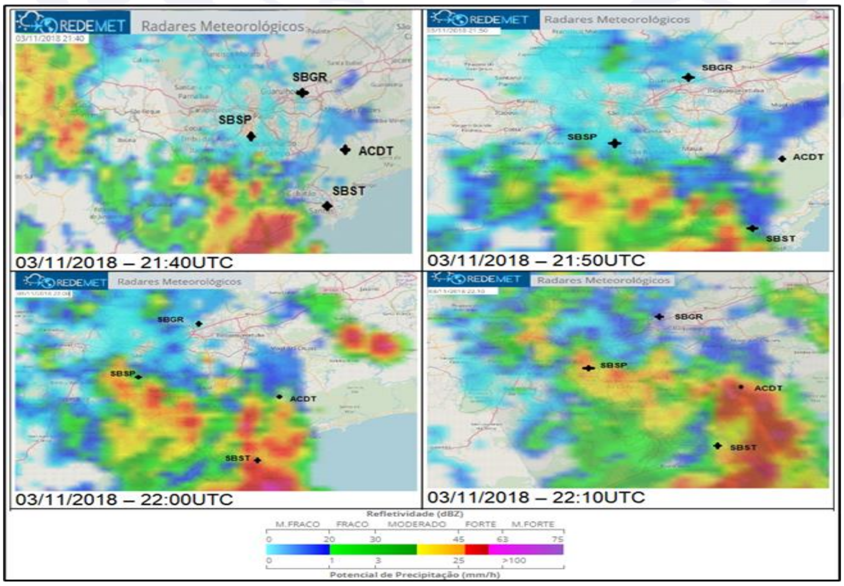


Figure 7 - Weather RADAR images. The accident site is marked “ACDT”. Source: REDEMET

Based on the reflectivity table, between 2200 (UTC) and 2210 (UTC), there was potential for a thunderstorm with heavy rain (+TSRA) at the aircraft impact site. The precipitation rate reached levels above 30 mm/h.

Also, at 2000 (UTC), an AD WRNG was issued for the aerodromes of SBSP, SBMT, and SBGR, which informed a forecast of thunderstorms and wind speed of 15 to 30 kt.

The images from the GOES 16 satellite, channel 16, at 2211 (UTC), showed considerable instability over the Southern and Southeastern regions of Brazil. The red color indicated cloud tops with temperatures below -60°C, indicating high potential for Cumulonimbus (CB) clouds. The storm was associated with this type of cloud (Figure 8).

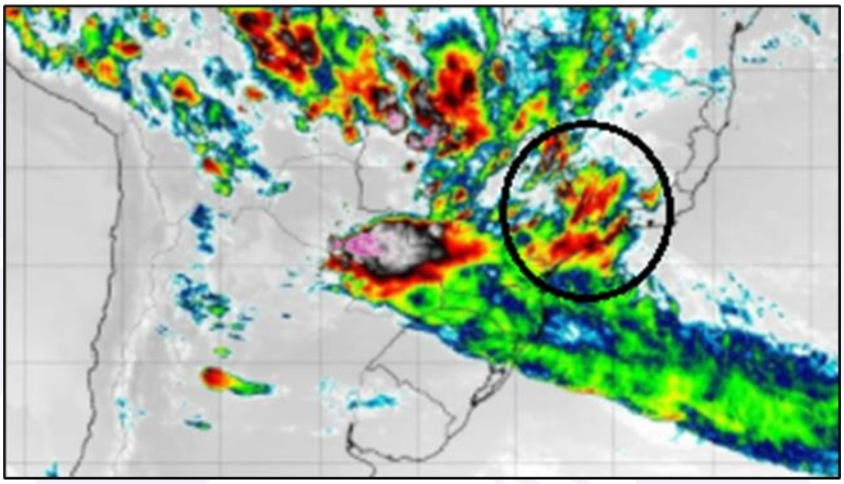


Figure 8 - Satellite image at 2211 (UTC), highlighting the accident region.
Source: CPTEC/INPE.

Between 1800 (UTC) and 2100 (UTC), the TAF recorded a probability of 30% for the occurrence of a thunderstorm with rain (TSRA) at the SBGR, SBSP, SBMT, and SBST aerodromes. Likewise, from 2100 (UTC) on, the occurrence of rain showers (SHRA) was also predicted on a temporary basis (TEMPO).

The GAMET, referring to the FIR Curitiba, in Sectors 5, 8, and 9, reported that, between 2100 and 2400 (UTC), it was expected thunderstorm with CB, whose base would be 3,000 ft and top above 10,000 ft (in relation to ground level), in the region close to the accident.

The prognostic messages (TAF, GAMET, AD WRNG) were consistent with what was observed in the present time (METAR/SPECI) and Meteorological/Satellite RADAR messages. Therefore, the phenomena associated with the presence of CB clouds in the region, that is, strong wind (vertical and/or horizontal), indicated that the conditions were not favorable for the visual flight.

1.8 Aids to navigation.

Nil.

1.9 Communications.

The flight took place in Class G uncontrolled airspace, as recommended by the AIC N 33/18, of 26APR2018, which dealt with the Circulation of Aircraft in VFR Flight at the TMA-SP.

In class G airspace, traffic under IFR was separated from VFR flights in the TMA-SP. For traffic in visual conditions, only the Flight Information and Alert Service were provided by the agencies providing the ATS.

It was stated, in item 4.2 of the respective Circular, that the coordination between aircraft in uncontrolled airspace should be carried out on the FCA. Thus, the aircraft should coordinate its flight through FCA Shore, frequency 122.925 MHz.

It is worth noting that the Flight Information Service and Airspace Alert “G” under the TMA-SP 1 was provided by the APP-SP, when feasible, through the 129,500 MHz frequency.

According to data extracted from the CVR, three times at the FCA Shore, the PP-MTX reported the position of the aircraft and its intentions.

At 21:44:15 (UTC), the aircraft reported its position and beginning of take-off:

> For coordination, MTX is in Juquehy and will start take-off.

At 21:46:36 (UTC) the aircraft reported that it started the take-off from SDJD and which heading it was maintaining:

> It took off from Juquehy, heading towards Riviera de São Lourenço, it's the MTX.

At 21:49:41 (UTC), the aircraft communicated its destination and en-route climb intentions:

> Boracéia … is heading towards Ribeirão Pires, climbing to 4,500 is the MTX.

There was no contact with the APP-SP requesting weather conditions en route.

1.10 Aerodrome information.

The occurrence took place out of the Aerodrome.

1.11 Flight recorders.

Although not required, the aircraft was equipped with a Honeywell SSCVR CVR, P/N 980-6022-001, Solid State Memory model.

The CVR data were extracted and analyzed by the CENIPA's LABDATA, to enable the reading of communications maintained between the pilot and the passengers. It was possible to extract communications from the last 30 minutes of the flight prior to the accident.

A dialogue was identified between the pilot and one of the passengers which helped to understand the dynamics of the accident, specifically with regard to the comments in the cabin about the weather conditions.

To record the times described in this field, Coordinated Universal Time (UTC) was used.

At 21:44:40, the first dialogue took place between the passenger and the pilot regarding adverse weather conditions on the route and their perceptions of them.

From that point on, throughout the flight, they verbalized the visualization of both meteorological phenomena and other visual references. In the end, communications signaled difficulties in keeping control of the aircraft.

At 21:46:00, the passenger expressed the presence of wind.

At 21:47:30, the passenger asked the pilot about the forecast of rain en-route.

At 21:52:41, the passenger asked about the wind en-route, receiving the pilot's answer that the aircraft was moving at a lower speed.

At 21:55:27, the passenger reported seeing cars parked on the roads.

At 21:59:45, the passenger commented that, on the following day, there would be a prospective of aircraft landing on the SDJD helipad, from where they took off. The pilot replied that the forecast would be of rain for the next day. Then the passenger commented again on the vehicular traffic on the road.

At 22:03:38, the passenger asked if what he was observing was a black cloud, receiving confirmation from the pilot. Then, the pilot reported the presence of rain to the left of the aircraft's trajectory.

At 22:04:25, the passenger exclaimed that they were flying inside a rain cloud. Then the pilot replied that everything was fine.

Passenger: “the flight is inside the rain cloud, damn it!”

Pilot: “calm down, calm down!”

At 22:06:05, the pilot recorded what would possibly be the end of an event, that is, the departure of the aircraft from within the cloud, then informed that it was a meteorological formation after the passenger said that he had never seen it.

Pilot: “Done!”

Passenger: "I've never seen it, right in the cloud!"

Pilot: “formation!”

At 22:07:05, the pilot asked the passengers if they were calm. Then the passenger asked the same question.

At 22:07:25, the pilot informed him that he would reduce speed and decouple the AFCS's “NAV” mode.

Pilot: “It will reduce speed!”

Pilot: “NAV OUT!”

Ten seconds later, at 22:07:35, the pilot verbalized what would be the end of an event.

At 22:07:42, the pilot made another exclamation.

Pilot: “Oops!”

Immediately, he and the passenger voiced exclamations that would correspond to an attempt to maintain the controllability of the aircraft.

Passenger: “Calm down!”

Pilot: “ok, ok!”

Immediately, the aural alarm of the aircraft “Rotor High” was identified, as well as the elevation of the sound of rotation emitted by the engines of the aircraft, interrupting the recording afterward, with the probable collision with the ground.

Thus, based on the analysis of the CVR frequencies, it was possible to identify that, from the moment the pilot reduced speed and decoupled the NAV mode (NAV OUT), a series of variations in the engine power began, until the moment of the accident (Figures 9, 10 and 11).

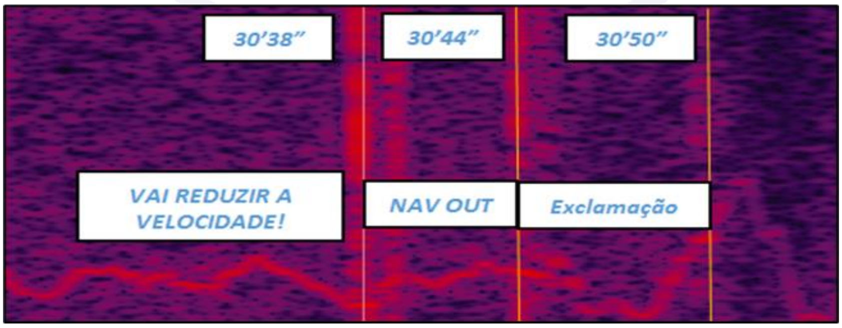


Figure 9 - Analysis of PP-MTX CVR frequencies.

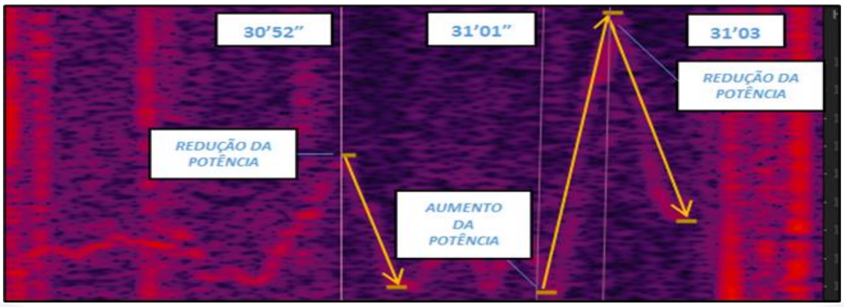


Figure 10 - Analysis of PP-MTX CVR frequencies.

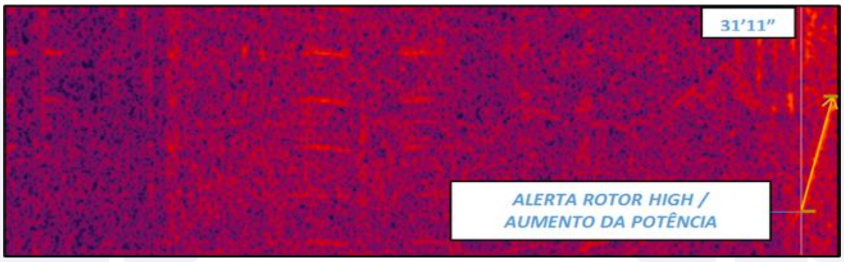


Figure 11 - Analysis of PP-MTX CVR frequencies.

To enable the analysis, the LABDATA performed a mixing of two audio channels from the CVR: the audio channel, which had the area noises, and the pilot channel. Afterward, the audios were synchronized since there was a time lag between the channels. Finally, the characteristic sound frequencies of the engines were identified and analyzed.

The frequency analysis time record took, as a reference, the timing of the CVR from the beginning of the recording.

1.12 Wreckage and impact information.

During the field action, it was found that the impact occurred with high energy, in a region of dense Atlantic forest, with vegetation characterized by medium-sized trees.

The first impacts of the aircraft occurred against some trees distant around 38 meters from the concentration of the wreckage core, which corresponded to the PP-MTX cabin. The average trajectory measured from these marks and the final position of the wreckage core had a magnetic direction of approximately 289°.

Figure 12 shows the flight trajectory and the first trees hit, including a side view of them.

Figure 12 - Aircraft trajectory at the accident site.

The wreckage was found dispersed in three large groups: cabin, engines, and tail cone section.

It was estimated that the impact angle of the aircraft trajectory in relation to the mid-ground plane was at an angle close to 45º.

The engines were found around 9 meters ahead of the wreckage core, at the farthest point of the site. Figure 13 shows the position of the engines from two angles, as well as the marks left on the ground due to their displacement and the position of the CVR.

Figure 13 - View of the engines and location of the CVR, in relation to the cockpit.

There were some trees whose trunks had greater mass, which partially broke, preventing the rest of the aircraft structure from moving across the terrain. Figure 14 shows the position of the wreckage core.

Figure 14 - Wreckage concentration.

The tail rotor section was found near the first points of impact against the tallest trees and showed no marks of fire or soot (Figure 15).

Figure 15 - View of the rotor and part of the tail cone.

Figure 16 shows the sketch corresponding to the top view of the accident site, as well as the position of an observer of the occurrence.

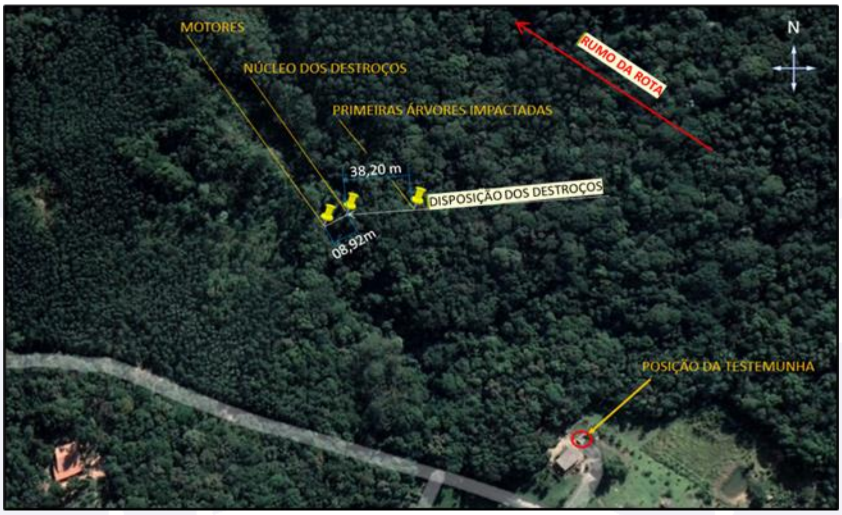


Figure 16 - Sketch of the wreckage layout. Source: adapted from Google Maps.

1.13 Medical and pathological information.

1.13.1 Medical aspects.

According to information collected in interviews after the accident, the pilot did not have any medical problems and was considered by people close to him to be in good health.

There was no evidence that physiological or disability considerations, medication use, or fatigue affected the crewmember's performance.

In post-mortem examinations, it was found that there was no evidence of alcohol, nor pharmacological or toxically active substances that could have interfered with his flight performance.

According to the autopsy report, the fatal injuries occurred due to multiple trauma.

1.13.2 Ergonomic information.

Nil.

1.13.3 Psychological aspects.

According to reports from people close to him and his acquaintance, the pilot was described by family and friends as an active, determined, thorough, hardworking person and was seen as a good leader in conducting his company's business.

According to family members, he was in good health, at a favorable moment in his life, with plans for business growth and good future expectations.

He was considered zealous in all aspects of his life. In addition, he demonstrated emotional control and a good ability to deal with conflict.

He trained as a private pilot 5 years ago. He was a businessman and did not work professionally in aviation, exercising aerial activity as a hobby. Commonly, on weekends, he used the aircraft for leisure and to transfer his family members to the coast of the state of São Paulo, where he had a residence.

The pilot had already flown other smaller, single-turbine helicopters and as reported in interviews, the acquisition of the A109E was for an “operational gain” with better and greater capacity to perform his usual flights (coast of SP, capital, and countryside), which allowed crossing the *Serra do Mar* with greater performance and altitude.

As reported by pilots who had contact with him during his training to perform the proficiency exam for the granting of the HMLT Rating, the acquisition of the new aircraft would provide more safety and confidence to the pilot due to the onboard technology, which had better operational resources.

During the week, there was a private pilot, who was hired to carry out flights related to his work commitments, usually to the countryside of SP, close to the capital.

According to the records of landings and take-offs at the Juquehy Baleia helipad, the pilot who owned the aircraft had been operating there for a year, as well as other nearby helipads, on average once a month, usually on weekends.

The pilot did not inform about the flights of the day of the accident in the App group of a cell phone, used for exchanging text messages, as he normally did. His family members were also unaware of the last two legs he performed that day.

According to the interviews, the pilot decided to anticipate the return to São Paulo, initially scheduled for Sunday, 04NOV2018, to the previous day (Saturday, 03NOV2018), as he believed in the entry of a cold front coming from the Southwest, which would degrade weather conditions, making it impossible to conduct the return flight on Sunday.

The pilot then scheduled himself to fly three legs on the day of the accident: the first leg was to take his family members who were at the *Condomínio Laranjeiras* helipad (SDLA) back to São Paulo; the second leg was from the HBR helipad to the Juquehy Baleia helipad (transfer flight); and the third leg, referring to the accident, whose objective was to transport four passengers.

1.14 Fire.

After the impact with the ground, there was a fire caused by the dispersion of fuel, which consumed the concentrated part of the wreckage and engines.

It was observed that the tail rotor section showed no signs of fire, soot, or smoke.

1.15 Survival aspects.

There were no survivors.

1.16 Tests and research.

The components were separated and distributed by systems, to better understand the pre-impact aircraft configuration against the *Cerrado* region (Figure 17).

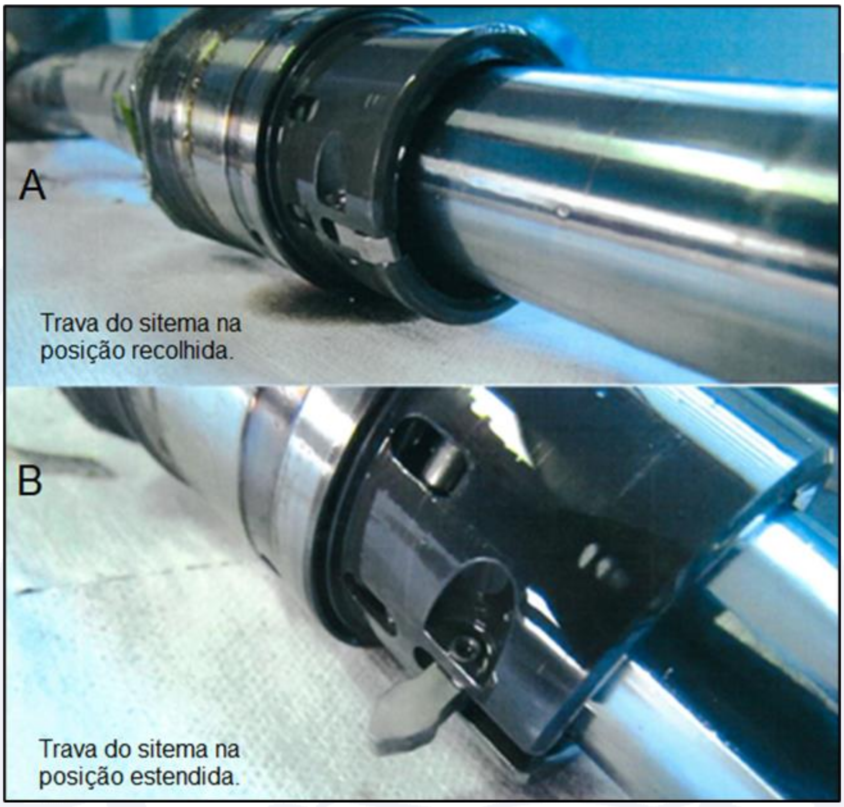
Figure 17 - Wreckage distribution.

From the analyses, it was observed that the landing gear actuation lever was in the “down” position, with no evidence of activation and use of the emergency system.

The main landing gears were found with one actuator extended and the other retracted, and the one that was retracted had damage and dents from the impact. It was not possible to identify which side (left or right) the actuators belonged to. The nose gear actuator was in the extended position.

Thus, given the degree of destruction of the aircraft caused by the impact, it was not possible to determine whether there was an attempt to lower the landing gear.

However, macroscopic examinations conducted by the Materials Division of the IAE indicated that the landing gear locking device in the extended position showed no signs of failure and that no fractures were observed in the lock (Figures 18 A and B).



Figures 18A and B - Landing gear locking system.

Thus, it was concluded that the landing gear locking system did not suffer failure or fracture.

In the tail rotor drive shaft, the damage was found that contained overload fracture characteristics, arising from the impact of the aircraft.

Due to the axis not showing signs of fire along its entire length, it was concluded that the tail rotor section was separated from the aircraft at the time of the first impacts against vegetation and that the fire occurred as a result of the aircraft's impact on the ground.

The Pratt & Whitney engines, model PW 206C, SN PCE-BC0258, and PCE-BC0257, which equipped the PP-MTX were dismantled and inspected at the Pratt & Whitney shop, in Sorocaba - SP. This work was accompanied by representatives of the SERIPA IV, Agusta/Leonardo, and the IAE.

Figures 19 and 20 show that the engines were subjected to deformations and fires resulting from the impact of the aircraft on the ground.

Figure 19 - Front view of the SN PCE BC 0258 engine.

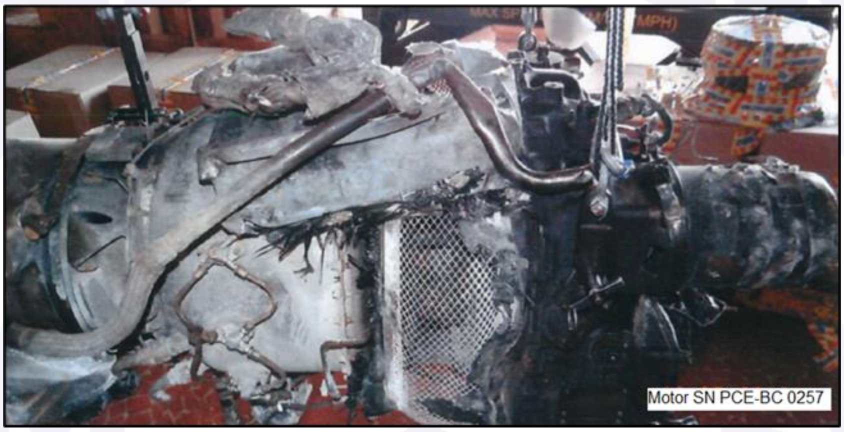


Figure 20 - Right side view of the SN PCE BC 0257 engine.

During the analysis, it was observed that the engines had damage by denting.

The severe action of the fire that followed the collision of the aircraft with the ground made it impossible to analyze the components of the engines that were exposed.

The hot sections were the ones that provided the greatest evidence of normal engine operation at the time the aircraft was involved in the accident. Rubbing marks were observed at the ends of the blades of the compressor`s rotors and the power turbines, which made it possible to verify that both engines were operating normally. (Figure 21).

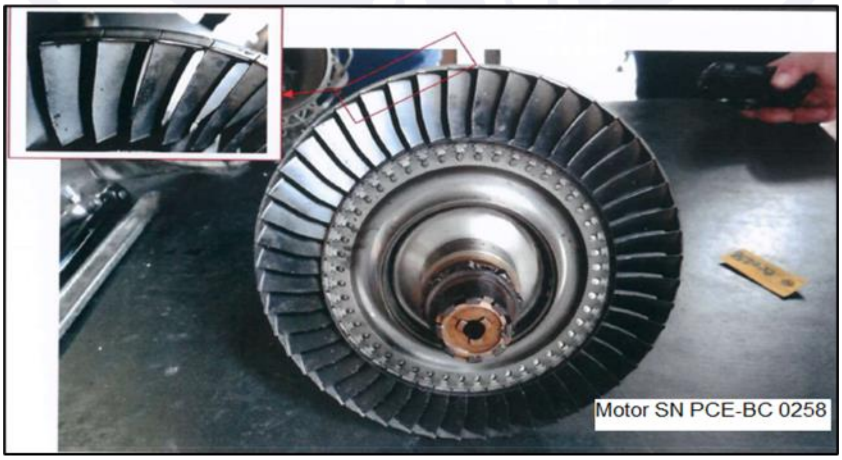


Figure 21 - Rear view of the power turbine rotor, highlighting the rubbing marks.

1.17 Organizational and management information.

The PP-MTX aircraft was operated by the real estate company owned by the pilot, based in Barueri - SP.

Although the aircraft was registered in the name of the pilot's company, its use was mixed, that is, it met both his professional and personal needs.

The aircraft's flights were programmed in advance in a cell phone App group, in which information was exchanged, via text message, about the flights that would be carried out, including to request aircraft fuel.

For weekday operations, there was a pilot hired to carry out flights related to work commitments.

This hired pilot exercised the air activity as a profession and had extensive experience in that segment and rotary-wing aircraft. According to the surveys carried out, this pilot had performed some “double command” flights with the pilot involved in the occurrence.

The “dual command” flights were intended to gain experience, as a kind of supplementary instruction on the aircraft. On these occasions, the pilot involved in the accident was evaluated as standardized and “smooth” in the controls.

1.18 Operational information.

On that day, the PP-MTX had already carried out two legs:

- take-off from SDLA at 2002 (UTC) with destination and landing on SSUB at 2057 (UTC), for transportation of family members; and

- take-off from SSUB at 2122 (UTC) with landing on SDJD, at 2140 (UTC), already at night.

In the pilot's planning, the leg between SDJD and SSUB would be the last flight of the day, taking four passengers.

The aircraft had been fueled in SSUB with enough fuel to carry out the intended legs and was within the weight and balance limits.

Figures 22 and 23 present the images of the security cameras showing the PP-MTX landing and taking off from SDJD, already at night, that is, after sunset.

Figure 22 - Image of the security camera at the time of landing in SDJD.

Figure 23 - Image of the security camera at the time of take-off from SDJD.

Item 3.3 of the Circular dealing with the Circulation of Aircraft in VFR flights at the TMA-SP established that:

> Pilots MUST keep the landing or taxi lights on during the flight, to improve the perception of other aircraft moving in the TMA-SP or under its projection.

Both SSUB and SDJD were aerodromes certified for VFR Night operations, according to the ROTAER.

The aircraft took off from a place without an ATC/ATS and the flight took place entirely in class G airspace. In Figure 24, it is possible to observe a schematic presentation of the TMA-SP, highlighting the airspace class G flown by the PP-MTX on the day of the accident.

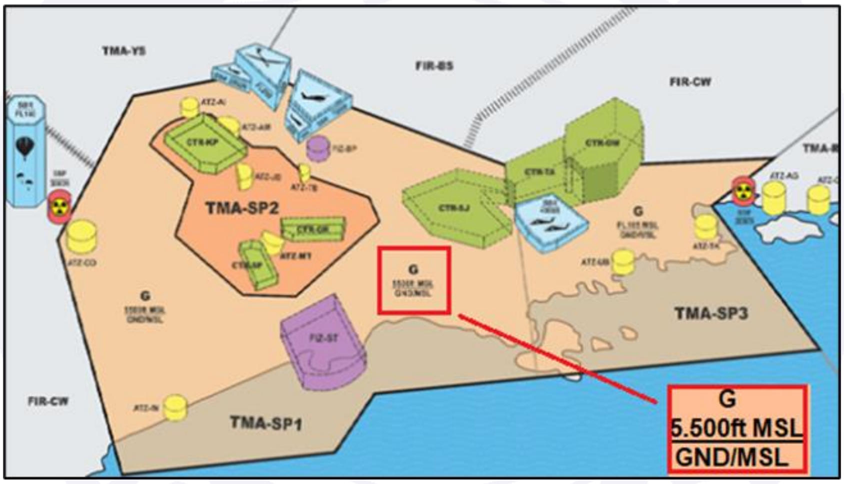


Figure 24 - Plan view of the TMA-SP, highlighting the “G” class airspace.

Based on what is recommended in items "b", "c" and "d" of item 2.3 of the ICA 100-11 - Flight Plan and, having the flight been conducted in the airspace underlying the TMA- SP, the pilot was exempted from submitting a Flight Plan.

By item 3.1.2 of ICA 100-4, Special Air Traffic Rules, and Procedures for Helicopters, in force at the time, to maintain VFR in uncontrolled airspace, flying above 3,000 ft altitude or 1,000 ft height, whichever is greater, helicopter pilots should:

> - keep in-flight visibility conditions equal to or greater than 3,000 m;
>
> - remain at least 1,500 m horizontally and 500 ft vertically from clouds or any other meteorological formation of equivalent opacity; and
>
> - keep reference with the ground or water, so that meteorological formations, below the flight level, do not obstruct more than half of the viewing area.

The pilot intended to proceed to the destination via REH, at an altitude of 4,500 ft, within the predicted lower and upper limits, according to AIC N 33/18.

Based on the information collected and on the transcripts of the CVR, the intended route would be flown with the initial heading of the RIVIERA fix, with a change of heading and climb to 4,500 ft near Boracéia beach, São Sebastião, heading to Ribeirão Pires - SP and, after, he would go to the SSUB destination (Figure 25).

Figure 25 - Sketch of the intended route.

According to interviews with people who knew the pilot's operational routine, it was found that he had on his personal device, tablet type, applications for aeronautical use, referring to meteorological planning and navigation. He used to consult the SBSP METAR to check the relevant weather conditions when he flew to SSUB.

Based on the views captured by the SAGITARIO of the APP-SP, it was observed (all times in UTC).

- at 21:57:39, the PP-MTX appeared for the first time in the RADAR synthesis with a 302° magnetic heading;

- at 21:58:33, the PP-MTX reached 4,500 ft;

- between 21:59:30 and 22:06:31, the transponder's “C” mode indicated that the aircraft would be flying at 4,600 ft. At that moment, from the summary presented by the SAGITARIO system, the position of the aircraft and no presence of meteorological formation can be observed;

- at 22:03:46, there was a shift of some meteorological formations from the West and South sectors of SBSP from Southwest to Northeast, on the South coast of São Paulo, between the cities of Santos and Itanhaém, and in the region of Mogi das Cruzes (Figure 26).

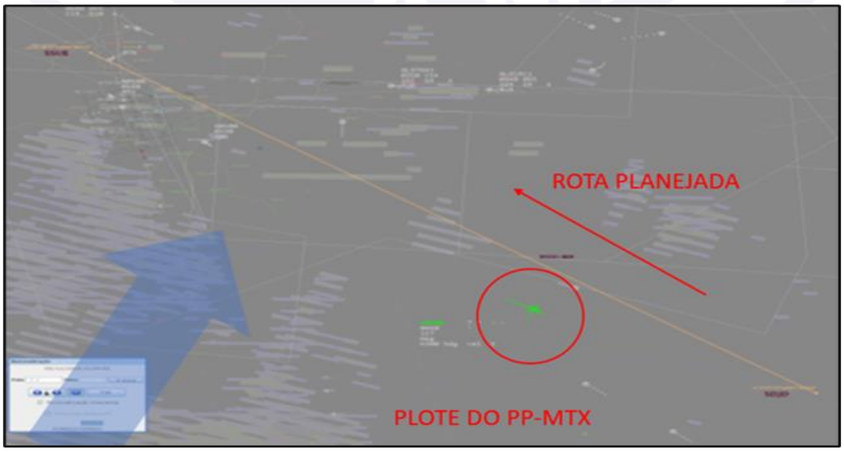


Figure 26 - Image of the SAGITARIO, highlighting the rapid advance of meteorological formations, characterized by gray lines.

- at 22:07:00, the PP-MTX transponder mode “C” revealed an altitude of 4,700 ft. There were many meteorological formations in the Mogi das Cruzes region. At that moment, the aircraft was on the 313° magnetic heading, the greatest variation of heading until then;

- at 22:07:24, the aircraft was still maintaining 4,700 ft and turned 29° to the left, changing to the magnetic heading 284°;

- at 22:07:27, the PP-MTX at 4,700 ft crossed the magnetic heading 244°, that is, the aircraft turned another 40° to the left, with the average turn rate employed by the aircraft of approximately 13.3° per second;

- at 22:07:32, the PP-MTX was at 4,600 ft on the 192° magnetic heading, having varied another 52° to the left, with the average turn rate employed by the aircraft in this period of 10.4° per second;

- at 22:07:35, the PP-MTX passed 4,400 ft in descent on the magnetic heading 159°, with an average turn rate of 11° per second;

- at 22:07:40, the aircraft passed 4,300 ft and was flying on the magnetic heading 132°, the average turn rate in this interval being 5.4° per second;

- at 22:07:47, the PP-MTX passed 4,100 ft on the 110° magnetic heading, the average turn rate in this interval being 3.1° per second; and

- at 22:07:51, the target was extrapolated, that is, from that moment on, the system stopped receiving information from the PP-MTX.

Figure 27 shows the presence of formations, characterized by gray lines, plotted on the SAGITARIO system screen close to the last position of the PP-MTX.

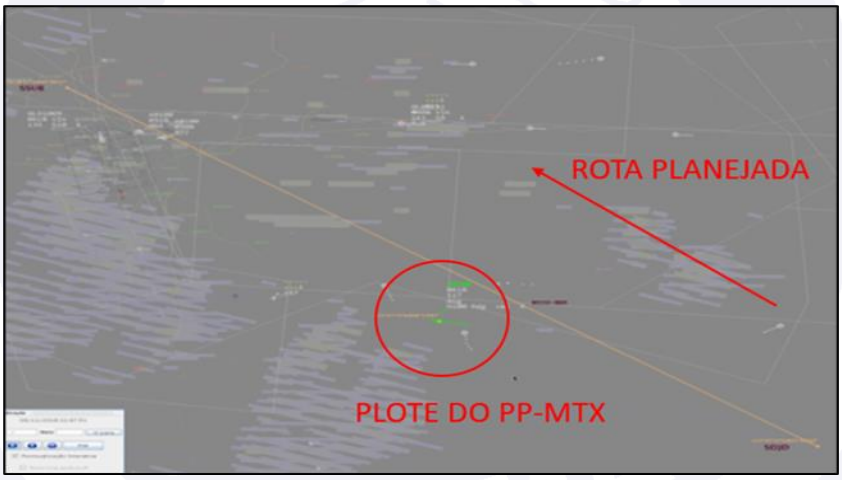


Figure 27- Image of the SAGITARIO, highlighting the presence of formations close to the last position of the PP-MTX.

The last position of the PP-MTX estimated by the SAGITARIO system was the point of geographic coordinates 23°42'25"S/046°13'02"W, about 0.6 NM from the accident site.

Despite a standard turn being performed with a variation of 3° per second (180° per minute), values above 6° per second (360° per minute) were verified, in other words, far above the recommended.

Since the flight was carried out entirely under the projections of the TMA-SP, there were no requirements that the pilot have an IFR flight License, nor that the aircraft be approved for the IFR flight, according to item 5.3.3 of ICA 100-12, Rules of the Air and Air Traffic Services, 08JUN2006, valid at the time.

The graph in Figure 28 summarizes the movements of the aircraft, in the moments before the accident.

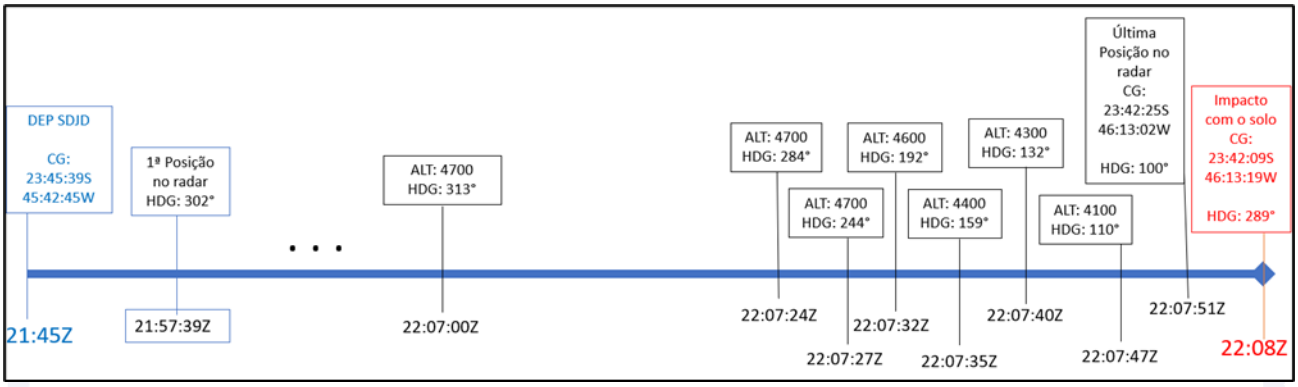


Figure 28 – STEP of the PP-MTX.

1.19 Additional information.

Regarding night operations, the FAA, through the FAA-H-8083-3B, Chapter 10, Night Operations, provided a series of information and proposed some guidelines on the subject, as follows:[1]

> Night flying operations should not be encouraged or attempted except by certificated pilots with knowledge of and experience in the topics discussed in this chapter.

The text warned that night operations should not be encouraged or undertaken, except by certified pilots with knowledge and experience in the subjects covered in that chapter.

When dealing with night vision, the document warned that, in addition to the limitations of vision, visual illusions can cause confusion and distractions during night flight. Layers of clouds or even lights ahead can confuse a pilot and indicate a false visual horizon.

Certain geometric patterns of ground lights, such as a freeway, can cause confusion. Dark nights tend to eliminate the reference line to the natural horizon. As a result, at night, pilots need to rely less on external references and more on flight and navigation instruments. Collision avoidance lights or other aircraft lights can cause vertigo. On long journeys, physical reactions such as nausea, dizziness, tremor, unconsciousness, headaches, or confusion may occur.

In this regard, Newman (2007) emphasized that flight in visual conditions was normally associated with a reference located on a horizontal surface, such as the horizon line or the top of a cloud layer. There were circumstances, however, where the visual system could perceive a horizontal reference when, in fact, that reference was not leveled. If an amount of clouds were indeed banked, the pilot could inadvertently fly with some degree of bank to maintain what was perceived to be a straight and leveled flight.

Likewise, on a night flight, an illusion of a false horizon can be created. If there is a lit coastal highway, the alignment of the runway lighting can lead the pilot to fly using this light corridor as a reference and, if it was not leveled, the pilot could place the aircraft in a certain degree of bank. This false horizon illusion is dangerous if the aircraft is operating with speed and at low altitude. If unrecognized, the situation can lead to a ground impact relatively quickly.[2]

When it comes to pre-flight training for night flying, the Airplane Flying Handbook (FAA-H-8083-3B), Chapter 10, Night Operations highlights that learning to fly safely at night takes

---

[1] FAA. Chapter 10 Night Operations. Available at: https://www.faa.gov/regulations_policies/handbooks manuals/ aviation/ airplane_handbook/media/12_afh_ch10.pdf. (our translation) Access on: 30NOV2021.

[2] Newman, David G. *An overview of spatial disorientation as a factor in aviation accidents and incidents*. *Australian Transport Safety Bureau*, *Canberra City*, A.C.T. VIII, p. 34, 2007. Available at: https://www.atsb.gov.au/media/29971/ b20070063.pdf (our translation) Access on: 30NOV2021.

time and your proficiency is enhanced with experience. For this, the pilot must practice a series of maneuvers, at night, to acquire competence in straight and leveled flight, climbs and descents, level turns, ascending and descending.

With respect to pre-flight, night flying requires pilots to be aware and operate within their abilities and limitations. Planning for the flight is essential, with special attention to weather forecasts, with emphasis on the direction and intensity of the wind since its effect may not be as easily detected at night as it was during the day.

Another aspect addressed in the publication is related to the recommendation not to fly towards the clouds. Typically, the first indication of flying in conditions of restricted visibility is the gradual fading of lights on the ground.

In this case, the publication warns that under no circumstances should a VFR night flight be conducted in adverse weather conditions unless the pilot and aircraft are certified and equipped for flight in accordance with the Instrument Flight Rules.

Chapter 10, Night Operations noted that night operations present additional risks that need to be identified and evaluated. To this end, pilots must be trained and familiar with the associated risks and how they differ from daytime operations. Even for experienced pilots, VFR night operations should only be conducted with unrestricted visibility, favorable winds, and no turbulence.

Also, in relation to the night operation, the TSB, in the Assessments of the response to Aviation Safety Recommendation A16-08 - Night visual flight rules regulations[3], recorded that, on 31MAY2013, a Sikorsky S-76A helicopter took off from the Attawapiskat Airport, Ontario - Canada, for an en-route night VFR flight, with 2 pilots and 2 paramedics on board, as described below:

> During the climb towards the planned cruise altitude of 1,000 ft above sea level, while cruising 300 ft above the ground, the pilot initiated a left turn. Twenty-three seconds later, the helicopter crashed into trees and then hit the ground in an area of dense woods and swampy terrain. There were no survivors. (our translation)

As a result of the investigation, the TSB concluded that the pilots took off for a VFR night flight under circumstances that did not allow them to safely maintain visual reference with the terrain.

Although the Canadian Aviation Regulation (CAR) required the pilot to maintain a visual reference to the ground in VFR night conditions, the regulation did not adequately define the visual references necessary for this compliance.

During the investigation, it was identified that many pilots operating VFR at night believed it was acceptable to do so, regardless of lighting conditions, as long as the reported weather conditions (i.e. ceiling and visibility) met the minimums specified in the regulations.

The report further stated that the risks associated with conducting VFR night operations in conditions where pilots were unable to maintain a visual reference to the surface were well documented in the TSB investigation reports.

In this way, the TSB revealed there was strong evidence which suggested that the regulations for carrying out VFR night flights, existing at the time, should be re-examined, and amended to establish the necessary conditions to guarantee the safety of the operation at this time of day.

Among the various actions taken to mitigate the problem, Transport Canada (TC), the regulatory agency, on the occasion of the publication of the Final Report of this occurrence,

---

[3] TSB. *Assessments of the response to Aviation Safety Recommendation A16-08 - Night visual flight rules regulations* Available at: https://www.bst-tsb.gc.ca/eng/recommandations-recommendations/aviation/2016/ rec-a1608.html. Access on: 30Nov2021.

was producing two Notices of Proposed Amendments: the first to update the rules for night VFR flight, and a second that contained a proposal to establish two types of requirements to allow a pilot to fly at night, under VFR rules.

A consultation carried out with the various regulatory agencies of international civil aviation revealed that the operation under VFR night flight conditions was regulated differently between these authorities, with no uniformity in the established requirements.

In the case of Brazil, the ANAC established, in the RBAC 61, the following night flight experience requirements for obtaining a PPH License:

> 61.81 Experience requirements for granting a private pilot license
>
> (a) The applicant for a private pilot license must have, as a minimum, the following flight experience in the requested aircraft category:
>
> [...]
>
> (2) helicopter category:
>
> (i) a total of 40 (forty) hours of instruction and solo flight, or 35 (thirty-five) hours of instruction and solo flight, if these were carried out, in their entirety, during the complete, uninterrupted performance and with the use of an ANAC-approved private helicopter pilot course. Total hours must include at least:
>
> [...]
>
> (e) 3 (three) hours of night flight instruction, which includes 10 (ten) take-offs and 10 (ten) complete landings, where each landing will involve a flight in the aerodrome traffic circuit;

At the time of publication of this Final Report, there were no night flight experience requirements to obtain a class Rating.

While, in Brazil, the prerogatives for night operation were based solely on the hours spent to obtain the License and to maintain recent experience, in other countries stricter specific criteria were established, which will be transcribed below:

- European Union Aviation Safety Agency (EASA) member countries:

EASA

Easy Access Rules for Flight Crew Licencing (Part-FCL)

ANNEX I (Part-FCL)

SUBPART I – ADDITIONAL RATINGS

FCL.810 Night rating

Regulation (EU) 2020/359

(b) Helicopters. If the privileges of a PPL for helicopters are to be exercised in VFR conditions at night, the applicant shall have:

(1) completed at least 100 hours of flight time as pilot in helicopters after the issue of the licence, including at least 60 hours as PIC on helicopters and 20 hours of cross-country flight;

(2) completed a training course at a DTO or at an ATO. The course shall be completed within a period of six months and comprise

(i) 5 hours of theoretical knowledge instruction;

(ii) 10 hours of helicopter dual instrument instruction time; and

(iii) 5 hours of flight time at night, including at least 3 hours of dual instruction, including at least 1 hour of cross-country navigation and 5 solo night circuits. Each circuit shall include a take-off and a landing.

(3) An applicant who holds or has held an IR in an aeroplane or TMG, shall be credited with 5 hours towards the requirement in (2)(ii) above.

Figure 29 - EASA Night Rating.
Source: adapted from Easy Access Rules for Flight Crew Licensing (Part-FCL).

Overall, EASA requirements demanded:

(1) complete at least 100 hours of flight time in helicopters after the license is issued, including at least 60 hours as a pilot on helicopters and 20 hours of flight en-route;

(2) have completed a training course with a DTO or an ATO. The course was to be completed within six months and comprised:

(i) 5 hours of theoretical knowledge instruction;

(ii) 10 hours of dual command instruction in helicopters; and

(iii) 5 hours of night flight, including at least 3 hours of dual command instruction, at least 1 hour of en-route navigation, and 5 solo night circuits. Each circuit must include a take-off and a landing.

- Australia:

The grant of a night VFR rating CASR 61.975

An applicant for a night VFR rating must:

- hold a private pilot licence, commercial pilot licence or air transport pilot licence;
- meet the requirements for the grant of at least one endorsement listed in the table on page 3.115;
- have at least 10 hours of aeronautical experience at night in an aircraft or an approved flight simulation training device for the purpose, including at least five hours of dual cross-country flight time at night under VFR in an aircraft
- have passed the flight test mentioned in the Part 61 manual of standards (MOS) for the night VFR rating.

The grant of a night VFR endorsement CASR 61.990

An applicant for an endorsement shown in the following table must hold a night VFR rating and have:

- completed flight training for the endorsement
- met the aeronautical experience requirements in the following table
- passed the flight test mentioned in Part 61 MOS for the endorsement.

Night VFR endorsements

3	Helicopter night VFR endorsement	Pilot a helicopter at night under the VFR	At least 10 hours of aeronautical experience at night as pilot of a helicopter (or an approved flight simulation training device for the purpose), including at least three hours of dual flight and one hour of solo night circuits At least three hours of dual instrument time in a helicopter (or approved flight simulation training device for the purpose)

Figure 30 - Authorization of a Night VFR rating.
Source: adapted from Australia Civil Aviation Safety Authority.

In the case of Australia, the Civil Aviation Safety Authority has established a series of requirements, including a requirement of 10 hours of previous night flight experience in an aircraft or an approved flight simulator, including at least 5 hours of en-route dual command flight under VFR night conditions.

In addition, there was an endorsement that, for its issuance, the interested party should have a minimum of 10 hours of night experience in helicopter flight or in an approved flight simulator, which included three hours in dual command flight and one-hour in-circuit night in solo flight. Additionally, the pilot must perform at least three hours of dual instrument flight and may be replaced by an approved flight simulator.

The ATSB, the accident investigation authority, reviewed 26 accidents that occurred in the country between 1993 and 2012 during night flights. All these accidents occurred in visual conditions and those that contained any type of mechanical failure were excluded.

In addition to the above events, there were also 10 accidents involving unintentional IMC, when loss of visual references, inadvertent VFR flight in IMC conditions at night, and/or collision with terrain/obstacle occurred when attempting to fly below the clouds at night.

As a result, the ATSB published - Avoidable Accidents No. 7, Visual flight at night accidents: What you can't see can still hurt you[4], in which it demonstrated how the adoption of appropriate strategies could significantly reduce the risks of night VFR flight.

In the introduction of the document, some key messages were transmitted, they were translated below:

> Flying at night is more difficult than flying during the day. Make sure you are up to date and proficient in instrument flying. Know your limitations in terms of flight with little or no visual reference. Fly only in environments that do not exceed your capabilities.
>
> Before departing on a visual flight at night or near dusk, make sure your aircraft is properly equipped and consider all available operational information, including visibility conditions.
>
> Some nights and some terrains are darker than others. Even in excellent visibility conditions, the contrast between sky and ground can be impaired.
>
> At night, it is more difficult to avoid inadvertent entry into IMC.
>
> Always know where the aircraft is in relation to the terrain, and know-how high you need to fly to avoid obstacles.
>
> Watch out for illusions that can lead to spatial disorientation, as they can affect anyone. Relying on instrument flight, learning how to avoid an abnormal attitude and how to recover. (our translation)

Furthermore, it is important to consider the risks and limitations inherent to single-pilot night operation, a condition in which a greater workload arises for the pilot.

1.20 Useful or effective investigation techniques.

Nil.

2. ANALYSIS.

It was a private flight en-route, at night, for the transport of passengers. The flight took place in non-controlled Class G airspace, with the Flight Information and Alert Service provided by the APP-SP, through the 129,500 MHz frequency.

Since the flight was carried out entirely under the projections of the TMA-SP, under VFR, there was no requirement for the pilot to have an instrument flight license, as provided for in item 5.3.3 of ICA 100-12, Rules of the Air and Air Traffic Services, from 08JUN2006, valid at the time.

The PP-MTX aircraft was registered in the TPP Category and was operated by a real estate company, based in Barueri - SP. It was managed by the pilot, who also owned the company, and reportedly the aircraft's flights were scheduled in advance.

According to the maintenance records, the airframe and engine logbook records were updated.

The landing gear actuation lever was in the "down" position. The actuator of the main and auxiliary landing gears was found extended and another landing gear was retracted. The one that was retracted had damage and dents from the impact.

Considering that the AIC 33/18, which dealt with the Circulation of aircraft in VFR flight at the TMA-SP, provided that pilots should keep the landing or taxi lights on during the flight, in order to improve the perception of other aircraft moving in the Terminal area or under its projection. It was considered the most probable hypothesis that the landing gears were down at the time of the accident.

---

[4] Avoidable Accidents No. 7, Visual flight at night accidents: What you can't see can still hurt you. Available at: https://www.atsb.gov.au/publications/2012/avoidable-7-ar-2012-122/. Access on: 30NOV2021

Examinations carried out on the engines concluded that the damage observed was characteristic of normal operation. The hot sections were the ones that provided the greatest evidence about the behavior of the powerplant at the moment the aircraft was involved in the accident. Rubbing marks were observed at the ends of the blades of the compressor`s rotors and the power turbines, allowing to verify that both engines presented normal performance.

Thus, all evidence observed indicated that the engines were operational and developing power at the moment of impact.

The analyzes carried out on the wreckage and the CVR audios ruled out the possibility of failure in any other system or component as a contributor to the occurrence.

The meteorological information collected indicated that the atmosphere in the accident region was unstable. This instability was characterized by the presence of thunderstorms, precipitation, and strong wind.

The meteorological radars detected, between 2140 and 2210 (UTC), a gradual increase in the intensity of precipitation in the region of the accident, whose peak occurred in the image at 2210 (UTC), evidencing the degradation of the meteorological conditions at the time of the accident.

Thus, the meteorological analysis showed that the phenomena associated with the presence of CB clouds in the region, characterized by a strong wind, high precipitation rate, thunderstorms, and restricted visibility, indicated that the conditions were not favorable for the visual flight.

Regarding visibility, the ICA 100-4, Special Air Traffic Rules, and Procedures for Helicopters, in force at the time, established that in order to maintain VFR in uncontrolled airspace, flying above 3,000 ft altitude, the pilots of helicopter should:

- keep in-flight visibility conditions equal to or greater than 3,000 m;
- remain at least 1,500 m horizontally and 500 ft vertically from clouds or any other meteorological formation of equivalent opacity; and
- keep reference with the ground or water, so that meteorological formations, below the flight level, do not obstruct more than half of the viewing area.

Still on weather conditions, in the publication entitled Airplane Flying Handbook (FAA-H-8083-3B), Chapter 10, Night Operations, the FAA warned that, under no circumstances, a VFR night flight should be conducted in adverse weather conditions, unless the pilot and aircraft are certified and equipped to operate in accordance with instrument flight rules. The text also emphasized that even for experienced pilots, VFR night operations could only be conducted with unrestricted visibility, favorable winds, and without turbulence, which was not the case with this flight.

Although the comments extracted from the flight recorder referring to the visualization of vehicles on the roads, other aircraft, and the formations themselves revealed the pilot's intention to fly in VFR conditions, the audios showed that, at a certain moment, the aircraft entered a rain cloud.

Concerning inadvertent entry into IMC conditions at night, the publication - Avoidable Accidents No. 7, Visual flight at night accidents: What you can’t see can still hurt you, from the ATSB, highlighted that, at night, it was more difficult to avoid inadvertent entry into meteorological conditions by instruments.

In addition, according to the pilot's comments, it was found that he was aware of adverse weather conditions close to the flight trajectory. However, he did not demonstrate the correct perception of the magnitude of the risk that such degradation could cause to the flight.

Additionally, the Flight Information and Alert Service were made available by the APP-SP for questioning en-route conditions. According to the last thirty minutes of CVR recordings, which included flight times before landing on the Juquehy helipad, there was no request for information regarding the meteorology en-route to the APP-SP.

Another resource available, to be used on the route, was the Digital Weather Radar System, RDR 2000 Bendix King, whose visualization could be made available on the pilot's EHSI screen. This equipment would have the ability to identify any type of meteorological formation, however, there was no evidence that it was in use during the flight.

Until that moment, at 22:07:24 (UTC), the PP-MTX was maintaining 4,700 ft, heading 284°. From this position, the graph that reproduced the movement of the aircraft indicated significant variations, both in the heading and in the altitude of the flight, to the point that the last RADAR synthesis indicated 4,100 ft and a magnetic heading of 110°, that is, 174° lagged from the initial heading.

It is noteworthy that, at various times, the RADAR synthesis indicated that the PP-MTX had a curve rate greater than 360° per minute, that is, well above the standard curve of 180° per minute.

Allied to this, the CVR frequency analysis revealed that, in this time interval, there were four variations in the power of the engines, two of which were of greater amplitude.

After the last reduction, this one of great amplitude, the voice (rotor high) and acoustic alarms were emitted, indicating that the rotation of the rotor would have exceeded the maximum allowed speed. The corrective action for this condition would be the use of the collective, which was done at the final moment of the flight, as identified in the spectral analysis of the CVR.

Evidence shown in the profile of the last 35 seconds of the flight suggested that the pilot experienced some sort of illusion, which may have led to spatial disorientation.

Regarding the pilot's experience in night VFR flights, there were only eight hours recorded in this type of flight in his digital CIV, in this aircraft model, and none of these hours were spent in instruction flight or dual command.

The reports collected also converged to the realization that most of the times he took that route had been during the day.

Additionally, with regard to compliance with the recent experience requirement, the RBAC 61 did not establish what would be necessary for a pilot to reacquire the recent experience rating.

Due to the complexity of night VFR flying, several countries, through regulatory agencies, have established specific requirements and training to allow the pilot to perform this type of operation.

In the case of countries linked to the EASA, for example, the pilot should have at least 100 hours in a helicopter and have completed a training course in a DTO or an ATO.

In relation to Australia, there was an endorsement that, for its issuance, the interested party must have a minimum of 10 hours of night experience in helicopter flight or in an approved flight simulator, which included three hours in dual command flight and one hour on a night circuit in solo flight.

The consequences of the speed reduction, combined with the withdrawal of the NAV mode and the possible loss of control, were analyzed. Automatic flight control depended on the FDC and was achieved automatically after selecting a valid mode in the FD controller. Without selecting a valid mode on the pitch or roll axes, the respective axis would revert to the attitude hold condition.

Thus, when flying in this condition, the pilot could command the attitude changes in a normal way through the cyclic control. Permanent attitude changes were performed by operating the aircraft's FTR button located on the cyclic grip.

After the removal of the NAV mode, the pilot did not mention the selection of the HDG mode, the way indicated to maintain automatic control of the helicopter's flight trajectory when coupled to the FDC and to perform formation deviations. Thus, it was inferred that he chose to command attitude changes manually through the FTR button.

It was not possible to identify how the pilot reduced speed, however, if he was using the IAS mode, speed changes could be controlled by operating the Beep Trim switch, in command of the cyclic.

Therefore, if the pilot selected a valid mode in the FD controller, in this case, the HDG and ALT modes, and with the help of the information provided by the meteorological RADAR, he could deviate from adverse meteorological formations, maintaining automatic control of the flight.

In this context, participation in the qualification and training process previously received by the pilot was presented as a probable hypothesis, either due to quantitative or qualitative deficiency, since, during the flight, the pilot did not demonstrate operating the control systems properly.

The lack of experience, both in the model and in the night flight, contributed to the pilot not making adequate use of the technology available in the equipment. This fact is accentuated when considering the possible lack of theoretical knowledge of the helicopter systems revealed during the stage that culminated in the accident.

In this regard, it is important to highlight that Appendix B - Tables of class aircraft models that require specific endorsement, from the IS, No. 61-006, Revision C, of 20APR2017, from the ANAC, in force at the time of pilot training, established that the instruction required for the endorsement of the A109E, multi-engine helicopter class, was at the discretion of the endorsing pilot, even though the AW109SP Operational Assessment Report contains the ground and flight training required for the A109E model.

In this sense, the endorsing pilot provided the ground and flight instruction that was sufficient for the endorsing pilot to be able to demonstrate full knowledge and proficiency in the aspects highlighted in the IS. It is important to highlight that there was no issuance of forms for follow-up during the instructional phase before the issuance of the endorsement by the instructor.

Therefore, the Investigation Team was not able to assess the quality of the theoretical and practical instruction given, since there was any record of it. There was only the instructor's endorsement, which released the pilot for the proficiency exam, and the FAP 04.7 - Class Rating - HMLT, which recorded the proficiency exam flight

On the other hand, according to the training programs proposed by the AgustaWestland Training Academy and approved by the EASA/ENAC, pilots with no previous experience in operating a multi-engine turbine helicopter should meet certain criteria, including a specific course related to this class of helicopters.

Likewise, the Operational Evaluation Board Final Report, AgustaWestland Report, A109E, A109S & AW109SP, detailed a series of minimum theoretical and practical training curricula for the qualification of pilots to operate the E, S, and SP variants. This training, although carried out in an aircraft, should necessarily cover, among several topics, those related to the use of the Flight Director in the VFR flight and the autopilot, whose operation, in the flight of this occurrence, proved to be inappropriate.

From the information collected and the reports, it emerged that one of the reasons why the pilot had acquired the PP-MTX was related to the possibility of fulfilling his plans and needs with greater capacity and safety, in operational terms.

With the incorporation of the new aircraft, the pilot likely felt more secure and confident due to the onboard technology, which provided better operational capabilities.

It should be noted, however, that the increase in equipment technologically more advanced would demand, at the same time, greater proficiency in the various parameters related to the operation of the aircraft itself, in risk management, and the decision-making process.

Conducting the flight based on the pilot's belief in the aircraft's capabilities and increased safety, combined with low awareness of the risks related to the visual operation at night under adverse weather conditions and without sufficient knowledge of all systems onboard, directly influenced his ability to perceive, analyze, choose alternatives and act appropriately in the face of a previously unexperienced situation.

Despite the internal communications between the pilot and the passenger confirming that the pilot, not only had knowledge but had also visualized and verified the presence of meteorological formations and clouds of the CB type, it was verified that he decided to continue with the flight.

This decision-making may have been a reflection of the overconfidence in the equipment and in his presumed technical proficiency, which led him to a complacent posture concerning the conditions of intense precipitation, thunderstorms, and restricted visibility experienced on that flight. As a result, the aircraft was unintentionally taken into meteorological formations which the pilot was not prepared to manage.

3. CONCLUSIONS.

3.1 Facts.

a) the pilot had a valid CMA;

b) the pilot had a valid HMLT Class Rating;

c) the pilot was qualified but had no experience in the type of flight (night VFR);

d) it was not possible to state that the pilot complied with the requirements established in the RBAC 61 regarding recent experience;

e) there were no records regarding theoretical and practical training given to the pilot;

f) the aircraft had a valid CA;

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

h) the airframe and engine logbook records were updated;

i) all evidence observed indicated that the engines were operational and developing power at the moment the aircraft crashed;

j) the analyzes carried out on the wreckage ruled out the possibility of failure in some system or component as a contributor to the occurrence;

k) meteorological conditions were not favorable for performing the visual night flight;

l) at a time close to the occurrence, there were thunderstorms with rain, CB type clouds, and wind gusts of up to 40 kt at the aerodromes close to the route traveled;

m) RADAR and satellite images indicated the presence of dense meteorological formation, with CB type clouds and rain over the accident site;

n) the meteorological radars detected, between 2140 and 2210 (UTC), a gradual increase in the intensity of precipitation in the accident region;

o) the CVR demonstrated that the pilot and the passenger next to him were aware of the weather conditions on the route and that, at times, the flight was carried out in a cloud and with rain;

p) the CVR frequency analysis revealed that from the moment the pilot reduced speed and decoupled the NAV mode (NAV OUT), a series of variations in engine power began;

q) according to RADAR views, the pilot made a series of deviations from the route with wide variations in heading and altitude;

r) there was a loss of control and the impact of the aircraft in the Atlantic Forest region;

s) the aircraft was destroyed; and

t) the pilot and the passengers died on the spot.

3.2 Contributing factors.

- **Control skills – a contributor.**

There was the decoupling of the NAV mode followed by wide variations in altitude, heading, and engine power.

- **Training – undetermined.**

The lack of operational proficiency demonstrated by the pilot when operating the aircraft systems reflected a possible insufficiency of the technical knowledge required to safely conduct the aircraft. In addition, it was not possible to verify the pilot's performance during dual-command flights, as no tokens were required to be issued to monitor the instruction.

- **Adverse meteorological conditions – a contributor.**

The phenomena associated with the presence of CB clouds in the accident region interfered with the normal operation of the aircraft and led to circumstances that conducted the pilot to unintentionally enter IMC flight conditions.

- **Disorientation – undetermined.**

Evidence shown in the profile of the last 35 seconds of the flight suggested that the pilot experienced some sort of illusion, which may have led to spatial disorientation.

- **Illusions – undetermined.**

The conditions prevailing on the route and at the time of flight were conducive to the perception of a false horizon capable of inducing the pilot to a visual illusion.

- **Instruction – undetermined.**

The investigation elements collected indicated that the pilot did not have all the skills and knowledge necessary to operate the aircraft under the conditions prevailing at the time of the accident. However, because there are no records regarding the practical and theoretical training including his examination, it was not possible to establish to what extent the content taught may have contributed to the deficiencies observed in the helicopter operation.

Furthermore, the expression "at its discretion" used in the IS 61-006 may have raised doubts for the endorser as to the syllabus of the instruction given to the endorser, even though there were references in the AW109SP Operational Evaluation Report about the training planned for the A109E model.

In addition, section 61.21 of the RBAC 61 did not clearly define what instruction would be required for a pilot to re-acquire recent experience. The lack of this clarification could lead to different interpretations on the part of the pilots, inducing them to seek solutions that met the desirable operational standards.

- **Perception – a contributor.**

Although internal communications recorded the pilot's identification of the rapid degradation of weather conditions, no action denoted his understanding of the real risks related to conducting the flight on a route close to the formations.

- **Insufficient pilot's experience – a contributor.**

The pilot's flight records indicated a total of 8 hours of night VFR flying on that equipment. The inexperience to perform the flight under the proposed conditions contributed to the low perception of the associated risks and to the flaws in the decision-making process that led to the accident.

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

The internal communications analyzed showed the pilot's perception of the degradation of meteorological conditions. However, there was no adequate assessment of this information or even a correct understanding of the operational implications for the safe maintenance of the flight under the conditions found.

4. SAFETY RECOMMENDATION.

A proposal of an accident investigation authority based on information derived from an investigation, made with the intention of preventing accidents or incidents and which in no case has the purpose of creating a presumption of blame or liability for an accident or incident. In addition to safety recommendations arising from accident and incident investigations, safety recommendations may result from diverse sources, including safety studies.

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

Recommendations issued at the publication of this report:

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

A-165/CENIPA/2018 - 01 **Issued on 05/27/2022**

Evaluate the relevance of clarifying in the table "Multi-engine Helicopters Class", of Appendix B of the IS No. 61-006, Revision J, of 26NOV2021, in force on the date of the publication of this Final Report, that the instruction required for the endorsement of A109E model aircraft must comply with the criteria established in the AW109SP Operational Assessment Report, given that both models have the same designation (A19S).

A-165/CENIPA/2018 - 02 **Issued on 05/27/2022**

Assess the relevance of including, in the minimum training and endorsement requirements for operating specific aircraft models required in item (1), letter (f) of Section 61.199 of RBAC 61, ground and flight training for night VFR operation.

A-165/CENIPA/2018 - 03 **Issued on 05/27/2022**

Establish guidelines in order to clarify to pilots what procedures are necessary to reacquire recent experience, after failing to perform, within the 90 (ninety) days preceding the flight, the operations prevised in section 61.21 of the RBAC 61, mainly regarding night flight requirements.

A-165/CENIPA/2018 - 04 **Issued on 05/27/2022**

Disseminate the lessons learned in this investigation to Civil Aviation Training Centers authorized to provide theoretical and/or practical instructions for helicopters, to contribute to the dissemination of the culture of endorsement, emphasizing its importance for the safe operation of aircraft.

A-165/CENIPA/2018 - 05 **Issued on 05/27/2022**

Evaluate the relevance of instituting flight and ground instruction follow-up sheets so that the endorsing pilot can record the evolution of the endorsed pilot's training.

A-165/CENIPA/2018 - 06 **Issued on 05/27/2022**

Analyze the possibility of translating and adapting, to the reality of Brazilian civil aviation, the texts of the handbooks and manuals published and made available by the FAA on its website, at https://www.faa.gov/regulations policies/handbooksmanuals/.

5. CORRECTIVE OR PREVENTATIVE ACTION ALREADY TAKEN.

None.

On May 27th, 2022.