COMANDO DA AERONÁUTICA

CENTRO DE INVESTIGAÇÃO E PREVENÇÃO DE ACIDENTES AERONÁUTICOS

FINAL REPORT
A - 031/CENIPA/2018

OCCURRENCE:	**ACCIDENT**
AIRCRAFT:	**PT-VKR**
MODEL:	**EMB-720D**
DATE:	**22FEB2018**

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 22FEB2018 accident with the EMB-720D aircraft, registration PT-VKR. The accident was classified as “[LOC-I] Loss of Control in-Flight”.

After the take-off from runway 11 of the Flores Aerodrome (SWFN), Manaus - AM, the pilot reported to the Manaus Approach Control (APP-MN) that there was a breakdown in an equipment, requesting return.

Observers at SWFN reported to Eduardo Gomes Aerodrome Tower (SBEG), Manaus – AM, that the aircraft had fallen near threshold 11 of that Aerodrome.

There was no fire and the aircraft had substantial damage.

Three occupants perished at the site and two were taken to hospital still alive, but one of them died a few hours later.

An Accredited Representative of the National Transportation Safety Board (NTSB) - USA, (State where the aircraft was designed) was designated for participation in the investigation.

CONTENTS

GLOSSARY OF TECHNICAL TERMS AND ABBREVIATIONS

ANAC	Brazil's National Civil Aviation Agency
ANP	National Agency of Petroleum, Natural Gas and Biofuels
APP-MN	Manaus Approach Control
AVGAS	Aviation Gasoline
CA	Airworthiness Certificate
CENIPA	Aeronautical Accident Investigation and Prevention Center
CI	Investigation Team
CIV	Pilot's Flight Logbook
CINDACTA	Air Defense and Air Traffic Control Integrated Center
CMA	Aeronautical Medical Certificate
CVR	Cockpit Voice Recorder
DCTA	Department of Science and Airspace Technology
FPL	Flight Plan
GLOG 8	Logistics Group 8
IAM	Annual Maintenance Inspection
METAR	Aviation Routine Weather Report
MNTE	Airplane Single Engine Land Rating
NTSB	National Transportation Safety Board (USA)
OS	Service Order
PCM	Commercial Pilot License – Airplane
PMD	Maximum Take-Off Weight
PPR	Private Pilot License – Airplane
RBAC	Brazilian Civil Aviation Regulation
RBHA	Brazilian Aeronautical Certification Regulation
SBEG	ICAO Location Designator – Eduardo Gomes Aerodrome, Manaus - AM
SWBR	ICAO Location Designator – Borba Aerodrome - AM
SWFN	ICAO Location Designator – Flores Aerodrome, Manaus - AM
SIPAER	Aeronautical Accident Investigation and Prevention System
UTC	Universal Time Coordinated

1. FACTUAL INFORMATION.

Aircraft	**Model:** EMB-720D **Registration:** PT-VKR **Manufacturer:** Neiva	**Operator:** Private
Occurrence	**Date/time:** 22FEB2018 - 1310 UTC **Location:** Out of the Aerodrome **Lat.** 03°04'19"S **Long.** 060°01'44"W **Municipality – State:** Manaus – AM	**Type(s):** [LOC-I] Loss of Control in-Flight **Subtype(s):** NIL

1.1 History of the flight.

The aircraft took off from the Flores Aerodrome (SWFN), Manaus - AM, to the Borba Aerodrome (SWBR) - AM, at about 1302 (UTC), in order to transport personnel, with two pilots and three passengers on board.

With about three minutes of flight, the aircraft requested the Manaus Approach Control (APP-MN) to return to Flores, immediately, because it was with an "indication in an equipment", (term used by one of the crewmembers).

Moments later, he made a new call stating that he would land on SWFN's threshold 29, losing contact soon after. Observers at the Amazonas Aeroclub reported to the SBEG tower that the aircraft had fallen near SWFN threshold 11.

There was no fire. The aircraft had substantial damage.

Three occupants perished at the site and two were taken to hospital still alive, but one of them died a few hours later.

1.2 Injuries to persons.

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

1.3 Damage to the aircraft.

The aircraft had substantial damage to the wings, engine, propeller, part of the front fuselage and landing gear.

1.4 Other damage.

None.

1.5 Personnel information.

1.5.1 Crew's flight experience.

Hours Flown		
	Pilot (Crewmember 1)	Copilot (Crewmember 2)
Total	74:30	605:50
Total in the last 30 days	Unknown	14:35
Total in the last 24 hours	Unknown	00:50
In this type of aircraft	26:00	114:56
In this type in the last 30 days	Unknown	14:35
In this type in the last 24 hours	Unknown	00:50

N.B.: The data related to the flown hours were obtained through the Pilots' Flight Record (CIV) registers and the aircraft's Logbook, and it was not possible to identify all flight hours' records.

1.5.2 Personnel training.

The pilot took the PPR course at the Tupi Paulista Aeroclub - SP, in 2017.

The copilot took the PPR course at the Amazonas Aeroclub - SP, in 2013 and took the PCM License in 2014.

1.5.3 Category of licenses and validity of certificates.

The pilot had valid PPR License and valid MNTE Rating.

The copilot had valid PCM License and valid MNTE Rating.

1.5.4 Qualification and flight experience.

The pilot was qualified, but did not have experience in that kind of flight.

The copilot was qualified and had experience in that kind of flight, as pilot in command. However, he was unfamiliar with flights as a copilot in the right seat.

1.5.5 Validity of medical certificate.

The pilots had valid CMA.

1.6 Aircraft information.

The aircraft, serial number 720254, was manufactured by Neiva Aviation Industry, in 1990 and it was registered in the TPP category.

The aircraft had valid Airworthiness Certificate (CA).

The records prevised in the airframe, engine and propeller logbooks were with its monthly usage registers outdated (PART I), since the last observed notes, from the documents presented by the operator, dated from December 2017.

The last inspection of the aircraft, the "50-hours" type, was performed on 03FEB2018, by the Tiarte Comércio e Manutenção de Aeronaves Organization, in Manaus - AM, having flown 12 hours and 55min after the inspection.

The last overhaul of the aircraft, the "IAM" type, was performed on 16SEPT2017, by the Tiarte Comércio e Manutenção de Aeronaves Organization, in Manaus - AM, having flown 149 hours and 30min after the inspection.

Commonly, both the owner and the pilot who frequently performed flights on the aircraft accompanied the maintenance services.

Maintenance tasks were usually assigned to a mechanic, designated to that aircraft, and supervised by an inspector.

The only inspector available to monitor the services performed on the aircraft was also responsible for the management of the maintenance activity of that organization and, therefore, accumulated the functions of inspector and manager.

There was no report of any abnormal aircraft behavior or noticing the need to perform repairs or adjustments not prevised by the inspection.

During the documentary investigation regarding the maintenance of the aircraft, specifically on the component control card, it was verified that there was maintenance service on the magnets that equipped it on 28JUN2014.

Service Orders (OS) were requested from the responsible maintenance organization so that the services performed were checked in more detail. This request occurred in four

moments, the first two, through electronic mail on 02AUG2018 and 21AUG2018, the third directly with the company, and, finally, the fourth contact was formalized through a letter received by the company on 17SEPT2018.

On 21SEPT2018, the company replied, stating that the OS had been lost on the day of the accident, as stated in the Occurrence Bulletin, dated 21SEPT2018.

During the investigation, it was found that the airframe, engine and propeller logbooks were not updated, in this sense, IS No. 43.9-003 (Airframe, Engine and Propeller Logbooks), of the National Civil Aviation Agency (ANAC) provided that:

> "5.4.1 Signature of the Opening Statement, Parts I and III, and the Closing Statement: Responsibility for the signatures of the Opening Statement, Parts I and III and the Closing Statement of the airframe, engine and propeller logbooks will be of one of the natural persons in the exercise of the following functions:
>
> a) Mechanic and pilot who have an employment relation or an employment contract with the owner / operator; or
>
> (b) The Technical Officer, or officer designated by him, of the companies ruled by RBHA 91, RBAC 135 or RBHA 145, provided that they are regularly certified or authorized, in which the aircraft, engine or propeller are being subjected to maintenance .
>
> 5.6.2 The update of Part I of the airframe, engine and propeller logbooks shall be carried out by the fifth day of the following month, whenever there is a change in the operating times mentioned in paragraphs 4.4 and 4.5 of this IS. In this way, if an aircraft, engine or propeller operates, after an inactive period of more than one month, this inactivity should be mentioned in a single line in the Monthly Control of Parts I field of the respective logbooks. Ex: Not totaled hours from 30APR02 to 30SEPT02 – reason IAM."

Yet, RBHA 91, from ANAC, provided that:

> "91.417 - MAINTENANCE RECORDS
>
> (a) Except for work performed under 91.411 and 91.413, each owner or operator shall keep for the periods set forth in paragraph (b) of this section the following records:
>
> (1) maintenance record, preventive maintenance, modification and inspection records of 100-hour, annual, progressive and other mandatory or approved inspections, as appropriate, for each aircraft (including airframe, engine, propeller, rotor and equipment). The records should contain:
>
> (i) description (or reference to acceptable data by the DAC) of the work performed;
>
> (ii) date of completion of the work performed; and
>
> (iii) the signature and license number of the person who approved the return of the aircraft to the service.
>
> (2) records containing the following information:
>
> (i) the total flight time of each airframe, engine and propeller;
>
> (ii) the present situation of parts with limited life of each cell, engine, propeller, rotor and equipment;
>
> (iii) the time since the last overhaul of aircraft-installed items that require overhaul based on specific times;
>
> (iv) the identification of the present position of the aircraft in relation to inspections, including the times since the last mandatory inspection required by the inspection program under which the aircraft and its components are maintained;
>
> (v) the present status of the applicable airworthiness (DA) guidelines, including, for each, the method of compliance, DA number and date of revision. If the DA requires periodic actions, the time and date the next action will be required; and

(vi) copies of the forms required by paragraph 43.9 (a) of RBHA 43 for each major modification or major repair of the cell, engines, propellers, rotors and equipment currently installed in the aircraft.

(b) The owner or operator shall keep the following records for the periods below:

(1) The records required by subparagraph (a) (1) of this section shall be retained until the work is repeated for the third consecutive time, even if it has been replaced by more detailed work, or for 2 years after the completion of the work, whichever is longer."

1.7 Meteorological information.

The METAR of the Eduardo Gomes Aerodrome (SBEG), 4.2 nautical miles away from the scene of the accident, had the following information:

METAR SBEG 221300Z 05008KT 9999 FEW010 BKN100 26/23 Q1014=

METAR SBEG 221400Z 05007KT 9999 FEW012 BKN100 27/22 Q1014=

It was found that the conditions were favorable for the visual flight, with visibility over 10km and few clouds between 1,000ft and 1,200ft, in the interval between 13h00min and 14h00min (UTC). The wind had intensity ranging from 7 to 8kt.

1.8 Aids to navigation.

Nil.

1.9 Communications.

According to the transcripts of the communication audio between the PT-VKR and the control bodies, it was verified that the crew maintained radio contact with the APP-MN and that there was no technical abnormality of communication equipment during the flight.

In order to support the analysis of the events sequence that preceded the crash, the Investigation Team highlighted some transmissions that could help in understanding the dynamics of the accident. For the recording of the schedules described in this field, the UTC was used as reference.

At 12:57:01, the PT-VKR crew reported that they were in Flores, with five people on board, six hours of autonomy and that it would takeoff from threshold 11.

At 13:02:07, the PT-VKR crew reported that it was off the ground.

At 13:02:10, the APP-MN reported that the PT-VKR was in radar contact, and requested that the aircraft go up and maintain "one thousand" feet, "Aleixo". The pilot checked right after.

At 13:03:09, the APP-MN authorized the PT-VKR to ascend to three thousand five hundred feet, in the head of Borba. The pilot checked right after.

At 13:05:44, the PT-VKR crew requested to return to Flores, "immediately".

At 13:07:14, the APP-MN requested that the PT-VKR confirmed the reason for the return, the crew immediately checked, stating: "there is an indication of instrument here. I must return".

At 13:07:29, the PT-VKR crew made their last communication with the APP-MN, informing that they would land on SWFN "29".

At 13:09:36, a radio operator from an Air Taxi company at the Amazonas Aeroclub informed APP-MN about the possible fall of an aircraft.

At 13:10:29, the APP-MN attempted to contact PT-VKR, but it was unsuccessful.

1.10 Aerodrome information.

The occurrence happened in a clearing, away, approximately, 360m from SWFN threshold 11.

1.11 Flight recorders.

Neither required nor installed.

1.12 Wreckage and impact information.

The impact occurred on an open ground near Torquato Tapajós Avenue, in Manaus - AM, approximately 360m away from SWFN threshold 11, and there was no evidence of previous impact. The wreckage distribution was of the concentrated type.

There was no fire after the impact. The aircraft had substantial damage to the wings, flaps, landing gear, engine, propeller and fuselage (Figures 1 and 2).

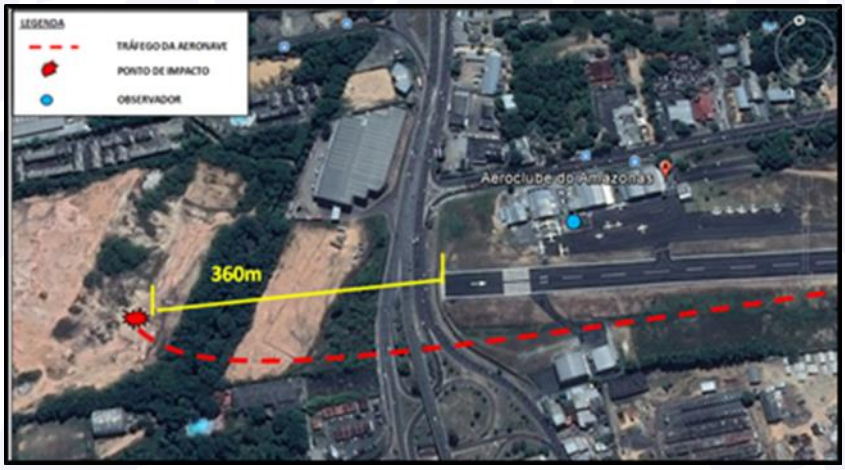

Figure 1 - Sketch of the accident, showing the air view of the impact site and its position in relation to the SWFN threshold 11. The dashed red line shows the route covered by the aircraft until the moment of impact.

Figure 2 - Aircraft image moments before the impact, taken from the security camera of the Amazonas Aeroclub.

The first impact occurred in a pitch down attitude, approximately 30º, and inclined close to 45º to the right. The impact marks, located 17m from the aircraft's final stop location, were produced by the right wing, causing its twisting in relation to the fuselage, as well as the rupture of the fuel system, which caused the formation of a puddle (Figure 3).

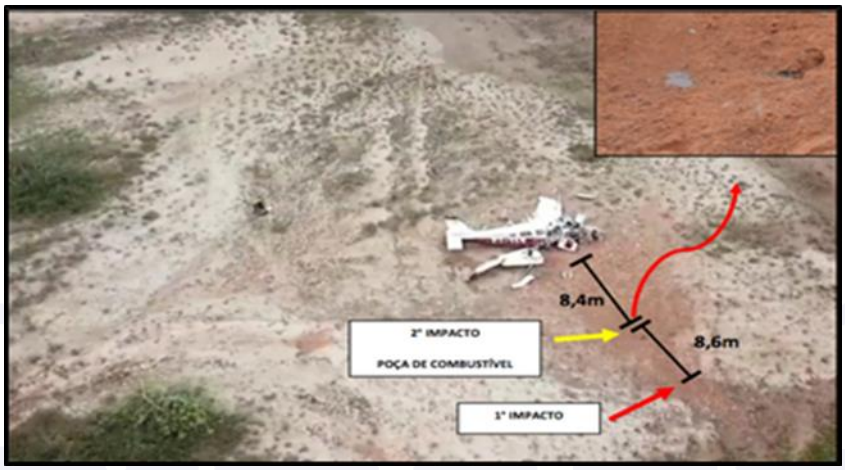

Figure 3 - Overview of the wreckage. The red arrow indicates the 1st point of impact, and the yellow arrow the point of the 2nd impact. In detail, the fuel puddle.

The flaps were retracted, according to the position of the control lever (Figure 4).

Figure 4 - View of the interior of the aircraft. It has been checked the position of the control lever of the flaps in the totally retracted position.

The power, propeller and fuel levers were close to the maximum power, maximum RPM and rich mix markings, respectively. However, as the impact violence caused a warping in the gearbox, it is possible that they have moved (Figure 5).

Figure 5 - Approximate view of the center console, with the levers and its positions.

1.13 Medical and pathological information.

1.13.1 Medical aspects.

According to information collected from the last health inspection, there were no significant medical changes related to the pilots, nor did they present associated diseases.

The tests of toxicology and the dosage of alcohol obtained showed negative results.

According to the information obtained, on the day of the flight, the pilots showed no signs of fatigue or stress.

There was no evidence that physiological or disability aspects affected the crew performance.

1.13.2 Ergonomic information.

Nil.

1.13.3 Psychological aspects.

Although the copilot register did not appear in the elaborated flight plan, there were two pilots on board the aircraft, on the flight that originated the occurrence.

The pilot registered in the flight plan as the commander, at that time did not have an employment relation with the owner, being his first flight on the PT-VKR aircraft.

The pilot was described by the other professionals who operated in SWFN, as an extroverted, communicative person who easily established contact with the others.

However, they did not know the level of proficiency of this pilot or its operational profile, since he had not completed his formation in that region. According to the reports, he was used to report situations experienced in aviation.

On social occasions, it was common for the pilot to report stories highlighting his skills in dealing with critical situations in flight. Despite this, he had not yet gained credibility among the other pilots in the region, since he was not well known at that Aerodrome.

According to a colleague of his acquaintance, during his formation in Tupi - SP, the pilot was considered a person with little aeronautical knowledge. As reported, he did not demonstrate control over the technical terms of piloting and presented difficulties in relation to the flight plan and calculation of weight and balance. Despite having accompanied his solo flight in 2017, he did not consider him a proficient pilot.

The copilot had an informal working relation with the owner and was frequently invited to perform flights on that aircraft, being recognized by others as "the PT-VKR's pilot". He was well known in the area and operated for the aircraft's owner for at least three years.

This relation had been established informally when the owner, who was also a pilot, accepted that he flew as companion on his flights, in order to provide the experience required for progression in the profession.

The people of his conviviality in the aviation context described this professional as a reserved, attentive person and of easy coexistence. He had been struggling to remain exclusively in the air activity and, in order to assist him, the owner gave him as many flights as possible, as pilot-in-command, on that aircraft.

According to the information obtained, the aircraft had been assigned to the pilot, who was reported as a possible buyer of the PT-VKR. However, the copilot had been called for that flight because of the owner's trust in his performance, in view of his familiarity with the aircraft because of previously performed flights.

Although they knew each other superficially, due to the contact in SWFN that would be the first flight that the crew would perform together.

The professionals involved with the air activity that operated in SWFN reported that it was common for newly aviation pilots, who were looking for employment opportunities, to request assistance from aircraft owners and other pilots.

This aid involved the authorization to follow the flights, in order to gain greater familiarity with the air activity. In these circumstances, it was common practice among them

to request that the flight plan to be made containing their data, in order to generate flight time records for operational progression.

Besides being a recurring and shared practice among most of the operators and pilots of the region, in these flights, the presence of another crewmember was rarely recorded as a copilot. In addition, a few times the flight was effectively conducted by the crewmember registered in the flight plan, as reported by some pilots.

It is noteworthy that both the pilots interviewed and the owner of the aircraft shared the perception that this type of assistance was necessary, so that beginning professionals could progress in aviation and reach the flight hours required by the ANAC.

1.14 Fire.

There was no fire.

1.15 Survival aspects.

The accident was reported to APP-MN by an observer at the Amazonas Aeroclub. Upon arriving at the scene, the investigation team accompanied the removal of two victims (passengers) who were rescued while still alive, but one of them died hours later in the hospital. The two pilots and a third passenger died on the spot.

1.16 Tests and research.

The aircraft engine was collected for analysis at an approved maintenance organization, with the participation of CI and an Engineer from the DCTA.

In the inspection, it was verified that the engine of the aircraft had little damage, due to the impact on the ground. The right magneto was removed and bench tested, exhibiting normal operation, with spark-ignition at all output terminals for the spark plug cables.

When it was handled, it was noticed that there was something loose inside the left magneto. Such alteration did not prevent the performance of the bench functional test. Initially, it showed spark at all the output terminals for the spark cables, and then it was concentrated in only one terminal.

The highlights of Figure 6 show that several distal gear teeth of the left magneto were damaged by kneading, crushing, or fracture.

Figure 6 - View of the gear and the various distal teeth of the left magneto damaged by dents or fractures.

The damages described may have led to the loss of synchronism of the magnetos, possibly causing the spark to be released out of the correct time, that is, the combustion of

the air / fuel mixture started inside the cylinders outside of the ideal angle. As a result, the engine may have presented failure, loss of power and rotation variation.

Figure 7 identifies that a lock of the high voltage coil of the left magneto was loose inside its housing.

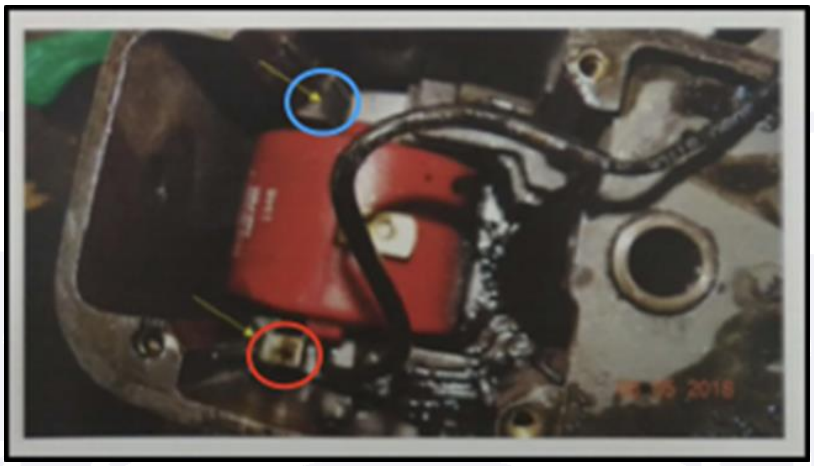

Figure 7 - Approximate view of the open left magneto. The red circle identifies a latched high voltage coil latch and the blue circle shows the absence of the other latches.

The lock was found, as shown in Figure 8. Several marks were observed due to contact with the gear teeth of both the rotor and the distributor.

Figure 8 - View of one loose coil lock inside the left magneto.

Another important finding was the presence of filings inside the engine crankcase (Figure 9) and the observed scratches on the lubricating oil pump housing.

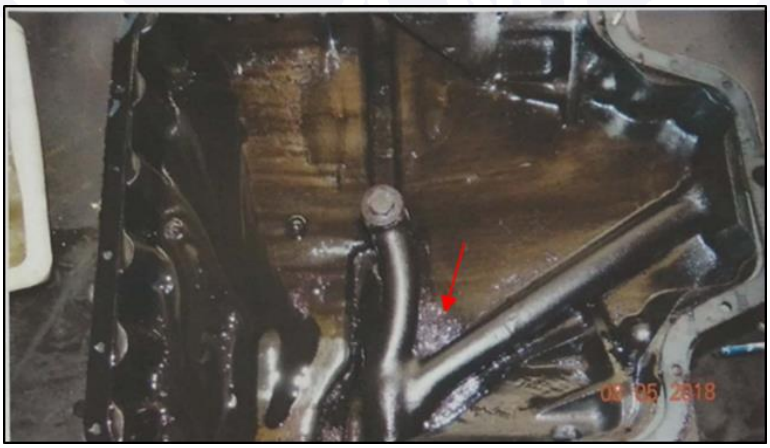

Figure 9 - View of the engine crankcase interior. The red arrow indicates an accumulation of filings.

At the time the semi-carcasses were separated, it was observed that the rear intermediate bearings were without their guides (Figure 10).

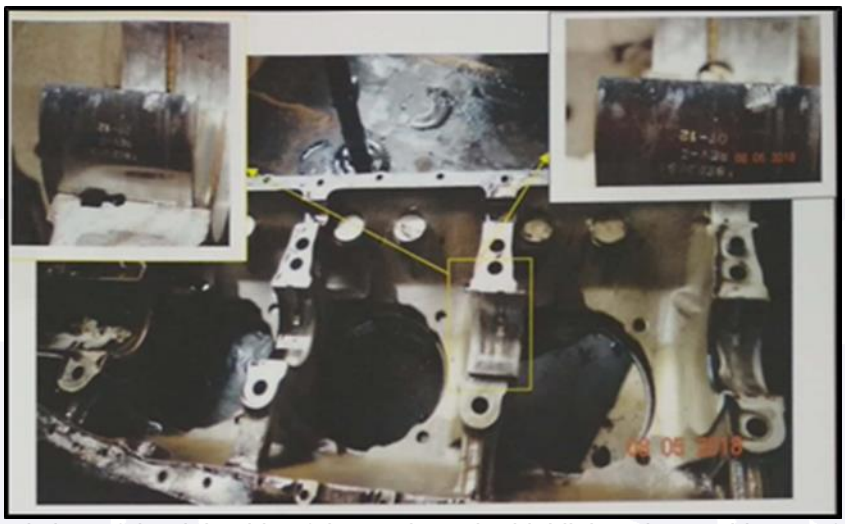

Figure 10 - General view of the right side of the engine. The highlights show evidence of movement of the rear intermediate bearing bronzine.

As shown in Figure 11, only one blade of the propeller presented transverse hazards (detail). A second blade presented kneading near its root and was probably the first to touch the ground. The third blade was practically undamaged.

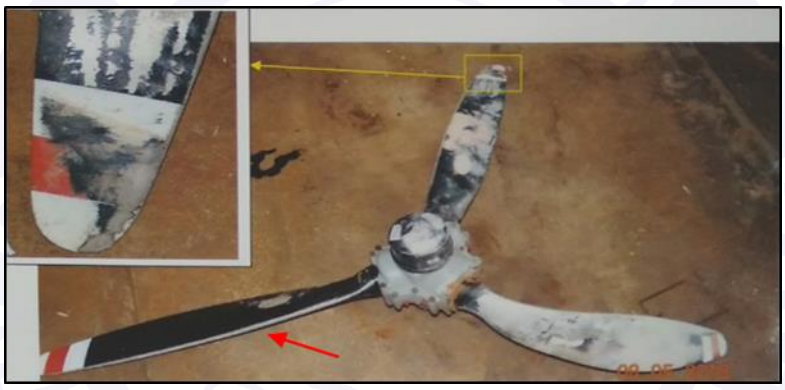

Figure 11 - Overview of the propeller that equipped the PT-VKR. In highlight the blade with the transverse marks. The red arrow indicates the blade that has not been damaged.

A sample of the fuel collected from the last supply point made by the PT-VKR was collected and submitted to an examination, carried out in an approved laboratory, in Manaus - AM. The result was "fuel suitable for use".

The speedometer that equipped the aircraft at the time of the accident was analyzed by the GLOG 8.

The method used, lighting with Ultraviolet Light (Black Light), has the property of causing, in certain substances, the phenomenon of fluorescence, which could not be observed on the speedometer in question. Therefore, in the absence of fluorescence, there was no response that could indicate its speed at the moment of impact.

1.17 Organizational and management information.

The aircraft's management was shared between the aircraft owner and the copilot at the time of the occurrence. As far as air activity was concerned, flights were scheduled by the owner or one of his business partners.

According to reports, the owner had two aircraft that stayed overnight in the apron of SWFN, as well as, he kept at home some materials for the maintenance of the aircraft.

As reported, the copilot did not have the autonomy to run flights without the owner's authorization.

According to the data contained in the aircraft's flight logbook, there was a rotation in the piloting. Despite this, reports indicated that most of the last flights performed were conducted by the copilot.

In relation to the flight that culminated in the accident, the owner, who was unaware of the pilot's proficiency, ceded the aircraft to him, provided that the pilot who normally operated the PT-VKR was on board to accompany the flight.

1.18 Operational information.

During the investigation, reports from people who accompanied the take-off said that the copilot would be at the controls (left seat). However, during the field investigation, the positioning of the bodies suggested that the pilot with fewer hours of flight was in the seat on the left, that is, the commands of the aircraft.

Thus, to facilitate the understanding of the following information, the pilot with less hours of flight was called as crewmember 1, and the pilot who had more hours of flight and who usually operated the aircraft was called as crewmember 2.

With regard to professional training, the aircraft owner reported that he accompanied crewmember 2's "professional development", having monitored several of his flights until he had the confidence to fly solo on his aircraft.

The Flight Plan (FPL) presented was issued by crewmember 1, and he was identified as pilot in command.

On the flight that caused the accident, the aircraft took off with two pilots and three passengers on board. Minutes later, a contact was made with the air traffic control, requesting the return, due to problems in an equipment.

At that time, no flight emergency was declared. The pilot reported that he would land at SWFN's threshold 29, however, the aircraft continued the flight, crashing near the threshold 11 of the aerodrome.

According to information collected, crewmember 1 had approximately 77 total flight hours and had recently obtained the PPR license. Crewmember 2 had about 605 total flight hours and, according to records, operated the PT-VKR since 06FEB2015.

According to information from the fueling vouchers, logbook record, as well as the interviewee reporting, the aircraft took off with the maximum fuel capacity, with the last fueling being made on the day of the accident.

For the weight calculation at the time of the accident, the data were estimated based on information from people who accompanied the supply on the day of the accident, the data contained in the flight plan issued, weight and balance sheet and technical manual of the aircraft.

The standard weight of 80kg per person was used. There were no luggage.

Values used in the calculation:

- Maximum Take-off Weight (PMD) – 1.633kg;

- consumption - 52.24 l / h;

- approximate time between take-off and crash, according to the transcription of ATS oral communications recording - 7 minutes and 34 seconds;

- basic empty weight - 1.083 kg;

- occupants - 5 x 80kg = 400kg;

- fuel supplied (0.72kg / l x 386l) - 278kg;

- estimated take-off weight - 1,761 kg; and

- estimated weight in the accident - 1,753kg.

In this way, it was concluded that the aircraft was outside the weight and balance limits specified by the manufacturer.

Although the FPL had SWBR as final destination, it was considered that the aircraft would return to SWFN, since at the time of the accident there was no fuel supply at that Aerodrome.

In this sense, considering the provisions of the RBHA 91, on fuel and oil requirements for visual flights (item 91.151), the fuel required for the proposed flight would be 95.78l (68.96kg), however the PT-VKR had been supplied with 386l (278kg).

Until moments before the accident, the communications went normal. The APP-MN initially authorized the PT-VKR to maintain "one thousand feet" in the profile of the "Aleixo" exit and, subsequently, authorized 3,500ft climb on the head of "Borba" (Figure 12).

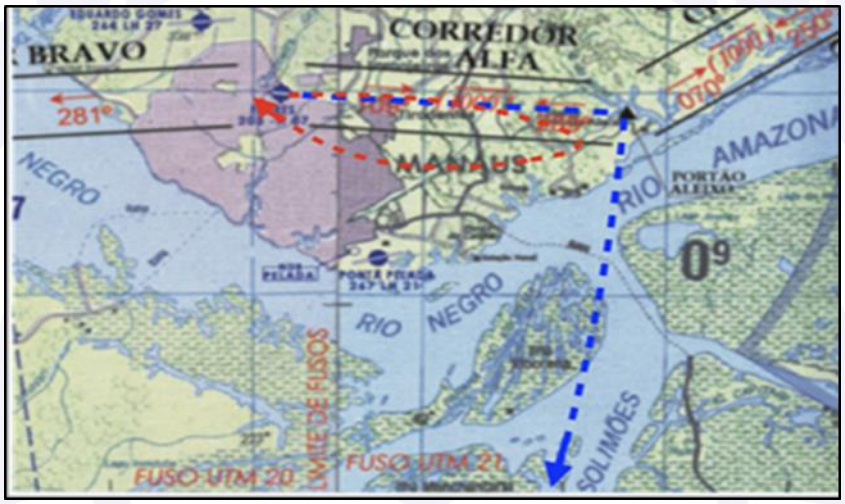

Figure 12 - Special Aircraft Routes in Visual Flight in the Terminal Control Area of Manaus - AM (REA AIC N11 / 10). The blue dash indicates the route authorized by APP-MN, and the red arrow indicates the route traveled by the aircraft until the time of the accident.

During the course since the take-off to impact, radar visualizations showed few height variations (up to 100ft), coupled with large speed variations (Figures 13 and 14).

HORA (UTC)	ALTITUDE (FT)	VELOCIDADE (KT)
13:00:37	700	91
13:00:49	800	112
13:00:54	800	95
13:01:02	800	88
13:02:10	1.000	74
13:02:22	900	71
13:02:31	800	104
13:02:33	800	66
13:02:38	800	92
13:02:42	800	121
13:02:47	800	76

Figure 13 - Data of the trajectory covered by the PT-VKR until moments before returning to SWFN, taken from the filming of radar revision images of CINDACTA IV.

HORA (UTC)	ALTITUDE (FT)	VELOCIDADE (KT)
13:03:19	900	111
13:03:33	900	91
13:03:42	900	106
13:03:46	900	91
13:04:37	1.000	113
13:04:44	1.000	95
13:04:50	1.000	118
13:05:49	500	122
13:06:03	300	103
13:06:14	300	86
13:06:30	300	82
13:06:54	300	68

Figure 14 - Data of the trajectory covered by the aircraft after the beginning of the return to SWFN, taken from the filming of radar revision images of CINDACTA IV.

In the tables above, large variations in speed are observed, many of them with altitude maintenance. From 13:05:40 (UTC), the aircraft begins descent, reaching, at 13:05:49 UTC (UTC), 122kt at 500ft. From that moment on, the aircraft loses altitude and speed gradually, reaching at 13:06:54 (UTC), 68kt at 300ft, until it disappears from the radar at 13:06:56.

According to the observers report, the aircraft made a final approach to SWFN threshold 29, which was unusual for pilots, because the prevailing wind in the region did not favor landing at that threshold. Upon entering the short final, the aircraft would apparently make the landing, but there was a go-around procedure.

The aircraft continued to fly over the runway and, according to the perception of some people who were in the place, it did not present power in the engine. When turning to return to the runway by threshold 11, the aircraft collided with the ground (Figure 15).

Figure 15 - Photographic sequence of the route of the aircraft, from the go-around procedure until seconds before the impact, taken from the safety camera of the Amazonas Aeroclub.

1.19 Additional information.

In the course of the investigation, the CI made attempts to contact the survivor of the accident. On the first occasion, via telephone contact, it was informed by a relative that the survivor had not recovered the memory of the event. After a period of time, a new contact was made, via text message, but there was no response.

1.20 Useful or effective investigation techniques.

Nil.

2. ANALYSIS.

It was a passenger transport flight between SWFN and SWBR.

The aircraft had been assigned to crewmember 1, registered in the FPL as pilot in command. According to the reports, the aircraft was to be conducted by the crewmember 2, at the request of the owner of the aircraft, which justified his presence on that flight.

It should be noted that it was common among professionals operating at that aerodrome to register less experienced pilots as flight commander, in order to assist in increasing flight hours for operational progression.

In spite of the reports obtained and the informal practice related to the flight plan, it was possible to infer, due to the positioning of the bodies observed during the field investigation, that the crewmember 1 occupied the seat on the left and, therefore, it was considered that he was acting effectively on aircraft commands on that flight.

The aircraft Logbook records indicated pilot rotation on the aircraft's controls. However, there were no formal and systematic procedures for the aircraft operator to control the flights.

This informality in the control of the air activity promoted vulnerabilities related to the flight safety.

According to the data obtained, minutes after takeoff, there was a contact of the crew requesting return to SWFN, due to a problem with the aircraft.

After an unsuccessful landing attempt at SWFN threshold 29, the aircraft began to slow down, indicating a possible engine failure, then entered a downward trajectory to the right, with a marked angle of incidence to the ground, until it collided against the ground, at approximately 360m from threshold 11.

The trajectory assumed by the aircraft until the moment of impact against the ground showed that, after the gradual decrease of speed, there could have been a loss of control in flight, due to loss of power.

According to information from observers of the accident, the aircraft did not have "power" when it flew over SWFN. This information was corroborated by the preliminary tests carried out in the powertrain at the place of the occurrence.

The transverse hazards, deformations and folds encountered in the propeller blades showed that, at the moment the aircraft collided with the ground, the engine did not develop high power.

When analyzing Figures 13 and 14, which show the radar visualization data since take-off to moments before impact, it was found that, initially, the aircraft presented an irregular flight profile, with great variations of speed, with little variation of altitude, denoting improper handling of the power lever by the pilot or a malfunction of the engine.

From 13:06:03 (UTC), which coincided with the moment the aircraft overflew SWFN, the PT-VKR began to lose speed, reducing it until reaching 68kt, disappearing from the radar in sequence.

In view of the above, it was tried to identify what would have caused the loss of power.

Although all fuel was lost at the time of the breakdown of the fuel system after impact, its existence inside the tanks could be proven by visualizing, during the field investigation, a puddle with a considerable amount of Aviation Gasoline (AVGAS), as well as the strong characteristic smell.

An observer, who accompanied boarding and take-off, reported that the aircraft was supplied with its maximum capacity.

According to the conclusion of the examination carried out, the AVGAS sample was considered in accordance with ANP specifications.

Therefore, the hypothesis of engine failure due to lack of fuel or contaminated fuel was discarded.

It was also found during the bench tests that there was no compromise in the feed lines that could interrupt the supply of fuel to the engine.

The dismantling of the engine showed that it had little damage, due to the impact on the ground. However, when analyzing its internal components, it was found that the left magneto had the high-voltage coil lock loose, which came into contact with the gear teeth of the magneto distributor, damaging them.

As a result, the magneto lost its synchronism and possibly the spark started to be released outside the correct time, that is, the burning of the air / fuel mixture began to start inside the cylinders, outside the ideal angle that would justify a possible failure, power loss, or rotation variation in the aircraft's engine still in flight.

The failure to provide OS for magnetos generated uncertainty as to the performance of the service or its effectiveness. If the magneto was properly inspected for its integrity and functionality, certainly any discrepancy (fracture) would be identified during routine maintenance actions.

Despite the fact that considerable amounts of filings were found inside the crankcase, the report did not show that this fact interfered with the possible malfunction of the engine.

Crewmember 1 had little more than 70 total flight hours, about 43 hours of which were still obtained during his training as PPR, a few months before the accident. According to reports, it would be his first flight aboard that equipment, which would be of interest to buy, thus indicating a lack of familiarity with the model of the aircraft.

Crewmember 2 had little more than 600 total flight hours, but he had no flying experience as copilot.

In this context, discrepancies in the flight parameters of the aircraft may have led to a critical flight situation and difficult to manage, given the lack of experience of crewmember 1 as pilot in command, as well as the lack of experience of crewmember 2 in flying as copilot.

Thus, the conduction of the aircraft to threshold 29 may have been impaired by the speed variations shown, leading to a destabilized approach.

Although the crew reported a problem, there was no information that would allow us to identify how the crew evaluated the failure, as it was not declared an emergency in flight.

The failure presented by the aircraft, coupled with poor flight proficiency, may have favored an inadequate assessment of existing conditions, causing the pilot to opt for landing at threshold 11 rather than at threshold 29.

This decision may have aggravated the critical situation in flight by requiring more power from the aircraft and prolonging the emergency situation.

The informality that characterized the operation of the aircraft allowed flights with different pilots on board, registered as commander of the flight, even when they did not perform such function.

Such informality did not define a clear division of tasks on board. Added to this fact was the lack of previous interaction between the crew, since they had never shared the cabin of the airplane.

Such circumstances combined with the problems presented by the aircraft may have favored an inadequate interaction between the pilots during the emergency, since, in the light of what was checked in this investigation, it is probable that there was no doctrine among them regarding cabin coordination.

In this way, the ability to properly identify and react to in-flight emergency may have been impaired.

Based on the calculations made, taking into account the average weight of its five occupants (80kg) and the fuel on board (278kg), it was observed that the aircraft was at least 123kg above its PMD.

In this context, the excess weight in the aircraft may represent both a decrease in the rate of climb and an increase in its stall speed.

According to the reports obtained, crewmember 1 had already presented difficulties of flight planning and calculation of weight and balance during his professional development in the aviation area.

However, the weight and balance failures were allegedly not detected and corrected by crewmember 2, who had more experience and knowledge about the aircraft and the operation in that region.

In this way, it is possible that the informal culture shared between some operators and pilots operating in the region could lead to low adherence to the norms and procedures stipulated in aviation, causing the crew not to observe these aspects during the planning of the flight.

Likewise, this informality may have contributed to the flight being conducted by a pilot with little experience and without familiarity with the EMB-720D.

Thus, the possible engine failure, coupled with the crew's lack of experience, as well as failure in flight planning, provided an unfavorable environment for the aircraft conduction in that emergency condition, culminating in the uncontrolled impact on the ground.

3. CONCLUSIONS.

3.1 Facts.

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

b) the pilots had valid MNTE Rating;

c) the pilot was qualified, but did not have experience in that kind of flight;

d) the copilot was qualified, but did not have experience of flights on the right seat;

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

f) the aircraft was not within the limits of weight and balance;

g) the airframe, engine and propeller logbooks records were outdated;

h) the meteorological conditions were favorable for the flight;

i) the aircraft asked the APP-MN to return to SWFN due to problems;

j) there was an unsuccessful landing attempt at SWFN threshold 29;

k) after flying over the runway, the aircraft hit the ground at approximately 360m from SWFN threshold 11;

l) tests on the powertrain found the release of the high voltage coil lock, which damaged the gear teeth of the left magneto distributor;

m) the aircraft suffered substantial damage;

n) one passenger suffered serious injury and;

o) the pilots and two passengers suffered fatal injuries.

3.2 Contributing factors.

- **Control skills – undetermined.**

It is possible that because of the difficulty of initially managing the abnormal behavior of the aircraft and then the possible loss of power, there has been an inadequate use of the aircraft's flight commands, which has put it into an attitude in which the maintenance of the control and its conduction to the accomplishment of the landing would be impracticable.

- **Crew Resource Management – undetermined.**

The pilot's lack of experience, coupled with the lack of familiarity of the crewmembers with in-flight emergency situations, and the fact that they have never flown together may have affected the crew's ability to properly identify and react to the critical situation in flight.

- **Work-group culture – undetermined.**

Between some operators and pilots who worked in SWFN, an informal culture remained in relation to the planning and management of the flights that fomented a low adhesion to the procedures and standards in force in the aviation.

These values and practices collectively accepted may have led to flaws in flight planning, particularly in aircraft weight and balance, and may have affected proficiency in managing the emergency situation.

- **Team dynamics – undetermined.**

The fact that they have never flown together, as well as the fact that there has been no formal definition of the functions on board, may have produced inadequate interaction and mutual collaboration between pilots.

- **Piloting judgment – undetermined.**

The pilot may have incorrectly evaluated that he would not be able to land at SWFN's threshold 29 due to the abnormal behavior exhibited by the aircraft.

- **Aircraft maintenance – undetermined.**

It is possible that the last scheduled maintenance has not been performed or has been performed incorrectly, providing conditions for the engine failure, due to the conditions of the left magneto and the lack of updating of the aircraft logbooks.

- **Flight planning – a contributor.**

The number of passengers associated with the amount of fuel on board, greater than the required for that flight, showed an inadequate preparation as it compelled the airplane to be at a weight above the maximum prescribed for take-off.

- **Insufficient pilot’s experience – undetermined.**

The pilot had a cumulative experience of approximately 74 total flight hours and, according to available records, no experience with the aircraft model involved in the accident, which possibly hindered the conduction of the aircraft under abnormal conditions.

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

Attempting to perform the go-around procedure from threshold 29 to landing from threshold 11 aggravated the critical conditions in flight, which indicated an inaccurate

assessment of the existing circumstances and actual flight conditions affecting the safe operation of the aircraft.

The flight parameters of the aircraft during the approach to the threshold 29 of the SWFN's runway, which characterized a destabilized approach, may have induced the decision to go around and change the threshold, to the detriment of the continuity of the landing.

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-031/CENIPA/2018 - 01 **Issued on 06/28/2019**

Act in conjunction with Tiarte Comércio e Manutenção de Aeronaves (COM No 1509-61 / ANAC), in order to make that maintenance organization to demonstrate that it possesses and applies all the necessary resources for the proper provision of maintenance services on EMB-720D aircraft, as recommends the legislation in force, the respective technical manuals and the list of capabilities of the company.

A-031/CENIPA/2018 - 02 **Issued on 06/28/2019**

Inspect aircraft that have performed maintenance services at Tiarte Comércio e Manutenção de Aeronaves, in order to verify the conformity of the services performed.

5. CORRECTIVE OR PREVENTATIVE ACTION ALREADY TAKEN.

None.

On June 28th, 2019.