COMANDO DA AERONÁUTICA

CENTRO DE INVESTIGAÇÃO E PREVENÇÃO DE ACIDENTES AERONÁUTICOS

FINAL REPORT
A - 605/CENIPA/2014

OCCURRENCE:	**ACCIDENT**
AIRCRAFT:	**PR-CRR**
MODEL:	**T206H**
DATE:	**20 APR 2012**

NOTICE

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

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

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

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

This Report does not resort to any proof production procedure for the determination of civil or criminal liability, and is in accordance with item 3.1, Annex 13 to the 1944 Chicago Convention, which was incorporated in the Brazilian legal system by virtue of the Decree nº 21713, dated 27 August 1946.

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

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

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

SYNOPSIS

This is the final report of the 20 April 2012 accident with the T206H aircraft, registration PR-CRR. The accident was classified as “engine failure in flight”.

Approximately two minutes after takeoff, the pilot made his last radio contact, reporting a technical problem. The aircraft was found in the same morning in a thicket area, at a distance of about 7 km from SBMQ.

The aircraft was destroyed in the crash.

Both aircraft occupants perished in the crash site.

An accredited representative from the National Transportation Safety Board – NTSB (USA) was designated for participation in the investigation.

CONTENTS

GLOSSARY OF TECHNICAL TERMS AND ABBREVIATIONS

ANAC	Brazil's National Civil Aviation Agency
APP-MQ	Macapá Approach Control
CENIPA	Aeronautical Accident Investigation and Prevention Center
CHE	Enterprise Homologation Certificate
CHT	Technical Qualification Certificate
CIAA	Aircraft Accident Investigation Commission
CIV	Pilot's Flight Logbook
CMA	Aeronautical Medical Certificate
FIAM	Annual Maintenance Inspection Sheet
GDU	Garmin Display Unit
IAM	Annual Maintenance Inspection
IFRA	Instrument Rating – Airplane category
METAR	Routine Aerodrome Weather Report
MFD	Multifunction Display
MNTE	Airplane, Single-Engine, Land - ASEL
PFD	Primary Flight Display
PPR	Private Pilot License – Airplane category
RBHA	Brazilian Aeronautical Certification Regulation
SACI	ANAC's Civil Aviation System
SBMQ	ICAO location designator – Macapá Airport
SBSN	ICAO location designator – Santarém Airport
SERIPA	Regional Aeronautical Accident Investigation and Prevention Service
SIPAM	Amazon Protection System
SIPAER	Aeronautical Accident Investigation and Prevention System
TPP	Private Public Transport Aircraft Registry
TWR-MQ	Macapá Control Tower
UTC	Universal Time Coordinated

1. FACTUAL INFORMATION.

Aircraft	**Model:** T206H **Registration:** PR-CRR **Manufacturer:** *Cessna Aircraft*	**Operator:** *MTR Gonçalves – ME*
Occurrence	**Date/time:** 20APR2012 / 08:54 UTC **Location:** *Sítio Jardim América* **Lat.** 00°00'27"N **Long.** 051°08'01"W **Municipality – State:** *Macapá – Amapá*	**Type(s):** System/Component failure.

1.1 History of the flight.

At 08:48 UTC, the aircraft departed on a passenger transport flight from SBMQ, destined for SBSN, with the pilot and a passenger on board.

About two minutes after takeoff, the pilot reported a technical problem, and radio contact was subsequently lost.

The aircraft was found in the same morning in a thicket area at a distance of approximately 7 km from the airport of departure. It had been entirely consumed by fire.

1.2 Injuries to persons.

Injuries	Crew	Passengers	Others
Fatal	1	1	-
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.

Hours Flown	
	Pilot
Total	Unknown
Total in the last 30 days	Unknown
Total in the last 24 hours	00:00
In this type of aircraft	Unknown
In this type in the last 30 days	Unknown
In this type in the last 24 hours	00:00

N.B.: It was not possible to locate the Pilot's Flight Logbook.

1.5.2 Professional formation.

The pilot did his Private Pilot (PPR) course (airplane category) at the *Aeroclube de Mogi das Cruzes*, State of *São Paulo*, in 1990.

1.5.3 Category of licenses and validity of certificates.

The pilot held a Private Pilot License (Airplane category), and a valid MNTE (Airplane, Single-Engine, Land) Technical Qualification certificate.

1.5.4 Qualification and flight experience.

The pilot was not IFR-rated, and did not have experience for the conduction of the flight in question.

The latest revalidation of his license was made by means of verification of his flight-hour records, in accordance with the Brazilian Aeronautical Homologation Regulation (RBHA) 61, item 143, letter (b), and, therefore, without a checkride with an ANAC accredited examiner.

1.5.5 Validity of medical certificate.

The pilot held a valid Aeronautical Medical Certificate (CMA).

1.6 Aircraft information.

The high wing single-engine T206H aircraft (SN20608845) was manufactured by Cessna Aircraft in 2008, and was registered in the Private Air Services category.

Its Airworthiness Certificate was valid.

The maintenance records were provided by the *Sete Táxi Aéreo Ltda* Workshop (CHE 8798-02/ANAC). On the occasion, the commission verified (by means of the Annual Maintenance Inspection Form) that the aircraft underwent the Annual Maintenance Inspection at the aforementioned workshop on 20 April 2011, when the airframe, engine and propeller had a total 476 hours and 54 minutes of flight. In this same period, the aircraft engine was subjected to the 10-, 25-, 50-, 100-, and 400-flight hours' periodical inspections.

The Inspection and Component Control Map made on 27 June 2012 and issued by the *Sete Táxi Aéreo* company showed that the aircraft airframe, engine, and propeller had 556 and 24 minutes of flight since 22 November 2011, suggesting that the aircraft had not flown in the period between November 2011 and June 2012, but there is a higher probability that the logbooks were not updated on the date the map was made. On this occasion, the aircraft also underwent the 10-, 25-, and 50-hours periodical inspections.

The commission was not able to collect the other records concerning the aircraft, engine and propeller, as well as the total aircraft flight hours until the time of the occurrence, since the logbooks were aboard the accident aircraft and were consumed by the post-impact fire.

The PR-CRR instrument panel had digital screens, and consisted of the *Primary Flight Display* (PFD), the *Garmin Display Unit* (GDU), relative to the G-1000 (*Garmin*) navigation system, and the *Multifunction Display* (MFD). Such screens provided information of the flight instruments, navigation, and aircraft engine (figure 1).

On account of the level of destruction, it was not possible to accurately calculate the weight of the aircraft at the moment of the accident, but the investigation commission made an estimate, and the aircraft seemed to be within the weight and balance limits established by the manufacturer.

Figure 1 – Example of a digital panel utilizing the G-1000.

1.7 Meteorological information.

The meteorological information relative to the region of *Macapá* on the day of the occurrence was analyzed by the *Belém* Regional Center (CR/*Belém*) of the Amazon Region Protection System (SIPAM).

The report issued by CR/*Belém* was conclusive in pointing out that the prevailing atmospheric conditions near SBMQ and the crash site were adverse, with strong instability and presence of cumulonimbus and stratocumulus clouds, associated with the base of the convective nebulosity. Since 08:00 UTC, there had been BKN cloud coverage, with occurrence of thunderstorm in the area surrounding the airport, with low altitude nebulosity.

At 09:00 UTC, the cloud ceiling in the region was 700 feet (about 200 meters), and there was light rain on the aerodrome and in the vicinity. According to the METAR, the weather conditions got worse from 10:18 UTC onwards, with a new episode of light rain and thunderstorm on the aerodrome, ceiling 500 feet, and visibility of 3,000 meters.

The weather radar of *Macapá* detected the presence of a thunderstorm formed by convective build-ups moving from east to west in the south sector of the aerodrome. The most intense convective cells were at a distance of about 10 km from the aerodrome in the period between 08:32 and 08:57 (UTC). This system generated low latitude nebulosity and light rain without significant reduction of horizontal visibility, although the ceiling was below the limits for VFR flights.

The commission found out that the weather information was available to the pilot at the moment of his departure from SBMQ.

The transcript of the communications with the control unit shows that SBMQ was operating VFR at the moment of the PR-CRR departure.

1.8 Aids to navigation.

Nil.

1.9 Communications.

The two-way radio communication between the aircraft and the ATC units was uneventful until two minutes after takeoff, when the pilot made his last radio contact, which was discontinued for unknown reasons.

1.10 Aerodrome information.

Not applicable.

1.11 Flight recorders.

Neither required nor installed.

1.12 Wreckage and impact information.

The T206H Cessna aircraft was found later in the morning in a thicket area at a distance of approximately 7 km (3.9 NM), on the 235º radial of SBMQ. It was completely destroyed on account of collision with trees and post-impact fire.

The aircraft first struck a tree and then crashed into the ground at a pitch-down angle of 30º in a 332º direction, apparently with level wings. On account of the impact, aerodynamic structures and control surfaces were broken, with the aircraft debris spreading in a linear fashion

Figure 2 – Wreckage in the crash site.

Due to the high level of energy of the impact against the ground and post impact fire, it was not possible to collect more detailed information on the position of the aircraft controls, electric and electronic components, and personal safety equipment, since the aircraft was totally destroyed (Figure 2). Nevertheless, the engine and the propeller were removed from the crash site and taken to a certified workshop for analysis.

The engine components, as well as the fuel (injection) and ignition systems were consumed by the fire, a fact that hindered the realization of performance tests.

1.13 Medical and pathological information.

1.13.1 Medical aspects.

No evidence was found that problems of physiological nature or incapacitation could have affected the flight crew performance.

1.13.2 Ergonomic information.

Nil.

1.13.3 Psychological aspects.

The pilot was also owner of the aircraft, and had done his pilot course in São Paulo in the 1990's. He had begun to fly more frequently in the last seven years, when the bought his first plane. He very much enjoyed the aviation activity, which he considered "easy".

He was a medical doctor, having graduated in Medicine in the State of São Paulo. He had already worked as a medical surgeon and forensic doctor, but had been more involved with politics lately, in his third term as a state representative in the State of *Amapá*.

The pilot was seen by his peers as a determined person, who would, at certain moments, exhibit an aggressive style in dealing with people. He liked to make a boast of his skills and, also according with his mates, was unconcerned with flight safety. Sometimes, he was even aggressive in his personal relationships. He used to be authoritarian and demanding towards his subordinates.

Family members described him as an extrovert person, who would fight for his ideals, and who had good relationship with his relatives, although he preferred to stay at a distance. They also considered him a stubborn person for whom it was hard to accept other people's opinions. He was seen, at times, as an impatient, anxious and stressed person.

His aviation colleagues' opinion was that he did not possess technical skills for flight, since he did not have much practice, did not master weight and balance calculation, or analogical equipment. On the other hand, he mastered the airplane digital system, on which he had done a course in the USA. They thought he relied too much on it.

He would usually ask another pilot to do the planning and navigation for him, since he had lacked knowledge about them. The airplane maintenance control was under the responsibility of a friend of his (also a pilot).

He would many times takeoff from an aerodrome operating IFR, although he was not IFR-rate. He believed that his airplane was prepared to endure adverse conditions. Colleagues said that they had warned him of the risks he was facing in aviation, such as planning direct flights even knowing that the fuel endurance was not enough, but he did not like to take such advice.

According to accounts, the pilot used to fly very high, without weather radar, and without being aware of the meteorological conditions for the flight. He would not do the checklist reading or observe basic aspects of the flight. There had already been occasions on which he landed at a destination which was not the one he had declared. He had already been object of a search by the SALVAERO (search and rescue organization) for failing to land at the declared destination.

He would not do regular training with accredited instructors or even emergency training. He had informal training with a pilot, an acquaintance of his, but they never trained emergencies.

The accident flight took off before the sunrise, and the pilot was not IFR-rated. According to witnesses, the sky was still dark and the pilot was highly motivated for the flight in the company of a female passenger, with which he was said to have an affair.

According to information collected, the pilot, just after having purchased the aircraft, had an incident in a landing attempt followed by a go-around, a maneuver that resulted in a broken auxiliary landing gear. In 2010, when the airplane had approximately 100 flight hours, he had a serious incident in *Macapá*, State of *Amapá*, after loading the aircraft with too much weight in the rear. It is worth pointing out that neither incident was reported to the SIPAER.

1.14 Fire.

The fire started after the impact with the ground. The combustion material was the aircraft fuel, and the ignition source was probably created by the friction of the airframe with the ground.

1.15 Survival aspects.

Nil.

1.16 Tests and research.

The Lycoming TIO-540-AJ1A engine (SN L-13023-61E) was disassembled by SERIPA I investigators for visual inspection of the internal parts.

The opening of the engine revealed the presence of a retaining ring and a washer which were loose inside the oil sump of the engine carter (Figures 3 and 4). The oil sump had a fracture on its base.

Figure 3 – Oil sump.

Figure 4 – Ring and washer found loose in the oil sump.

When the lid of the accessories' control gears was opened, one verified that the external retaining gear (PN STD-1737) was not in the fit located in the shaft PN 72246 (Shaft, fuel pump idler) of the gear assembly (PN 71664), which was out of its position. In such situation, the referred gear would not have control over the mechanic fuel pump (Figures 5 and 6).

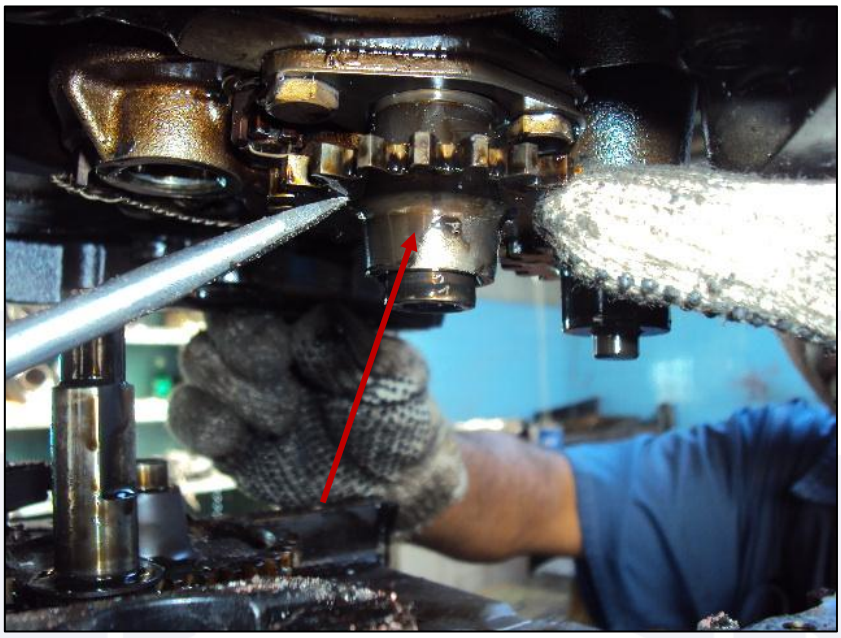

Figure 5 - Shaft (P/N 72246) without the retaining ring.

According to the Lycoming Parts Catalog PC-315-12 (pages 1-11 and 1-12), the PN 71664 gear transmits the rotation movement of the crankshaft by means of the control gear of the accessories for activation of the fuel pump (Figure 6).

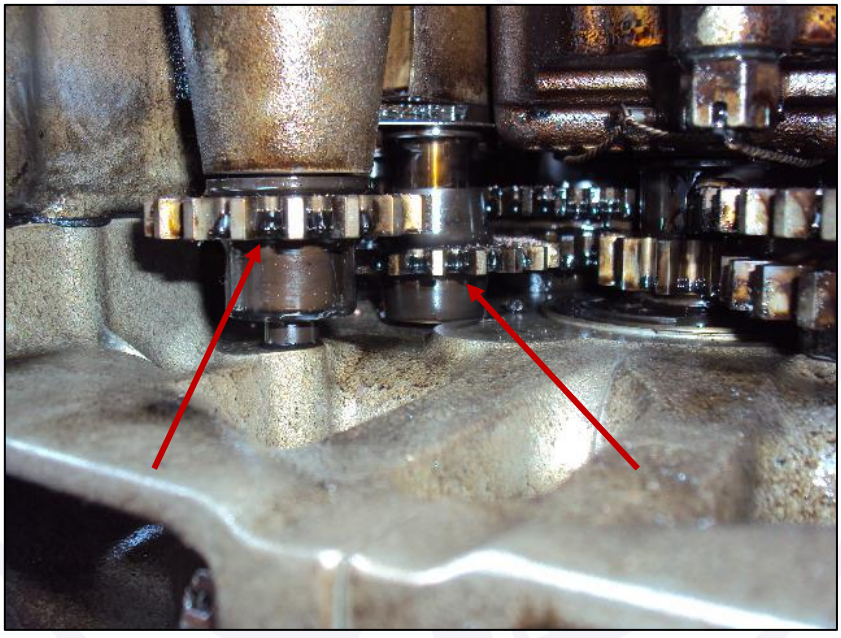

Figure 6 - Gear P/N 71664 out of position and misaligned with the fuel pump control gear.

The retaining ring (P/N STD-1737) holds the gear in the proper fitting position relative to the other three gears to maintain the movement of the mechanical fuel pump shaft.

In a correct assembly, in accordance with the Lycoming PC-315-12 (page: 1-11), there is, between the retaining ring and the gear, a spacing washer (Washer, fuel pump idler thrust, P/N 70474) with an internal diameter of .625 in. One verified that this spacing washer was not in the shaft P/N 72246 (Figure 5), nor was it found in the interior of the engine.

After measuring the washer found in the sump, one verified that it was another type of spacing washer with a smaller diameter (.5 in)

Upon examining the retaining ring PN STD-1737, one verified that it had irregular wear on one of the faces (Figure 7).

Figure 7 - *External retaining ring* (P/N STD-1737) with marks of rubbing.

The Lycoming accredited representative appointed by the National Transportation Safety Board was consulted with the purpose of identifying the washer found in the engine oil sump and report on the possible discrepancies encountered.

The washer was identified as the "Washer, retaining shaftgear (P/N 77708), item no. 13, described in the Lycoming Parts Catalog PC-315-12 (TIO-540-AJ1A), pages 2-9 and 2-10, belonging to the *turbo scavenge and hydraulic pump component* (DRIVE ASSY) P/N 29A22457 (Figure 8).

The referred pump was disassembled for verification, which confirmed that the item "Washer, retaining shaftgear" (P/N 77708) was missing.

Still during the disassembly of the *turbo scavenge and hydraulic pump*, a fracture of the item P/N MS16562-28 (PIN, 3/32 dia. X 3/4 long, slotted – described in the Lycoming Parts Catalog PC-315-12 [TIO-540-AJ1A], pages 2-9 and 2-10) was observed close to the structure of the "Shaft, Hydraulic pump drive" (P/N 29E22367), as can be seen in Figures 8 and 9.

The item PIN (P/N MS16562-28) has the function of blocking the "Washer, retaining shaftgear" (P/N 77708) so as to maintain the position of the "Shaftgear, Hydraulic pump drive" (P/N 29H22368), item no. 12, page 2-10 of the Parts Catalog PC-315-12.

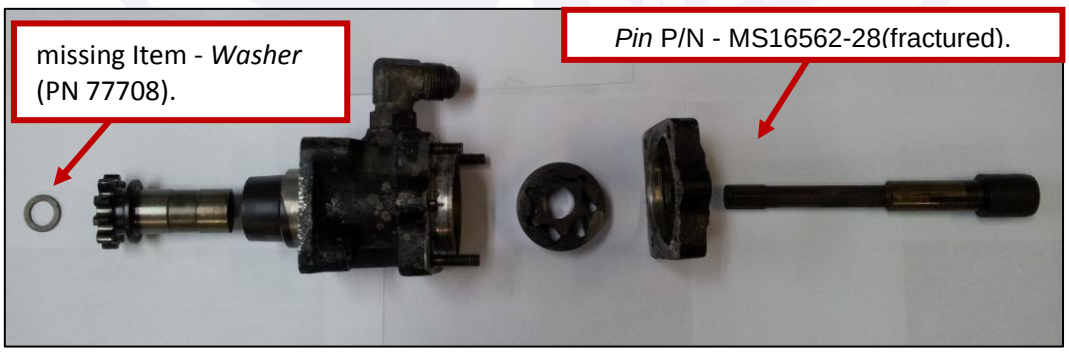

Figure 8 - *Turbo scavenge pump and hydraulic pump* disassembled. The WASHER (P/N 77708) was not installed. In the picture above, it is shown just for purposes of illustration.

The fractured part of the item PIN (P/N MS16562-28) was not located, and the part that remained inside the item “Shaft, hydraulic pump drive” (P/N 29E22367) sustained kneading that hindered the analysis of the type of fracture.

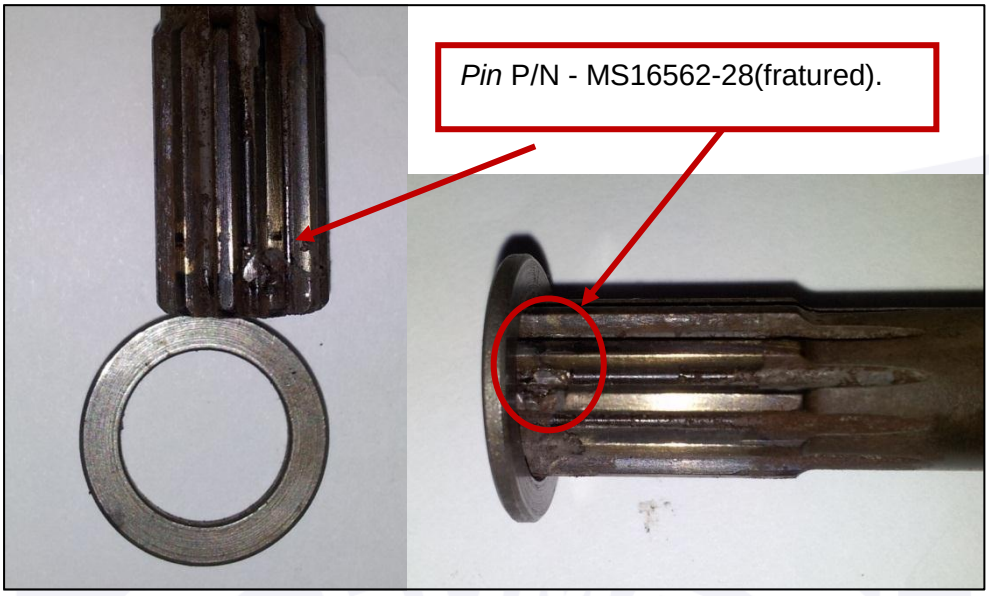

Figure 9 - *3/32 dia. x 3/4 long, slotted PIN,* (P/N MS16562-28) fractured.

The investigation found out that there were no maintenance services or inspections programmed for the components which showed discrepancies when examined, namely, the “turbo scavenge and hydraulic pump” (DRIVE ASSY), PN 29A22457, and “Shaft, fuel pump idler” (PN 72246).

The B3D36C432 McCauley propeller, S/N 08193 (Figure 10), was also examined. The exam led to the conclusion that it initially collided with a tree, resulting in its separation from the engine and fracture of the cube.

One of the propeller blades was fractured due to pressure in the direction of the longitudinal axis of the blade (from the root to the tip of the blade). It was broken into three parts, and the middle part was missing (Figure 11). The other blades were not fractured.

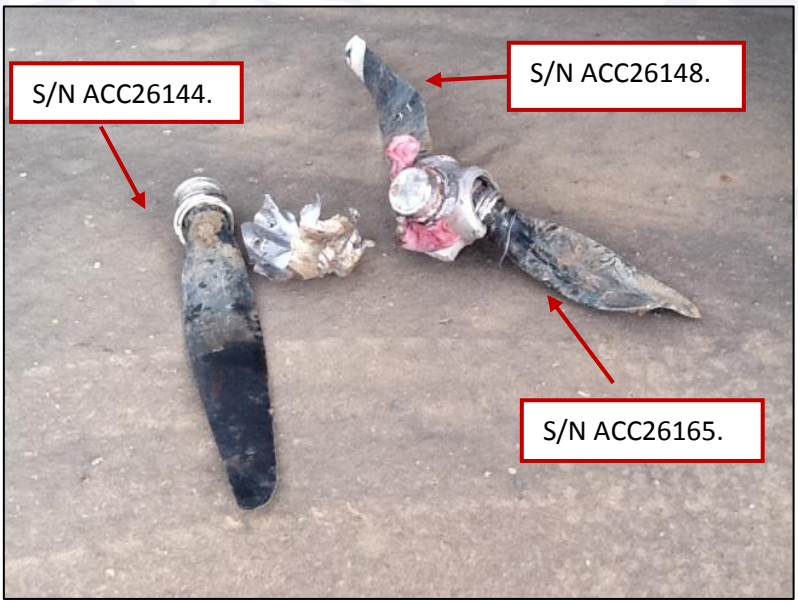

Figure 10 – Propeller blades.

An analysis revealed that the blades of the McCauley propeller (SN 08193) struck the ground either at slow rotation or even with no rotation at all.

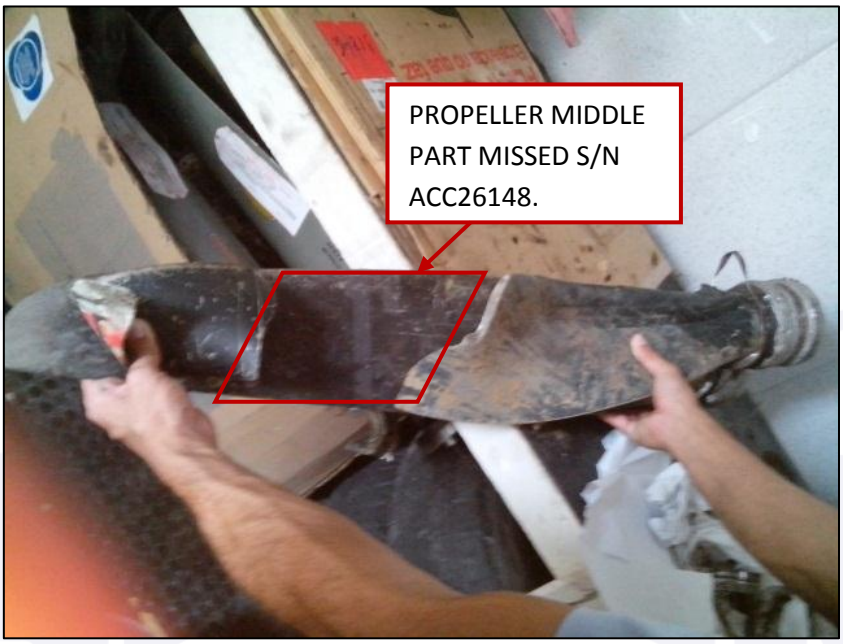

Figure 11 – Fractured propeller blade.

1.17 Organizational and management information.

Nil.

1.18 Operational information.

The pilot operating the Cessna T206H in the accident flight was also owner of the aircraft.

On the day before the accident, he filed a VFR flight plan at 21:48 UTC. The estimated time of departure, according to the plan, was 09:00 UTC of 20 April 2012. The flight level requested was FL105, and the destination was *Santarém*, State of *Pará*.

On the morning of the 20 April, the aircraft took off before the sunrise although the flight was supposed to be conducted according to visual flight rules. The transcript of the communications between the aircraft and *Macapá* Control Tower (TWR-MQ) shows that the actual time of departure was 08:48 UTC, and the aircraft took off from the runway 26.

According to information provided by the SBMQ AIS office, the sunrise on the day of the accident took place at 09:19 UTC.

Approximately two minutes after takeoff, the pilot called *Macapá* Control (APP-MQ) to inform that he was having a technical problem. This was the last information provided by him, since his transmission was discontinued on account of an unknown reason.

According to the APP-MQ radar re-run, the first radar detection of the aircraft was obtained when the airplane was at .5 nautical miles from SBMQ soon after departure, and the last detection was obtained when the PR-CRR was on the 253º radial at 6.1 nautical miles from SBMQ (approximately 2 minutes and 51 seconds after the first detection), and between one minute and one minute and thirty seconds after the last transmission (Figure 12), because the times registered in the radar re-run and in the ATC/PR-CRR aircraft communication transcript were not synchronized.

The Cessna T206H aircraft was found in the same morning in a thicket area at a distance of approximately 7 km (3.9 NM) on the 235º radial of SBMQ.

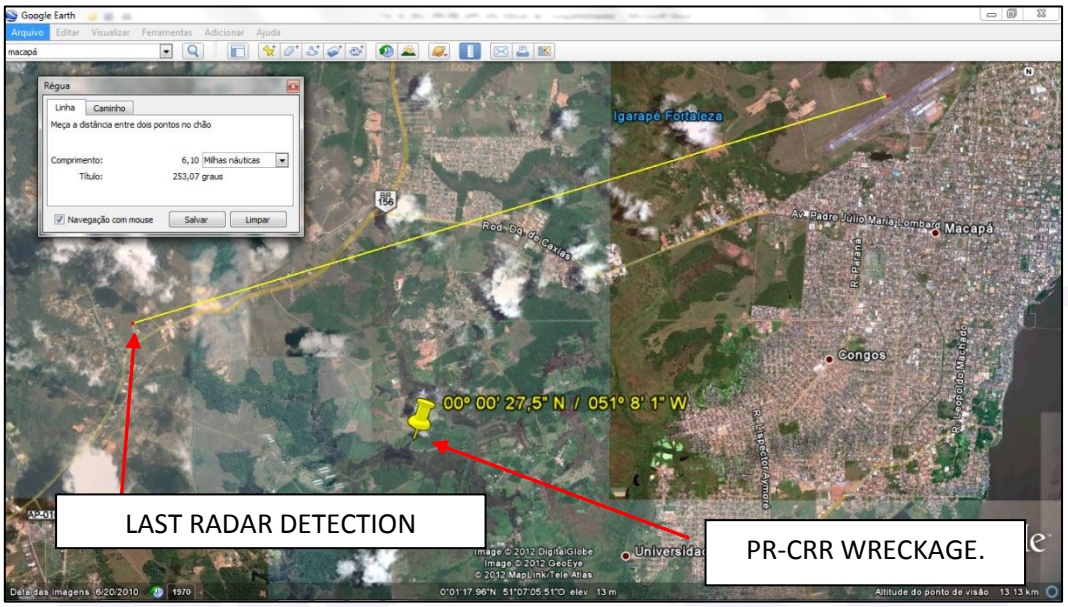

Figure 12 - Position of the last radar detection and location of the aircraft wreckage.

1.19 Additional information.

According to the prescriptions of the ICA 100-12/2009 (*Rules of the Air and Air Traffic Services*), the pilot-in-command of an aircraft had to be aware of all the information necessary for the planning of the flight, as well as of the weather conditions (updated meteorological reports and forecast) affecting the aerodromes along the route to be flown.

The same ICA stated that the ATS units had to consider, on the occasion of flight plan submission, that the conditions verified by the pilot-in-command were in accordance with the requirements of the legislation in force for the type of flight in question.

This ICA, in its item 5.3.2, letter “a” (*Requirements for the conduction of night-time VFR flights*), prescribed that the pilot had to be IFR-rated, since the destination declared in the flight plan was an airport outside the Macapá terminal control area and, taking into account the aircraft cruise speed, the segment to be flown in the night-time period would reach a point located 40 nautical miles beyond the boundary of the referred terminal area.

The ICA 100-11 (*Flight Plan*) stated that, for the planning and preparation of the flight plan, the pilot had to be aware and consider the pieces of aeronautical and meteorological information associated with the flight in question, as required by the Rules of the Air.

In relation to the Flight Plan clearance, there is an ANAC system known as DCERTA, whose procedures are detailed in the ICA 63-27 (*AIS operators procedures related to the DCERTA*). This system was established as an integral part of the Operational Safety Risk Management prescribed in the Civil Aviation Operational Safety Program (PSO-BR). It operates in conjunction with the AIS Automated System of the SISCEAB, aiming at verifying and monitoring both aircraft and technical crews’ compliance with the rules in force.

The AIS Office operator was not required to have technical knowledge on the reasons for the restrictions affecting the flight, since the established rules were part of the DCERTA system functionalities made available at the AIS offices.

In accordance with this system, if a pilot lacked a given qualification (such as, for example, IFR rating) and filed a flight plan which required the pilot to be IFR-rated, the system would detect the non-conformity, and the pilot in question would be advised that the flight plan could not be accepted for that reason.

On the other hand, if the pilot possessed the required qualifications (as declared in the flight plan), the system would not detect any irregularity, and the flight plan would be accepted into the system.

The item 3.1.1 of the ICA 63-27 (*Verification of compliance*) stated that the verification of the aircraft and pilots' compliance in the AIS Office would be based on the information made available by the ANAC through the DCERTA system.

1.20 Useful or effective investigation techniques.

Nil.

2. ANALYSIS.

The aircraft was operating a passenger transport flight between SBMQ and SBSN, with the pilot and a female passenger on board. It was not possible to calculate the aircraft weight accurately, but it is estimated that it was within the weight and balance limits established by the manufacturer.

The investigation commission's conclusion was that the estimated time of departure (ETD) proposed in the flight plan filed at the AIS Office should not have been accepted, since the pilot was not IFR-rated. This was a requirement because the flight was to take place during night-time, outside of terminal area.

In addition, even considering that he pilot took off in VMC, the flight would continue during night-time as far as 40 nautical miles after leaving the *Macapá* terminal area.

The statements above become especially relevant to this occurrence, since, from the information available, one reached the conclusion that there inflight engine failure occurred approximately two minutes after takeoff. The pilot was confronted with a situation that he had not faced before, that is, engine failure during night-time under adverse meteorological conditions, and without an IFR-rating qualification.

The conclusion was based on the analyses of the aircraft power plant, which showed characteristics of lack of power at the moment of the impact.

The opening of the engine revealed a series of discrepancies. One of them was that the gear retaining ring responsible for transmitting the rotation of the crankshaft to the mechanical fuel pump was missing.

The spacing washer normally located between the retaining ring and the gear was also missing.

The absence of the retaining ring allowed the gear to move out of place, thus failing to activate the fuel pump gear, causing lack of fuel to be burnt in the cylinders.

This retaining ring was then found in the oil sump, showing irregular wear on one of the sides, suggestive of (irregular) rubbing on the gear, possibly for not having fully fitted in the shaft groove (or due to the lack of the spacing washer).

In this latter situation, the gear may not have been adjusted properly and the existing play would have caused the irregular wear and expelling of the retaining ring from the shaft groove, possibly during takeoff, when vibration is stronger.

The hypothesis that the retaining ring separated from the shaft at the moment of the impact with the ground is considered remote if one considers the aspects explained in paragraphs above.

The Investigation Commission believes that a faulty assembly of the engine may have taken place, still in the manufacturing plant, since the aircraft had less than 600 flight hours, and the components involved were not items verified in the manufacturer

maintenance program. Moreover, there were not records in the workshop responsible for the maintenance services of any type of service provided to the items mentioned above.

However, such hypothesis is not conclusive, since the aircraft logbooks were destroyed in the crash.

In addition to the retaining ring, a washer identical to the one utilized in the *turbo scavenge and hydraulic pump* component was also found in the oil sump.

After the component was disassembled, it was possible to see that the washer was missing, and that there was a fracture in the part of the shaft that holds this retaining washer close to the gear. It was not possible to determine the reason for the fracture because it had sustained kneading, leading to the conclusion that it was functioning at the moment of the engine failure.

Due to the position in which it is normally installed, the investigation commission concluded that the washer could move out of place in the *turbo scavenge and hydraulic pump* and fall into the oil sump. The most probable hypothesis is that this happened during the engine assembly, and that the *turbo scavenge and hydraulic pump* would have been working without such item.

On account of this scenario, two hypotheses were raised:

The first hypothesis suggests that the manufacturing process was a contributor to the accident due to an incorrect assembly of the referred engine, since loose items were found in the engine oil sump (namely, a spacing washer of the *turbo scavenge and hydraulic pump*, and a retaining ring of the gear responsible for transmitting movement to the mechanical fuel pump) while the spacing washer of the gear was also missing.

The second hypothesis points toward the process of maintenance as a contributor to the occurrence, and the loose items that were found in the engine would be the result of adjustments performed at the moment of testing the engine on the bench shortly after its assembly still in the manufacturing plant; or even as a result of adjustments made by the engine manufacturer at the moment of installing the engine in the aircraft for the first time.

The engine components, such as the fuel (fuel injection) and ignition systems were consumed by the fire. The hypothesis of failure of these components was not ruled out (together with engine failure in flight). However, since these components were destroyed by the fire, the conduction of performance bench tests was not possible.

In addition to the mechanical fuel pump, the aircraft was also equipped with an electrical pump which, once activated, would be able to supply fuel to the aircraft engine and allow the normal continuation of the flight.

The position of the electrical auxiliary fuel pump switch could not be verified, because of the extent of the damage caused by the impact with the ground and the post-impact fire.

From reports, the investigation commission learned that the pilot had difficulty analyzing the analogic instruments and only knew to operate the aircraft with the G-1000 (Garmin) navigation system, restricted to the normal operating procedures and tasks.

Such fact indicates a posture of excessive confidence in his own operational skills, to the extent of minimizing the risks involved in an operation in which he did not master the available instruments.

In addition to lacking knowledge on how to handle the analogic equipment of the aircraft, the pilot used to fly during night-time or under adverse weather conditions without being IFR-rated, revealing an attitude of unconcern with operational procedures.

From such context, the commission raised the hypothesis that the pilot may not have been able to accurately interpret the existing technical problem and switch on the auxiliary electrical pump as prescribed in aircraft manual.

Such mistaken response on the part of the pilot corroborates with lack of training for emergency situations, since the revalidation of his ASEL certificate was made by means of confirmation of his flight hours, in accordance with the RBHA 61.143 (b). On the occasion, he did not fly a checkride with a civil aviation examiner accredited by the ANAC.

Moreover, the pilot was neither used to following a training program nor to flying regularly, but only when it was convenient to him. In this sense, there is the hypothesis that such state of training deficiency may have contributed to the accident.

In light of the above mentioned, the pilot did not have enough training for an adequate management of the inflight emergency situation. Such lack of continued training may have degraded the performance of the pilot in dealing with the airplane failure, since he did not have knowledge for the correct identification, evaluation and action in response to the occurrence.

The investigation commission considered that the pilot's little experience, together with insufficient training for dealing with emergency situations, was aggravated by the fact that the flight was being conducted during night-time in IMC, with direct influence on the pilot's performance, as he lacked adequate knowledge for the correct identification, evaluation and action in response to the adverse condition.

3. CONCLUSIONS.

3.1 Facts.

a) The pilot held a valid Aeronautical Medical Certificate (CMA);

b) The pilot had a valid Technical Qualification Certificate (CHT);

c) The pilot was not qualified for the conduction of flights under IMC;

d) The pilot had qualification, but it was not possible to verify his flight expereince;

e) The aircraft had a valid airworthiness certificate (CA);

f) It was not possible to verify whether the airframe, engine, and propeller logbook records were up-to-date;

g) It was not possible to verify whether the aircraft was within the weight and balance limits;

h) The pilot took off on a VFR flight plan during a night-time period, destined for an airport outside of the SBMQ Terminal Control Area;

i) The AIS office accepted a flight plan containing an Estimated Time of Departure (ETD) not prescribed in the ICA 100-12/2009

j) The meteorological conditions en route were not favorable for VFR flights;

k) Two minutes after departure, the pilot reported that he was having technical problems;

l) Radio contact and radar contact with the aircraft were lost;

m) The aircraft was found in a thicket area, at a distance of about 7 km from SBMQ;

n) There was post-impact fire;

o) According to analyses, the aircraft crashed with low engine power;

p) The investigation found out that the gear train respnsible for activating the engine accessories did not have the retaining ring (P/N STD-1737) and the spacing washer (P/N 70474);

q) The lack of the retaining ring (P/N STD-1737) led to misaligment of the gears and inoperability of the mechanic fuel pump, resulting in interruption of engine feeding;

r) The aircraft was destroyed; and

s) The passenger and the pilot perished in the crash.

3.2 Contributing factors.

- **Disorientation – undetermined.**

Although the aircraft collided in an apparently level attitude, one may not rule out the possibility that the pilot, at some point, may have suffered disorientation, since visual conditions were degraded, and he was not qualified for flying under IMC.

- **Attitude – a contributor.**

The conduction of a flight during the night-time period without being IFR-rated, under bad weather conditions, and without mastering the operation of the equipment shows the pilot's overconfidence in his own operational skills, together with disregard of the prescribed procedures, minimizing the risks involved in such situation.

- **Motivation – undetermined.**

The pilot, according to reports, seemed to be highly motivated for the trip with the passenger. Such excessive stimulation for the flight may have interfered with his evaluation of the conditions involving the flight, drawing his attention to aspects away from the situation of the very flight, culminating in his premature decision to take off in conditions incompatible with his operational capability.

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

The pilot's decision to take off before the sunrise, without knowledge of the estimated time *en route* and without being IFR-rated, reflects the lack of an adequate evaluation of the information necessary for the conduction of the flight, probably reinforced by his high confidence in his own operational skills.

- **Training – undetermined.**

The lack of regular flights and emergency training may have hindered the pilot's management of the problem, since he did not have enough consolidated knowledge to assist him in accurately interpreting the adverse situation.

- **Adverse meteorological conditions - undetermined.**

All the indications suggest that, upon attempting to return to SBMQ, the meteorological conditions involving the aircraft, that is, night time, low altitude nebulosity and light rain, interfered in the operation of the aircraft, contributing to the accident.

- **Instruction – undetermined.**

In the hypothesis of a failure of the mechanical fuel pump, it is suspected that the pilot failed to switch on the auxiliary electrical pump after misinterpreting the technical problem. Such misinterpretation corroborates with his lack of training relative to emergency situations, since his ASEL qualification was revalidated with reference to the number of hours flown, without a check ride with a civil aviation examiner.

According to his peers, the pilot did not have enough training for a satisfactory management of an emergency situation in flight. Besides, he neither followed a training program nor flew regularly, but only when it was convenient for him. In this sense, a

hypothesis is raised that the characteristics of his training may have contributed to the accident.

- **Piloting judgment – undetermined.**

Considering the reports made by the pilot's peers depicting him as a poorly skilled pilot (despite being qualified to fly the aircraft), it is believed that such condition may have had an influence on his inadequate evaluation of certain aspects related to the operation of the aircraft, such as the perception and management of a technical problem, resulting in the accident.

- **Aircraft maintenance – undetermined.**

Due to the fact that a spacing washer (PN 77708) and a retaining ring (PN STD 1737) were found loose in the interior of the engine oil sump, and the fact that the spacing washer PN 70474 was not found, it is suspected that: - the adjustments made in the engine at the moment of the bench test just after the assembly of the engine still in the manufacturing plant; or - the adjustments made by the engine manufacturer while installing the engine in the aircraft for the first time - may have concurred to the loosening of the parts mentioned, resulting in engine failure and contributing to the occurrence.

- **Flight planning – undetermined.**

This may have been a factor that contributed to the occurrence, considering that the pilot prepared his flight taking into account only the meteorological conditions at the aerodrome of departure, disregarding the meteorological conditions along the intended route in the night-time period, despite the fact that he was not IFR-rated.

- **Pilot's insufficient experience – undetermined.**

Considering pilot's friends' comments concerning his little experience, and also the circumstances in which the technical problem occurred, i.e., engine failure during a night-time flight under IMC, a hypothesis is raised that the pilot's little experience may have contributed to the accident.

- **Knowledge of ATS norms – undetermined.**

The acceptance of a flight plan containing an estimated time of departure not in accordance with the rules may have contributed to the outcome of the flight, since the pilot did not have the required qualification for conducting a night-time flight outside of the terminal control area. Even so, it is not possible to establish a direct cause-effect relationship in this case, because more information would be necessary relative to the conditions encountered by the pilot at the moment of the engine failure.

- **Manufacturing – undetermined.**

A hypothesis was raised of a possible deficient assembly of the referred engine, since loose parts were found in the oil sump (namely, a spacing washer (P/N 77708) and a retaining ring (P/N STD 1737), whereas the other spacing washer (P/N 70474) was not located. These facts would have caused malfunctioning of the mechanical fuel-pump with resulting engine failure, thus contributing to the accident.

4. 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 National Civil Aviation Agency (ANAC):

A-605/CENIPA/2014 - 01 **Issued on 26/08/2016**

Evaluate the effectiveness of the DCERTA system in relation to the acceptance of flight plans without considering the pilots' qualification requirements, as well as the restrictions associated with the conduction of night-time visual flights outside of terminal area boundaries.

To Lycoming Engines:

A-605/CENIPA/2014 - 02 **Issued on 26/08/2016**

Review the process of manufacture and assembly of TIO-540-AJ1A engines, aiming to find a possible failure capable of concurring to a faulty installation of the following components: P/N STD-1737 (external retaining ring), P/N 71664 (Gear Assy, Fuel pump idler), and P/N 70474 (Washer, fuel pump idler thrust).

5. CORRECTIVE OR PREVENTATIVE ACTION ALREADY TAKEN.

None.

On august 26th 2016.