COMANDO DA AERONÁUTICA

CENTRO DE INVESTIGAÇÃO E PREVENÇÃO DE ACIDENTES AERONÁUTICOS

FINAL REPORT
A-162/CENIPA/2016

OCCURRENCE:	**ACCIDENT**
AIRCRAFT:	**PT-REI**
MODEL:	**EMB–721D**
DATE:	**07DEC2016**

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 07DEC2016 accident with the EMB-721D aircraft, registration PT-REI. It was classified as (SCF-PP) “System/Component Failure or Malfunction (Powerplant)”.

After take-off from the Flores Aerodrome (SWFN), runway 11, the aircraft lost altitude, entering a left turn, falling in a forest area, 500 meters from the threshold, opposite to the take-off one.

During the fall, the aircraft collided with the local vegetation (trees) and then, against the ground, rolled over, caught fire and exploded.

The aircraft was completely destroyed.

The Commander and four occupants perished on the site. One passenger was taken away alive; however, he died at the hospital.

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 5

1. FACTUAL INFORMATION. 6
1.1 History of the flight. 6
1.2 Injuries to persons. 7
1.3 Damage to the aircraft. 7
The aircraft was destroyed due to damage caused by ground impact, followed by fire and explosion, which consumed fuselage, wings and other components. 7
1.4 Other damage. 7
1.5 Personnel information. 7
1.5.1 Crew's flight experience. 7
1.5.2 Personnel training. 7
1.5.3 Category of licenses and validity of certificates. 7
1.5.4 Qualification and flight experience. 7
1.5.5 Validity of medical certificate. 7
1.6 Aircraft information. 7
1.7 Meteorological information. 8
1.8 Aids to navigation. 8
1.9 Communications. 8
1.10 Aerodrome information. 8
1.11 Flight recorders. 8
1.12 Wreckage and impact information. 8
1.13 Medical and pathological information. 9
1.13.1 Medical aspects. 9
1.13.2 Ergonomic information. 9
1.13.3 Psychological aspects. 9
1.14 Fire. 10
1.15 Survival aspects. 10
1.16 Tests and research. 10
1.17 Organizational and management information. 12
1.18 Operational information. 12
1.19 Additional information. 13
1.20 Useful or effective investigation techniques. 16

2. ANALYSIS. 16
3 CONCLUSIONS. 18
2.1 Contributing factors. 18
- **Attitude - undetermined. 18**

3. SAFETY RECOMMENDATION. 19

4. CORRECTIVE OR PREVENTATIVE ACTION ALREADY TAKEN. 19

19

GLOSSARY OF TECHNICAL TERMS AND ABBREVIATIONS

ANAC	National Civil Aviation Agency
CA	Airworthiness Certificate
CENIPA	Aeronautical Accident Investigation and Prevention Center
CMA	Aeronautical Medical Certificate
CI	Investigation Committee
DA	Airworthiness Directive
DCTA	Aeronautics Science and Technology Department
FCDA	Airworthiness Directive Compliance Form
IAM	Annual Maintenance Inspection
ICA	Aeronautics Command Instruction
IFR	Instrument Flight Rules
IFRA	Instrument Flight Rating - Airplane
MLTE	Airplane Multi Engine Land Rating
MNTE	Airplane Single Engine Land Rating
PCM	Commercial Pilot License - Airplane
PMD	Maximum Take Off Weight
PPR	Private Pilot License - Airplane
RBAC	Brazilian Civil Aviation Regulation
RBHA	Brazilian Regulation of Aeronautical Homologation
SERIPA	Regional Aeronautical Accident Investigation and Prevention Service
SIPAER	Aeronautical Accident Investigation and Prevention System
SWBR	ICAO location designator – Borba Aerodrome - AM
SWFN	ICAO location designator – Flores Aerodrome – AM
SWNA	ICAO location designator – Novo Aripuanã Aerodrome – AM
SWYN	ICAO location designator – Apuí Aerodrome – AM
TPP	Registration Category of Private Aircraft Service
UTC	Universal Time Coordinated
VFR	Visual Flight Rules

1. FACTUAL INFORMATION.

Aircraft	**Model:** EMB 721D **Registration:** PT-REI **Manufacturer:** Neiva	**Operator:** Private
Occurrence	**Date/time:** 07DEC2016 - 1150 UTC **Location:** Out of the Aerodrome **Lat.** 03º04'20"S **Long.** 060º00'41"W **Municipality – State:** Manaus - AM	**Type(s):** (SCF-PP) System/Component Failure or Malfunction (Powerplant) **Subtype(s):** Engine Failure in Flight

1.1 History of the flight.

The aircraft took off from the Flores Aerodrome - AM (SWFN), to the New Aripuanã - AM (SWNA) Aerodrome, at about 1145 UTC, in order to transport cargo and personnel, with one pilot and five passengers on board.

After take-off from the Flores Aerodrome (SWFN), runway 11, the aircraft lost altitude, entering a left turn, falling in a forest area, 500 meters from the threshold, opposite to the take-off one.

During the fall, the aircraft collided with the local vegetation (trees) and then, against the ground, rolled over, caught fire and exploded. The aircraft was completely destroyed.

The Commander and four occupants perished on the site. One passenger was taken away alive; however, he died at the hospital.

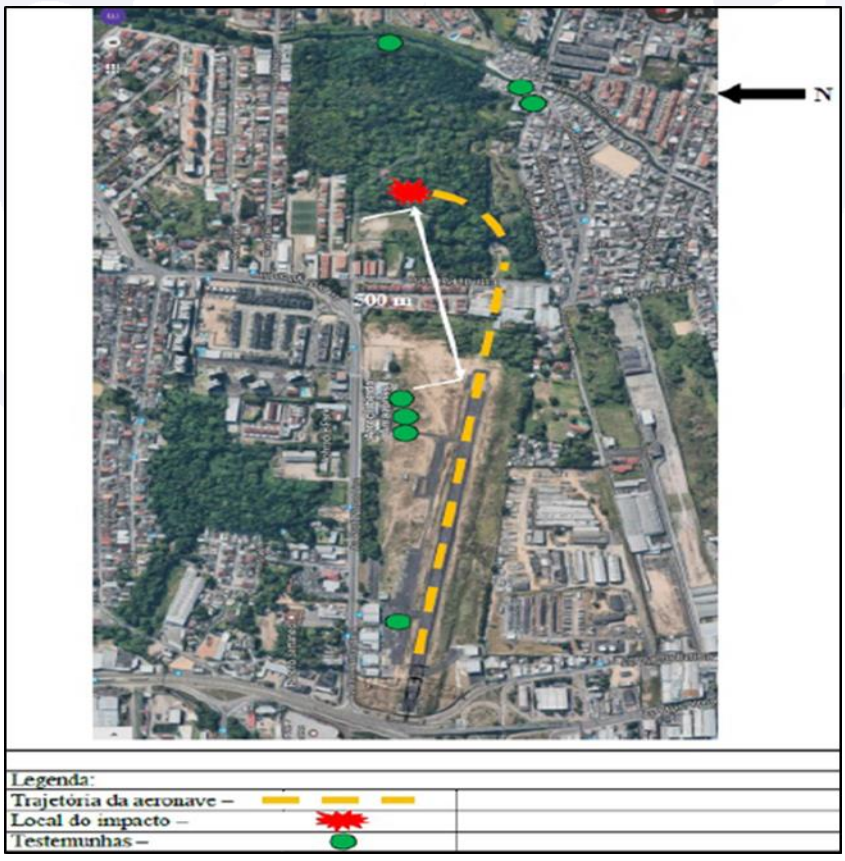


Figure 1 - Sketch of the accident.

1.2 Injuries to persons.

Injuries	Crew	Passengers	Others
Fatal	1	5	-
Serious	-	-	-
Minor	-	-	-
None	-	-	-

1.3 Damage to the aircraft.

The aircraft was destroyed due to damage caused by ground impact, followed by fire and explosion, which consumed fuselage, wings and other components.

1.4 Other damage.

Nil.

1.5 Personnel information.

1.5.1 Crew's flight experience.

	Pilot
Total	6.000:00
Total in the last 30 days	65:00
Total in the last 24 hours	00:00
In this type of aircraft	Unknown
In this type in the last 30 days	45:45
In this type in the last 24 hours	00:00

N.B.: The Data on the flown hours are approximated and were obtained from the aircraft's operator.

1.5.2 Personnel training.

The pilot took the Private Pilot Course – Airplane (PPR) at *Aeroclube de Votuporanga* - SP, in 2003.

1.5.3 Category of licenses and validity of certificates.

The pilot had the Commercial Pilot License – Airplane (PCM) and had valid MNTE and MLTE Ratings.

1.5.4 Qualification and flight experience.

The pilot was qualified and had experience in that kind of flight.

1.5.5 Validity of medical certificate.

The pilot had valid Aeronautical Medical Certificate (CMA).

1.6 Aircraft information.

The aircraft, serial number 721153, was manufactured by Neiva, in 1981 and it was registered on the TPP category.

The aircraft had valid Certificate of Airworthiness (CA).

The airframe and propeller Logbook records were updated.

The engine Logbook records were not updated.

The last inspection of the aircraft, the "100 hours" type was carried out on 23NOV2016, by TIARTE *Comércio e Manutenção*, in Manaus - AM, having flown 13 hours and 30 minutes after the inspection.

The last revision of the aircraft, the "IAM" type was carried out on 22APR2016, by TIARTE *Comércio e Manutenção*, in Manaus - AM, having flown 179 hours and 35 minutes after the revision.

1.7 Meteorological information.

The conditions were favorable for the visual flight.

Localidade	Tipo	Data/Hora	Mensagem
SBEG	METAR	07/12/2016 09:00	METAR SBEG 070900Z 00000KT 9999 FEW008 SCT100 24/23 Q1010=
SBEG	METAR	07/12/2016 10:00	METAR SBEG 071000Z 00000KT 2000 BCFG SCT004 BKN100 25/23 Q1010=
SBEG	METAR	07/12/2016 11:00	METAR SBEG 071100Z 00000KT 8000 SCT006 BKN100 26/24 Q1011=
SBEG	METAR	07/12/2016 12:00	METAR SBEG 071200Z 18002KT 9999 SCT008 BKN100 27/25 Q1012=
SBEG	METAR	07/12/2016 13:00	METAR SBEG 071300Z 22003KT 9999 FEW015 SCT100 29/25 Q1012=

Figure 2 - Meteorological bulletins before, during and after the occurrence.

1.8 Aids to navigation.

Nil.

1.9 Communications.

The pilot made the planned communications with the Manaus Control until the moment before the take-off.

He reported, initially, that he had four people on board and later he reported that he had five people on board. His last report was at 07:46 (local), when he checked the transponder code.

At 07:51 (local time), the PT-ICU aircraft, which also took off from SWFN, informed Manaus Control that an aircraft had fallen after takeoff and that he was visual with the smoke.

1.10 Aerodrome information.

The occurrence took place outside the Aerodrome.

1.11 Flight recorders.

Neither required nor installed.

1.12 Wreckage and impact information.

The first impact of the aircraft occurred with the trees of the local vegetation, followed by a collision against the ground, overturning and stopping upside down.

With the force of the impact, the pilot was thrown out of the aircraft, which exploded in sequence.

Figure 3 - The arrow indicates the first point of impact of the aircraft.

Figure 4 - View of the wreckage of the aircraft. The red arrow indicates the ravine, site of the second collision; the yellow arrow indicates the engine and propeller assembly; the green bracket shows the place where the passengers were found and the blue arrow shows the place where the pilot was found.

1.13 Medical and pathological information.

1.13.1 Medical aspects.

There were no major medical changes related to the pilot. He was reported to have color vision impairment, but he recognized the colors separately and used corrective lenses. He did not have other associated diseases.

The crewmember had the health inspection up to date; he did not take medication and had no history of smoking or alcoholism.

There were no signs of fatigue or stress.

His last flight performance occurred 48 hours before the day of the event.

1.13.2 Ergonomic information.

Nil.

1.13.3 Psychological aspects.

The pilot was described as a dedicated, responsible and professionally competent person who valued being with family and friends. According to the information obtained, he practiced sports and had healthy eating habits, in addition to quiet and regular sleep. Professionally, he was described as an organized, judicious and experienced pilot.

He graduated in 2008 and began his activities as a pilot in the company *Agência Brasil Moreno*, with which he maintained employment until 2015. During this period he operated, among others, the aircraft involved in the accident in question.

In 2015, the pilot left the company for approximately four months, seeking other professional opportunities in São Paulo. According to the report of one of his relatives, after this attempt, the pilot returned to Manaus - AM.

On that occasion, he began to provide pilot services as a freelancer, performing flights with the PT-REI aircraft. It was reported that the pilot knew the aircraft well, since he had operated it for some years and usually performed flights in the Manaus - Novo Aripuanã section.

According to reports, there was the expectation of being promoted to Head of Operations, as soon as the owner of the aircraft obtained its regularization to act as air taxi. According to the interviewees' perception, the pilot was in a positive moment in his personal life and apparently did not have affective, professional or financial conflicts.

In the workplace environment, the pilot had a solid relationship and proximity to the owner of the aircraft, since his father had already acted as an aircraft mechanic for this same professional, a fact that contributed to the relationship between the pilot and the operator.

1.14 Fire.

After the impact, the aircraft caught fire due to the contact of the electrical system and hot parts of the aircraft with the fuel, which consumed much of the structure and its components.

1.15 Survival aspects.

The occurrence took place in an urban and residential area, which facilitated some people approach, who even managed to rescue one of the passengers, who died in the hospital hours later due to injuries.

The pilot and four other passengers died on the spot.

1.16 Tests and research.

The aircraft engine was sent for examination and testing in an approved shop. The Investigation Committee (CI) accompanied the event with a professional from the Aeronautics Science and Technology Department (DCTA) accredited in Material Factor. During the tests, it was observed that the engine had severe damages due to the fire that happened due to the fall of the aircraft (Figure 5).

In the ignition system, only the spark plugs were observed. They had normal appearance and coloring. Excessive wear, evidence of over temperature or detonation were not found.

Due to the fire, the magnets were completely carbonized and this prevented the performance of any functional test (Figure 6).

In the nozzles, no obstructions were found that could compromise the operation of the cylinders. They were individually inspected and, as shown in Figure 7, were with the fuel passageway clean.

At the fuel distributor, nothing was observed that could compromise the engine performance. The Servo Injector had part of the region of the pneumatic chamber consumed by the fire. This prevented the functional testing and the individual analysis of its internal components.

The lubrication system showed evidence of proper operation and no contamination and / or obstructions were found. The engine cylinders and pistons were disassembled and analyzed and no abnormalities were observed. During its disassembly, the engine was considered operational, as no excessive wear or damage was observed, such as fractures in its internal mechanical components.

There were remained doubts as to its ignition system, since the magnets could not be examined. In case of a magnet malfunction, it would result in loss of power. If the fault occurred in the two magnets, the engine would be shut down.

Evidence found in the propeller denoted that the engine was running low, idle compatible or residual rotation at the time of impact. This could be observed through the transversal scratches on the back of only one of the blades, shown in Figure 08, indicating that the engine shutdown was immediate, as it did not affect the third blade that was intact.

With this, it was also shown that the engine did not develop power at the moment of impact.

Figure 5 - Rear view of the engine.

Figure 6 - Fragments of what remained of the engine magnets.

Figure 7 - View of the engine nozzles. Highlighting one of the unobstructed nozzles.

Figure 8 - View of the blade with the transversal scratches.

1.17 Organizational and management information.

According to the information obtained, the owner of the PT-REI aircraft was requesting authorization to carry out air taxi operations and intended to hire the pilot as Head of Operations of the company to be formed.

At the time of the occurrence, the pilot performed flights as a freelancer and, when not involved in flights, performed administrative activities aimed at managing the documental part of the aircraft of the operator. According to the reports, the pilot worked from 07:00 a.m. to 5:00 p.m. (local), but he only received for the flights he made.

It was also found that the operator had a travel agency, for which he hired the services of freelancers. However, it was not possible to identify if this was the case of the occurrence.

According to reports, the owner of the aircraft, which informed when flights would happen, usually the day before, determined the activities of the pilot involved in the occurrence.

According to the other pilots who rendered service to the operator, there were no formalities related to flight planning and use of the aircraft.

1.18 Operational information.

It was not possible to obtain weight and balance data.

The pilot would perform a flight to SWNA, as a freelancer, carrying five passengers, in a private aircraft.

The take off, according to the flight plan presented, was scheduled to take place at 1145 (UTC).

It was found, through an interview with the Commander's wife, that he was called for the flight between 1000 and 1030 UTC, on the day of the occurrence and arrived at Flores Aerodrome at about 1115 (UTC).

During an interview, an *Aeroclube's* employee stated that he arrived at there at 1000 (UTC) and that the pilot arrived at 1030 (UTC). He affirmed that he followed all the pre-flight procedures with the pilot; he weighed the luggage, which totaled 60kg, and boarded the passengers, in addition to fasten the safety belts in all of them.

He also reported that the pilot himself, who became aware of the next day's flight, had fueled the aircraft, the previous day, at its maximum capacity, approximately 291 kg.

Such flight, according to the operator, would be from Flores to Apuí. During the return he would land in Novo Aripuanã, and then in Flores. At the time of refueling, the pilot was not yet aware of the number of people boarding the aircraft.

After the procedures, the pilot started the aircraft, waited for the engine to warm up for ten minutes and performed magnet and propeller tests.

According to the weighing chart, the basic weight of the plane was 925.41kg; it carried 60kg of luggage and was stocked with 291kg of fuel. The pilot and five other passengers were on board, four men being adults and one six-year-old.

The weight of the pilot, informed by his wife, was approximately 88kg. Considering 77kg for each adult passenger (estimate taken from the aircraft manual) and 20kg for the child, it is estimated that the aircraft weight was at least 1,692.41kg, with the maximum take-off weight (PMD) being 1,633 kg.

The pilot informed Manaus control that he was initially with four people on board (POB), correcting the information immediately afterwards to five people. However, the aircraft had six POBs.

Observers reported that during the take-off run, the engine of the aircraft presented a characteristic noise of power loss for a few moments; it took off near the marking (stripes) of the opposite threshold and then retracted the landing gear.

Then he began to sink, bending left until he was no longer seen. Seconds later, a pillar of black smoke was rising.

These facts were also observed with images of security cameras installed in places close to the occurrence.

1.19 Additional information.

In section 5 of the aircraft manual, there was the following take-off run graph:

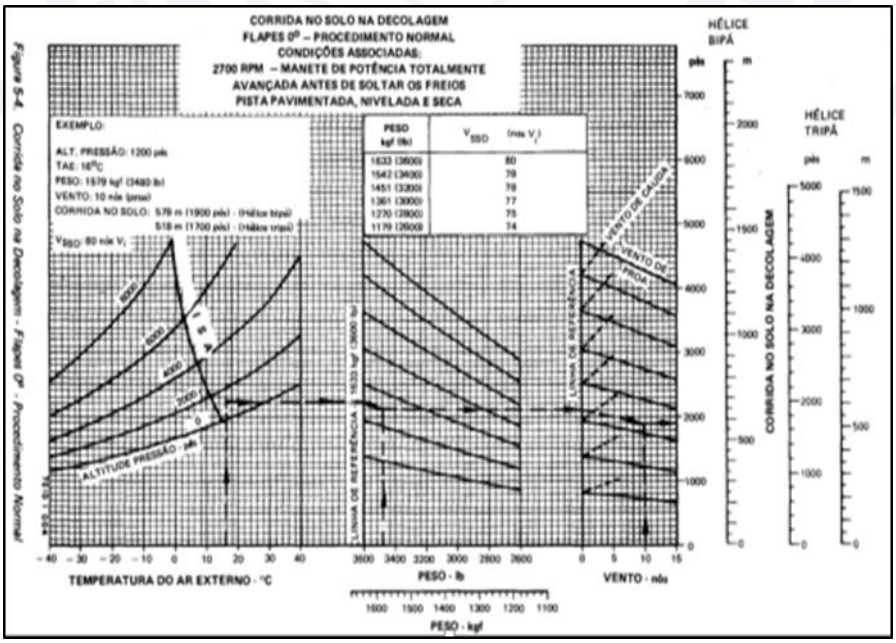


Figure 9 - Graph of running distance on the ground during take-off.

For the calculation of the takeoff distance, the conditions at the time of takeoff and the PMD were used as parameters. In this situation, the aircraft would need to travel approximately 650 meters to take off, out of a total of 799 meters available in SWFN.

ICA 100-12 (AIR RULES AND AIR TRAFFIC SERVICES) provided the following for flight planning:

> 3.4.2.1 Before starting a flight, the Commander of an aircraft shall be aware of all information necessary for the planning of the flight.
>
> 3.4.2.2 The information required for the flight referred to in 3.4.2.1, shall include at least the detailed study:
>
> a) of meteorological conditions (updated weather reports and forecasts) of the Aerodromes involved and the route to be flown;
>
> (b) of the estimated fuel for the flight;
>
> c) of alternative planning in case the flight cannot be completed; and
>
> d) of the pertinent conditions to the flight planned in AIP-BRASIL and ROTAER, as well as those disclosed through NOTAM.

In addition, on the planning, fuel calculation, RBHA 91 predicted that:

91.151 - VFR FUEL REQUIREMENTS

> (a) No person may commence a VFR flight on an airplane unless, under wind and weather conditions, there is sufficient fuel to fly to the first landing site and assuming normal cruise consumption:
>
> (1) during the day, fly over at least 30 minutes; or
>
> (2) overnight, fly over at least 45 minutes.

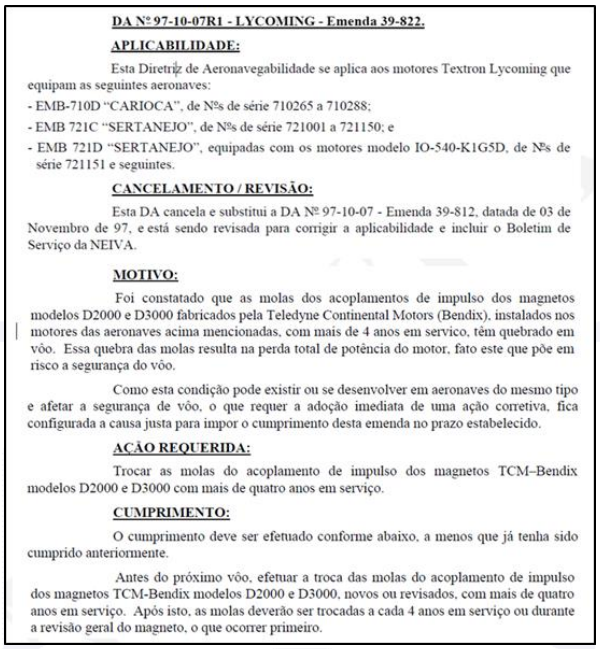
About that, the following was considered:

> (a) the flight plan prevised a flight from SWFN to SWNA, at level 045, cruising speed of 140Kt, alternating SWFN;
>
> (b) the aircraft's operator reported that on the day before the occurrence the route would be SWFN-SWYN-SWNA-SWFN;
>
> c) there was no fuel in SWNA; and
>
> d) On the day of the occurrence, the flight plan was for SWNA.

The aeronautical authority of each country issues an Airworthiness Directive (DA) after analysis of an unsafe condition in an aeronautical product that could develop in other products of the same project.

As a result of the analysis of some investigated accident or unsafe condition reported in mechanical reliability reports, service difficulties reports and flight disruption reports issued by operators; defect report or non-airworthy condition reported by maintenance shops or service bulletins and service letters issued by manufacturers, the authority issues the directive making it necessary to correct any abnormalities found.

In that sense, during the documentary investigation, it was verified that the Airworthiness Directive No. 97-10-07R1 of 15JAN1998, issued by the aeronautical authority at that time, Department of Civil Aviation (DAC), was as follows:



DA Nº 97-10-07R1 - LYCOMING - Emenda 39-822.

APLICABILIDADE:

Esta Diretriz de Aeronavegabilidade se aplica aos motores Textron Lycoming que equipam as seguintes aeronaves:

- EMB-710D "CARIOCA", de Nºs de série 710265 a 710288;
- EMB 721C "SERTANEJO", de Nºs de série 721001 a 721150; e
- EMB 721D "SERTANEJO", equipadas com os motores modelo IO-540-K1G5D, de Nºs de série 721151 e seguintes.

CANCELAMENTO / REVISÃO:

Esta DA cancela e substitui a DA Nº 97-10-07 - Emenda 39-812, datada de 03 de Novembro de 97, e está sendo revisada para corrigir a aplicabilidade e incluir o Boletim de Serviço da NEIVA.

MOTIVO:

Foi constatado que as molas dos acoplamentos de impulso dos magnetos modelos D2000 e D3000 fabricados pela Teledyne Continental Motors (Bendix), instalados nos motores das aeronaves acima mencionadas, com mais de 4 anos em servico, têm quebrado em vôo. Essa quebra das molas resulta na perda total de potência do motor, fato este que põe em risco a segurança do vôo.

Como esta condição pode existir ou se desenvolver em aeronaves do mesmo tipo e afetar a segurança de vôo, o que requer a adoção imediata de uma ação corretiva, fica configurada a causa justa para impor o cumprimento desta emenda no prazo estabelecido.

AÇÃO REQUERIDA:

Trocar as molas do acoplamento de impulso dos magnetos TCM–Bendix modelos D2000 e D3000 com mais de quatro anos em serviço.

CUMPRIMENTO:

O cumprimento deve ser efetuado conforme abaixo, a menos que já tenha sido cumprido anteriormente.

Antes do próximo vôo, efetuar a troca das molas do acoplamento de impulso dos magnetos TCM-Bendix modelos D2000 e D3000, novos ou revisados, com mais de quatro anos em serviço. Após isto, as molas deverão ser trocadas a cada 4 anos em serviço ou durante a revisão geral do magneto, o que ocorrer primeiro.

Figure 10 - Aircraft directive.

The operator of the aircraft, submitted two aircraft engine control charts for 2014 and 2016, where there were no records of compliance with the directive, and the last verified compliance record of the directive occurred in 26MAY2010, as shown in part III of the engine Logbook.

Supplementary Instruction (IS) n ° 39-001 provided that:

> 5.1 Brazilian Airworthiness Directives:
>
> The RBAC 39 establishes that all Brazilian Airworthiness Directives applicable to aircraft with Brazilian nationality and registration marks, engines, propellers and aeronautical equipment, installed or eligible for installation, are mandatory.
>
> 5.5 Impact of the non-compliance with a DA:
>
> 5.5.1 An aeronautical product with applicable DA, whether Brazilian or foreign, loses the airworthy condition at the time the deadline to meet its requirements expired, or the requirements stipulated in the text of the DA were not correctly fulfilled. This condition includes engines, propellers and other equipment, including those not installed. Consequently, an aircraft with an expired DA, including engine, propeller or components, has its certificate of airworthiness automatically suspended.
>
> 5.5.2 A DA that establishes a final action and, after a certain date or time interval, complementary actions, has a partial compliance condition between the final action and the complementary action, and this note must be duly filled out in the FCDA. However, it is important to realize that once the initial action or complementary actions are initiated, they must be finalized in their pertinent occasions, generating the corresponding FCDA, which may be another partial action, final or repetitive action. The pendency to be finalized at the correct time shall be considered a non-fulfilled DA.
>
> 5.12 Compliance Control of a DA.
>
> 5.12.1 All DAs applicable to aircraft, engines, propellers and any other aeronautical equipment must have compliance records checked, even if a certain DA product is not applicable for a particular aeronautical product. In this case, it must appear as Not Applicable, justifying the reason. For example, a DA may be applicable to a particular product but does not include certain serial numbers.
>
> 5.12.2 Effective control of DAs is mandatory. Lack of control or maintenance records proving compliance with a DA shall result in the loss of the airworthy condition, and the validity of the Airworthiness Certificate - CA of the aircraft shall be suspended. As established in RBHA 91, owners or operators are primarily

responsible for the conservation of products operating under airworthy conditions. The observance of this item is considered an indispensable condition in the demonstration to the ANAC that this responsibility is effectively exercised.

5.13 Records of compliance with a DA

5.13.2 Pursuant to section 91.403 (a) of RBHA 91, every owner or operator of an aircraft is primarily responsible for the maintenance of that aircraft under airworthy conditions. In this case, if applicable, the owner shall appeal to an Aeronautical Product Maintenance Organization, certified in accordance with RBHA 145 and with its aircraft listed in its Operational Specifications, to verify the applicability of a DA.

1.20 Useful or effective investigation techniques.

Nil.

2. ANALYSIS.

The aircraft would fly from SWFN to SWNA and the pilot and five more passengers were on board.

A few seconds after take-off, the aircraft started a descending left turn, blasting out moments after.

In view of the characteristics of the accident, the Investigation Committee found it pertinent to conduct tests and research on the aircraft engine. Evidence showed that it was operational because its internal mechanical components were intact.

However, its rotation was compatible with idle or residual rotation. This indicated that the engine did not develop power required for the flight the moment the aircraft collided with the obstacles.

There were doubts as to the operation of the magnets of the engine, since they were found carbonized, preventing any functional test or analysis of its components.

Given that, it was concluded that the power produced by the aircraft at the time of the fall was not sufficient to keep it flying, however, due to the damage caused to the engine, it was not possible to reach a concrete conclusion of the cause of the loss of power.

It was verified the existence of the Airworthiness Directive (DA) 97-10-07-R1, with application as stated in item 1.19 of this report, applicable to the aircraft object of this investigation. The directive had repeatable compliance, every four years, or during the magnets overhaul.

The owner of the aircraft submitted two aircraft engine control charts for 2014 and 2016, where there were no records of compliance with the directive. The last compliance record verified in the directive occurred in 26MAY2010, as it appears in part III of the engine logbook.

It should be noted that the failure to comply with a mandatory procedure, which may result in damages to the aircraft's airworthiness condition, consisted in a failure, regarding the organizational processes necessary for the effective control of the air activity.

Although the tests performed on the aircraft engine have not identified the actual cause of the power loss, the operator or contracted maintenance company may have contributed to the accident, since the failure of the springs of the magnetos pulse couplings could have caused the loss of power found.

On the day of the occurrence, during the communications between the pilot and the Manaus control, it was verified that he reported, twice, wrong information regarding the number of people on board.

There were divergences of information as to when the pilot learned of the 07DEC2016 flight, however, it is believed that he supplied the aircraft at its maximum capacity, taking into account its initial route. For the route to be flown, considering the alternative plus 30 minutes of flight, approximately 235kg of fuel was needed (conservative calculation).

If only the fuel needed to meet the route and reach the alternative were taken into account, approximately 210kg would be needed. On the day of the occurrence there was change in the route, the pilot would make SWFN-SWNA-SWFN. In that case, the fuel needed would be even smaller.

The weight of the aircraft to comply with the flight was not correctly observed. The weight of the passengers, pilot, luggage and fuel, added to the basic weight of the aircraft, were estimated at 1,692.41 kg. The Maximum Take Off Weight (PMD) stipulated for the aircraft in the operation manual, and according to the equipment-weighing sheet was 1,633kg. Therefore, it was estimated an excess weight of at least 59.41 kg.

In the event of a possible low altitude engine flight failure, this excess could influence the performance of the aircraft in maintaining an adequate glide ratio, taking into account the speed predicted for such a procedure, in order to have time for an emergency landing.

It could also be concluded that overweight would require a greater distance to be able to take off safely, which was confirmed by observers who saw the aircraft leaving the ground very close to the opposite threshold.

Although the weight of the aircraft did not have a direct cause-effect relationship with the accident, the decision to take a takeoff above the permitted limits signaled an inadequate assessment of the risks involved in that operation. This behavior may have been influenced by pilot acquired habits in relation to flight planning, which compromised its quality and, consequently, the safety.

On the day of the occurrence, when he became aware of the number of people he was going to carry, he proceeded on the flight without making any modifications to his previous planning, despite the excess weight of the aircraft caused by such circumstances.

According to the reports obtained, the pilot was considered organized, judicious and experienced. However, despite the perception of such characteristics, the decision to perform the flight under conditions that compromised the safety indicated a compliant attitude towards the risks in that air operation.

The knowledge acquired by the pilot, due to his professional experience and self-confidence in relation to the flight procedures, may have influenced his permissive attitude, favoring the flight in conditions that diverge from the predicted parameters.

Also, the proximity between the pilot and the operator, which favored the adoption of informal practices, may have contributed to this attitude. In this context, the absence of a formal employment relationship, the expectation of being promoted and the interest in remaining active in the air activity, may have raised the motivation of the pilot, leading to an uncritical assessment of the flights that he performed.

As far as the organizational context was concerned, there were no processes formally established by the operator to manage the air activity. This fact, together with the use of freelancers, made it impossible to use a supervision system that would allow to assess and correct possible malfunctions in relation to the management of the aircraft and the performance of the pilots.

Thus, the permissiveness that prevailed in that operational context, characterized by the absence of orientations directed to the conduct of the pilots, can be considered a

weakness that could compromise the adhesion to the formal rules of operation and the principles of action directed to the flight safety culture.

3 CONCLUSIONS.

3.1. Facts.

a) the pilot had valid Aeronautical Medical Certificate (CMA);

b) the pilot had valid MNTE and MLTE Technical Qualifications;

c) the pilot was qualified and had experience on that kind of flight;

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

e) it was not possible to verify if the aircraft was within the limits of weight and balance;

f) the airframe and propeller logbook records were updated;

g) the engine logbook records were not updated

h) the meteorological conditions were favorable to the accomplishment of the flight;

i) the aircraft started a downward left turn a few seconds after take-off;

j) the aircraft crashed into a tree and then into the ground, exploding;

k) the evidence found in the propeller denoted that the engine was at low rotation, compatible with idle or residual rotation, at the moment of impact;

l) the aircraft was completely destroyed; and

m) the pilot and four passengers perished on the site. One passenger died later, in the hospital.

2.1 Contributing factors.

- **Attitude - undetermined.**

The accomplishment of the flight in different conditions of the predicted parameters, with probable excess weight in the take-off, indicated a complacent attitude on the part of the pilot. This attitude may have been influenced by overconfidence in relation to flight procedures, motivation for air operations, and enhanced informality through the relationship established with the aircraft owner.

- **Aircraft maintenance – undetermined.**

Due to the characteristics of the accident, it was not possible to identify the reason for the loss of engine power; however, there was a failure to comply with the applicable Airworthiness Directive, which may have contributed to this failure.

- **Motivation - undetermined.**

The absence of a formal employment relationship, coupled with the expectation of a promotion, may have raised the pilot's motivation for the air activity, to the point of disfavoring a more careful evaluation of the flights that he performed.

- **Flight planning – undetermined.**

The planning for the operation of the aircraft was inadequate, since the pilot completely fuelled the aircraft the previous day, without knowing the amount of passengers that would embark on the flight the following day. This may have influenced the glide of the aircraft and impaired the choice of a location more suitable for forced landing.

- **Decision-making process – undetermined.**

The decision to fly the aircraft probably outside the manufacturer's weight parameters, disregarding a possible engine failure during take-off, reflected an inadequate judgment regarding the risks involved in that operation, which may have contributed to the occurrence.

- **Interpersonal relationship – undetermined.**

The relationship between the pilot and the aircraft owner may have favored informality in relation to flight planning procedures and contributed to a compliant attitude on the part of the pilot regarding the risks involved in that air operation.

3. SAFETY RECOMMENDATION.

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

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

Recommendations issued at the publication of this report:

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

A-162/CENIPA/2017 - 01 **Issued on 11/07/2018**

Act together with *Tiarte Comércio e Manutenção*, in order to check the conformity of the maintenance actions performed by such organization, especially with respect to the compliance with the Airworthiness Directive No. 97-10-07R1 of 15JAN1998 (or of another that comes to replace it).

A-162/CENIPA/2017 - 02 **Issued on 11/07/2018**

Disseminate the lessons learned in the present investigation, in order to alert pilots, operators and maintainers of civil aviation about the importance of faithful compliance with what is included in the technical documentation (manuals, reviews, bulletins, guidelines, etc.) of aircraft operating in Brazilian territory, especially with respect to Airworthiness Directive No. 97-10-07R1 of 15JAN1998 (or any other that may replace it).

4. CORRECTIVE OR PREVENTATIVE ACTION ALREADY TAKEN.

Nil.

On November 7th, 2018.